

# ASRITE

Annual Symposium on Research and Industrial Training  
of Department of Electronics

## Proceedings of Annual Symposium on Research and Industrial Training of Department of Electronics

30<sup>th</sup> April, 2015



**Department of Electronics**

Faculty of Applied Sciences

Wayamba University of Sri Lanka

Kuliyapitiya, 60200

Sri Lanka.



**Proceedings of  
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## **Foreword**

Research thrives best in university environment due to the interaction of young minds with those of the experienced. The universities are also the fountainheads for technological and scientific innovations. They are the repositories of creative knowledge. Thus, the research carryout in this department can be harnessed for developmental programmes by the states and also for the formulation of policies and in training middle and higher level human resources for development. As a state funded university it is obligatory on the part of Wayamba University to disseminate its acquired advanced knowledge and research capabilities to foster such developmental plans. Thus organizing 2<sup>nd</sup> Annual Symposium of Research and Industrial Training of Department of Electronics (ASRITE-2015) in which the undergraduates of the department who have been trained to identify, investigate, produce optimal solutions and could present latest research to an intellectual forum and share their experiences is an important event.

This publication comprises 51 research articles presented by final year undergraduate students to reflect their findings from industrial training program and the research project conducted by the department. All the articles were improved by our senior staff members of the Department of Electronics.

On this occasion I would like to express my sincere gratitude to the academic staff members in the Department of Electronics for their internal supervision and to the external supervisors from the Industry for their external supervision.

***Senior Professor C. A. N. Fernando***

Head / Department of Electronics



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# INDUSTRIAL MOTOR VIBRATION DETECTING SYSTEM FOR PREDICTIVE MAINTENANCE

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## ABSTRACT

Motor Vibration Detecting System is very important and useful tool for Predictive Maintenance in industry. The basic aim of this research study is to design a low cost device to determine the present working state or condition of the single or three phase induction motor of the industry. The idea behind that is, predicts the present working condition of the any motor by analyzing its vibration characteristics or properties. Actually, it is not measuring the vibration directly and hence the acceleration of the vibration is measured instead of the vibration by using ADXL345 accelerometer. It is measured the acceleration produced by the motor when it is running. SMT32F103 Cortex-M3 core Microcontroller collects the data of acceleration with 1000Hz sampling rate. Then the collected data set is analyzed with the Fast Fourier Transform Technique (FFT). As the result of the FFT, the magnitude of the fundamental wave form is varied with the vibration pattern of the relevant motor. The amplitude of the resultant wave form is varied in between 1 to 43 LSB and vibration frequency goes up to nearly 500Hz. So that maximum RPM can be used to monitor is 30000RPM.

**Keywords:** Predictive maintenance, Vibration Analyzing, Fast Fourier Transform

## 1. INTRODUCTION

The basic principle of predictive maintenance is to take measurements that allow for the prediction of which parts of the machine will break down and when. The Predictive Maintenance concept is the most important and useful concept for the industry which is used to predict and prevent any failures of motor based machines. Continuous monitoring identifies the onset of component failures in advance, which means that maintenance is performed only when needed. By using this approach, unexpected downtime can be reduced or eliminated and the risk of catastrophic failure is mitigated up to some extent. In this study it is developed a device to monitor the working conditions of the industrial electrical motor

especially helping for Predictive Maintenance as motors are widely used in many machines of many industries<sup>1</sup>. There are some monitoring devices commercially available at the market with unbelievable higher cost. Therefore this new proposed device will be more helpful for industry.

## 2. EXPERIMENTAL

The vibration detecting and monitoring are probably the most widely used predictive maintenance techniques with some modifications it can be applied to wide variety of rotating equipment such as motors, conveyers etc. Since the mass of the rolling elements is generally small compared to that of the machine, the velocities generated are generally small and result in even smaller movements of the bearing housing. In that case it is difficult to measure without having any device.

### 2.1. Vibration Monitoring and Analysis

Mechanical vibrating systems consist of elements such as a spring for storing potential energy, mass and inertia for kinetic energy, and damper for dissipating mechanical energy. The vibration process alternatively converts energy between its potential and kinetic forms. In its general sense the vibration is a periodic motion that repeats itself in all its details after a certain interval of time, called the period of vibration. Some energy must be replaced in each cycle of vibration from an external source to maintain the vibration.

All mechanical equipment in motion generates a vibration pole, or signature, that reacts its operating condition. This is true regardless of speed or whether the mode of operation is rotation, reciprocation, or linear motion. This motion is called periodic and harmonic and the relationship between the displacement of the mass and time is expressed in the form of a sinusoidal equation:

$$X=A \sin (\omega t) \text{ ----- (1)}$$

Where,

X = displacement at any given instant t;

A= maximum displacement;  $\omega = 2 \Pi f$ ;

f = frequency (cycles/s hertz Hz); t = time (seconds) <sup>2</sup>

Depending on the application, a wide variety of hardware options exist in the world of vibration. Actually, it's hardware requirements are depend on several factors such as speed of the machine, on-line monitoring or off-line data collection, analysis needs, signal output requirements, etc. However any vibration program or device will require a sensing device (transducer) to measure the vibration of the motor and translates that measured information into some useful electronic or digital signal. Transducers are relatively small in size and can be permanently mounted or affixed to the monitoring location periodically during data collecting<sup>1</sup>. In addition it's required a device such as PC, Microcontroller to analyze the collected data. For this study it is used ADXL345 accelerometer and STM32F103 ARM Microcontroller to sense the vibration of the motor and analyze the data obtained by sensor.

## 2.2. OPERATION OF THE SYSTEM

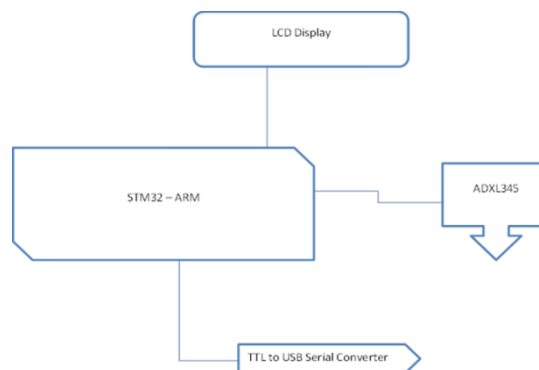


Figure 2: Block Diagram of the System

The accelerometer should be mounted on the motor and then when it running, the microcontroller collects the Time-Domain data from accelerometer and it collects data up to 1000Hz sampling rate. Then the Time Domain data is converted into Frequency-Domain data by microcontroller. Frequency-domain data are obtained by converting time-domain data using a mathematical technique referred to as a fast Fourier transform (FFT). Finally the output generated by the Microcontroller in order to results of the FFT.

The Fast Fourier Transform (FFT) is an algorithm for calculation of the Desecrate Fourier Transform DFT. It has revolutionized the modern experimental mechanics, signal and system analysis, acoustics, and paved the way for the introduction of modal analysis. The FFT algorithm applies only to signals comprising a number of elements which is equal to  $2^m$  (e.g.  $2^8= 256$ ,  $2^{10}=1024$  etc.). Its main advantage is that it significantly reduces the computation



time by a factor of the order  $m/\log_2 m$ , i.e. more than 100 times for a sample of 1024 elements. In this study, 256 elements are collected by microcontroller due to memory limitation of the Microcontroller<sup>3,4</sup>.

The procedure of FFT used in this project is illustrated in following block diagram (Figure:3).

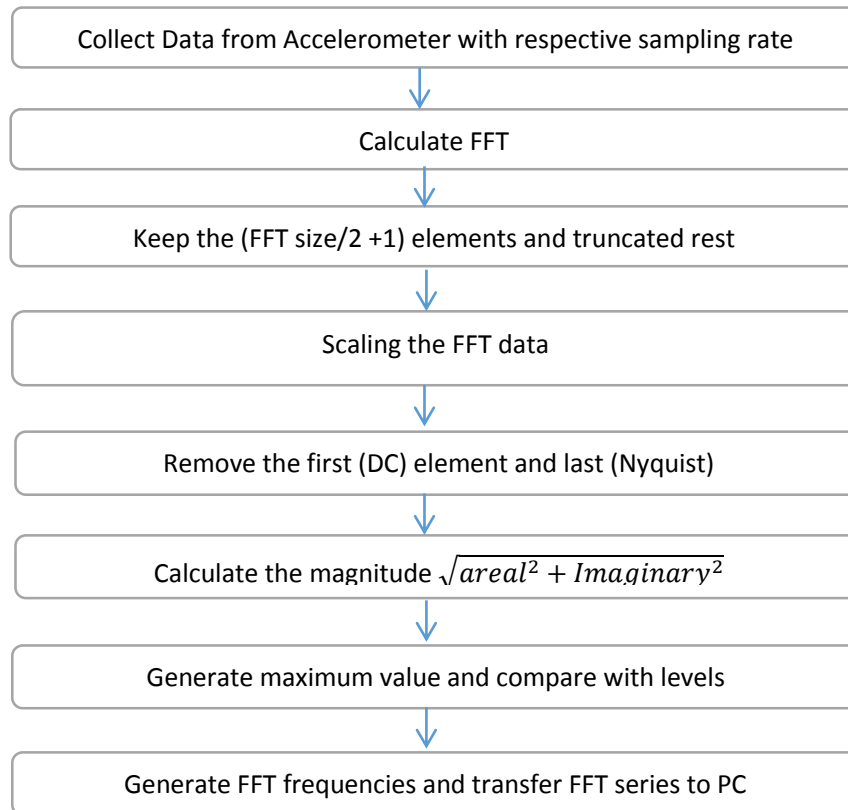


Figure 4: Algorithm for the FFT spectrum and producing a magnitude

Sampling frequency ( $F_s$ ) = 1000Hz ----- (2)

Number of Samples (NFFT) = 256----- (3)

Therefore Maximum Frequency =  $(NFFT/2 - 1) \times F_s / NFFT$  ----- (4)

Vibrating Frequency = RPM/60 ----- (5) [2]

### 3. RESULTS AND DISCUSSION

#### 3.1. Results

The idea behind that study is developing a low cost Motor Vibration Detecting System for Predictive maintenance. The expected results could be obtained by using that system.

Output magnitude range 1 to 43 LSB, and frequency range 0 to 500Hz. Therefore the maximum motor RPM in measurable frequency range should be less than 30000 RPM.

The displacement, velocity and acceleration characteristics of vibration are measured to determine the severity of the vibration and these are often referred to as the ‘amplitude’ of the vibration. In terms of the operation of the machine, the vibration amplitude is the first indicator to indicate how good or bad the condition of the machine may be. Generally, greater vibration amplitudes correspond to higher levels of machinery defects<sup>1</sup>.

FFT allows each vibration component of a complex machine-train spectrum to be shown as a discrete frequency peak. The frequency-domain amplitude can be the displacement per unit time related to particular frequency, which is plotted as the Y-axis against frequency as the X-axis. This is opposed to the time-domain spectrum, which sums the velocities of all frequencies and plots the sum as the Y-axis against time as the X-axis

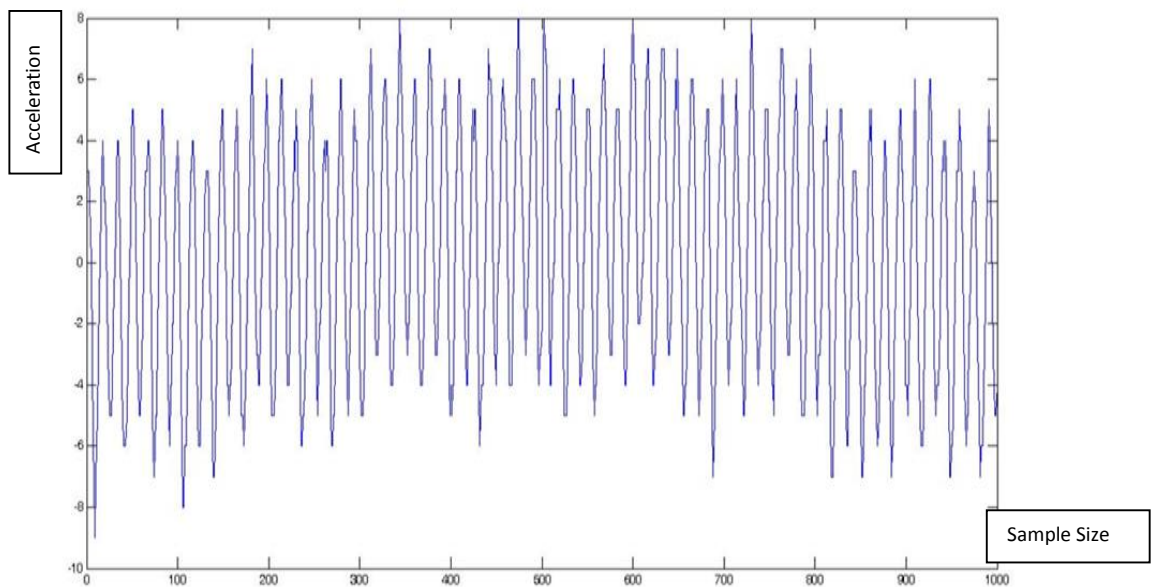


Figure 5: Variation of Time-Domain data

This figure shows the variation of 1000 acceleration samples. These values are proportional with the vibration frequency of the motor. By inspection this figure we cannot get any decision because it is same in everywhere. The following figure shows the FFT series of above data set.

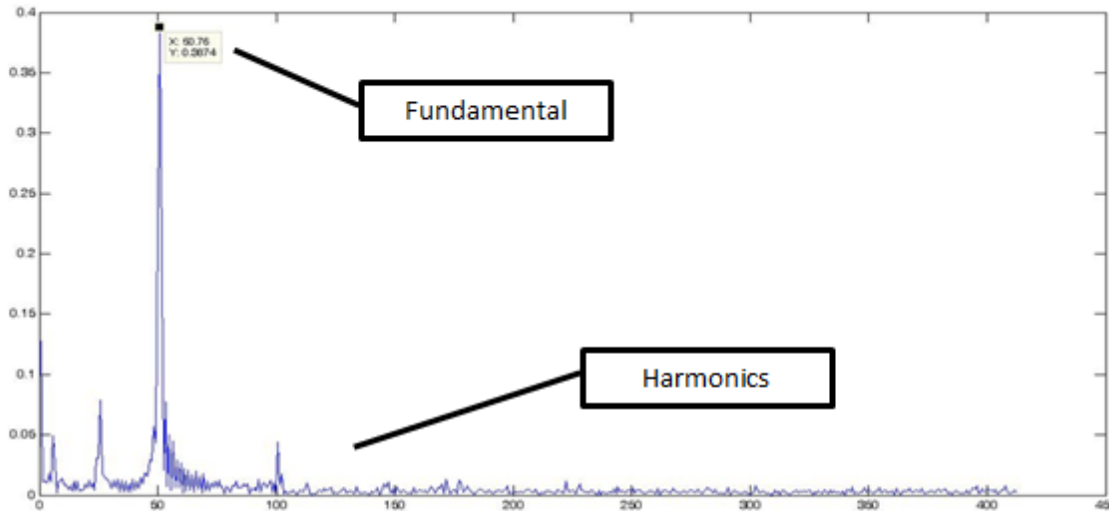


Figure 6: Fourier Series of Time-Domain data

By analyzing this figure we can clearly identify the fundamental wave and other harmonics with respective frequencies. The result from the FFT can be used to predict the current situation of the Motor because its natural vibration frequency of the motor changes automatically. So then the resulting wave pattern also changed.

Normally if there is any fault in a motor, it getting vibrate with high frequency than its natural frequency. Therefore fundamental frequency of the FFT series goes higher level. By using that change we can decide that there is a fault.

By analyzing this figure we can clearly identify the fundamental wave and other harmonics with respective frequencies. As mentioned before if there is any fault in the motor vibrates with high frequency than normal operation because that the accelerometer also vibrates with high frequency. Therefore readings of accelerometer getting high and finally the amplitude of the fundamental wave of the Fourier series is getting high. Then that change of the wave form is used to predict the current condition of the motor<sup>1, 2, 3, 4</sup>.

#### 4. CONCLUSION

For proper functioning of this device, we have to calibrate for different motors with different conditions. By connecting this device with different motors (from good to bad) we can measure the output. The by inspection those values with respective motor condition, we can predict the fault any unknown motor. After connecting sensor properly to the motor, it can be started the device. In initial state it allows you to set the fault level and warning level as well. After giving these values to the system through PC it starts the operation. It is detected any

fault indicate and inform it through indicators and alarms and pre programmable setup can be activated. Furthermore the system is going to sleeping mode. This device can be connected with a PC and set values can be entered to the device by using its software. By using that software it could be see the spectrum view of the data. Here I have used 16X2 line LCD display to show some output data. But it is impossible to show all data such as Spectrum view in this LCD Display. It is more valuable if there is a large display and if so everything can be done using that display without connecting with a PC.

### **ACKNOWLEDGEMENTS**

The author would like to acknowledge and extend gratitude to the persons who have made the completion of this research project success.

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## **DESIGNING A LOW COST TILT AND AZYMUTH ADJUSTMENT SYSTEM FOR AN ANTENNA USING A MOBILE PHONE**

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### **ABSTRACT**

The aim of this project was to design and construct a Low Cost Mobile Controlled Tilt and Azimuth Adjustment system for an antenna. This is a device which can be installed in a sector antenna at the top of a tower. Basically this device has two servo motors, a GSM shield and an arduino circuit. The two servo motors are installed to control both tilt and azimuth separately, a sim card installed in GSM shield provides the connectivity between operator and the unit. The arduino circuit was used to control the whole system. Installing a sim card in GSM shield provides unique identity for each sector antenna. C++ language was used in coding to provide a very efficient algorithm for carrying out required task.

**Keywords:** *Tilt, Azimuth, Arduino*

### **1. INTRODUCTION**

Although the existing systems available to control antennas have some failures. Some of them are designed to control antenna from the ground level of the tower using a switch. Some of the antennas are controlled manually. In both these situations there should be an operator/technical officer to adjust tilt and direction levels in to desired levels. In rainy days these operations are not possible.

When coverage optimization is carried out at desired areas, these problems arise for each network provider in Sri Lanka. Most of the times these problems are not available in foreign countries because they are having sufficient amount of investments to automate their networks. As a developing country, the providers in Sri Lanka cannot achieve that level because of the investment needed.

By considering these drawbacks, this mobile controllable low cost tilt and azimuth adjustment system was introduced.

## 2. EXPERIMENTAL

The block diagram of the designed system for low cost mobile controlled tilt and azimuth adjustment system for mobile antenna is shown in figure1.

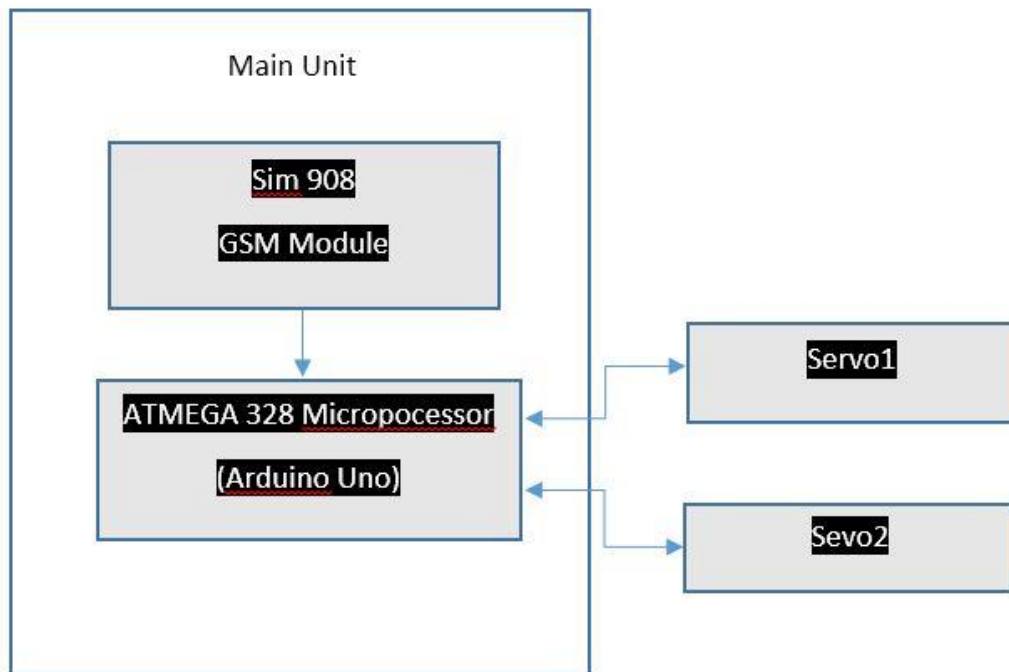


Figure 1: Block diagram of Proposed Low Cost Mobile Controlled Tilt and Azimuth adjustment system

To establish a connection between operator and the antenna sector, a sim card was installed in a GSM shield. This method was used because it enables operator to identify any antenna sector by a unique number.

The job assigned to GSM shield was to receive SMS (Short Message Service) from the operator and hand over them to ATMEGA328 Microprocessor<sup>1</sup>. The Microprocessor checks whether the messages arrived are in given format or not. If a message is in a correct format, it starts to read the message. At the reading stage of the message it identifies what the message saying. i.e. the message is to control tilt or azimuth. To achieve efficient control from the mobile phone, two servo motors are attached to the system to control both tilt and azimuth separately.

At the development stage, C++ language was used to write the code and Arduino software was used as IDE.

Tilt - Elevation refers to the angle between the beam pointing direction, and the local horizontal plane. It is the up-down angle

Azimuth - Azimuth refers to the rotation of the whole antenna around a vertical axis. It is the side to side angle. Typically the main mount bracket is loosen and the whole antenna is swing all the way around in a 360 degree circle<sup>2</sup>

### 3. RESULTS AND DISCUSSION

The circuit diagram of the designed system is given in figure no 02.

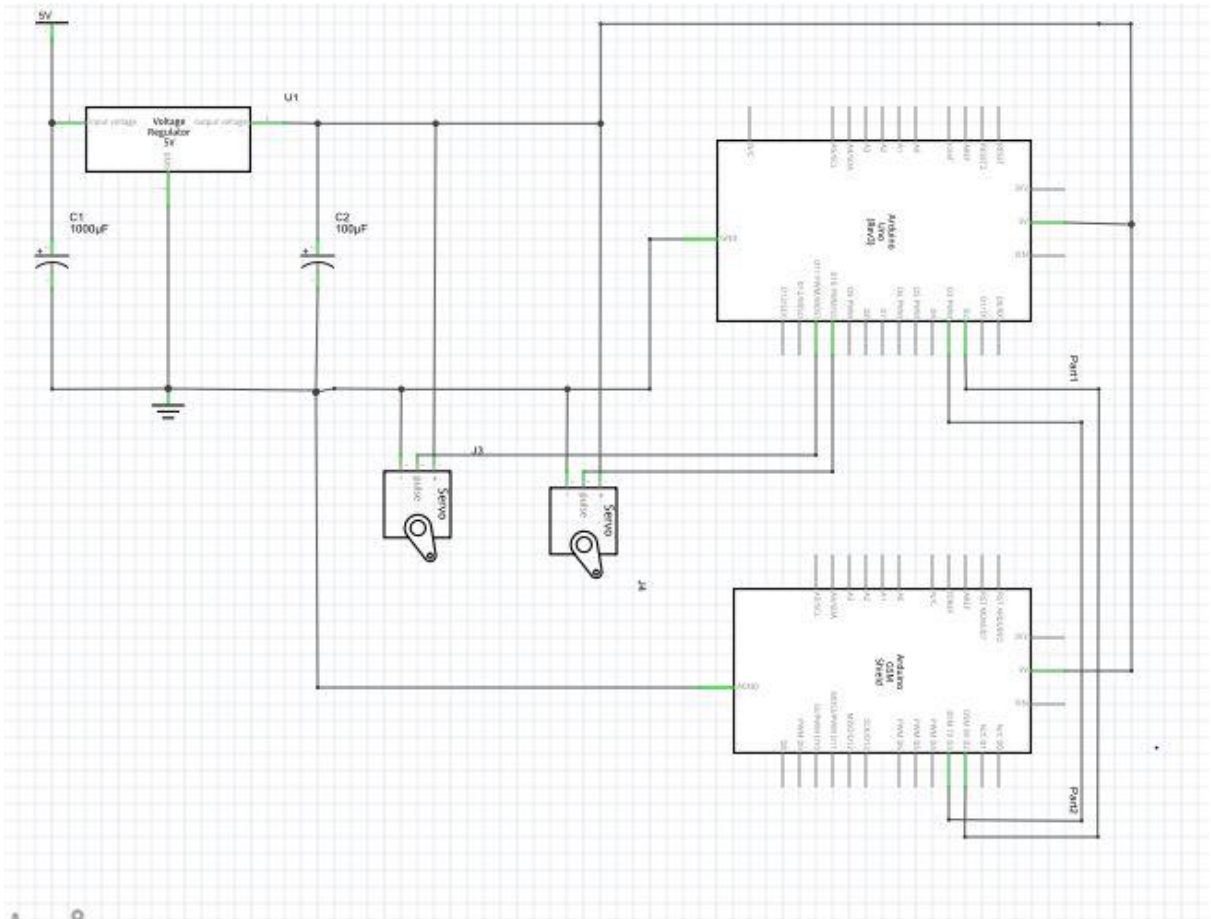


Figure 2: The Circuit Diagram of the Circuit

At the development stage of the system, the controllable amount of tilt and azimuth angles were extended than in existing systems to provide an optimizing ability.

The device was tested by sending each of tilt and azimuth angles within scope of the unit. As a result of testing, the device was corrected to avoid some of the errors.

But when a sms received to the unit, both servos attached to the system vibrate due to pulses generates by the GSM shield.

The arduino Uno (ATMEGA328) and GSM Shield (Sim908) were used as in given figure 03.



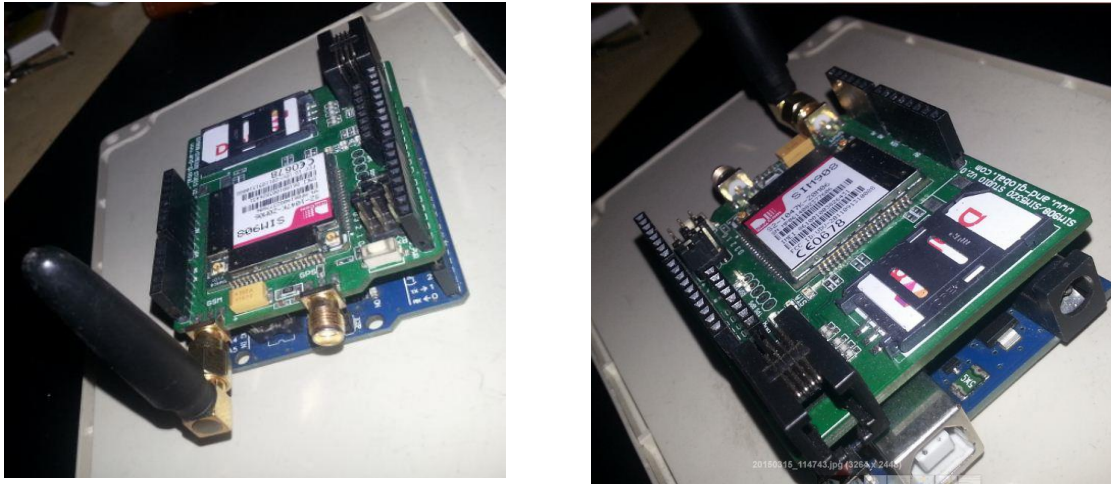


Figure 3: The method used to connect GSM shield and Arduino Uno

#### 4. CONCLUSION

The Main aim of this project was to develop a system to control tilt and azimuth of an antenna using a mobile phone. At the initial stage, it was developed as a prototype. But when apply to practical scenarios it can be developed using industrial servo motors. For that only change to be done is to be replace the Servo motors and the power supply. Mainly this low cost project was targeted developing country like Sri Lanka. This solution will help to any network provider who uses antennas. Also this would be helpful for operators who is having responsibility to optimize coverage level at any weather condition or in any rural area.

#### ACKNOWLEDGEMENTS

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## **AN ANDROID APPLICATION TO COMMUNICATE WITH OBD-II GPS TRACKER VIA SMS**

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### **ABSTRACT**

Real time vehicle tracking device is an electronic device which can be plugged in a vehicle to enable the owner or a third party to track the vehicle parameters at any given time. Such systems work using GPS and GSM technologies, which would be the cheapest source of vehicle tracking. With the increasing tendency for using mobile applications to enhance the convenience in day-to-day activities real time vehicle tracking even comes as a mobile application. And in today's environment mostly used mobile platform is Android, turning Android OS based smart phones to become increasingly powerful in recent years. Real time vehicle monitoring with an OBD II device is commercially available even for Android based devices. They use technologies such as Bluetooth and GPRS for communication process with OBD II device. This study is a solution to communicate with OBD II device to get vehicle parameters and diagnostic trouble codes under a user friendly environment in an efficient manner via SMS. This application enables formatting user input data in accordance with pre-defined SMS formats and presents the device sent reply SMS in an understandable manner.

**Keywords:** OBD II (On-Board Diagnostic version II), SMS, Android, GPS (Global Positioning System)

### **1. INTRODUCTION**

To face the competition successfully in the telecommunication industry it's vital for telecommunication providers to do research and development in order to launch new products and services to gain more customer attention and loyalty towards their brand. This study is the earliest development of such an upcoming product of one of the main telecommunication service providers in Sri Lanka.

Every vehicle owners' intention is to know the status of their vehicle, which will make their life more convenient and make them more confident as well. Using OBD II device which can be plugged to a vehicle via an OBD II port the driver can communicate in order to get vehicle parameters such as vehicle speed, engine RPM, engine temperature and etc<sup>1</sup>. Also this equipment can be used to get error codes with respect to vehicle model<sup>3</sup>. These OBD II devices communicate either via GPRS or SMS.

Under the current situation all the device codes are handled manually. In other words user have to create the SMS in accordance with the pre-defined message structure as stated in user manual which is provided along with OBD II GPS tracking device. And when a reply message is returned the user have to carry out hexadecimal to binary conversions and calculations to convert the device returned message into an understandable format. To overcome this inconvenience thus enabling effective communication with user and the vehicle this application can be used.

## 2. EXPERIMENTAL

User can provide input data by clicking a button or entering a text and by submitting it. The application performs the task of formatting the user input data into a device understandable format and sends it. This format differs with the type of parameters the user wants to get. The OBD II device gets the required parameters from vehicle via OBD II port and sends it to application via SMS. The application performs calculations with those data in return message and shows the parameters in a user understandable manner.

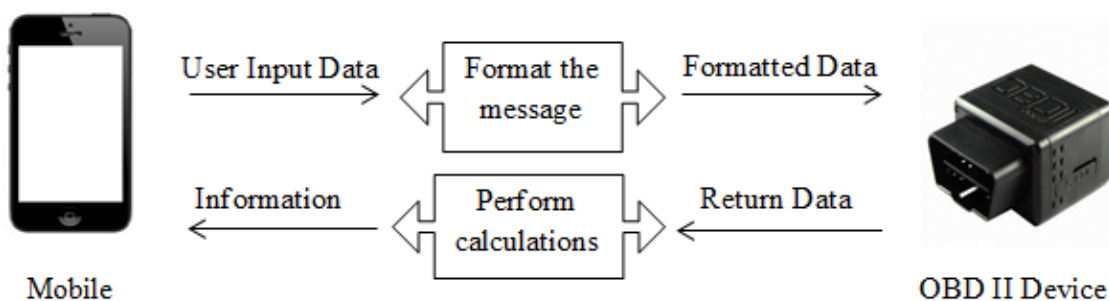


Figure 1: Architectural diagram of the application

The application was developed in Android Studio IDE and Java was used as the programming language<sup>2</sup>. For testing purposes 'Freematics' OBD II emulator was used together with 'Freematics' GUI software.

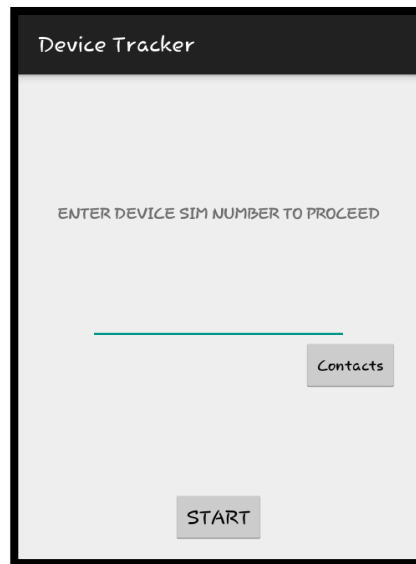


Figure 2: Main interface of the application

### 3. RESULTS AND DISCUSSION

The major task achieved with development of this system is high efficiency in communication process to get real time vehicle status via SMS. The final outcome of this research is an Android Application which enables mobile to OBD II device communication via SMS to get vehicle parameters. Though OBD data can be acquired through SMS it is not used as it is not user friendly and time consuming. Also the reply SMS contains hexadecimal values which are to be processed in order to get the information in an understandable manner. The resultant application provides a user interface which is more convenient for user and also it performs the formatting of SMSs which can be used to query vehicle parameters. Also it processes the return SMS and displays the information in an understandable format. This application was tested with an emulator and it worked successfully.

#### 3.1 Strengths of the application

- User friendly
- Less time consumption
- Inbuilt DTC database

### 3.2 *Limitations of the application*

- Only general trouble codes are included in database
- Compatible with Android Jellybean and above versions

This application can be further developed for other mobile operating systems. Also the inbuilt database can be populated with more trouble codes based on vehicle manufacturers' specifications.

## 4. CONCLUSION

Even though this is a preliminary study, the resultant application enables effective communication with OBD II device via SMS. Due to the lack of user friendliness and high time consumption this feature of OBD II device to communicate with vehicle via SMS was not used in any commercially available applications. To bridge that gap and to support researchers in developing their own product to commercialize this application was developed as the initial step.

## ACKNOWLEDGEMENTS

The authors would like to acknowledge and extend heartfelt gratitude to all who have helped in numerous ways to make this study a success.

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# **REAL-TIME REMOTE SYSTEM FOR INDUSTRIAL ENVIRONMENTAL PARAMETER MEASUREMENT AND MONITORING**

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## **ABSTRACT**

Modern technologies extensively influence on the output gain of today's industries. Many industries are using real-time monitoring technology to improve their productivity with fewer or rare breakdowns of machineries. But the complexity of installation and high cost associated with such monitoring systems are the disadvantages. Data transferring in current remote monitoring systems should be developed with the accessibility to wireless technology as wireless sensing devices provide increased flexibility. The aim of the research study is to build a reliable and cost effective remote monitoring system that would be able to link the input data wirelessly to a remote computer which control industrial process. The remote monitoring system has three main components; transmitter unit, receiver unit and the client software. An ATmega328P-PU microcontroller is used to collect inputs and XBee radio modules are used to build the wireless network between the remote locations. This system is designed to gather data from DC or AC sources as inputs to the transmitter which placed outdoor in order to transmit data wirelessly. The receiver unit of the system connected to an indoor remote computer which receives data. Then the data can be displayed on the screen with the use of client software. This shows unique as implemented system gives about 50% cost advantages and increase speed of 90% than human involved monitoring.

**Keywords:** Remote-real-time-monitoring, Wireless communication, Receiver, Microcontroller based automation

## **1. INTRODUCTION**

Many processes in today's industries are automated and hence human assistance is manually used for maintaining the system. Whenever there is an equipment failure, supply run out or unexpected condition at a remote location, it may sometimes results in costly catastrophic

consequences. Such can happen as the result of the unawareness of the maintenance responsible company people about the sudden occurrence of such situations. The people responsible for making corrective action of such automated systems are not aware of the abrupt situation<sup>1</sup>. Therefore, in order to avoid such situations, this proposed new device will be more helpful for industry. So nowadays, it is essential to monitor such information from a remote location or need to be gathered into a database of a central monitoring system.

Although the remote monitoring system features are developing faster within more user friendly environment, there are some problems and difficulties for local adoption of those systems such as; high cost unbearable for medium scale industries, machine-oriented, complexity of installation and maintenance, need of long distance network wiring.

Thus the idea behind the research project is to build a real-time remote monitoring system for measuring industrial parameters in order to overcome shortcomings associated with readymade industrial systems. This remote monitoring system would be a reliable and cost effective embedded device that would link the input data wirelessly to a remote computer. The basic idea is to improve the applicability and adoptability of the system for a real-time industrial environment. The use of wireless communication techniques will eliminate the need of lengthy and costly network wiring and crate a tidy easy-to-install software based system. These kinds of features are highly valuable for today's industry environment with less human interactions.

## **2. EXPERIMENTAL**

### **2.1. Wireless network requirement**

This project has been chosen to use a wireless communication medium than wired one in order to make use some advantage features such as; easy implementation of physical components, one time bearable high cost of wireless media based software solution. Moreover such implementation doesn't interfere or damage architectural aspects of a building or device connected and easy expandability bare for future enhancements.

The project requires certain quality features in the wireless technology to be used for the proposed system. During the selection process of the wireless technology for the project, the most required features were the reliability, maximum range approach and the bearable cost. Maximum range is very important as the system communicate outdoor to indoor vice versa. Also this system is primarily targeting the electrical device manufacturing industrial application; it should be robust and much reliable. Other than that, operating frequency, amount of data can be transmitted; system autonomy and compatibility with microcontroller

based system interfacing operations are needed to be considered. The standard (IEEE 802.15.4) low cost, low power and low bandwidth digital radio technology; ZigBee has chosen as the most compatible wireless technology for this system<sup>2</sup>.

## 2.2. System overview and operation

The goal of this project is to monitor the conditions of parameters and sensor readings of the devices placed outdoor, with the use of a computer (GUI) placed at indoor. Basically the real-time remote monitoring system has three parts; Transmitter unit, Receiver unit and the client software. An overview of the implemented system is shown as in Figure.1.

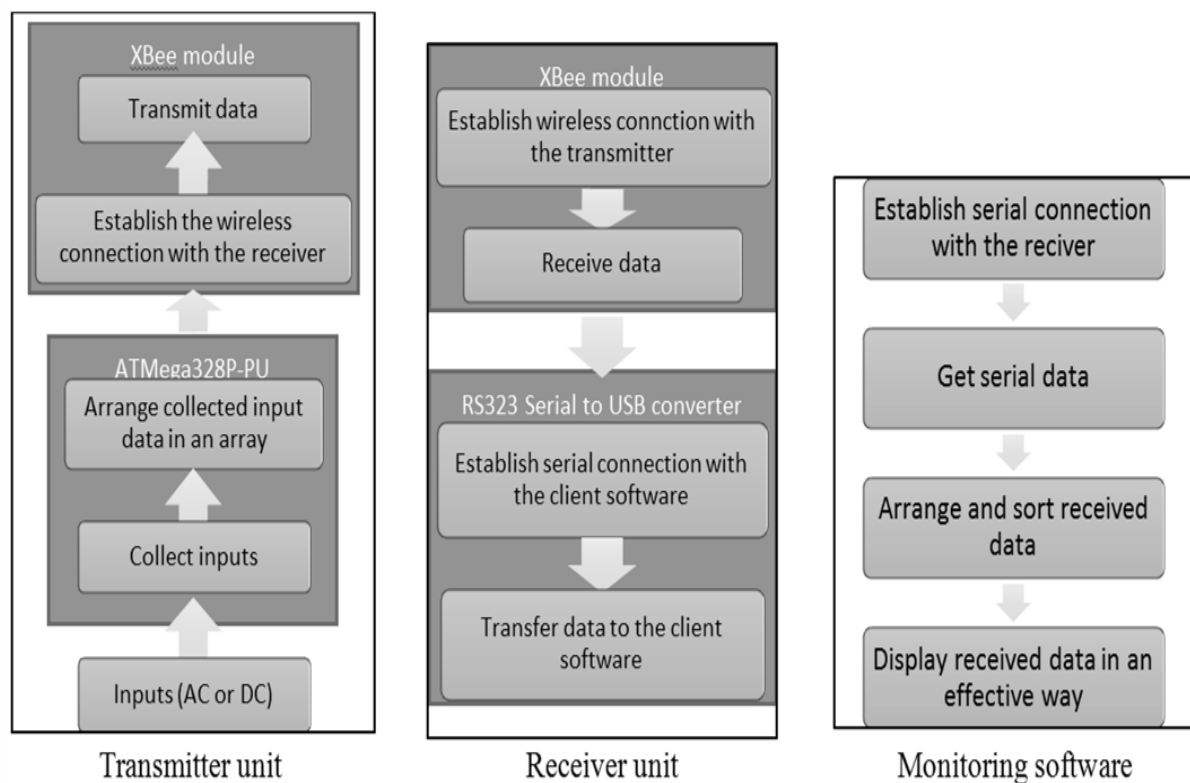


Figure 1: Overview of the implemented monitoring system operation

Basically sensors and required parameters from outdoor panels (AC or DC inputs) are taken as the inputs and they are interfaced to an ATMega328P-PU microcontroller. Then the signals can be transmitted with the use of XBee to the remote receiver. The microcontroller has been programmed to collect input data signals, arrange them in an array and serially transfer the data to the XBee module. The XBee module has been configured to transmit the collected data, establishing wireless connection with the receiver module at a remote location. Then the XBee receiver module which is interfaced to the computer through an RS323 serial to USB converter module received data. Then the readings will be displayed in the computer



GUI with the use of created monitoring software. The monitoring software refresh always since the data receiving in every second has to be updated and thus real-time monitoring could be achieved.

### 3. RESULTS AND DISCUSSION

#### 3.1. Results

The prototype of the real-time remote monitoring system was successfully implemented within the company in a project called Wireless fire panel monitoring system. For this the novel proposed system was interfaced with the fire panel.

Software was tested by connecting the transmitter unit to the AC inputs taken from fire panel placed outdoor and receiver unit to the remote computer. The results of the monitoring system was analyzed and obtained from the software and they are shown in Figure.2 and Figure3.

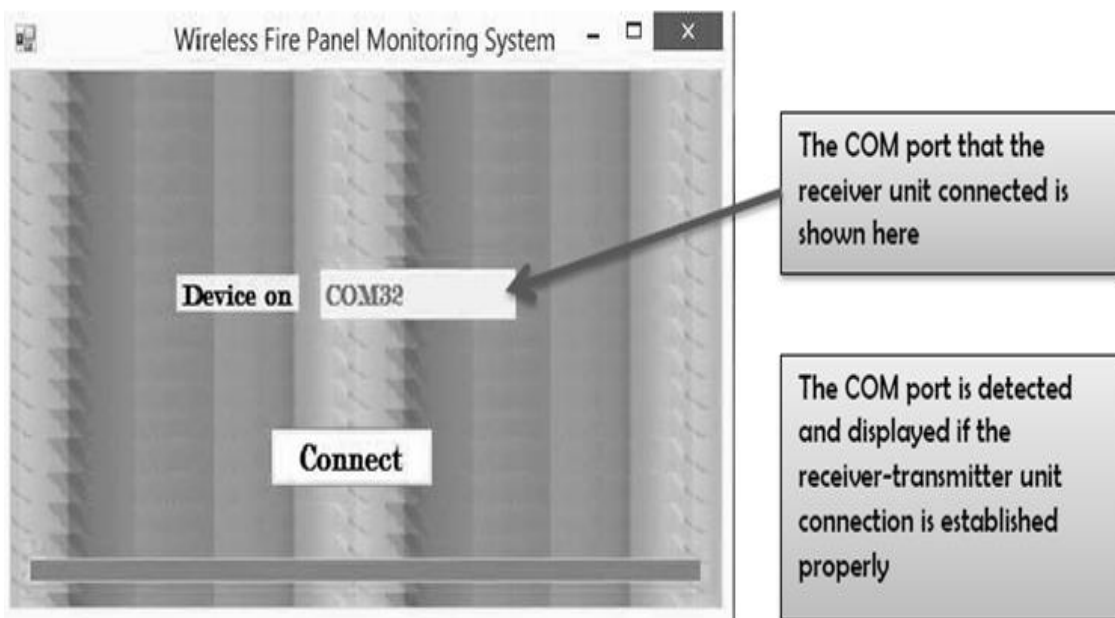


Figure 2: Wireless network connection detecting window GUI

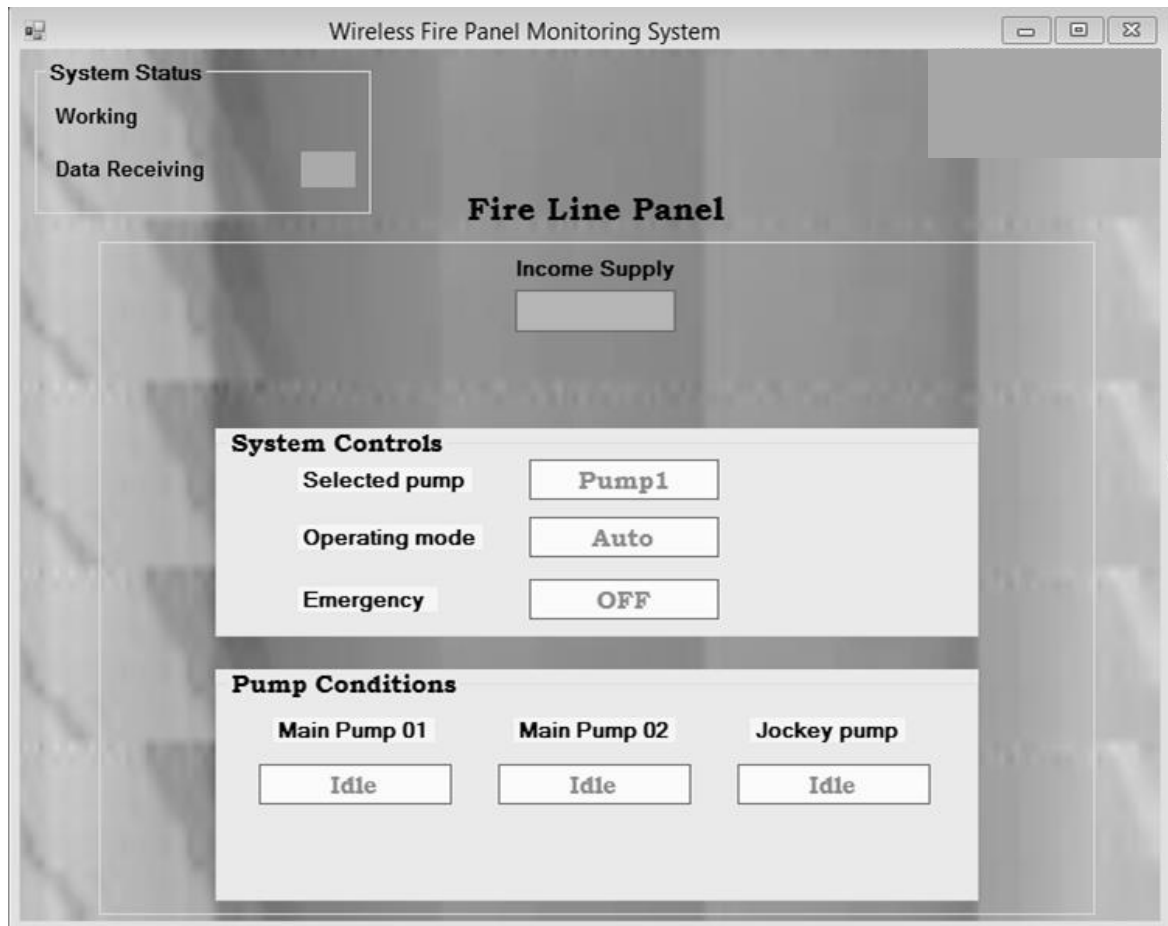


Figure 3: The GUI of the system input monitoring interface

The changes of input signals were detected by the monitoring software and were displayed. All the input states and the system states were correctly and dynamically displayed while refreshing the main monitoring window automatically in every second. In the future develop state it was proposed continue as system for critical machinery which have tendency to get fire due to unawareness of their temperature increase.

### 3.2. Discussion

The project objectives were successfully achieved by implementing a real-time remote monitoring system that communicates wirelessly as a modification to the existing systems for medium scale local industry environment. The wireless network connection strength is depend on the distance between the remote locations and the CPU, so the network range should be extend when required by replacing XBee modules with higher power and range capable transceiver module.

#### **4. CONCLUSION**

The final outcome of this research study is a reliable, cost effective real-time remote monitoring system which can be used for industrial purposes regardless of the input signal type AC or DC that will be useful for medium scale local industry environment. Moreover this simple system doesn't require inconvenient wire or LAN connection since it communicates through wireless connection and hence reduce the cost by about 50%. Moreover this shows unique as implemented system increase speed of monitoring by about 90% than human involved monitoring because it facilitates real-time monitoring.

#### **ACKNOWLEDGEMENTS**

The author would like to acknowledge and extend increment gratitude for everyone who has supported to make this research project a success.

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## **A PWM SOLAR CHARGE CONTROLLER FOR BATTERY CONSERVATION THROUGH LOAD REGULATION**

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### **ABSTRACT**

In a garden solar lamp system, the major concern over maintenance is the battery backup storage supplied with the system becoming unusable in a shorter period of time, even before the expiry of the guarantee period of a battery. The main reason behind this is the irregular charge and discharge cycles of the batteries. The existing charge controllers only focus on the voltage present on the battery. But according to this study, the life time of a lead acid battery is expected to go higher through proper charge controlling with Pulse Width Modulation and temperature compensation; and discharge control with load control. The designed system has a separate Liquid Crystal Display (LCD) to display the solar panel voltage, battery voltage, battery temperature, load power and energy for monitoring.

**Keywords:** solar charge controller, solar PV system, temperature compensation, load control

### **1. INTRODUCTION**

Solar energy has been identified as a very popular renewable energy source during the past few decades, since its energy is free and clean. For centuries, people have tried and used many ways to generate electricity. Those methods were expensive and required maintenance. Solar panels convert solar energy to electricity; but they can't store the generated energy to be used when the sun light is not available. Batteries are used to store energy to be used at a later time. The life time of the batteries used in them is very important. In order to reduce the maintenance cost, it is important to extend the battery life as much as possible. This can be done by optimizing the charging and discharging of the battery. Charging is controlled by the charge controller. When charging a battery, there are many factors to be concerned about, such as capacity of the battery, temperature of the battery and charging current cycle. When

discharging, the maximum current that can be drawn from the battery should be a concern. This study suggests a charge controller with load controlling facility which also takes into account the important parameters in battery charging such as temperature compensation and battery voltage.

### 1.1 Garden Solar Lamp System

Garden solar lamps are quite suitable to light up places situated in areas where wiring is very difficult. In a garden solar lamp system, there are 4 major parts <sup>(1)</sup>. They are solar panel, charge controller, battery and the load (usually LED lamps of 5W or 10W). Lamps are automatically lit when the dark comes and turns off in the morning without human intervention.

## 2. EXPERIMENTAL

The charge controller designed in the present work is a microcontroller based system (AtMega 328). The microcontroller in the Arduino Nano 3.0 <sup>(2)</sup> board controls the charging process, the load control process and the LCD display. Voltage values of the solar panel and the battery, battery temperature value and the load current value are the inputs to the system

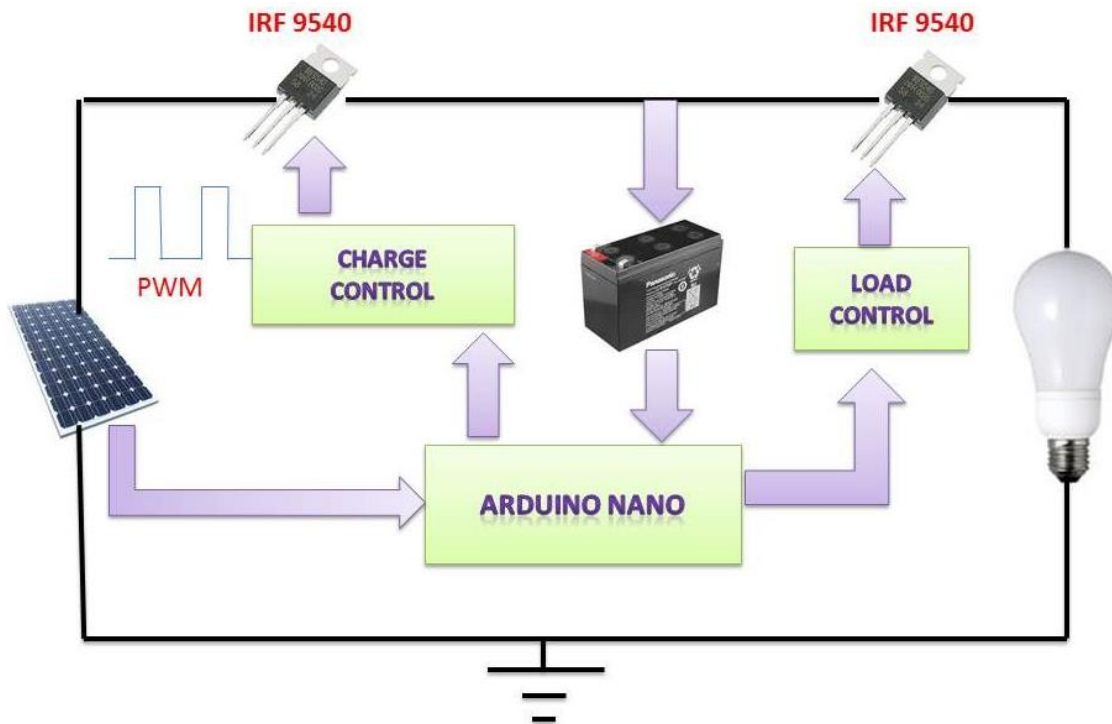


Figure 2.1: Block Diagram of the Charge Controller

## 2.1 Operation of the Circuit

The microcontroller takes the voltage values of the solar panel and the battery. The solar panel itself was used as the light sensor. If the voltage of the solar panel is less than 5V (during the dark) and the battery voltage is greater than 10.5V, the load is turned on. If the solar panel voltage is greater than 5V or battery voltage is less than 10.5V, the load is cut off. The resistance effects on the charging current decreases with the temperature. Therefore, the room temperature was measured and the width of the charging pulse (time duration of the pulse) was changed accordingly.

Existing voltage of the battery at a time concerned was measured, and there also the charging pulse width was changed. During the night, if the battery voltage is reduced below 12V, then the Q4 MOSFET in Figure 2-2 is activated and Q6 MOSFET is turned off. Then a low current is drawn from battery and it can keep the load on for a longer time.

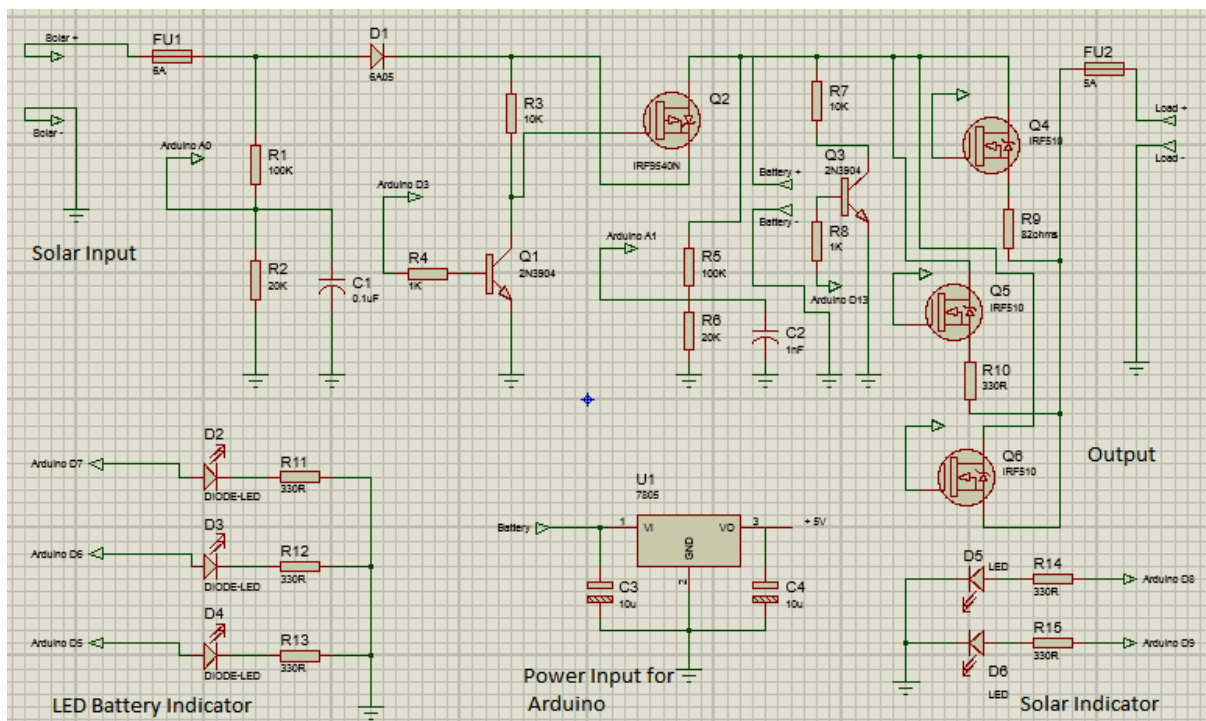


Figure 2.2: Circuit Diagram

## 3. RESULTS AND DISCUSSION

The charge controller system gave a smooth charge cycle without sudden declines in the battery voltage. The fuse attached to the load side, protected the battery from outputting a large current and short circuiting at the load side.

### 3.1 Temperature Compensation

Lead acid batteries store energy and generate current through a series of chemical reactions. The chemical reactions in a lead acid battery are affected by the temperature. As the temperature increases, the gas generation inside the battery increases; which means resistance for charging decreases and when the temperature decreases the reverse happens. <sup>(3)</sup>

Depending on how much the battery temperature varies, it is important to adjust the width of the charging pulse for temperature changes. Therefore it is important to adjust charging to account for the temperature effects. The temperature sensor will measure the battery temperature, and the Solar Charge Controller uses this input to adjust the charge set point as required.

### 3.2 Charging Pulse

Battery is charged by supplying a series of pulses, whose width is changed according to the existing voltage of the battery.

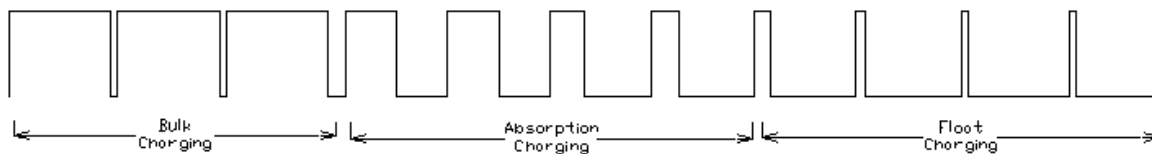


Figure 3.1: Charging Pulses applied

### 3.3 Load Control

Preserving the power of the battery is very important in fulfilling the required purpose of a garden solar lamp system. There may be rainy days or shadowy days on which the sun light won't be fallen enough on the solar panels so that the battery get fully charged. But the lamps should be lit up for a whole night.

In order to achieve this, few parallel outputs are connected to the load through logic level MOSFETs whose gates are connected to the output pins of the Arduino and switched on only one MOSFET at one time. Each path has different resistance values to regulate the current from the battery according to the battery's voltage. <sup>(4)</sup>

## 4. CONCLUSION

This study and the implementation presented in this paper was an attempt to solve one of the problems in solar garden lamps; battery becoming unusable in a short period of time. The concepts of microcontrollers and electricity were used in this study to achieve the project

goals. The developed solar charge controller will be useful to illuminate large states and isolated places through solar power, because it helps prolong the lifetime of the battery.

### **ACKNOWLEDGEMENTS**

Authors would like to thank all who helped to complete this project successfully, and also would like to express the gratitude to the staff of the Department of Electronics, Faculty of Applied Sciences, Wayamba University of Sri Lanka for their support.

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## REMOTELY CONTROLLED POWER MONITORING SYSTEM FOR BASE TRANSCEIVER STATION (BTS)

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### ABSTRACT

This solution was developed for the backup power problem that all the mobile service providers are facing currently. This study was mainly focused to protection of the battery bank and remotely controlling the generator by using GSM module at the instance of commercial power interruption. This power issue was mainly occur when the CEB power breakdowns. At this moment power of the battery bank is automatically switched to base transceiver station BTS. Then battery bank was gradually drained while reducing the voltage level according to amount of traffic that handled by BTS at that time. Draining completion time depend on the congestion and amount of traffic going through this site. According to the condition of the BTS site, effect of this issue was fluctuated. Also if the voltage level of the battery bank is drained with exceeding certain voltage level it will directly affect to lifetime of the batteries. This study reports a system developed to monitor the voltage level, load current, status of battery bank and generator through power monitoring unit by using PIC microcontroller. Those data are delivered to relevant site engineer via SMS by using GSM module.

**Keywords:** *Battery bank, Power level monitoring unit, Base transceiver station*

### 1. INTRODUCTION

CEB power, backup generator and battery bank are main power sources for the BTS. There exists a power issue when a failure occurs in CEB power, backup generator and battery bank which is used as additional power source. The power of the battery bank is automatically switched to BTS when CEB power is down. Then battery bank start to drain reducing the voltage level. They are always connected to rectifiers to keep 100% charged.

When system is running with battery bank, firstly BTS will be shut down by Network Operation Centre (NOC) in order to keep microwave active. Microwave link will be shut down when the voltage level of the battery bank is reached to 43V. If the voltage level of the

battery bank is lower than 43V it will directly influence to the life time of the batteries. Generally the total value of a one battery bank is approximately Rs 700,000. The solution provided in this study will prevent any kind of effect to the battery bank within outage time. Site engineer cannot exactly predict how much time it will take to drain the battery bank up to critical power level after it was informed by network operation center. Because this time is depend on the congestion of site and amount of traffic going through this site. According to the category of the BTS site, effect of this issue fluctuated. If the BTS site is hub site, most of the microwave links are crossed over through this site. The organization will have economical loss if such an incident cause at BTS site. Site Engineer does not have a system to recognize the power level of the battery bank without visiting to the BTS site. This is a critical situation that site engineers have to face. Proposed system can monitor the voltage level, load current, status of the battery bank and generator by using PIC microcontroller. Those data are delivered to relevant engineer via SMS by using GSM module where by site engineer can decide whether to switch on the generator, via SMS without visiting the site.

## **2. EXPERIMENTAL**

In the proposed system the discrete voltage level of the battery bank is measured using the power monitoring unit (PMU) of the BTS<sup>1</sup>. The observed analogue value is then converted in to digital signal by using ADC module. Finally the data is send to the mobile of the site engineer via a GSM module which is connected to GSM network. The system generates a SMS at every voltage level with the information of load current of battery bank the details of the generator, when battery bank gradually drained.

As a solution to this situation, a device was designed to monitor the voltage of battery bank throughout the day and deliver a SMS to the site engineer at each voltage when CEB power is breakdown. This monitoring system is designed to monitor the voltage level, load current of the battery bank and oil, fuel, heat details of the generator remotely. There are four main parts in this design.

- Measuring voltage, current value of the battery bank and oil, fuel and heat details of the generator using PIC microcontroller<sup>2</sup>.
- Checking the main power availability by using optocoupler IC
- Sending the details of the battery bank and generator to site engineer through GSM module.

- Two relay circuit for switch ON\OFF the generator.

Power level of Battery Bank is drained according to capacity of the BTS site. In BTS site which was considered for this study, rectifier modules are assigned to the requirements of the BTS and microwave. In disconnecting microwave link and BTS, microwave is prioritized in order to protect the battery<sup>3</sup>.

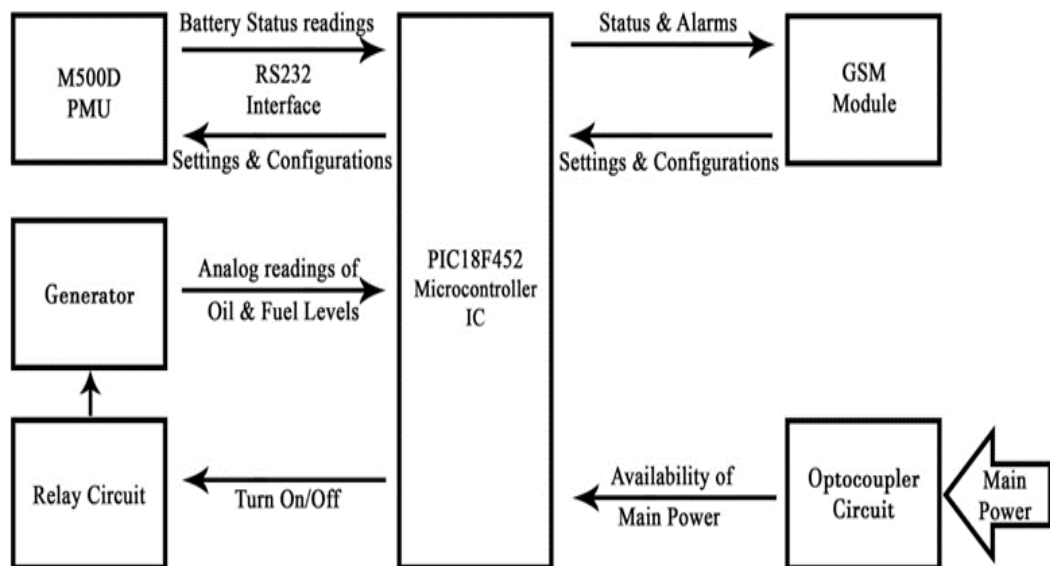


Figure 1: Schematic diagram of system design

Table 1: Low voltage disconnecting (LVD) status According to voltage of battery bank

Naming System	Range of voltage	Status	
LVD1	54V - 48V	Non-critical	Disconnect BTS
LVD2	48V - 43V	Critical	Disconnect Microwave

### 3. RESULTS AND DISCUSSION

The major task to achieve during the development of this system was to reduce the cost since it has to be implemented to thousands of BTS sites belong to the mobile service provider. In the other hand, the company was not willing to spend huge amount of money on the system. Because this product is not an income generator but only an expenditure for the mobile company. But it will reduce the cost of the company because site Engineer can switch ON/OFF the generator without visiting the site. Failure of the CEB power is to be critical reason when the stability of the mobile network is considered. The breakdowns of CEB power are very frequent. So that mobile service provider should adopt solutions to any incident that will affect to the consistency of the service.

Strength and weaknesses of the proposed solution are,

- It will help to provide a continuous service to the customers, Quality of services will increase.
- From this system, site engineer get updates about status of battery bank and generator except the alarm of failure of CEB power by NOC.
- Remoteness of the system is a very important factor of this solution. Hence site engineer can easily determine what should do next.
- Site engineer can remotely (switch on or off) control the generator by using mobile phone.
- In this system the brake down SMS is send to a one responsible person. If he couldn't attend to it there will be a problem. So if the message can be send to many responsible people it will be more helpful.
- Quantity of this system should be increased according to the gravity of the issue.

Developed system was not tested by fixing to the operation because permission from Network Operating Centre (NOC) is required to do it. Therefore two PRE SETs were used instead of power monitoring unit to get voltage values and load current. It worked successfully. Especially the voltage value was monitored by the PIC microcontroller accurately and that value was passed to the mobile phone as quickly as possible.

### 4. CONCLUSION

In this study a system was developed to monitor the situation of power supply at a BTS and inform the relevant engineer when there is a breakdown. This system is more useful device to

keep the site active continuously. This solution provides optimum solution for the above described issue with most appropriate and cost effective manner.

### **ACKNOWLEDGEMENTS**

Author would like to thank all at Wayamba University of Sri Lanka who had helped immensely to make this study success and staff at Access Telecommunication Services (Pvt.) Ltd.

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## **IDENTIFICATION OF THE EXACT UNDERGROUND FIBER ROUTES**

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### **ABSTRACT**

Underground communication cable system is an important part of the communication world which is the fastest and most reliable medium. In Sri Lanka Telecom Plc. an underground system is used for the metro areas to avoid complexity and congestion. But in practice finding the underground routes is difficult because of the poor finding techniques and the new road developments. In maintenance situations, employees of Sri Lanka Telecom Plc. faced difficulties in finding the exact location of the cables from huge number of cores. The fiber cables' characteristics can be used to find the location of them from huge cores. Man holes detecting method is a very elementary method. It makes many mistakes and huge wastage of time, cost, and manpower. The new system contains a current transmitter, which supplies the current to the guard wire of the underground fiber optic cable with a specific frequency. It create a magnetic flux around the cable. Then the magnetic flux detector can detect the magnetic flux from the fiber cable and helps to find the cable easily.

**Keywords:** Man-Hole (MH), Underground (UG), Current Transmitter, Flux detector, Fiber Cables, Fiber to the Home (FTTH).

### **1. INTRODUCTION**

Sri Lanka Telecom Plc. Headquarters ANP (Access Network Project) is the main responsible division for the FTTH (Fibre to the Home). FTTH is the latest technology wire line connection with high speed communication. In that project fibre optics are used as the communication media. The prime difficulty of FTTH is underground routes be identified after few road development projects. The suggested system will help to avoid the time, money and human power wasting with accuracy. Underground fibre optic cables have their own guard wire or a metallic sheath. Therefore it can be used as a part of the system. Then the system helps to detect the exact location of the cable route accurately.





Figure 1: Fiber Cable with Steel Guard wire

## 2. EXPERIMENTAL

The suggested route finding system should be developed as two units.

- Current transmitter<sup>4</sup>.
- The magnetic flux<sup>3</sup> detector.

The current transmitter should be connected to the guard wire<sup>1</sup> in a proper manner. One end of the cable should be earthed. Since the current loop should be completed by contacting with the ground.

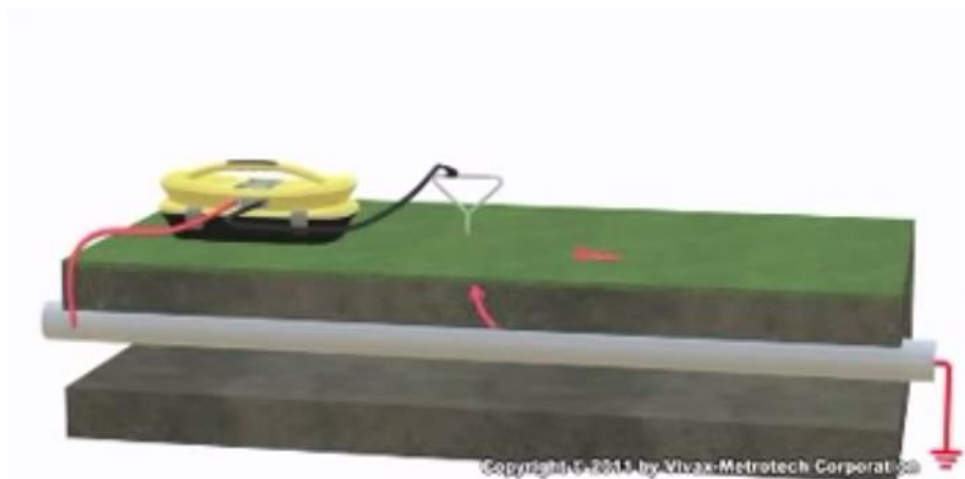


Figure 2: Current Transmitter in application

But the supply current frequency should be known. The guard wire produce magnetic flux around it due to the current. The flux detector can detect the cable's flux with a correct directions and well accurate manner.



Figure 3: Detecting magnetic flux using the coil

After detecting the magnetic flux underground route can be identified correctly. Even when the route buried under several layers of road developments (tar carpet, concrete ..... etc.)

The suggested equipment will be able to detect the magnetic flux and produce a result with considering the detected flux form blink the LED. Using that element (In Figure 3)the exact location can be found.

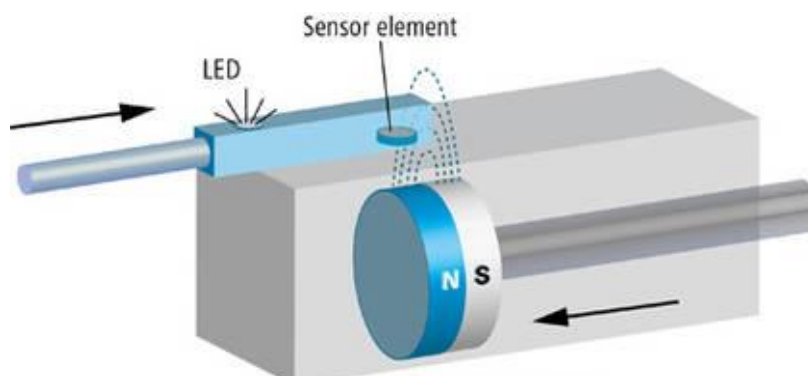


Figure 4: Flux Detecting Element

### 3. RESULTS AND DISCUSSION

The underground fibre cable detecting method is developed for the communication world for identification their UG cable path appropriately. Final outcome of this project is to

successfully identify the path with the suggested method. It is created with concepts that can be trusted with accuracy. That suggested system is much better than the older method, The MH detecting system is the method the SLT is using today. It has less accuracy to identify the exact location so this method do not fulfil requirement of accuracy. Another process should be followed to do the cable path identification. All the difficulties can be avoided using the suggested method. The suggested equipment costs around more than Rs.20000.00. Because the accuracy depend on the equipment quality.

#### **4. CONCLUSION**

With the lack of cable network maps the detection of Man Holes has become almost impossible task in urban areas (to find the cable routes), especially when the area was undergone development projects. But using “Locating the exact underground fiber routes” method it locating of cable routes would be easier and more precisely. Therefore manpower will not be wasted on unwanted digging. This can be done easily without disturbances for development projects. Furthermore this system can be utilized to detect pipeline and detect splicing defects in the fiber cables by using high-end actuators.

#### **5. ACKNOWLEDGEMENT**

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## **A DEVICE TO HARVEST RESIDUAL DAY LIGHT TO BE USED FOR INDOOR POWER REQUIREMENTS**

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### **ABSTRACT**

Solar energy has received a considerable attention from industries that are active in the field of electricity. This project is aimed at using a solar panel inside a building and use residual day light as a source of energy to power equipments for a short time period. The device stores solar energy extracted from the residual daylight in a battery bank for a long time period. The battery is charged at any voltage above the threshold voltage given by the solar panel. Power inverter directly converts direct current (DC) from the battery to alternating current (AC). In order to achieve the frequency of home electrical appliances it has used an integrated circuit (IC) component to generate clock signals. Design has a charge controller and it uses a boost converter (step-up converter) to step up the voltages from the low values. For the protection of the power inverter, a varistor circuitry is used. The advantage of this system is this photovoltaic solution can be used inside a building similar to a table. Since this device harvest energy from renewable source, the cost for the electricity would be saved<sup>1</sup>.

**Keywords:** Power inverter, Charge controller, Boost converter, Battery bank

### **1. INTRODUCTION**

Nowadays people use renewable energy sources such as photovoltaic solutions in order to fulfill their electrical needs. Usually solar panels need an unobstructed and south-facing area to obtain maximum power. Obstructing sun may cause them to be not effective as they could be<sup>2</sup>. This project is also about a renewable energy source which harvests energy from residual daylight inside buildings. It resolves the problem of accommodating large spaces for energy sources. This is also a photovoltaic solution, but the advancement from the predecessors is that size of this is similar to a normal office table. Since the shape of the device is similar to an office table, this can be used as an office table. Since the device harvests solar energy from

the residual day light inside buildings, in buildings which are designed to have maximum day light the photo energy does not waste completely. The device can be used to absorb this renewable energy and can be consumed later.

## 2. EXPERIMENTAL

Following fig 1 explains the processes of each step in the device with respect to fig 2. In this setup, a sealed lead-acid battery is used as the battery bank. The capacity of the battery is 45 Ah. Polycrystalline silicon solar panel of 235 W is used to collect photo energy and other electrical equipments are designed to provide the maximum efficiency for the device.

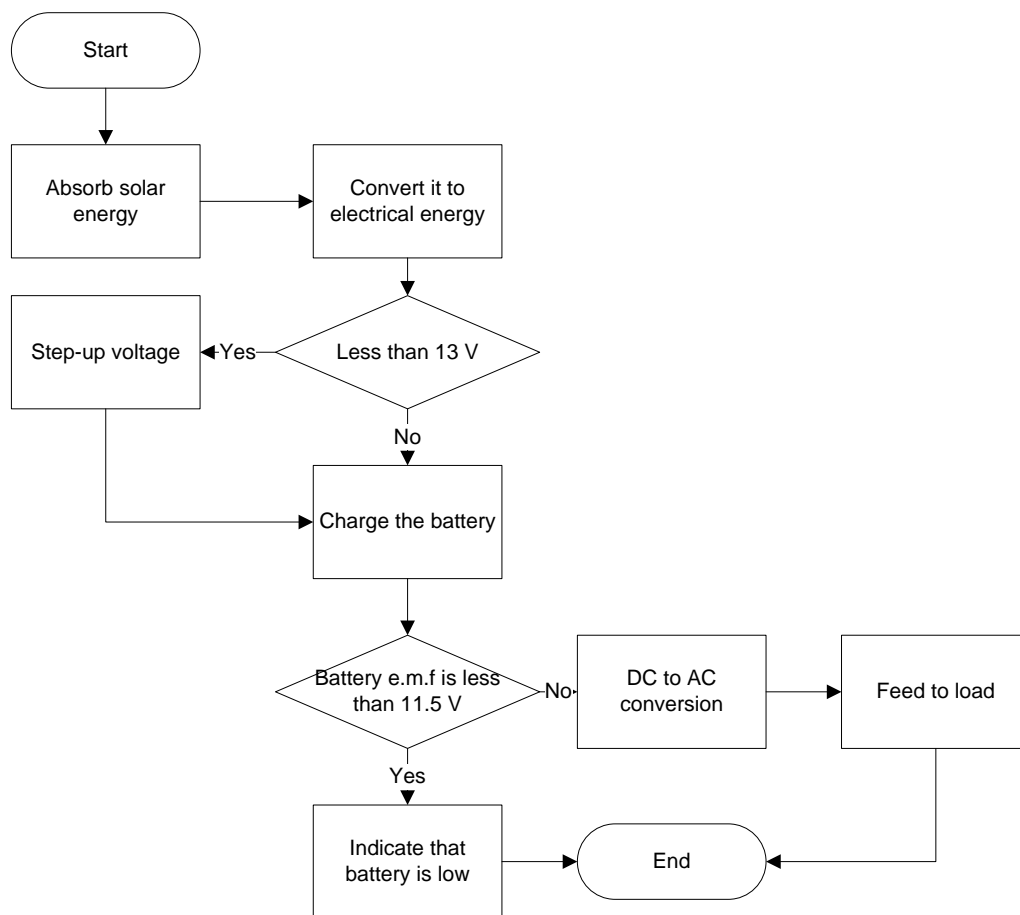


Figure 1: Flow chart of the system

The solar panel of the device fixed as a table absorbs the photo energy and then the energy is converted to electrical energy by the photovoltaic effect in the solar panel. Sometimes this electricity is of low voltage. This low voltage is stepped-up by a boost converter (step-up converter) in the charge controller as a battery can be charged using this stepped-up voltage.

DC to AC inverter operates only when the electromotive force (e.m.f.) of the battery is greater than the reference voltage of 11.5 V. Else it indicates by lighting a light emitting diode (LED). DC to AC inverter converts 12 V DC voltage into 230 V sine wave with the frequency of 50 Hz. Fig. 2 shows the operation of each component as an overview. DC to AC inverter is used immediate to the battery. In order to protect the power (DC to AC) inverter from electrical current surges, a surge protector is used.

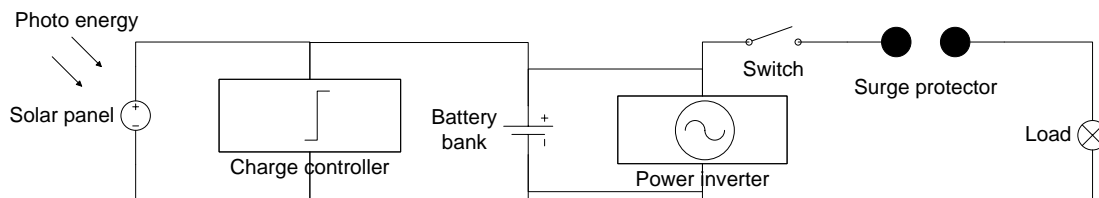


Figure 2: Operation of the device

The solar panel receives energy inside the building. Charge controller directly receives the energy from the solar panel which is converted to higher voltage than the received voltage if the voltage is below the threshold (fig 1). In the charge controller step, a boost converter is used. The function and the charge controller circuitry is explained below

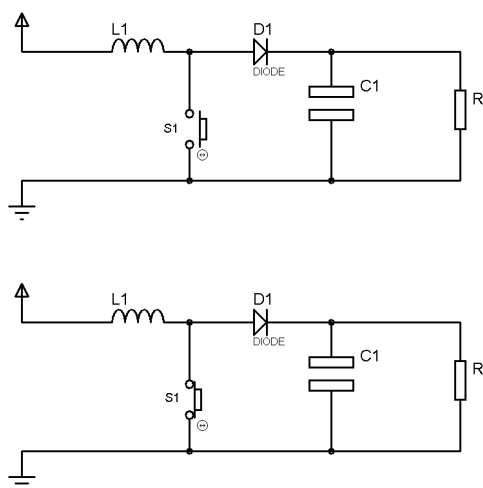


Figure 3: Boost converter used inside the charge controller

The circuit simply explains the function of a boost converter. When the switch (S1) is closed, inductor (L1) stores a portion of magnetic energy. Sudden opening of the switch (S1) changes the current through the inductor (L1), and implements a back e.m.f. as to resist the current change in the inductor. This increased voltage stores in the capacitor and releases to the load<sup>3</sup>.

In this circuitry, it has used a programmable integrated circuit to control the switch (S1). This has made the circuit to convert the voltages accurately as in ideal conditions.

Following diagram describes the function of the power inverter which takes energy from the battery bank.

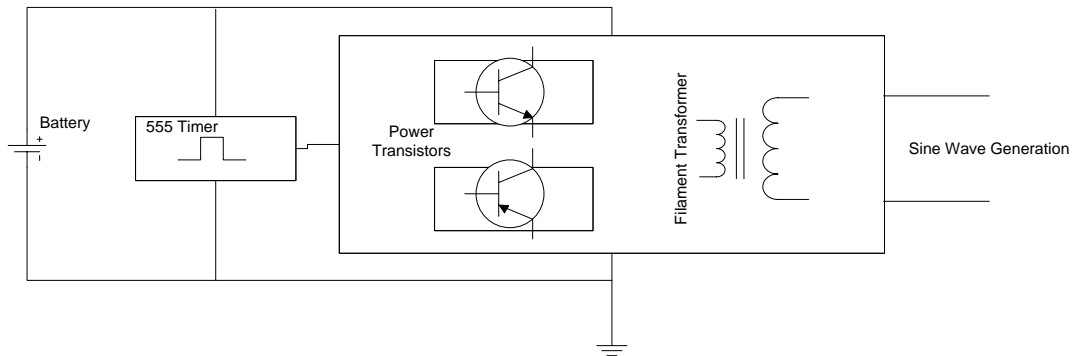


Figure 4: DC to AC power inverter’s main components

Here, the clock signal generator generates clock signals at the frequency of 50 Hz. But those are square wave signals. Generated clock signals are fed to power transistors which generate high current pulses according to the 555 Timer outputs. The square wave pulses which are received to the filament transformer change their shapes into sine wave signals and also this transformer increases the amplitude of the signal.

The received signal can be used for any domestic electrical equipment. But in some equipments, they use Switch Mode Power Supply (SMPS) as their power supply. In these equipments, large voltages are freed in the input terminals. These freed voltages are called electrical surges. In order to avoid the surges go to the inverter circuit, a varistor circuit is used. This varistor circuit is called the surge protector/remover. Following figure shows the surge protector operation.

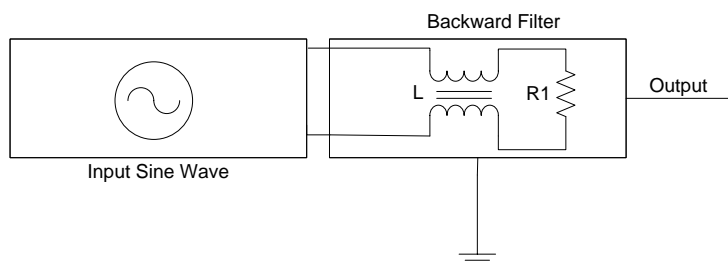


Figure 5: Surge remover operation block diagram

The inductor couple in this part of the circuitry is arranged in series in order to remove unwanted signals. Only sine waves pass the inductor couple since they are wound in opposite direction. R1 is the load resistance called varistor which dissipates the power of the surge

when an input voltage is given from the output terminals. Inductor couple blocks one sided surges and direct them to the varistor (R1). High frequency signals are grounded through capacitors.

### **3. RESULTS AND DISCUSSION**

This device is able to power a 15 inch laptop (65 W) for nearly a six hours time with idling the laptop. If the storing time is nearly ten to fifteen days, the device operates successfully (depending on the electricity consuming item). A 10 W electrical lamp and a 35 W electrical fan were simultaneously used to test this device since the measurement can be taken for the feasibility evaluation of using this device. The device was possible to successfully operate them for nearly four hours.

The total cost for the device with a polycrystalline silicon solar panel, table frame, 45 Ah lead-acid battery and other circuits designed was nearly 32000 Sri Lankan rupees.

Usage of lithium-ion cells instead of lead-acid cells will serve well in the battery bank since their self discharge rate is smaller compared to sealed lead acid batteries<sup>4</sup>. This will reduce the charging time of the battery. In contrast with the normal lead acid cells, sealed lead acid batteries are cost alternative to the lithium-ion cells<sup>5</sup>.

In order to reduce the size of the circuitry, timer IC can be replaced by a programmable microcontroller since its operation can be changed at any time<sup>6</sup>.

In this project, a panel which consists of polycrystalline silicon solar cells is used. Instead of using polycrystalline silicon solar cells, usage of monocrystalline silicon solar cells will increase the efficiency of the device<sup>7</sup>. But it will also increase the cost of the device.

Thin film GaAs or InGaP/GaAs/InGaAs would be successful alternatives for silicon solar cells in this device and they would generate electrical energy than now since their efficiencies are greater than silicon solar cells<sup>8</sup>.

### **4. CONCLUSION**

Even though this is a preliminary product for harvesting indoor renewable energy, it has proved that this can handle a considerable amount of throughput. For darker conditions this device can step-up voltages and store them in the battery using its charge controller. With the integration of AC conversion this is equally contributed to the domestic electrical needs. Since this device is similar to a normal table, this can save the additional space required for power generators inside buildings. For high power devices this would not be suitable since



they require large amount of stored energy. The efficiency of the device can be increased by maximizing the day light in the building design.

## ACKNOWLEDGEMENTS

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## SC-FDMA TRANSMISSION SCHEME FOR LTE NETWORKS

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### ABSTRACT

Single Carrier Frequency Division Multiple Access or SC-FDMA is a multiplexing technique used in wireless communications with the development of Long Term Evolution (LTE). Over last few years, since the demand for accessing internet over the mobile devices increased rapidly, SC-FDMA scheme has obtained tremendous reputation, as it could provide a framework to gain required performance. This report is focused on the performance of the SC-FDMA scheme in a wireless communication environment, some of the history, principles, implementation and advantages of SC-FDMA, over other multiple access techniques. Further, a Matlab / Simulink simulation of a LTE transceiver using SC-FDMA scheme is discussed and analyzed its results in terms of BER (bit error rate) for various modulation schemes and channel impairments.

**Keywords:** Signal Carrier Frequency Division Multiple Access, Long Team Evolution, Wireless communication

### 1. INTRODUCTION

SC-FDMA is a form of Orthogonal Frequency Division Multiplexing with advanced performance and complexity. SC-FDMA is called as a DFT spread OFDMA. There, time domain signal is converted to frequency domain using discrete Fourier transform (DFT). This is the special feature belongs to SC-FDMA and why it has become more popular. The frequency spreading is done before the standard OFDM modulation. So that SC-FDMA is having all the advantages and benefits of OFDM. The concept for this new technology to develop is complexity of the multipath data reception with the existing technologies. The reason for becoming both OFDMA and SC-FDMA popular in wireless communication is the ability to support better performance in the presence of multipath signal propagation. Among these two, SC-FDMA has low peak to power ration with respect to OFDMA. That feature has brought SC-FDMA suitable for upstream transmission for wireless technology. <sup>1</sup>

With the development of LTE, wireless revolution is achieving an important stage in communication world. LTE is becoming the dominant standard for next generation (4G) cellular networks.

LTE supports scalable radio frequency channel bandwidths. Allowed values are 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz, 20MHz. LTE has two different multiple accesses for downlink and uplink. They are Orthogonal Frequency Division Multiple Access (OFDMA) and Single-Carrier Frequency Division Multiple Access (SC-FDMA) respectively. Multiple access techniques should be highly flexible and efficient. They must be flexible to support low rate signals and the signals which are having high data rates for users. OFDMA is the main technique for radio transmission and reception in LTE and it works well on the LTE downlink. SC-FDMA which is a modified form of OFDMA is preferred for uplink.<sup>3</sup>

Generally in OFDMA transmits multicarrier signals whereas SC-FDMA transmits single carrier signal. Therefore SC-FDMA has lower Peak to Average Power Ratio (PAPR) than OFDM. This PAPR reduces battery power consumption, improve uplink coverage and cell edge performance. And also it requires a simple amplifier to amplify the signals. So the reason behind SC-FDMA not for choosing downlink is the need of a complex receiver.

## 2. EXPERIMENTAL

This project is carried out to investigate the performance of SC-FDMA transmission scheme for LTE networks. This involves design and implementation of an upstream LTE transmitter using MATLAB/SIMULINK simulation platform.

### 2.1. Block Diagram of the Model

In this simulink model, it consists with a binary generator, a transmitter, a channel and a receiver. In order to test the performance of the entire system, a bit error rate calculator is introduced to the system. The following Figure 1 shows the basic block diagram of the simulink model

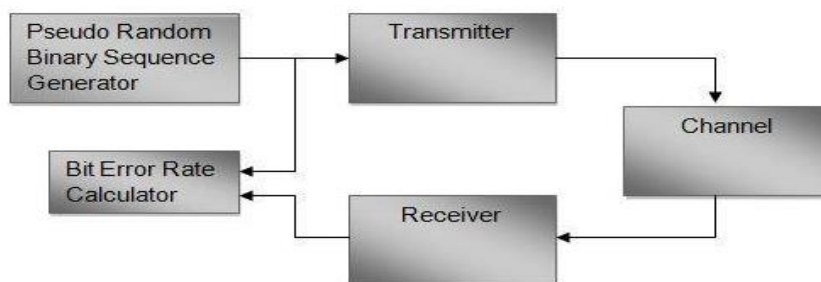


Figure 1: Basic Block Diagram

In this project, there are many hardware implementations of the SC-FDMA which are not practical as the large number of elements involved.

**Transmitter:**

The basic implementation of the transmitter which is designed using MATLAB/SIMULINK is shown in Figure 2 below. In this basic transmitter design, the modulator is changed with QPSK, 16 QAM and 64 QAM when is required.

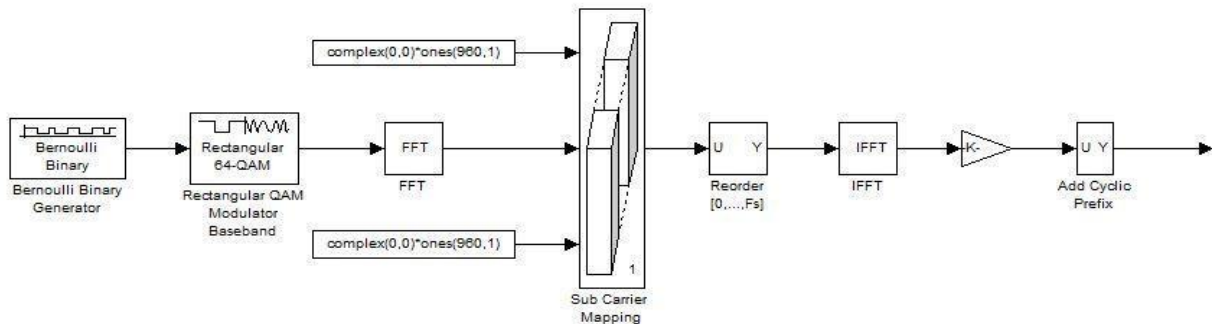


Figure 2: Transmitter simulation Model

**Receiver:**

The functions of the receiver blocks are the opposite as they were at the transmitter. The receiver consists of a cyclic prefix removal, Fast Fourier Transform block, Reorder, removal of zeros, Inverse Fast Fourier Transform and a demodulator. The following Figure 3 shows the simulink model of the receiver:

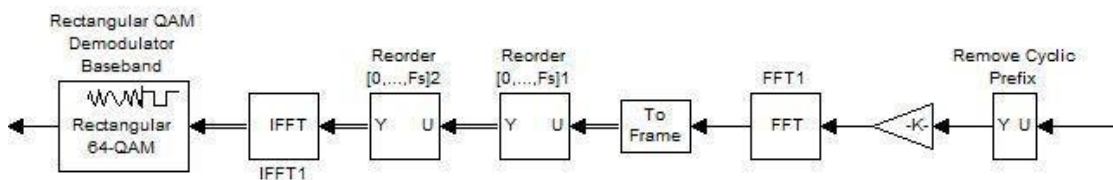


Figure 3: Receiver Implementation

In order to analyze the performance, Bit error is taken as the mode of measurement. BER is calculated according to the Monte Carlo Method in which a pre-defined number of bits are transmitted over the channel and the required rate is obtained as a ratio. The ratio can be defined as the bits which are lost during the transmission over the total number of bits transmitted through the channel.

A plot of BER vs Eb/No was taken for each simulation and analyzed. The following parameters were used while carrying out the simulations:

Table 1: Parameters used while carrying out the simulations

Parameters	Value
Sample Time for 64 QAM	10.763 MHz
Sample Time for 16 QAM	7.175 MHz
Sample Time for QPSK	3.587 MHz
FFT Length	128
IFFT Length	2048
Cyclic Prefix	144

Both the transmitter and the receiver was used to test the system performance for three different modulation schemes (QPSK, 16QAM and 64QAM) and further, various characteristics were investigated during the project period. The performance of the SC-FDMA was investigated with the help of Bit Error Rate (BER) calculations obtained in different parts of the simulation model.

### 3. RESULTS AND DISCUSSION

The system performance was investigated with different channel characteristics. Additive White Gaussian Noise (AWGN) channel was used in this simulation model. The performance results were obtained while changing the AWGN channel parameters. As it is mentioned earlier, this project was set to investigate the performance of the SC-FDMA in the upstream transmission. Different modulation techniques were used and those techniques were chosen according to the application in which they applied. Since the SC-FDMA scheme can only be implemented in phase and amplitude modulations, three of the most commonly used modulation schemes were chosen. i.e. QPSK, 16-QAM and 64-QAM. It was observed according to the obtained results, that the performance of the Quadrature Amplitude Modulation (QAM) gives the better performance with respect to QPSK or 4-PSK. 64 QAM performs well with having more bits per symbol with respect to other modulation schemes.

When it comes to the spacing between the constellation points, 64 QAM can be used for different requirements by changing the parameter 'minimum distance' which means the distance between the constellation points. That brings a system to achieve quite better presentation of the modulation technique than typically use of it.

Then as the next part of the project, the numbers of subcarriers used in upstream were increased and the performance was investigated. The model was originally implemented to

have 128 sub carriers and then the system was developed to cater with 256 sub carriers. Sub carrier increase has affect to system performance as it gives unconstructive result for better performance of SC-FDMA. As it is discussed in the second chapter of this project, by means of increasing the numbers of sub carriers, the spacing between frequencies are reduced. This can be affected for the orthogonal feature as it directly relates and causes for crosstalk. Hence, the BER gets increased and resulting increase the power consumption for the system. Further, the main advantage of the SC-FDMA transmission scheme is that it can give the available bandwidth to other users as a result of the spread the spectrum prior to the IFFT. This is achieved by setting the unused sub carriers to zero, as in cellular communication; it only allows one user to use one spectrum. Therefore it allows other users to set the spectrum to another portion to transmit within it.

#### **4. CONCLUSION**

This project is successfully completed with the proper designing and implementing the MATLAB/SIMULINK simulation of the upstream transmission using SC-FDMA scheme. There, a wireless transceiver is simulated with the use of different blocks in the MATLAB libraries. The project scope is described under project aims and objectives.

In overall, it is obvious that the use of SC-FDMA in the upstream is much beneficial as it gives enormous advantages over other technologies. Even though LTE is still in the phase of improving its functions, this enormous technology is becoming more dominant in the communication industry.

#### **ACKNOWLEDGEMENTS**

Authors wish to express their indebt gratitude to the staff of Department of Electronics, Faculty of Applied Sciences, Wayamba University of Sri Lanka and Sierra Telecom Engineering Division, Colombo 06.

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## USB SWITCHER FOR CCTV SYSTEM

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### ABSTRACT

The aim of this project is to design and construct a low cost USB Switcher for CCTV System. USB Switcher is a device which has the ability to do the DVRs (Digital Video Recorder) operations using a single mouse. That means the some kind of multiplexing function is done by the USB Switcher. This USB Switcher circuit consists of a PIC18F2550, LM2596 power unit, ULN2003, USB ports and relays. The PIC Microcontroller is programmed in Constant 5V is provide by the Power unit. This PIC program is basically built by considering USB ports and Relays. By using this device we can perform the task using one mouse instead of several mouse(s).

**Keywords:** Closed Circuit Television, Microcontroller, Digital Video Recorder, USB Switcher

### 1. INTRODUCTION

USB Switcher is mainly connected with the DVR (Digital Video Recorder) in a CCTV system. Although there are commercially available USB Switchers, they are very expensive. In this study it was attempted to develop a USB Switcher with very simple logic, which is user friendly and low cost. When consider about the cameras connected to several DVRs the USB Switcher is very useful for that system. The device works under the basic functions as shown in figure 1.



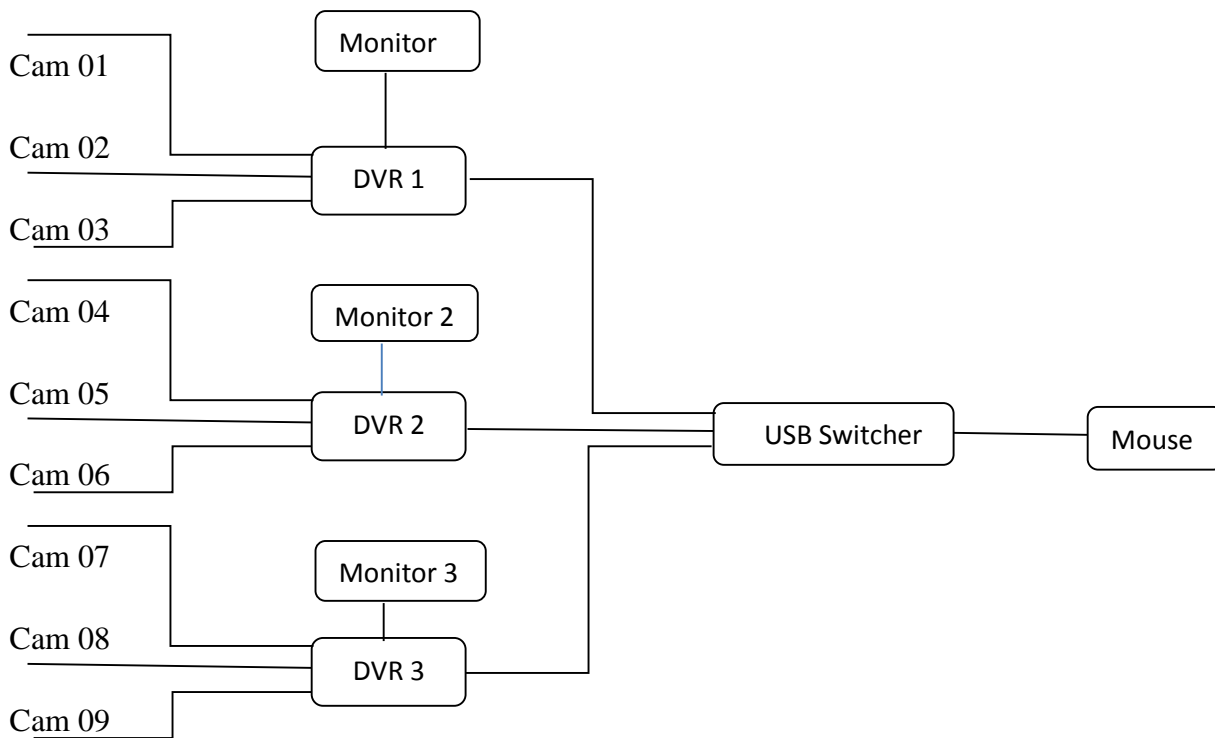


Figure 1: Block diagram of the CCTV system

Cameras were connected to the Digital Video Recorder (DVR) which was directly connected to the monitor. Each DVR having a mouse to control the system. That mouse ports were connected to the USB Switcher. So it could be control the whole system by one mouse which was connected to the USB Switcher. Also there are push buttons to activate the corresponding monitor. Monitor should be selected manually using push buttons. After it can be used USB switcher mouse for selected Digital Video Recorder's functions.

## 2. EXPERIMENTAL

For the designing of the USB switcher for the CCTV system, a microcontroller was used. This microcontroller is connected to the ULN2003 which is a motor driver IC, Relays and LM2596 power unit. The details of the components are as follows.

### 2.1 Circuit Components

PIC18F2550 Microcontroller

This family of devices offers the advantages of all PIC 18 mc namely, high computational performance at an economical price-with the addition of high endurance, Enhanced flash program memory. In addition to these features, the PIC18F2455/2550/4455/4550 family introduces design enhancements that make these microcontrollers a logical choice for many high-performances, power sensitive applications. Microcontroller is used to determine doing the multiplexing part in USB switcher. [2]

### ULN2003 (Relay driver)

The ULN2003 is high voltage, high current Darlington arrays each containing seven open collector Darlington pairs with common emitters. Each rated at 500mA and can withstand peak currents of 600mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout. [1]

### 2.2 Design of the circuits

At the beginning the program was implemented and the circuit was designed using the Proteus software and the PCB design was taken from the ARES. Finally the circuit board was designed and the components were soldered to the circuit board.

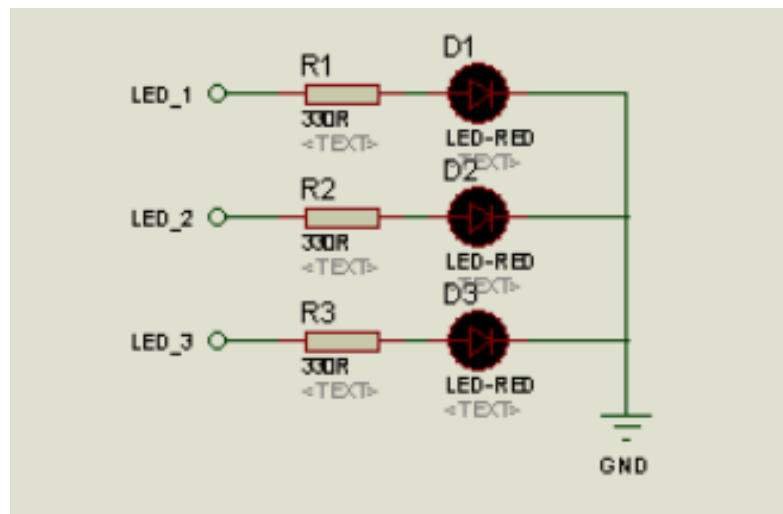


Figure 2: Indicator circuit part within the USB switcher

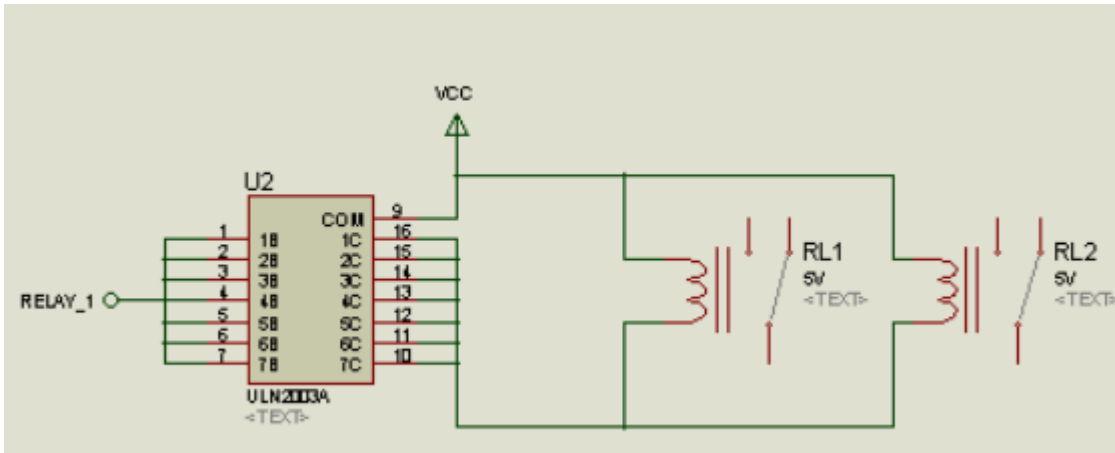


Figure 3: ULN 2003 Relay drive circuit

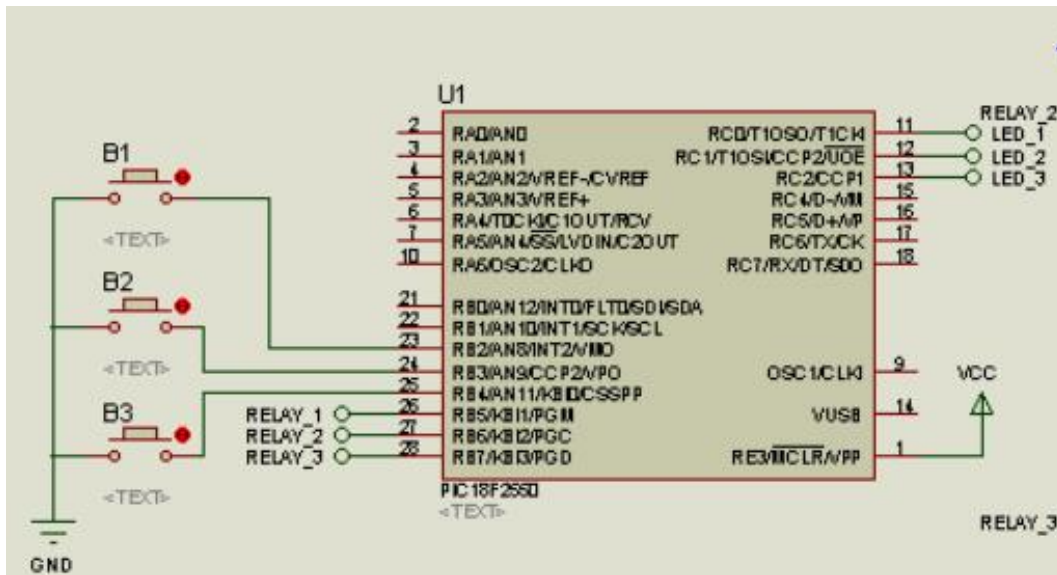


Figure 4 Data processing unit

Three input buttons were connected to the Microcontroller. There are three LEDs which are connected through the output pins of the microcontroller. The LEDs are used to indicate the active channel. Also there were ULN2003 IC used to drive the three relays.

### 3. RESULTS AND DISCUSSION

This USB Switcher consists of a very simple circuit design. By using this we can handle a large number of DVRs using a single mouse. This can be used for the large CCTV projects. USB

Switcher connected to the Digital video Recorder using female USB ports. Only one port is activated at a time. Using a single mouse we can do the process of the CCTV system having a large no of cameras. This device has several advantages they are,

- Low price
- Easy to use
- Lower initial cost
- Minimum video losses

Although USB switcher available in the market highly expensive than this one. Because of that it can be implemented for large CCTV projects.

#### **4. CONCLUSION**

The purpose of this project was to design a simple, low cost but reliable USB Switcher for CCTV systems. It is easy to handle the entire system. Also with the designed switcher it can use for the other similar systems not only CCTV system. This was practically used in CCTV systems at Wattala Toyota Company.

#### **ACKNOWLEDGEMENT**

The authors would like to acknowledge and extend gratitude to the persons who have helped to make this project a success.

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## **RADIO FREQUENCY ENERGY HARVESTING SYSTEM**

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### **ABSTRACT**

Recent advances in ultra-low power wireless communications and energy-harvesting technologies have made self-sustainable devices feasible. Typically, the major concern for these devices is battery life and replacement. This paper presents a study of ambient RF energy harvesting technique, in which the radiated RF energy from ambient is extracted and converted into usable energy to power up devices. Applying energy harvesting techniques to devices can significantly extend battery life and sometimes even eliminate the need for a battery. The preliminary results indicate that the recovered energy is not sufficient to directly power devices but could be stored in a super-capacitor.

**Keywords:** harvesting energy, RF energy, Schottky diode, Voltage doubler

### **1. INTRODUCTION**

Radio frequency energy is emitted by sources that generate high electromagnetic fields such as TV signals, wireless radio networks and cell phone towers, but through using a power generating circuit linked to a receiving antenna; this free flowing energy can be captured and converted into usable DC voltage. The circuit systems which receive the detected radio frequency from the antenna are made on a fraction of a micrometer scale but can convert the propagated electromagnetic waves to low voltage DC power at distances up to 100 meters [2].

We are being bombarded with energy waves every second of the day. Radio and television towers, satellites orbiting earth, and even the cellular phone antennas are constantly transmitting energy. What if there was a way we could harvest the energy that is being transmitted and use it as a source of power? If it could be possible to gather the energy and

store it, we could potentially use it to power other circuits. In the case of the cellular phone, this power could be used to recharge a battery that is constantly being depleted [6].

There are many complications to be dealt with. The first major obstacle is that it is not a trivial problem to capture energy from the air. We will use a concept called energy harvesting. Energy harvesting is the idea of gathering transmitted energy and either using it to power a circuit or storing it for later use. The concept needs an efficient antenna along with a circuit capable of converting alternating-current (AC) voltage to direct-current (DC) voltage [2]. The efficiency of an antenna is related to the shape and impedance of the antenna and the impedance of the circuit.

In this study it was attempted to design a feasible Radio Frequency Energy harvesting system.

## 2. EXPERIMENTAL

According to the Objective, the system shown in the figure 1 was designed.

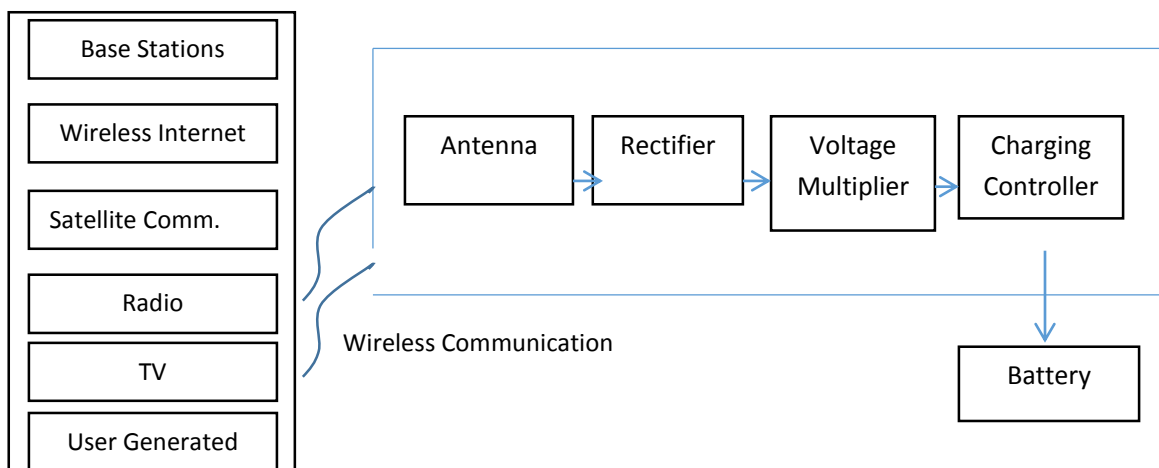


Figure 1: Basic block diagram

As for the Antenna widely available CDMA antenna and cellular antennas were used. For converting Radio frequency to DC, a rectifier circuit is used. A charge pump circuit such as a voltage doubler (multiplier) circuit can be used as the rectifier. A charge pump is a circuit

which with two diodes and two capacitors and gives the output as twice as the input, as shown in Figure 2 [3].

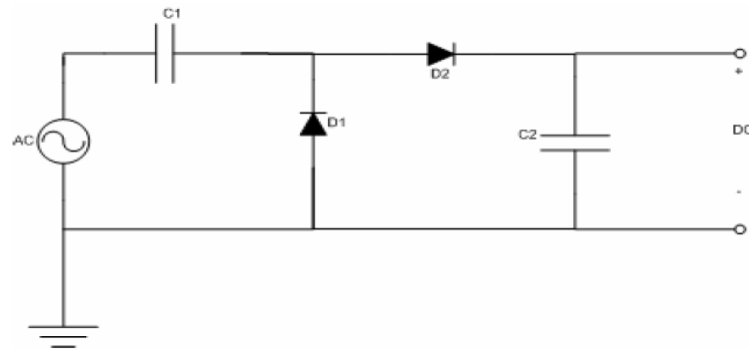


Figure 2: Single stage voltage multiplier circuit

It has been observed that the number of stages is essentially directly proportional to the amount of voltage obtained at the output of the system. Generally, the voltage of the output increases as the number of stages increases [1]. This is due to how the voltage multiplier works. In this paper a seven stage voltage multiplier circuit consisting of diodes and capacitors has been used for the rectifier and for the voltage multiplier as shown in Figure 3. Here the diode used is a schottky diode (HSMS 2820) because of its low forward voltage of 0.34V and high switching speed.

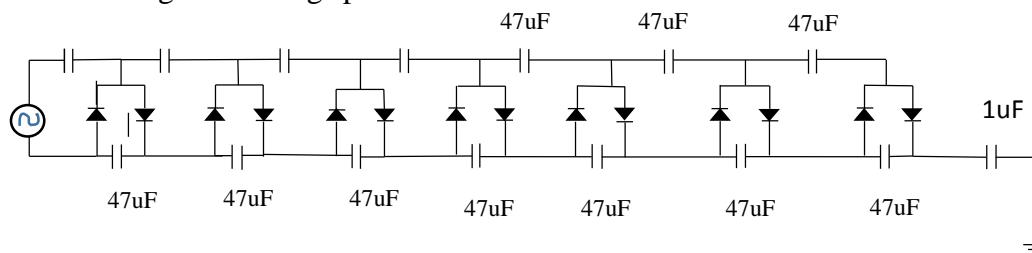


Figure 3: Seven stage voltage multiplier circuit using LTSpice

The capacitor values were changed and the output was observed. The capacitor value of 47uF gave the highest output, therefore 47uF was been chosen as the capacitor values. After all the simulations were run using the same capacitance for each stage, a simulation was run using varied stage capacitances between stages. The capacitance was varied in such a way that, from one stage to the next, the capacitance was halved. So, if the first stage was 47μF, the second was 22μF, third was 10μF, and so on. But, values were used so that they matched a component that was available in commercial components for testing. This meant that the 23.5μF capacitors were actually 22μF, and the 11μF capacitors were 10μF.



After studying the two simulations it was observed that the resulting output voltages were equivalent except for the rise time. The rise time for the circuit with different capacitor values for each stage was slower than the circuit which has the same capacitor values for each and every stage.

For the charging controller a super capacitor of 1F has been used. . A super capacitor with 1F was selected as it has less self-discharge ability and low internal impedance.

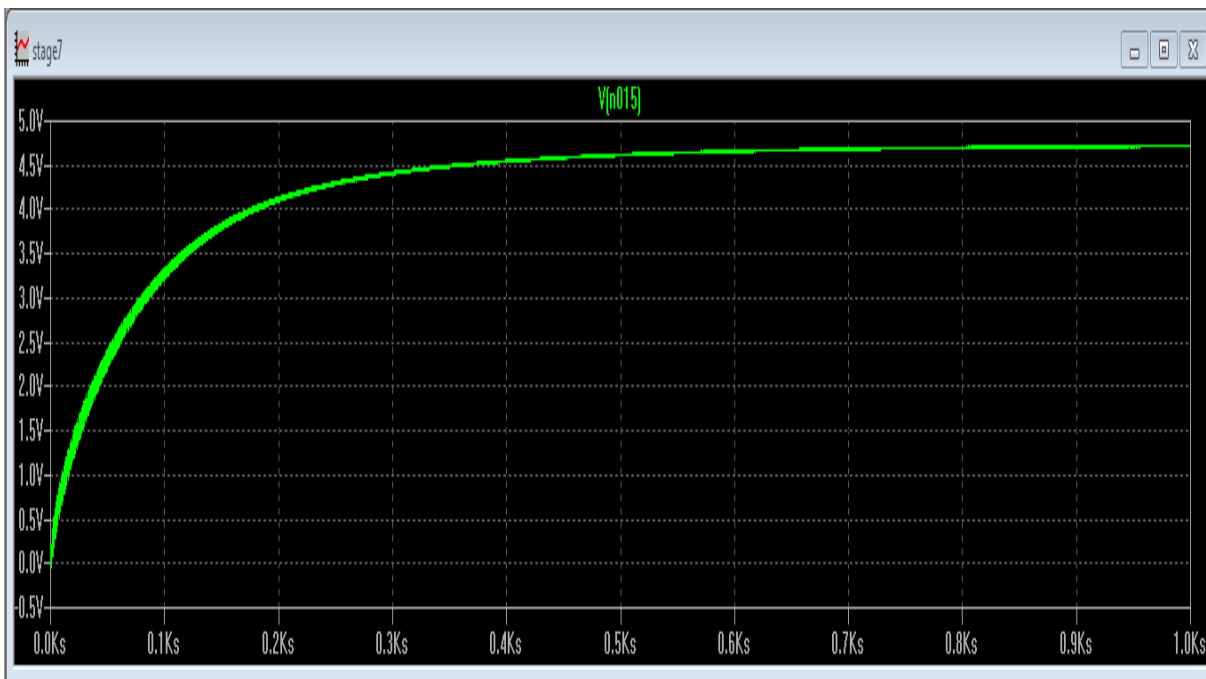


Figure 4: Simulation results for a seven stage voltage doubler circuit

### 3. RESULTS AND DISCUSSION

The final outcome of this research is a development of a DC current using freely available Radio Frequency signals. This is a very reliable system since the power source can be controlled and has minimum effects from weather. This is also a low cost, wire free device.

The DC output, harvested with the implemented system is very low. The level of RF energy and the mismatching of the antenna to rectifier are the causes of this low level DC output. The use of antenna arrays can increase the RF power and the DC output but for attended the significant DC level the size of the array must become very large.

#### **4. CONCLUSION**

The study and the implementation presented in this paper is an attempt on harvesting freely available Radio Frequency energy as a power option. It is found that we can harvest energy in micro watt range from ambient RF sources. Here the harvested power highly depends on the distance between the transmitter and RF harvesting system. By using an array of harvesting antennas we can harvest considerable amount of power.

#### **ACKNOWLEDGEMENTS**

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## **ENDURANCE TESTER FOR DETECTION OF FAULTY POINT IN SWITCHES AND SOCKETS**

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### **ABSTRACT**

This paper describes the design of system that detects the faulty point of the switch/socket of the endurance tester. This endurance machine is used to test switches/sockets for their endurance about 15000 or 20000 times by switching the switches on and off. The endurance machine also helps to identify the lifespan of switches for household and similar fixed electrical installations. Besides, it is also applied in the test of breaking volume of plug and socket, and mechanical action of normal operation lifespan. It uses a dolly counter, which is designed to on/off switches automatically until it reaches to given number of counts. The main drawback is that the machine cannot record the count which is having highest probability to break the switch. After operating the given number of counts, a visual inspection is needed to check the faults and defects in the tested switches and sockets. The main problem in the existing endurance machine is that it is not capable of find the exact point where the failure occurs. This study proposes a new method to solve this problem and find the lifespan of a switches and sockets, which is very important for quality control of the production line.

**Keywords:** Switch, Socket, Endurance, Defective Count

### **1. INTRODUCTION**

The endurance machine for switch/socket endurance testing is a customized machine built with necessary requirements for standard testing (IEC standard-60669). It is used to check whether the switches or the plugs and sockets can endurance the mechanical damage or electric fatigue failure during the normal operation. Whether the contact adhesion occurs or there is a phenomena of being the on (off) station for a long time, which is the criterion of judging the sample is over damage or not. Therefore study about this special tester is performed initially. Overall process of current controlling, pneumatic mechanism of the

endurance tester is inspected thoroughly. Apart from this new technologies are used in various switch socket tester. Some of the existing systems are explained below.

### Switch and Plug-Socket Endurance Tester SLT-3<sup>7</sup>



Figure 1: Switch and Plug-Socket Endurance Tester SLT-3

The test machine is designed and manufactured according to IEC60669-1 standards. It can do endurance testing for button switches, toggle switches, rocker switches, push switches, rotary switches, plug and sockets. Coupled with the load (resistive, inductive, capacitive) can process loading test, it has a corresponding PLC control system.

It is applicable for household and similar fixed electrical installations' breaking capacity and normal operating life test, also suitable for household and similar uses plug/ socket's breaking capacity and normal operating life test. The purpose is assessing whether the switch is able to withstand the normal use of mechanical damage and electrical fatigue damage, and whether the contacts has adhesion phenomenon, long-term closed or disconnected phenomena, to examine whether the test samples excessive worn and have other harmful consequences. It is a special test equipment for switches and plug-sockets electrical endurance test.

### Switch Endurance Test machine<sup>6</sup>



Figure 2: Switch Endurance Test machine

Switch tester model SW-800D is equipment for switch testing in durability of a switch under a simulation. Providing various test equipment for reducing the product operation failure and maintaining the quality are our main objectives. Switch Tester is suitable for test Rocker Switch, Wall Switch, Push Button Switch, Slide Switch, Micro Switch, Limit Switch, Vibration Switch...etc. Multi-functions of the Switch Endurance Tester are absolutely value added and able to connect with personal computer for viewing the test

reports and data. Switch Endurance Tester has been widely adopted by many international well know test laboratories and enterprises around the world.

### Plug Socket Insertion Endurance Machine<sup>8</sup>



Figure 3: Plug Socket Insertion Endurance Machine

In order to ensure that the quality of plug and socket is in accordance to meet the EN60335 standard, several inspection test machine are provided to help client to minimize the risk of getting defective and control the quality of production. Plug Socket Insertion Endurance Machine was designed for determine the life test of plug and socket by moving backwards and forwards as simulate actual use. The information resulting from this quality test can be used to determine the exact source of imperfection. Several famous laboratories around the world have used this model.



Figure 4: X5 switch TEST IN THE tester



Figure 5: 13A socket test in the tester

## 2. EXPERIMENTAL

Before designing the main modification circuit, the existing control circuit of the tester is inspected. After that, various circuits are analyzed to sense such devices and their functionality. LDR, Atmega328P microcontroller and Buzzer are used as major components in designing. Initially, current line from the endurance tester is taken for the analysis in our system. It's fed to the LED to identify whether the signal is approached to the system. When the LED light up, LDR<sup>3</sup> sensor circuit is utilized to detect the variation in light. Detected variation in the signal is stored in the microcontroller<sup>1</sup> memory. When the switch socket tester is in activated mode the counting process in continuously running and in that case corresponding variations of signal is stored as we mention earlier. There were two reasons to store those data's such as.

- To maintain the counting process continuously when a power failure occurred.
- To run the machine continuously without blocking the pneumatic dolly.

Stored data are compared with incoming data and analyzed to detect the error point of the counting process.

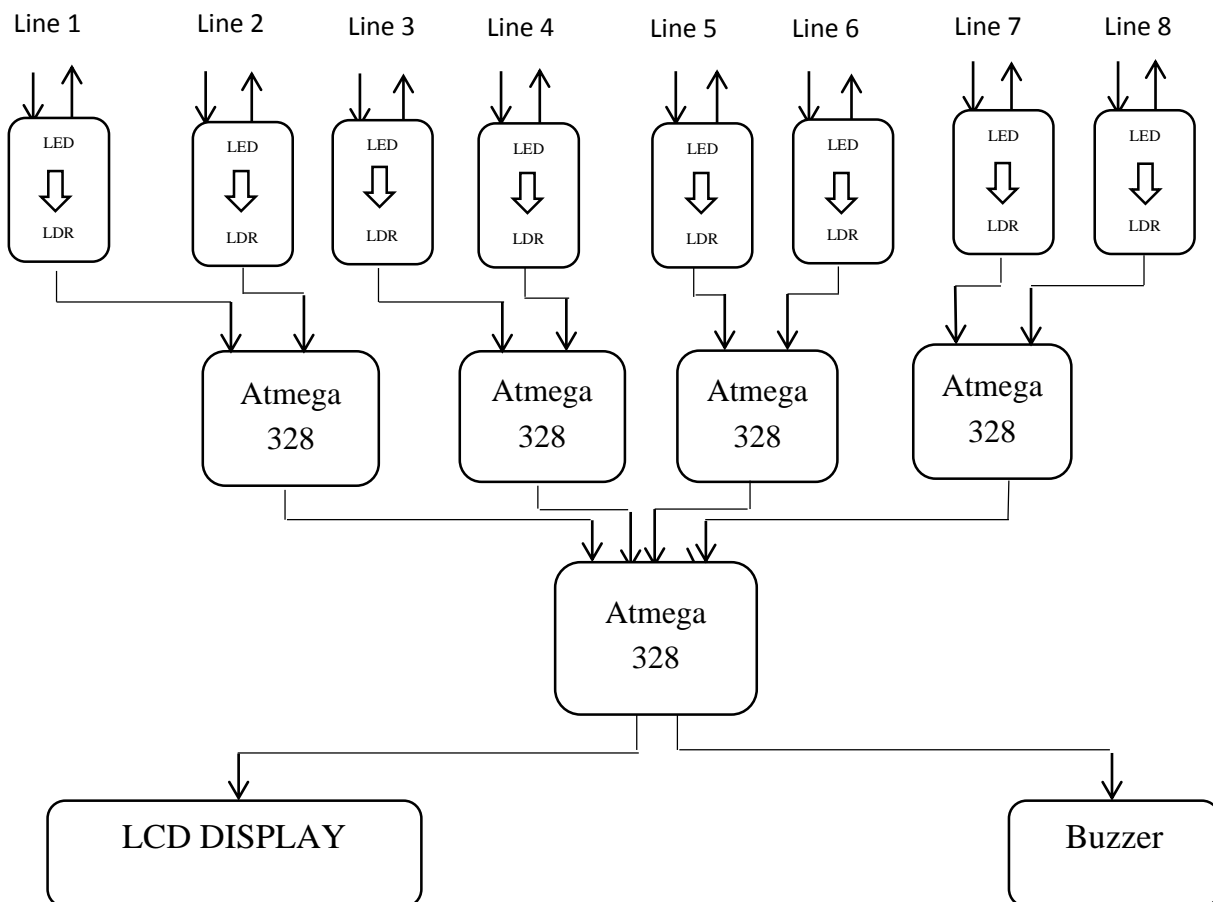


Figure 6: Schematic of the Circuit Diagram

X7, X5 & Bit Rocker series of switches in various brand names (Kevilton, Chint, Orange, Schenider) were tested in the newly designed faulty detection system.

Table 1: Result Details

Brand Name	Type of the Switch/socket	Completed cycles Pass/Fail
Kevilton	X5- 2gang , 3gang	15000 – pass, pass
	X7- 2gang , 3gang	15000,9700 – pass, fail
	45A appliance switch	1900 – fail
Chint	X5- 2gang , 3gang	15000 – pass, pass
	X7- 2gang , 3gang	1700, 1850 – fail, fail
	45A appliance switch	15000 – pass
Orange	X5- 2gang , 3gang	15000 – pass, pass
	X7- 2gang , 3gang	15000 – pass, pass
	45A appliance switch	1950 – Fail
Schenider	X5- 2gang , 3gang	15000 – pass, pass
	X7- 2gang , 3gang	15000 – pass, pass
	45A appliance switch	15000 – pass

Chint-2gang, 3gang and Orange 45A appliance switches are failed in 1700-2500 count range from 15000 counts. Further Kevilton X7 series 3 gang failed in 9770 counts. Our systems showed the exact point on the LCD screen where the failure occurred. The results show that the system works accurately to capture the point where the switch or a socket fails to operate. When comparing the system with the previous system, not only visual inspecting the defected of the switches and sockets, but also the new system can detected the error counting point using this sensor circuit. The cost for the system is around 5000/= Sri Lankan Rupees.

#### 4. CONCLUSION

We have designed a system using an ATmega microcontroller to find the faulty point of endurance testing of switch/sockets. This system adds extra features to the existing endurance machine and it provides valuable information for quality control division to produce reliable products to the market. This study can be extended to find the faulty point due to different current flows through the switches and sockets using current sensors, which provides full-featured endurance testing capability.



## **ACKNOWLEDGEMENTS**

We wish to extend their gratitude for the assistance given by the staff of the quality assurance department of Orel Corporation and thank all who have supported to make this project a success.

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## **DESIGNING A PORTABLE SIGNAL TO NOISE RATIO (SNR) DETECTOR**

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### **ABSTRACT**

High speed internet access network is enabled by Sri Lanka Telecom PLC (SLT) in island wide for the customers. The speed and quality of a broadband line depends on several factors. One of the most important factors is noise which affects the speed and the quality of broadband line. Signal-to-Noise Ratio (SNR) is a measurement that is related with noise. SNR compares the level of a desired signal to the level of background noise. Most of the times, technical assistants reach the customer premises and then resolve faults in megalines. SNR value of that particular line is an important factor when resolving troubleshoot in a broadband line. An instrument is available in SLT for SNR detection which is expensive and complicated. Due to this reason, it is used in rarely by people who are in the field. The main objective of the project is implementing a low cost SNR detector for broadband line with the facility of portability. Benefits of this device can be gained by people who are in the field without any discomfort.

**Keywords:** Signal-to-Noise Ratio, Broadband Line

### **1. INTRODUCTION**

Sri Lanka Telecom PLC (SLT) is the largest telecommunication service provider in Sri Lanka. SLT provides both voice and data service to the customer. There are several factors that affect the speed and the quality of a broadband line in SLT. The most important factor is noise. SLT is always attentive for maintenance and tries to provide a good quality service for their customers. Most of the times, technical assistants reach the customer premises and then resolve the reported faults. When resolving a troubleshoot in a broadband line, one of an important factor is Signal-to-Noise Ratio (SNR) value of that particular line. Usually, they use two options to find SNR value in a line. One method is calling the Network Operation

Center (NOC) over the phone and gets the value. The other method is logging in to the router and checking SNR value. Already there exists SNR testers in SLT, which are expensive and complicated. Due to above drawbacks, most of the technical assistants not prefer to use SNR testers. The goal of this project is to develop a device to detect SNR value in a high frequency line as a simple, low cost implementation with the facility of portability to outcome the above drawbacks. Filtering techniques and microcontrollers have been used to input signal analyzing and calculations. This is used to get SNR value of a broadband line at any point in copper transmission medium with high frequency signal. Public Switched Telephone Network (PSTN) and Asynchronous Digital Subscriber Line (ADSL) operate at different frequencies. They can be carried through the same wire at the same time when the operating conditions are correct. Voice calls operate within a narrow frequency range and ADSL operates between 25.875 kHz and 1.1 MHz. Following figure (1) shows frequency allocation for PSTN and ADSL in SLT.

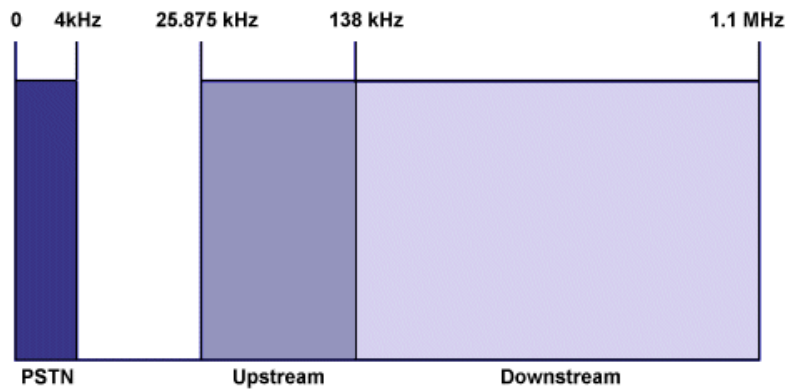


Figure 1: Frequency allocation for PSTN and ADSL

Filtering techniques have been used to separate both signal and noise. Filters are networks that process signals in a frequency-dependent manner. Band pass filters have been used for filtering specific bandwidth and band reject filters have been used for rejecting a particular band width.

## 2. EXPERIMENTAL

SNR is defined as the power ratio between a signal (meaningful information) and the background noise (unwanted signal). SNR is often used to measure the quality of a system. It is given in decibel (dB).

$$\text{SNR (dB)} = 10 \log \left( \frac{\text{Signal Power}}{\text{Noise Power}} \right) \quad (1)$$

This can be written equivalently using amplitude ratios as;

$$\text{SNR (dB)} = 20 \log \left( \frac{\text{Amplitude of the Signal}}{\text{Amplitude of the Noise}} \right) \quad (2)$$

The frequencies of both ADSL and PSTN transmit in a single wire. Then, it is separated while transmitting through filters. Microcontroller detects separated signals as “Noise” and “Signal” and SNR value is calculated according to the equation(2).

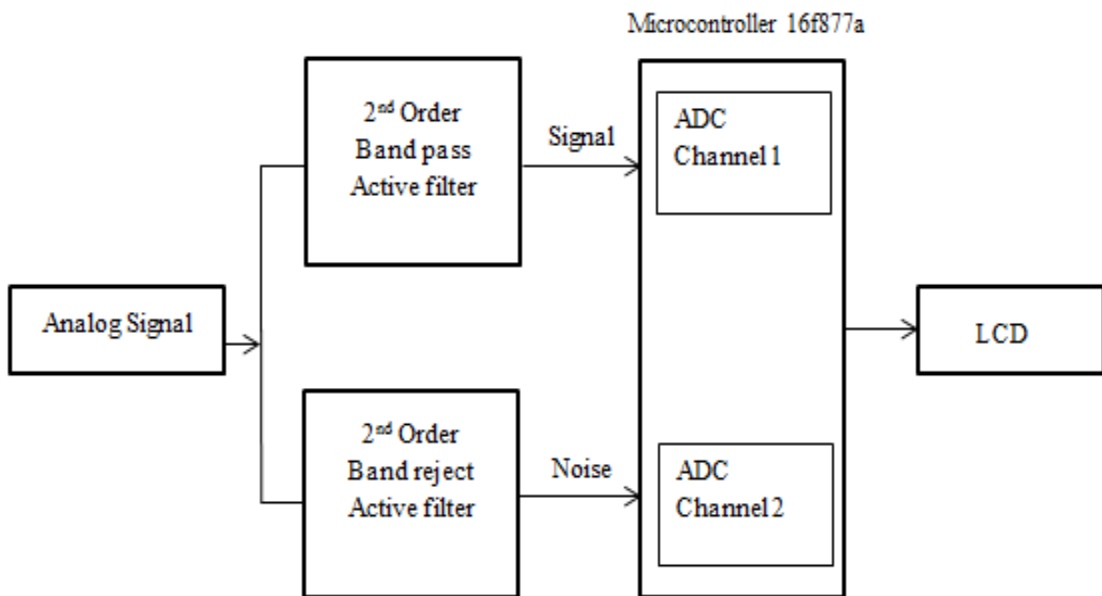


Figure 2: Block diagram of the system

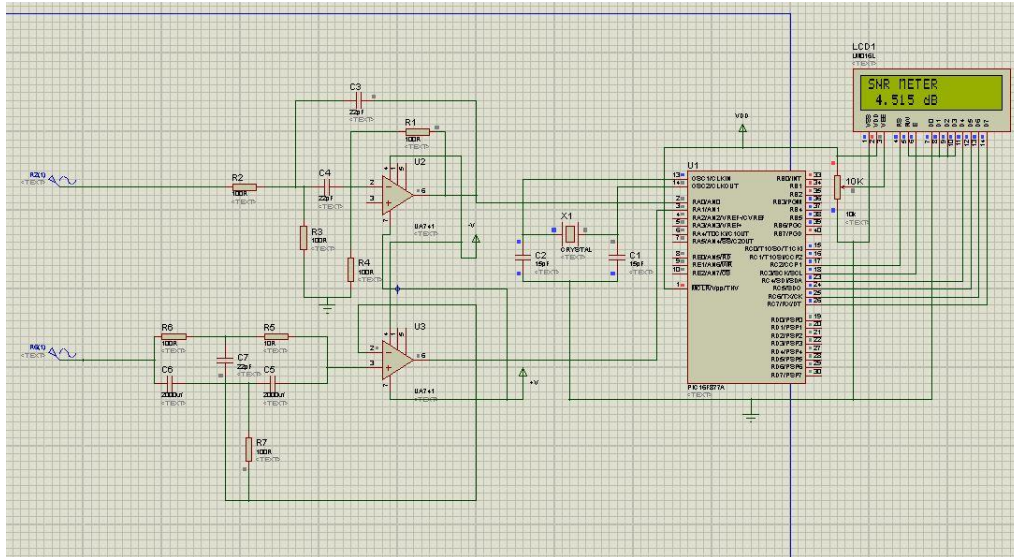


Figure 3: Circuit diagram of the system

### 3.0 RESULTS AND DISCUSSION

#### 3.1 Results

All the separate circuits have been tested individually before simulation and then integrated as a whole circuit. Results were observed using different sinusoidal signals with different frequencies and amplitudes for two inputs. Results are given below. SNR values were calculated as per equation (2).

Table 1: SNR values for different sinusoidal signals

Input as signal with 10 kHz (V)	Input as noise with 15 kHz (V)	SNR value on LCD (dB)	Calculated value (dB)
48.5	45.5	0.58	0.61
46.0	42.0	0.75	0.79
45.5	39.5	1.18	1.23
44.0	35.0	2.01	1.99
43.5	32.5	2.50	2.53
42.0	30.0	2.89	2.92
41.5	26.5	3.82	3.90

### 3.2 Discussion

This portable SNR detector can be used to check SNR value of an analog signal. This is most useful for getting SNR value of a broadband line in Outside Plant Network (OSP). The existing instrument for SNR detection is about two lakhs in rupees and it can be used for many testing in addition to SNR detection. Advantages of this implemented device are user friendly and less complicated, low cost and easy to use for analog signal with fast response. This device can be used without having any expertise knowledge and SNR value can be seen on the LCD in dB.

### 4. CONCLUSION

This implementation can increase effectiveness of the workers and get accurate SNR value at any point in copper access network. Maximum sampling frequency of PIC16F877A microcontroller is 50 kHz. Therefore, this device can be used for frequencies up to 50 kHz. 10 kHz and 15 kHz signals have been used for testing purposes of the device. The broadband bandwidth in SLT is 25.875 kHz to 1.1 MHz. Hence, the microcontroller used in this project is suitable for a part of bandwidth. To cover the whole range, Field-Programmable Gate Array (FPGA) can be used which is bit expensive than PIC microcontroller. FPGAs are programmable semiconductor devices that are based around a matrix of configurable logic blocks connected through programmable interconnect with up to 300 MHz frequencies.

### ACKNOWLEDGMENTS

Authors would like to acknowledge and extend heartfelt gratitude to Department of Electronics, Wayamba University of Sri Lanka.

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## EVALUATING PERFORMANCE OVER UHF AND RESEARCHING FOR HIGH GAIN TV ANTENNA

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### ABSTRACT

Ultra high frequency (UHF) is the ITU (International Telecommunication Union) designation for radio frequencies in the range between 300 MHz and 3 GHz, also known as the decimeter band as the wavelengths range from one to ten decimeters. Radio waves with frequencies above the UHF band fall into the SHF (super-high frequency) or microwave frequency range. A television antenna is an antenna specifically designed for the reception of over-the-air broadcast television signals, which are transmitted at frequencies from about 41 to 250 MHz in the VHF band, and 470 to 960 MHz in the UHF band in different countries. This antenna design is for UHF TV band. Main purpose of this design is to give good UHF reception for the users. This is an out-door antenna which can be modified to use as indoor antenna as well. The materials that need to build the antenna are cheaper and easy to find in local market. The constructed antenna with new design could be used to obtain high gain with low cost (unlike boosters with high power consumption) as well the HVS (Human Visual System) measurement verifying the clear and increased resolution on the TV screen. The clarity in reception for our constructed antenna is 75% (using 5 viewers) than obtain by using commercially available UHF antennas.

**Keywords:** *Modified high gain antenna UHF Antenna, Human Visual System (HVS)*

### 1. INTRODUCTION

In Sri Lanka people tends to use many type of antenna. They appeared differently but technology behind is the same. The concept of Yagi<sup>1</sup> Antenna design and Loop antenna designs are widely used (Shown in Figure 1).But original Yagi antenna design not equipped with high gain. The signal to noise ratio is very high. But in my design it is high gain when comparing to the ordinary UHF antenna designs. Technically our design have vertically polarized, 7-10dB gain and 75 ohm co-axial cable.



UHF is the most commonly used frequency bands for transmission of television signals. Modern mobile phones also transmit and receive within the UHF spectrum. UHF is widely used by public service agencies for two-way radio communication, usually using narrowband frequency modulation, but digital services are on the rise. Narrowband radio modems use UHF and VHF frequencies for long range data communications; e.g. for supervision and control of power distribution networks and other SCADA and automation applications. There has traditionally been very little radio broadcasting in this band until recently. The Global Positioning System also uses UHF.

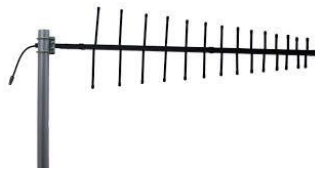


Figure 1: Yagi Antenna<sup>1</sup>

## 2. METHODOLOGY

When considering material and components used in implementation of this project, we have to consider five categories. They are PVC frame, wire mesh, PCB, metallic element, co-axial cable. It uses very cost effective materials to implement. Frame is constructed using PVC water pipes. 0.5'' gauge PVC pipes are used with to construct antenna elements. Theoretically, in each and every antenna design there should be a good reflector to get good reception. But, without a reflector some designs have good reception. As an example, Yagi design doesn't have a reflector<sup>1</sup>. But in this case we have used a wire mesh as a reflector but with a Aluminium foil in order to get a better reception. This proposed design is a vertically polarized antenna, due to the direction of the wind, the structure with all covered reflector has no stability. Therefore, the wire mech is a good reflector for an antenna. A PCB is designed to connect the co-axial cable to the antenna and added some extra port to connect to co-axial cable to the same PCB. So that antenna can connect two TVs at the same antenna. Also added series inductor to match the impedance to 75 ohms.

The copper elements will absorb the signals reflect from the wire mesh and then they will transport to the PCB. In every antenna design elements are the signal absorbers with or without the reflector. In the proposed design we have used gauge 8mm copper wire folded as below (figure 3) as the driven element.

The coaxial cable is used as a transmission line for radio frequency signals. It is connecting radio transmitters and receivers with the antennas and distributing the cable television signals. One advantage of coaxial over other types of radio transmission line is that in an ideal coaxial cable the electromagnetic field carrying signal exists only in the space between the inner and outer conductors<sup>2</sup>. In our design we have used RG59B/U type cable<sup>3</sup>.

For most of TV antennas this cable is used. Since it has normal impedance matching as at 75 ohms and nominal attenuation is much low<sup>4</sup>.

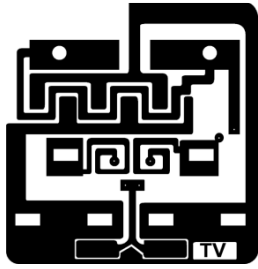


Figure 2: PCB Design

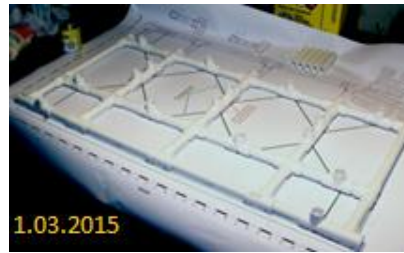


Figure 3: PVC Frame

### 3. RESULTS AND DISCUSSION

The proposed UHF antenna is designed to work as high gain antenna. Typically the gain is in between 7dB-10dB. Despite of the location the receptions were good.



Figure 4: The constructed proposed antenna

The antenna was tested in both Pandura and Gampola areas for reception. For capturing images a TV card was used. Components used in this project cost are Rs.1500.00. Considering cost with gain of this design 75% effective than compared to a commercially available antenna.

Further, Development of this antenna can be done using the following ideas,

- The gain can be increased by using a booster circuit.
- With the use of loop antenna design easily upgradable for UHF/VHF antenna
- By using a UHF signal filter circuit the noises can be removed

- This proposed antenna design will be commercialized as a new antenna design by Sri Lanka's well known antenna manufacture; IE Technics Pvt Ltd.

The Primary advantages of our antenna are low cost design, high gain, easily upgradable and can also upgradable to receive any type of UHF/VHF signals. The disadvantages are larger in size, wind is an obstacle for holding it upright. Because of vertical polarization effects the Design is rather complex.

#### **4. CONCLUSION**

The high gain UHF antenna can be used in UHF TV band. This antenna design can be improved by adding much sensitive signal boosting circuit. The design uses low cost components and available in local hardware stores.

Most of the UHF antennas built for single purpose. But this design can easily modified for other applications such as radio communication transceiver, radio beacons (tsunami boyars) captures and receiver for radio tagged devices (wild elephant tagging).

With some miner modification to the antenna design this model can be used as indoor UHF TV antenna, and also can be used as UHF receiving antenna for other applications. According to this study, this antenna can be used as radio frequency capture for small RF signals.

#### **ACKNOWLEDGEMENTS**

The authors would like to acknowledge and extend heartfelt gratitude to the people who have helped to make this project success.

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## HARNESS TESTING AND LIVE DATA UPDATING SYSTEM

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### ABSTRACT

Automobile Wire harness is one of the most essential parts of electronic mechanism. It serves as bridging and connection among various parts together in order for machine to work. There are many kinds of wiring harness in complete automotive body.

When manufacturing seat belt harnesses should be in exact quality because the seat belt prevents this from happening by restraining passenger movement and holding the passenger in place. The passenger may end up with bruises from the seat belt, but these are minor compared with the injuries that would otherwise occur.<sup>1</sup>

Therefore for the testing harness should be done in proper way. For this Wireless Harness Testing machine could be proposed. There is another major difficult is that factory managers needed identify progress of the production randomly. In this case the existing system is only attending to each line supervisor for check progress of the production.

For above identified problems as a solution, Harness testing and live data updating system can be proposed that will store testing results in real time in a database and shows in a wide screen. Through this automation system, data loss will be eliminated and human interaction for collecting data is excluded therefore managerial staff will be beneficial through this proposed system since production data relevant to the harness testing machines can be gathered quickly via the display of the system.

**Keywords:** Automobile, Harness, Automation, Android

### 1. INTRODUCTION

Tos Lanka Co (Pvt) Ltd is renowned as valued wire harness manufacturer for our high quality wire harnesses in Sri Lanka. Tos Lanka Co (Pvt) Ltd has been serving as wire harness supplier to leading countries such as Japan, Europe, North America and India and many other renowned brands of automotive industry.

Other than being top quality automotive wiring harness manufacturer, Tos Lanka Co (Pvt) Ltd is able to manufacture wire harness as per the desire of valued clients and customers. Buyers can send their samples or wiring harness diagram as the orders to the company, therefore the company would be able to manufacture them exact replica of their wiring harness as they expected desired quality.

The company factory No.2 is mainly producing wire harnesses. For the testing of the quality of the Wire harness a machine is used to check the faulty items. In the factory the items are known as “Good” or “Not Good (NG)” items. The machine capable of detect following.

- Harness is short circuited.
- The wire connections are not in order.
- Wire connections loosely tied.

If the above conditions are satisfied then the testing machine recorded the harness is not good (NG) otherwise recorded as good.

## 2. EXPERIMENTAL

The block diagram of the proposed system for Harness testing and live updating system is shown in the following Figure1.



Figure 1: The block diagram of the harness testing and live updating system

The Harness testing and live updating system has three major components.

- Wireless harness testing machine
- Android application server
- Main server database

### 2.1 Wireless Harness Testing Machine

For the new testing machine the main circuit board extended with another Atmega328P microcontroller for collect data from the PIC16F876A secondary microcontroller. After data is collected from the secondary microcontroller, the Atmega328P microcontroller started to

communicate with ESP8266 Wi-Fi module. When the Wi-Fi module is able to establish the connection with the Android server, then the testing machine is started to send data to the Android server. After completion of the data sending the testing machine disconnected the connection with the android server for allowing other machines to communicate with other testing machines. After few seconds the wireless testing machine starts to sending requests to the Android application server. This whole process running again and again to keep Android application server and Main server database is to be updated.

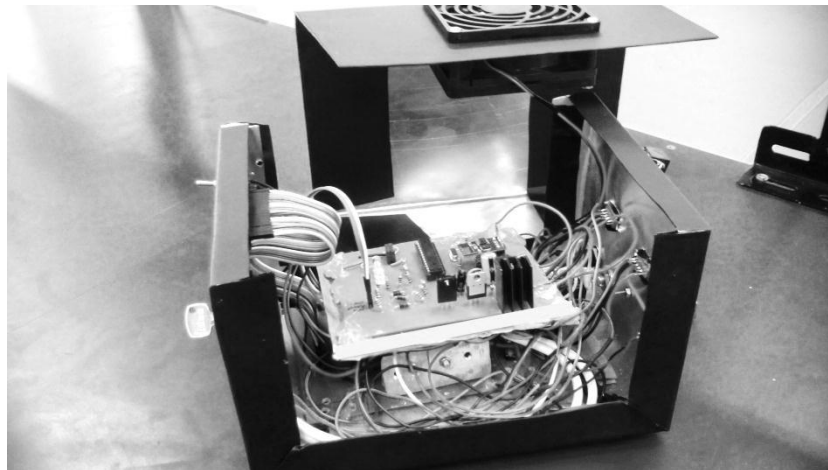


Figure 2 : Wireless harness testing machine

## 2.2 Android Application Server

Android application server is designed to match with the Hackberry A10 device. Android language is used to develop the Android application server. The Android application server is able to communicate with every Wireless testing machine via Wi-Fi. But only one testing machine can send data to the Android application server at a time.

After completing the data receiving from one testing machine the Android application server recorded the data, and send data to the main server database through Wi-Fi. And the same time the Android Sever updated the screen. Storing data in the main server database is also controlled by the android server. PHP script manages the database connection and run this script using HTTP protocol from the android server. Therefore the Android server is able to update the main server database at the same time.

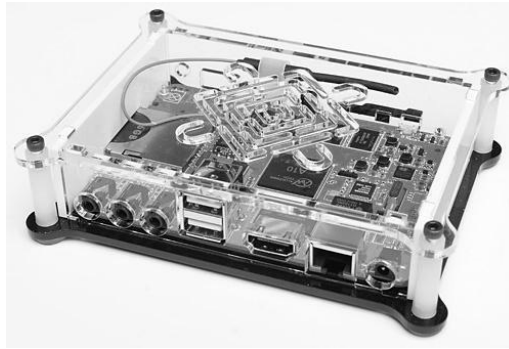


Figure 3 : Hackberry A10

### 2.3 Main Server Database

MySQL workbench is used to build the database for the Wireless Harness testing system. The tables were created for each testing machine to store live data. Only authorized persons could see the content of the database because the MySQL database is protected by using a password.

Altogether above major components will make complete Harness testing and live updating system. Using this completes system the company is able make exact quality of wire harnesses.

## 3. RESULTS AND DISCUSSION

Developed Harness Live Data Updating System consists following main parts.

- Showing live data in a LCD screen through Wi-Fi.
- Sending the live data to the main server database through Wi-Fi.

In order to observe proper outcome of the system, above mentioned parts should be precisely operated simultaneously.

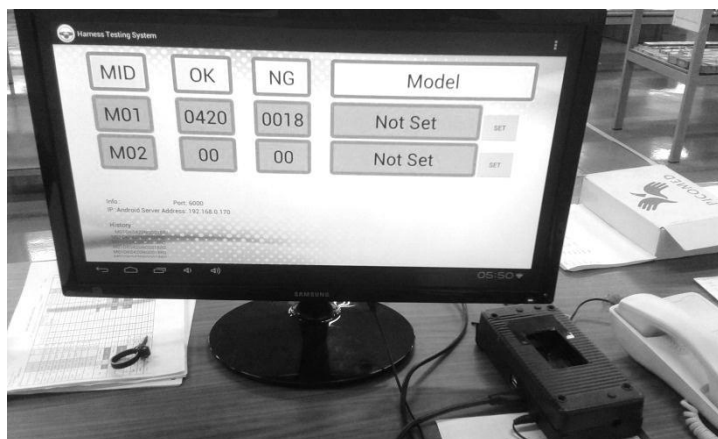


Figure 4 : Android application server output

The major task to achieve during the development of this system was to avoid data loss and human interaction for collection data. Therefore managerial staff will be beneficial through this proposed system since production data relevant to the harness testing machines can be gathered quickly via the display of the system.

The system was tested after completing the designing. It worked successfully. This project reflects optimum solution for the above described issues with most appropriate and cost effective manner.

#### **4. CONCLUSION**

The existing testing machine which had previously is only able to check quality of the wire harness. By this improved of implementation system, if a testing machine is fails, the data not getting lost due to the failure. Therefore production process never getting slow due to failure, because laborers do not require recounting manually. Also there is another advantage regarding the developed system for the factory managers, if they needed to identify the progress of the production randomly they do not necessary to attending to each line supervisor for check progress of the production. Only they have to log into the main server database and they could download what they want immediately.

Since most of the times customers are visiting to the company therefore the implemented system shows the ongoing process of the production lines. Therefore customers would get satisfied by looking at the company ongoing process of the production line and can increase their business with the clients by getting orders from the foreign countries as well as the local market according to the requirements.

After completing the project, the completed system was tested at the company. The system was worked successfully. Especially displaying data and updating the remote server database are can be monitored quickly. When considering the system especially the technology that used, the system can be implemented for any kind of real time data logging.

#### **ACKNOWLEDGEMENTS**

Authors would like to extend their sincere thanks to all specially Tos Lanka Co (Pvt) Ltd staff that helped to perform this study successfully.



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## DESIGNING A LOW COST REPEATER FOR GSM 900 BAND

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### ABSTRACT

Most of the times customer complaints in mobile telecommunication system are filled with low signal coverage. When providing a solution to customers who are not having stable network connection, it is possible to use a repeater solution for underground buildings, a building fully covered with other buildings from outside, geographically un-visible areas and far places from RF range. To have good coverage level inside or outside it is needed to amplify the signal levels and serve customers by amplified signal. To solve these kinds of issues in mobile networks it is need to place a suitable equipment at the customer's location. An equipment is used to amplify the signal level into suitable percentage. The device which is used to do the amplification is called a repeater. But the existing systems are very expensive and they amplify another subscribers frequency bands as well. In this study, it was decided to provide a solution to this problem is reported. For that, ADL5545 was used as preamplifier, HMC476MP86E used as a power amplifier, Band pass filter was used to filter the required GSM 900 frequency band. It has a filter called as B67900M1 which is having high accuracy. Transmitting and receiving antennas were used as a purpose of transmitting and receiving of GSM 900 Band. System has total gain of 50dB and having the 50dB uplink gain and 50dB downlink gain. The uplink is amplified and filtered for the GSM 900 (885MHz to 892.5 MHz) frequency band and the downlink is amplified and filtered for the GSM900 (930MHz-937.5MHz) frequency band.

**Keywords:** Customer Complaint, Pre amplifier, Power amplifier

### 1. INTRODUCTION

Repeaters are available in telecommunication market nowadays. These repeaters are universal and make huge costs for installation and maintenance<sup>1</sup>. The service provider is using 900MHz, 1800MHz for 2G (GSM) and 2100MHz for 3G services. Basically the repeaters which are available at the telecommunication market are having the facility to

function on 2G (900 & 1800) and 3G (2100). These are functionally well but are very costly. When a customer only requires 3G or 2G, it cannot be selected from repeater because it's coming with dual band supported. In the present method, low cost repeater solution is provided for low signal coverage. This proposed system includes a solution for the band selection while solving coverage problem. Also it has the ability to filter the GSM900 frequency band and then do the amplification.

## 2. EXPERIMENTAL

The block diagram of low cost repeater system is shown in figure 1.

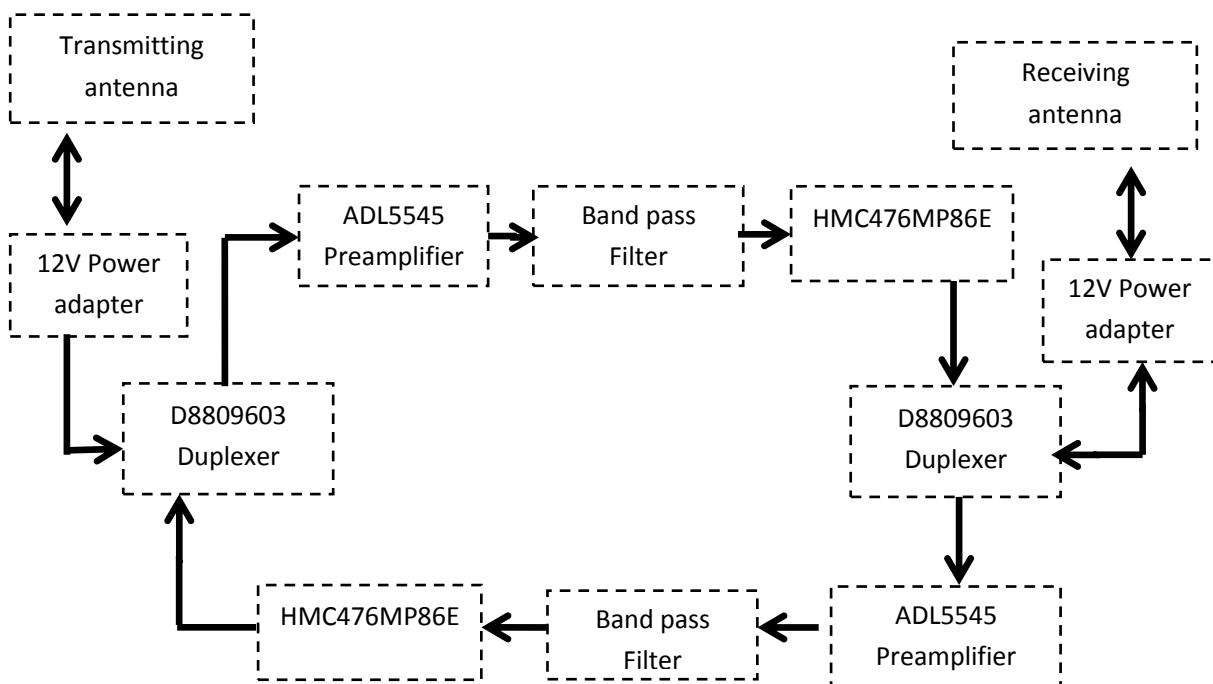


Figure 1: Block Diagram of Low cost repeater

The input/output connector of the repeater is SMA Female type and a communication method is Duplex Communication. The power supply is AC-DC (+5 V) external power supply adapter. In the forward path (Base Station Controller towards (BTS) User Equipment (UE)) of system, a signal from the BTS is received through the donor antenna and the received signal is isolated from the transmitter by a duplexer. This isolated signal is first go through a low noise amplifier and then it is amplified at the second stage prior to final stage power amplification the signal is filtered by a band-pass filter<sup>2</sup>. The output signal from the final

amplifier is transmitted through the duplexer towards the service antenna. A directional coupler monitors the output power level of the transmitting signal to serving antennas. The circuit of the reverse path is the same as that of the forward path. The signal from the mobile handset is received by the service antenna of the repeater and transmitted through the donor antenna. PCB design is shown in figure 2, 3 for uplink and downlink.

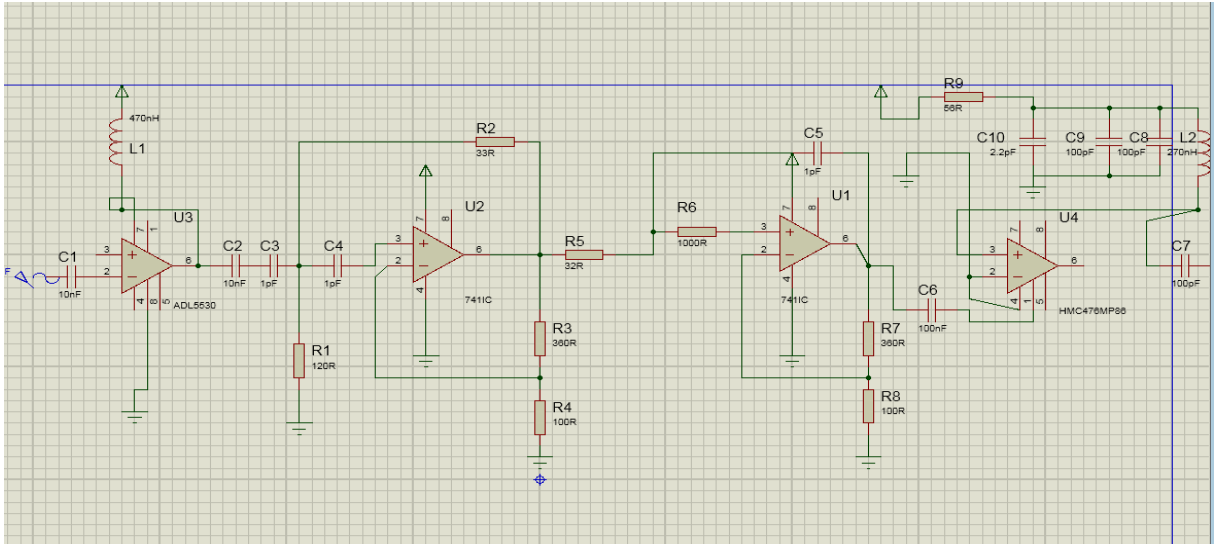


Figure 2: Circuit diagram for uplink (885MHz-892.5MHz) of GSM 900 repeater

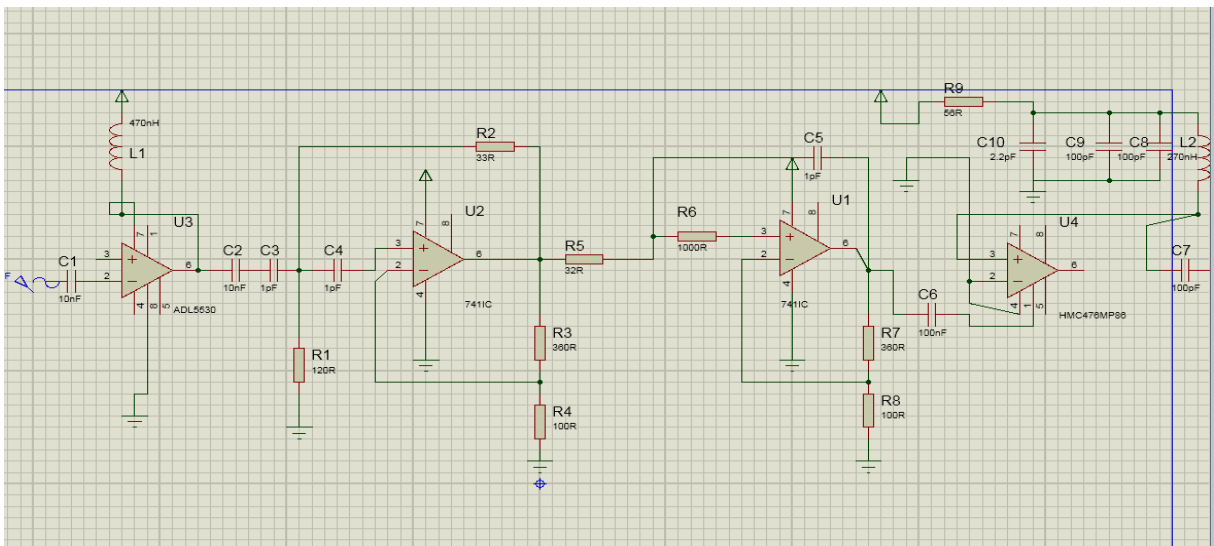


Figure 3: Circuit diagram for downlink (930MHz-937.5MHz) of GSM 900 repeater

### 3. RESULTS AND DISCUSSION

Output of the Low cost GSM 900 Repeater is shown in table 1.

Table 1: Total output details of Low cost repeater system.

<b>System</b>	
Total Gain	50dB max
Operating Voltage	5V to 9V (AC-DC)
Pass band ripple	
Noise Figure	< 7dB to 10dB
Characteristic Impedance	50 ohm
<b>Uplink</b>	
Gain	50dB Max
Operating Frequency	885MHz to 892.5MHz
Input power range	< -45dBm
Maximum Output Power	5dBm Max
<b>Downlink</b>	
Gain	50dB Max
Operating Frequency	930MHz to 937.5MHz
Input power range	< -85dBm Min
Maximum Output Power	0dBm Max

Gain of the amplifiers and noise figure of preamplifier and power amplifier can be represented by equation 01, 02.

$$\text{Gain (dB)} = 10 \log \left( \frac{\text{Output signal power}}{\text{Input signal power}} \right) \longrightarrow (01)$$

$$\text{Noise Figure (NF)} = \frac{\text{Signal to Noise ratio of input signal (SNR}_{\text{in}})}{\text{Signal to Noise ratio of output signal (SNR}_{\text{out}})} \longrightarrow (2)$$

This repeater system has two antennas, one for receiving purpose and other for transmitting purposes. Transmitting antenna is placed in a place that has a good coverage. It means, most of the time this type of problems is occurred inside of a building but outside of building is having good coverage area. Receiving level of signal at outside of building may be larger than -70 dBm. This is the best place to place the transmitting antenna. The antenna receives the GSM 900 band signal (885MHz-992.5 MHz) and this signal is amplified through the two amplifiers called as preamplifier and power amplifier.<sup>3</sup> Preamplifier is used to increase the strength of the signal to drive the cable to main instrument without decreasing the signal-to-noise ratio (SNR). Power amplifier is used to convert a low-power radio –frequency signal into large signal of significant power.

This type of signal goes through band pass filter. Band pass filter was used to filter the GSM 900 uplink and downlink frequency bands. Band pass filter allow 10MHz bandwidth on 885MHz to 892.5MHz range and its Operation voltage 5V to 12V<sup>2</sup>. This amplified and filtered signal is sent to the receiving antenna. Receiving antenna is getting good receiving levels. It means, receiving antenna is having the ability to spread out signals with high strength where by subscriber can receive signals of same strength. This signaling process will be applied to both uplink and downlink. System results a total gain of 50dB.

#### 4. CONCLUSION

The low cost GSM 900 repeater was designed to solve the low voice signal coverage problem and quality problem. In this design, only uplink was included because it was difficult to find the power amplifier and pre amplifiers. This system improves the receiving level of signals that is limited to one type of frequency range. This can be developed to include GSM 1800 and 3G bands using required filters, preamplifiers and power amplifiers.

#### ACKNOWLEDGEMENTS

Authors would like to express their gratitude to all at Wayamba University who have helped for the successful completion of the system. Also support provided by Mr.Sumith Fernando

who is the external supervisor of Manager Radio Network Optimization of Mobitel (pvt) Ltd is highly acknowledged for his guidance and supervision.

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## **MSAN SECURITY SYSTEM WITH A FEEDBACK**

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### **ABSTRACT**

In the outside plant maintenance center of the Sri Lanka Telecom, when the multi-service access node (MSAN) has a power failure, it gives a message to main switch. Then the board takes an action to this error. But this facility is only available for failures of power. When there is a fault of other parts of MSAN, there is no way to identify such failure. So, in this project it was aimed to develop a security system with an identification message for MSAN when there are failures of power card, rectifier and line card also. The proposed design includes a security system with an identification message as a solution. Though this, a message will be sent to the responsible person informing that there is a failure of MSAN and then a reply with response action taken him.

**Keywords:** Multi Service Access Node, Power Card, Rectifier, Line Card

### **1. INTRODUCTION**

MSAN is assigned for Multi-Service Access Nodes. This is the device typically installed in a telephone exchange which connects customers' telephone lines to the core network to provide telephone connection, Integrated Services Digital Network (ISDN) and broadband such as Digital Subscriber Line (DSL) all from a single platform. Earlier in the deployment of MSANs, telecom providers typically had a multitude of separate equipment including Digital Subscriber Line Access Multiplexer (DSLAM) to provide the various types of services to customers.<sup>1</sup>

Integrating all services on a single node which typically backhauls all data streams over internet protocol or Asynchronous Transfer Mode can be more cost effective and may provide new services to customers quicker than previously possible. A typical outdoor MSAN cabinet consists of narrowband (POTS), broadband (xDSL) services and batteries



with rectifiers, optical transmission unit and copper distribution frame. MSANs overcome many of service limitations by integrating multiple network functions into a single platform.<sup>2</sup>

When there is a power failure in MSAN, there is a provision to send a message reporting this to a responsible person. Then, the board takes an action to this error. But it gives this kind of message when there is only a failure of power. So, project is aimed to develop a security system with an identification message for MSAN when there are failures of power card, rectifier and line card in addition to a power failure.

## 2. EXPERIMENTAL

### 2.1 Block diagram of the design

There are four indicators to show the failures of those four factors separately. Then, the indicator identifies the signal and gives it to integrated controller circuit. It consists with ATmega328P. Then, the IC identifies the failure and sends the message using GSM module to a responsible person through GSM network. The reply message from the responsible person is thereafter sent to the IC. Then it waits for some time and checks the action taken by the message receiver. If there is no action taken by him then the second warning is sent to the next responsible person. The waiting minutes depend on the distance between the MSAN and the main maintenance center.

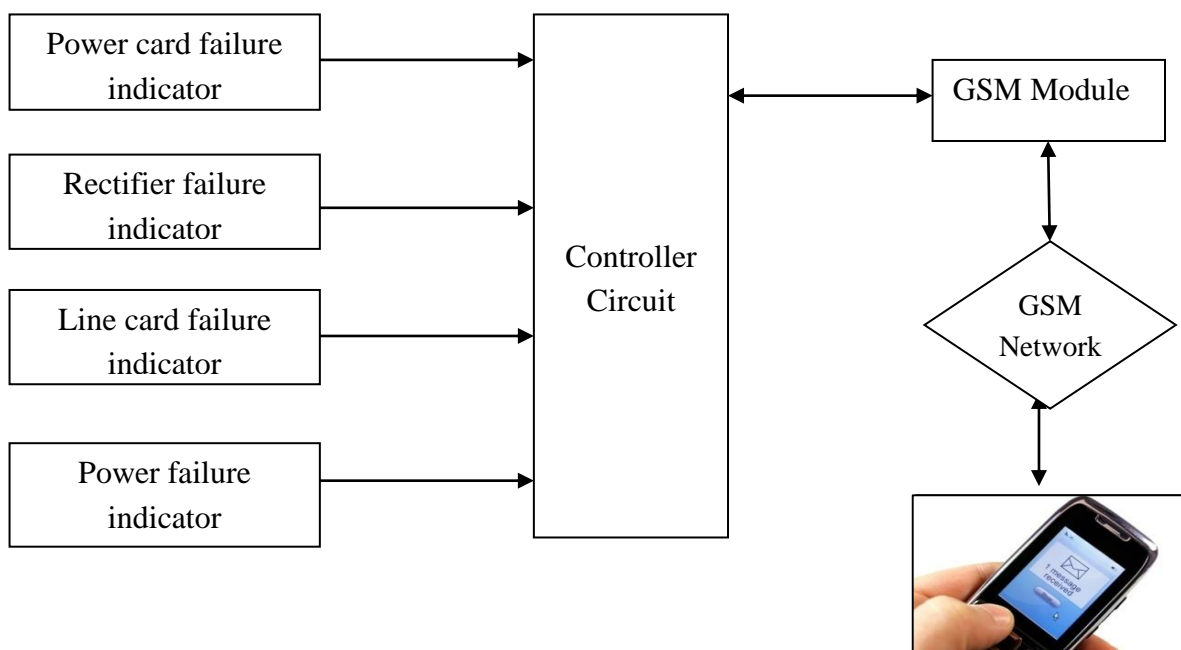


Figure 2.1: Conceptual block diagram of the design

## 2.2 Flow chart for design operation

When the first message is sent to the first responsible person (TTO), the system waits for some time an action. Then, a second message will also be sent to the second responsible person (AE) if there is no responsible action from the first person. If rectifier is not fixed at that instance then system will send third message to third responsible people (DIT). After 03 days the system checks the state of the failure. If anyone could not fix the problem within 03 days, the system will send messages to all responsible people as a reminder. As well as if it is fixed after 03 days, the MSAN will work continuously. Above waiting times for replying depends on the distance from the site to the main exchange.

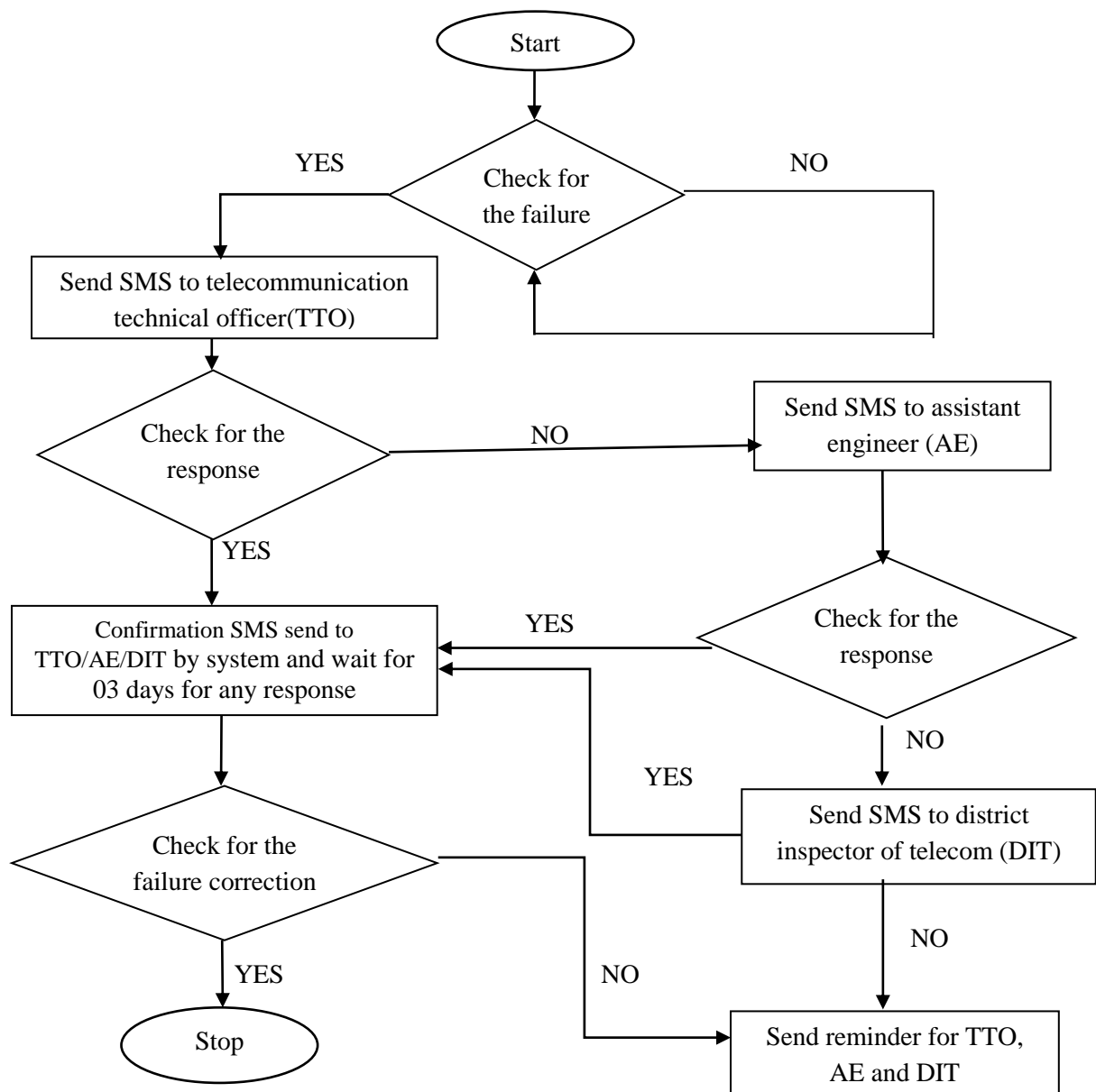


Figure 2.2: Flow chart of the system operation

### 2.3 Printed Circuit Board Design

The Printed Circuit Board (PCB) layout is as follows.

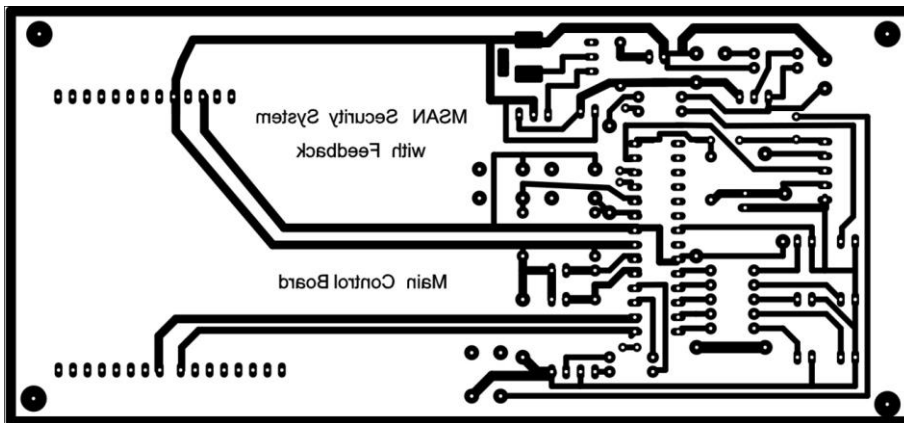


Figure 2.3: PCB design of the system

### 3.0 RESULTS AND DISCUSSION

This project contributes to the organization mainly to give a continuous service to the customers and it helps SLT to keep their goodwill on the top with the competitive environment. As well as it can help the company to minimize their cost by reducing labor cost and maintenance cost due to instance action taken by the responsible people who work in this section. Also, the traveling cost and labor cost that is required for maintenance can be minimized. This system helps to increase the responsibility of the technical assistants and officers who are able to correct a certain failure. There-by, this proposed design may help to give a continuous service to the customers and increase the customers' trust on the company.



Figure 3.1: MSAN security system

#### **4.0 CONCLUSION**

MSAN connects telephone lines of customers to the core network to provide connection. Its operation is disturbed due to various reasons such as power, rectifier, line card and power card failures. When such a disturbance occurs, customers are affected badly. As per the present day situation, MSANs are having a facility to inform any interruption of power. But, none of the other causes will be identified and well attended on time for rectification. This project was aimed to develop a design to address other disturbing issues in addition to power failures. Thereby, any one of the four failures will be informed to the responsible person. If any satisfactory action is not taken, error will be notified to next higher officers in stepwise. So, the design may help the customers to get a continuous service and on the other hand, SLT gets the benefit of customer satisfaction which is needed for their survival in a top place.

#### **ACKNOWLEDGEMENTS**

Authors like to express their indebt gratitude to the staff of Department of Electronics, Faculty of Applied Sciences, Wayamba University of Sri Lanka. Sincere gratitude is hereby extended to outside plant maintenance section of Sri Lanka Telecom, Chilaw branch for offering an opportunity to carry out a project during the industrial training placement.

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## LOW COST INPUT/OUTPUT MODULE FOR TRANSMIT BOILER STATUS

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### ABSTRACT

Building Management Systems and industrial automation is a highly developing area in Sri Lanka. BMS is mainly used for energy serving in particular buildings or areas. As the commercial products such as automation servers, power supply units and input/output modules are very expensive, this research is aimed at implementing a low cost module for transmit a boiler status to central BMS via Modbus link. This module is developed by microcontroller programmable technology. The input/output module contains safety method for high voltage and Modbus convertor circuit for transmit the signal for a long distance.

**Keywords:** *BMS, Industrial Automation, Modbus, Arduino Microcontroller, ADC*

### 1. Introduction

The concept of this paper is to implement an I/O module for BMS application. The main objective of this study is to build an I/O module for transmit Ferroil Boiler<sup>3</sup> status to central BMS via Modbus link in Cinnamon RED hotel. Monitoring boiler status in central BMS is an effective and low cost method of providing immediate attention for heating system. Under this system, technicians are no longer access to machine room to manual status checking of boilers. This system enables to monitor all boilers' status and conditions simultaneously. Arduino Uno board<sup>4</sup> was used for simulate the testing circuits and components. The microcontroller program was written by using Arduino language. Boiler on status, 1st burner flame status, 2nd burner flame status, Burner shutdown status and Safety pressure switch status were taken as input for the I/O module and transmit to central BMS.

## 2. EXPERIMENTAL

### 2.1 Preparation of the I/O module

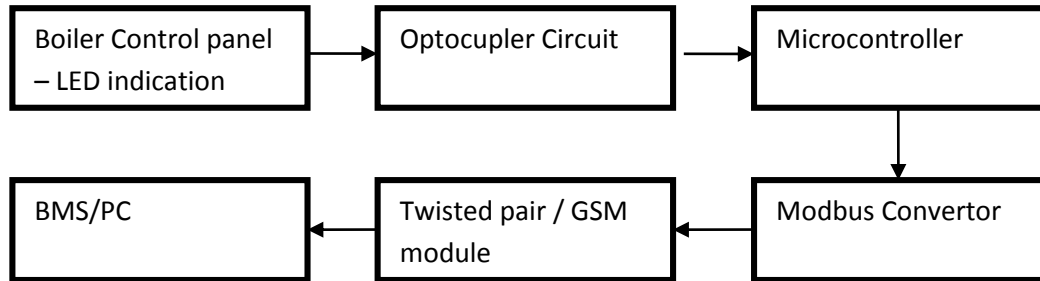


Figure 1: Block diagram of Boiler status transmit system

The main task of the study was to implement a low cost input/output module for transmit boiler status to central BMS via Modbus link. The main circuit contains basically three parts Power supply unit, Data processing part and Communication part.

Power supply unit contains step down transformer and voltage rectifier circuit. Internal circuits were used 5V DC voltage. Power supply unit was converted the main current in to 5V direct current.

The LED indication of the boiler control panel was taken as the input signals for the module. The signals were transmitted through the Optocoupler, and then there is no electrically connection between boiler control panel and the internal circuit. It is a very safety method to protect internal components in the circuits from an electrically shocks and high voltage current generated by inside the boiler.

The input signal processed by Atmega328 Microcontroller<sup>1</sup> while generating different ID for different status. The microcontroller programming part was done by Arduino language.

MAX 485 IC<sup>2</sup> converted digital signal into Modbus signal then it can transmit long distance without distortion.

In this research project signals were transmitted by twisted pair, GSM module can be used for very long distance transmitting.

## 2.2 Circuit Diagrams of the system

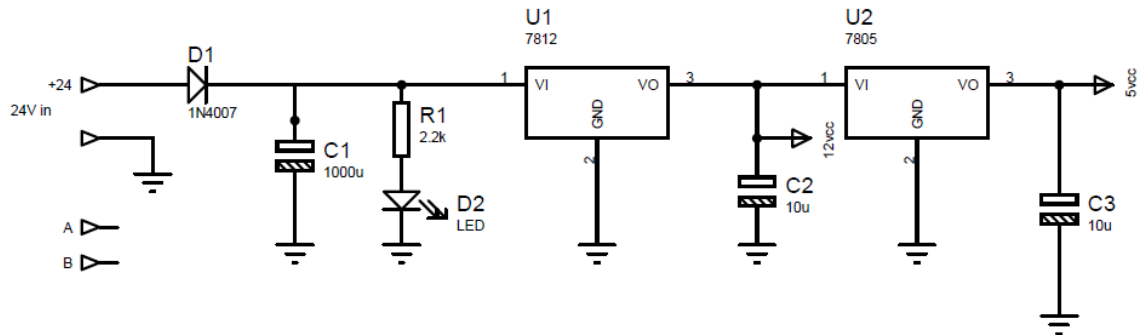


Figure 2: Power supply unit

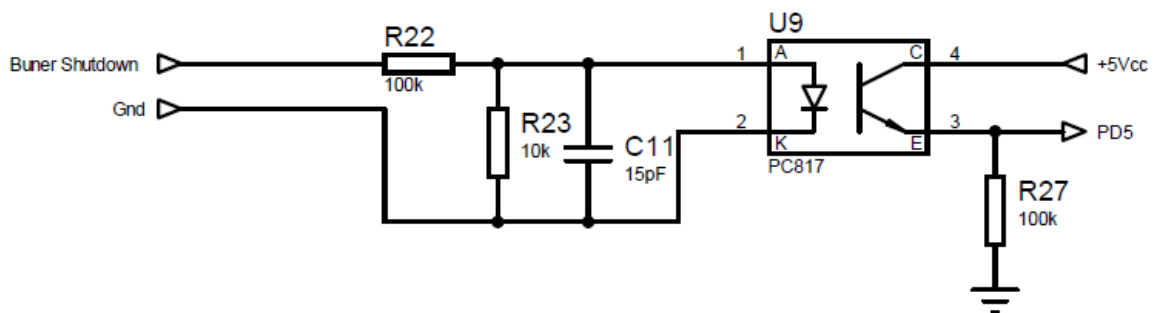


Figure 3: Data receiving mechanism

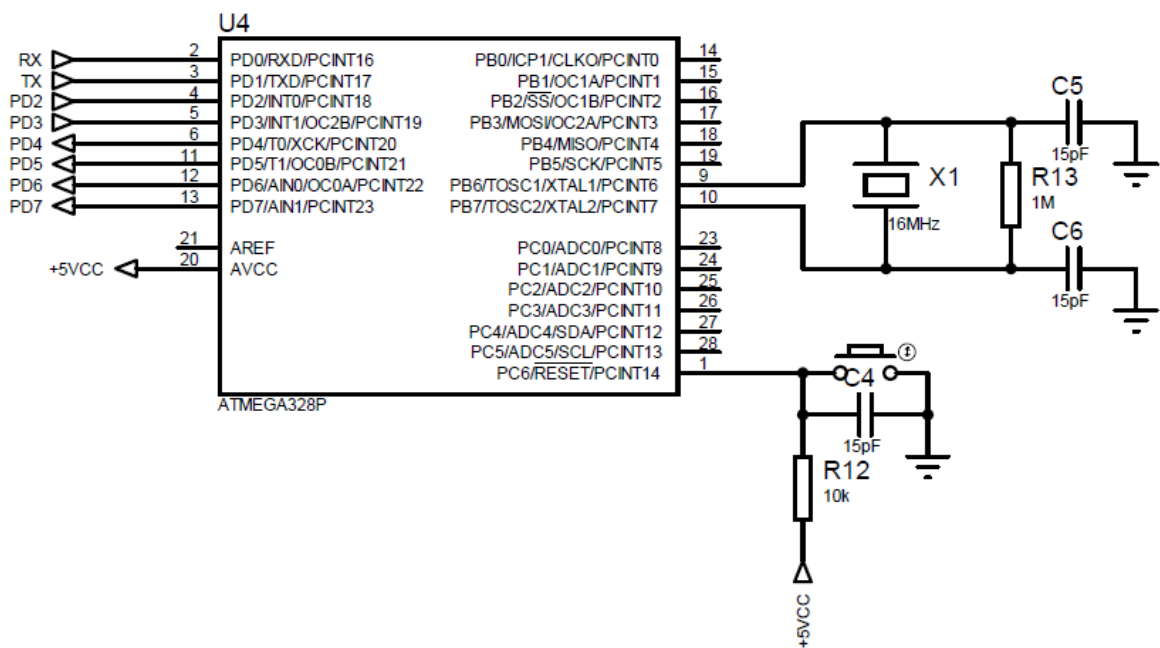


Figure 4: Data processing unit



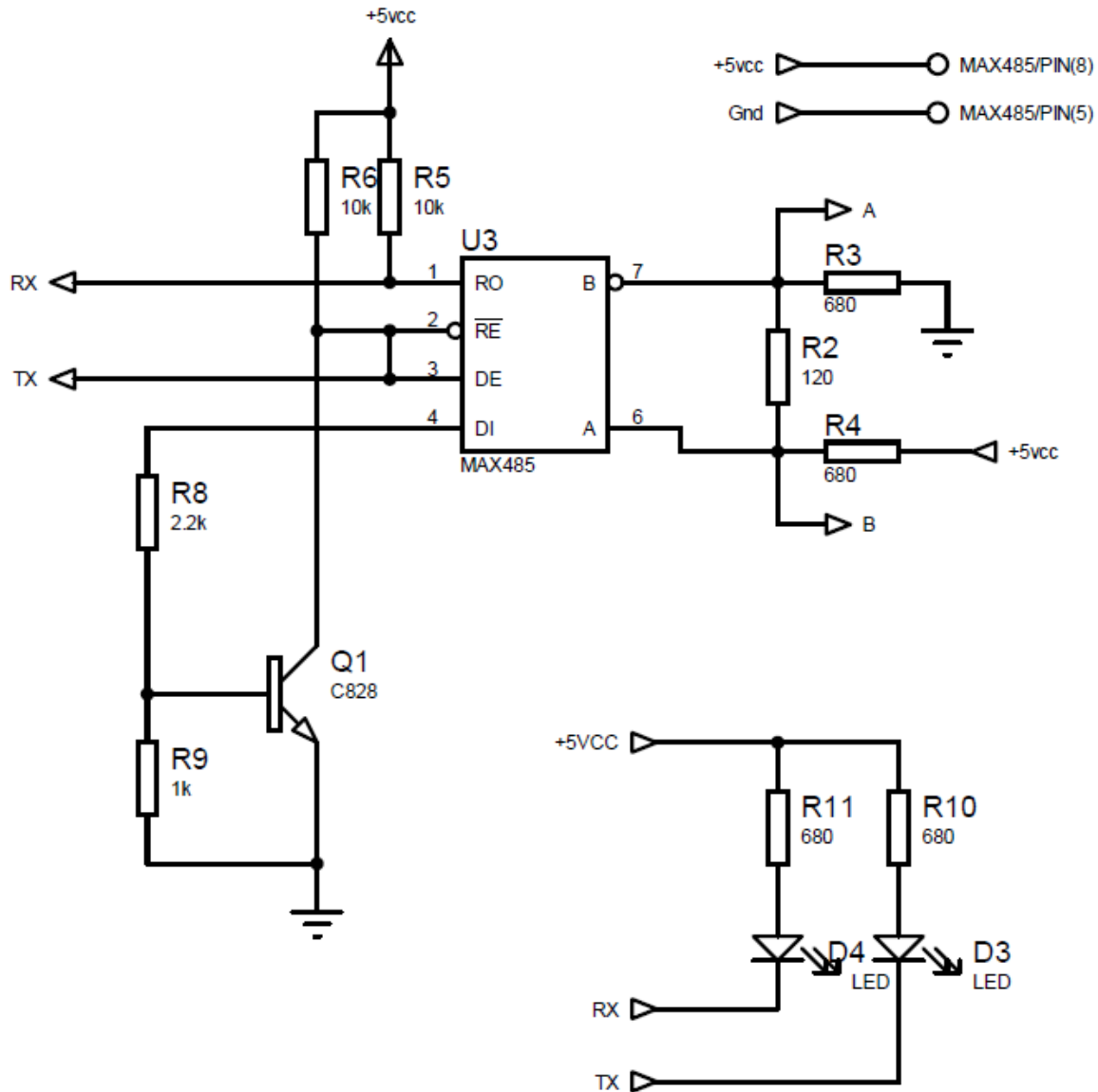


Figure 5: Modbus Conversion Unit

### 3. RESULTS AND DISCUSSION

The testing circuit was designed using Arduino UNO board and programmed by Arduino programming language. After simulated the circuit, the PCB was implemented for Atmega 328 processor and all other components. Electrically isolation between Boiler control panel and I/O module is one of advantage in this system. The cost of this module was 2500 rupees. Commercially available I/O modules are normally 10000 rupees, but they cannot install without an automation servers. This module can be directly transmitting data to BMS or

personal computer without an automation server and external power supply. The image of the final product is shown in figure 6.

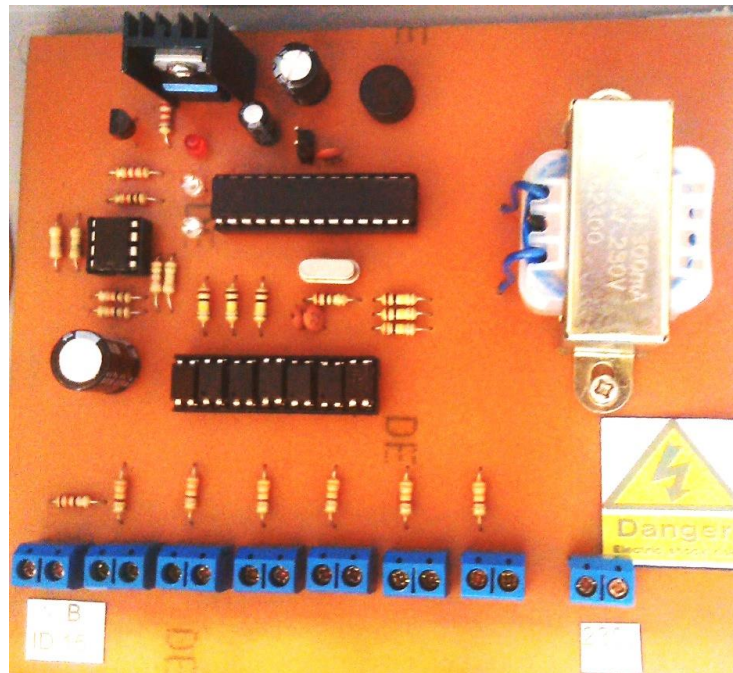


Figure 6: Input/output module

#### 4. CONCLUSION

In this study, a low cost I/O module was implemented to transmit boiler status to central BMS. Not only the boiler status, the module can be used to transmit or control digital status of any equipment such as VSD, AHU or Generator for a long distance via Modbus link. This module can also be further extended to monitor and control analog values such as temperature, pressure etc. Processing analog signal is some hard difficult than digital signal processing, if this module extend to monitor and control analog values, its better to design an inbuilt analog to digital convertor<sup>5</sup> (ADC) part in the module.

#### ACKNOWLEDGEMENT

Authors would like to thank all at Department of Electronics, Wayamba University of Sri Lanka who helped to make this study success. Also I would like to acknowledge the people in Intelligent Automation (PVT) Ltd who helped me to success this research project.

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## COMPACT FLUORESCENT LAMP OPERATION AND ENDURANCE ANALYSIS

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### ABSTRACT

Compact fluorescent lamps (CFLs) are gaining wide-spread acceptance due to energy conservation concerns. The key objective of the work presented in this paper is to gain improved and updated understanding of the operation and performance of the CFL. The work presented in this paper summarizes the detailed testing that has been performed to characterize the response of modern CFL to temperature and power abnormalities. Moreover, an effective criteria to detect defect components of CFLs is implemented. The tests are based on recent testing standards and utilized a modern industrial advanced power supply with newly designed chamber. Finally, the impacts of excessive voltage fluctuations on sensitive low voltage (LV) equipment were also investigated. Experimental results show that all CFLs are sensitive to voltage sags and vary in a wide range. It also proves that some brands of CFLs having similar power rating are sensitive to both voltage sag magnitudes and its duration. Finally a method to improve the sensitivity of CFLs to voltage sags is implemented. The information in this paper proves useful facts to decision makers in industry.

**Keywords:** Compact Fluorescent Lamp (CFL), Power abnormalities, temperature

### 1. INTRODUCTION

Compact fluorescent lamps (CFLs) have recently emerged as cost-competitive, energy efficient alternative to replace conventional incandescent lamps in their existing fittings. Recently, power companies have been encouraged the use of CFLs due to its energy efficiency<sup>1</sup>. The use of CFLs is expected to save up to 10% of a household's electricity usage and have longer life time when compare to other lighting alternatives. Beside from energy efficiency, CFLs are susceptible to power system abnormalities such as voltage dips, pops, outages and lack of temperature sensitivity. During dip, the voltage suffers a sudden reduction of voltage between

10-90% of the nominal voltage that lasts between 10 milliseconds and one minute. Voltage sag may cause lamps to extinguish or flicker that cause nuisance and reduction of light intensity or damage in some cases. However, there is a little available information related to the sensitivity of CFLs due to voltage sags or temporary outages and temperature tolerances. In most of research papers about CFL performances discussed effect of harmonics and their influences. Some literature have discussed flicker generation in CFLs mainly due to fluctuations in their supply voltage. Moreover, there are few works on the sensitivity of CFLs in the presence of power system disturbances such as inter harmonics and phase jumps which are not normally associated with flicker<sup>6</sup> and its operation performances. The extensive use of CFLs with electronic ballasts demands a comprehensive analysis, including not only their effects on harmonic emissions<sup>2</sup> and flicker sensitivity, but also their performance during the other power quality problems such as voltage sags, temperature sensitivity in electric distribution systems. In this study, after a thorough description about the operation of compact fluorescent lamps, variety of tests are performed on various CFLs. These tests are carried out to observe the variation of tube temperature with chamber temperature and light intensity variation of the CFLs during voltage fluctuations. Moreover, to evaluate the voltage, temperature tolerance levels of the tested CFLs are subjected to test repeatedly to gain threshold tests values. Typical circuit of a CFL is shown in the Figure1.

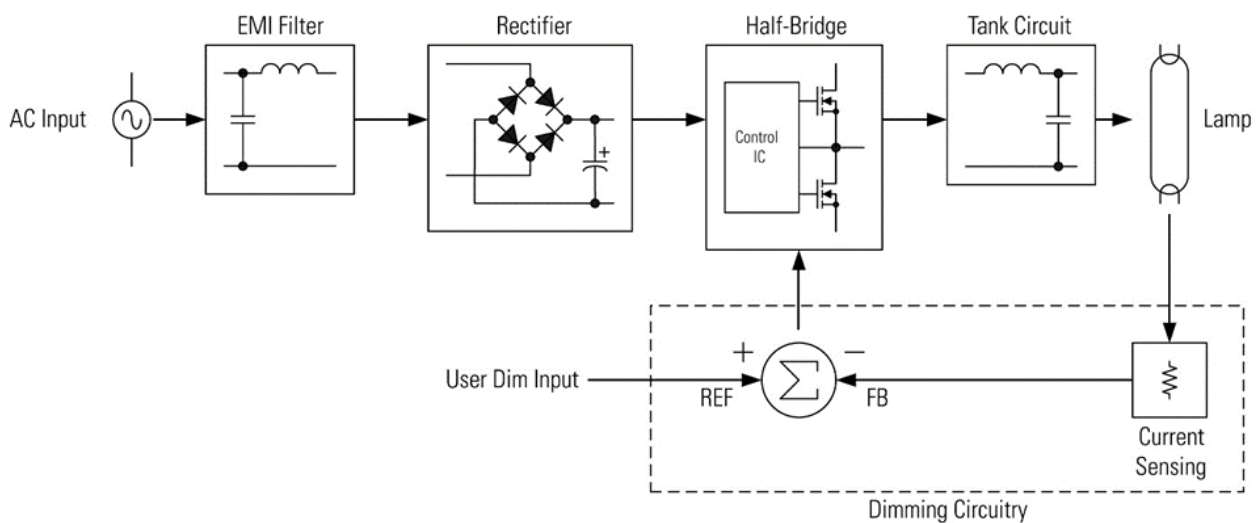
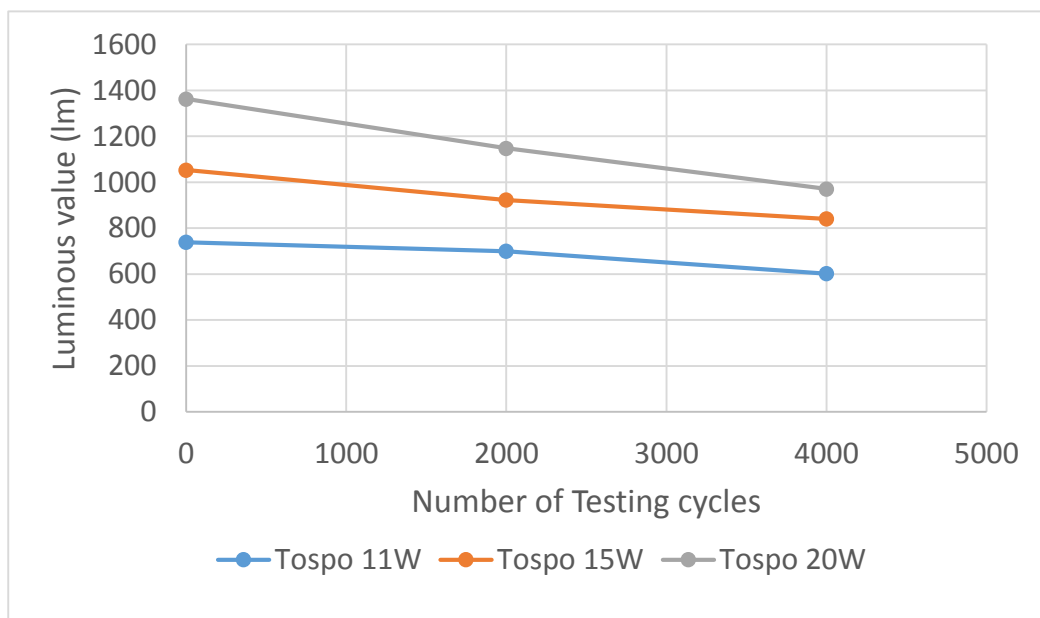


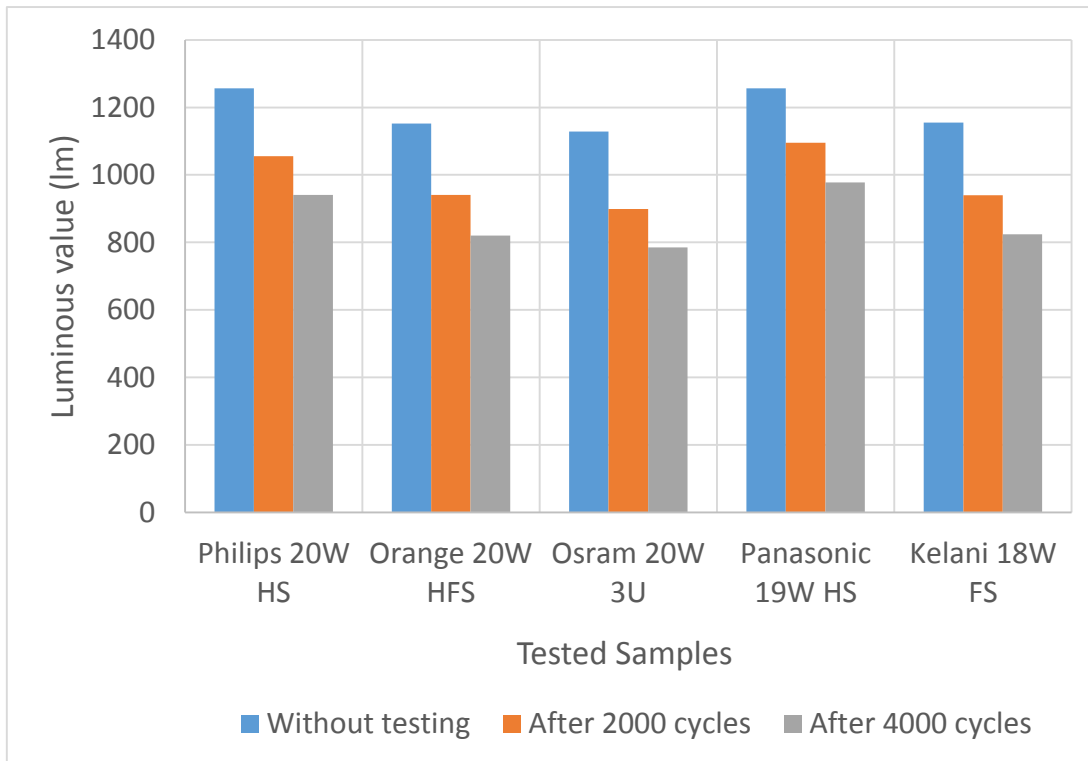
Figure 1: Schematic diagram of typical CFL

## 2. EXPERIMENTAL

Before starting tests, the researcher searched on available sources for different types of power abnormality tests that applied to test compact fluorescent lamp. Newly designed torture chamber and advanced power supply is utilized for experimental apparatus. The methodology that is used in the testing is generally based on the guidelines published in the IEC Standard 61000-4-11. Selected samples from production line and competitor brands from different manufacturers in various power ratings were tested to study the effect of temperature, voltage sags<sup>5</sup> on the performance of the lamps. Initially temperature<sup>3</sup> endurance tests are performed. Torture chamber has in built facility to adjust temperature inside using its digital PID controllers. Temperature readings of corresponding lamps are measured by IR thermometer. Then, the specifications for power abnormality simulations of the tested CFLs are studied using the standards (IEC 61000-4-11). Advanced power supply can be used as voltage fluctuations generator which also consists programming advanced power simulations. After that, simulating power disturbances<sup>4</sup> from the mentioned power supply and their functionality were studied. Finally observed results were evaluated. Variation in Luminous values by the affect from power abnormality cycles are shown in Graph1 and Graph2.



Graph 1: Variation in Luminous vs Tested cycles



Graph 2: Luminous variation in tested samples

## RESULTS AND DISCUSSION

After test performed the complete analysis, evaluation of the measured data is implemented in two parts. Initially the temperature analysis and then endurance analysis to voltage fluctuations. According to temperature readings tube temperature is increased with chamber temperature. Above 150°C some lamps are showed startup delay. Most of the lamps turned off above 170°C. Due to rapid ageing in high temperatures lamp performances, lumens value is reduced. According to power abnormality reading of lamp performances, lumens value was greatly affected. Graph 1 illustrates the reduction in luminous value after affected by 0, 2000 and 4000 power abnormality cycles. When the immunity level of the tested lamps is compared in terms of voltage fluctuations, it can be noted that low power rating (11W) lamp was least sensitive while the high power rating (20W) lamp was most sensitive to voltage fluctuations. Further Graph 2 illustrates the reduction in luminous value in competitor brands after affected power abnormality cycles. It can be clearly noted that Osram lamp is more sensitive to voltage fluctuations. For instance Panasonic lamp is least sensitive to voltage fluctuations. Therefore, as a result of voltage fluctuations light output reduced badly.

### 3. CONCLUSION

An extensive experimental study has been performed to determine the effect of temperature, voltage fluctuations and to gain overall knowledge in operation of the CFL. From the results of the tested data, voltage tolerance curves and temperature variation curves were constructed to describe the sensitivity of various CFLs to temperature and power abnormalities. Furthermore, Temperature tests have been performed in extreme low temperatures and behavior of CFL in cold environment should have been discussed to make the research more success. Moreover, effect of humidity on CFL could have been discussed as well.

### ACKNOWLEDGEMENTS

The author wishes to extend gratitude for the assistance given by the supervisor, quality assurance staff of Orel Corporation and thank all who have supported to make this research a success.

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## **SOLAR TRACKING SYSTEM FOR SOLAR POWERED GARDEN LAMPS**

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### **ABSTRACT**

With the growing human population and advancement of technology, requirement for clean renewable energy goes high. Solar energy is the most abundant clean renewable energy resource and it can be used either direct (solar radiation) or indirect form. About 60% of the total energy emitted by the sun reaches the Earth's surface. By using energy efficient photovoltaic (PV) modules, solar energy can be efficiently converted in to electricity. This fundamental concept is used in a wide range of applications and efficiency of all these applications depend on the success of the solar radiation collecting process by PV modules. This research discusses how dual axis solar tracking system can be used in solar powered garden lamp units to increase solar radiation harvesting process. Solar tracking system includes a solar panel (20 W, 18 V), PWM charge controller, four light dependent resistors (LDR), Arduino UNO R3 development board with built in ATmega 328P-PU microcontroller and high torque DC gear motors 60 rpm and 80 rpm. With fitted solar tracking system solar powered garden lamps can harvest solar energy efficiently regardless of sun's motion across sky, seasonal changes, geographical location and shading.

**Keywords:** Solar radiation, Solar tracking, LDR

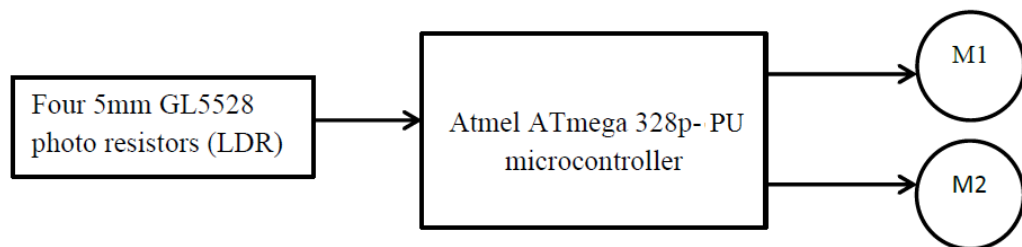
### **1. INTRODUCTION**

To improve the efficiency of devices that produce solar energy, it is an essential to pick up solar radiation much as possible. For that it is needed to improve materials and methods used to harvest solar radiation. There are several factors that govern the harvesting process such as solar cell efficiency, intensity of radiation and in addition energy storage techniques<sup>1</sup>. From three factors mentioned above, improvements in the solar energy collection process can lead to increase the mean solar radiation intensity received from the Sun. Solar radiation intensity

on a PV module (solar panel) depends on movement of the sun from east to west, seasonal changes, geographical location and shading<sup>2</sup>. Solar energy collection of a PV module can be made efficient with help of a solar tracking system. Sun tracker is a mechanical tracking system use to collect the highest possible radiation and thereby to maximize the energy output from solar panels. It follows the motion of Sun when moves from east to west every day. By tracking motion of the Sun, sun tracker aligns solar panels directly towards the sun bringing solar panel in to its optimal position.

## 2. EXPERIMENTAL

### 2.1 Methodology:



M1-12V DC, 60rpm high torque gear motor

M2-12V DC, 80rpm high torque gear motor

Figure 1: Block diagram of solar tracking system

When the sun is rising early in the morning, solar tracker is in its default position which is  $10^\circ$  incline to horizontal plane. Solar radiation is sensed by four LDR (Model: GL 5528) and all 4 LDRs are connected to analog input pins in the Arduino UNO R3 board using point “A” (Figure 2). Voltage values at “A” are analog inputs to the Arduino UNO R3 (inputs to the micro controller ATmega 328P-PU). As there is a 10-bit analog to digital converter in Arduino UNO board<sup>3</sup>, it will map input voltages between 0 and 5 V into integer values between 0 and 1023. When it is dark, LDR has very high resistance. When solar radiation is sensed, resistance values of the LDR go to a low value changing the voltage value at point “A”. Sun’s motion across the sky or a shade of an object on the solar panel changes the radiation intensity which changes resistance value of each LDR. Solar radiation intensity variation generates changing voltage inputs for all four analog inputs that will be converted in to values between 0 and 1023. After sensing 4 analog inputs from 4 LDRs, program written on the microcontroller decides logically what output signal should be given to motors in the

solar tracking system to direct the solar panel to its optimal position to collect optimum yield of solar radiation.

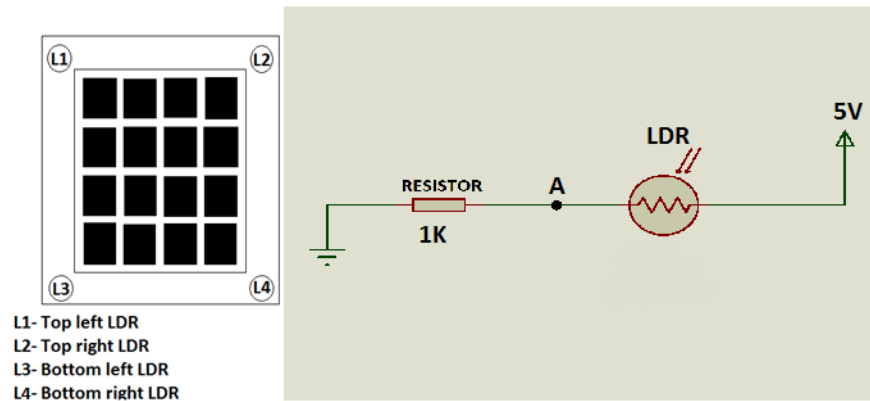


Figure 2: LDR configuration

2.2 Arduino program logic flow chart:

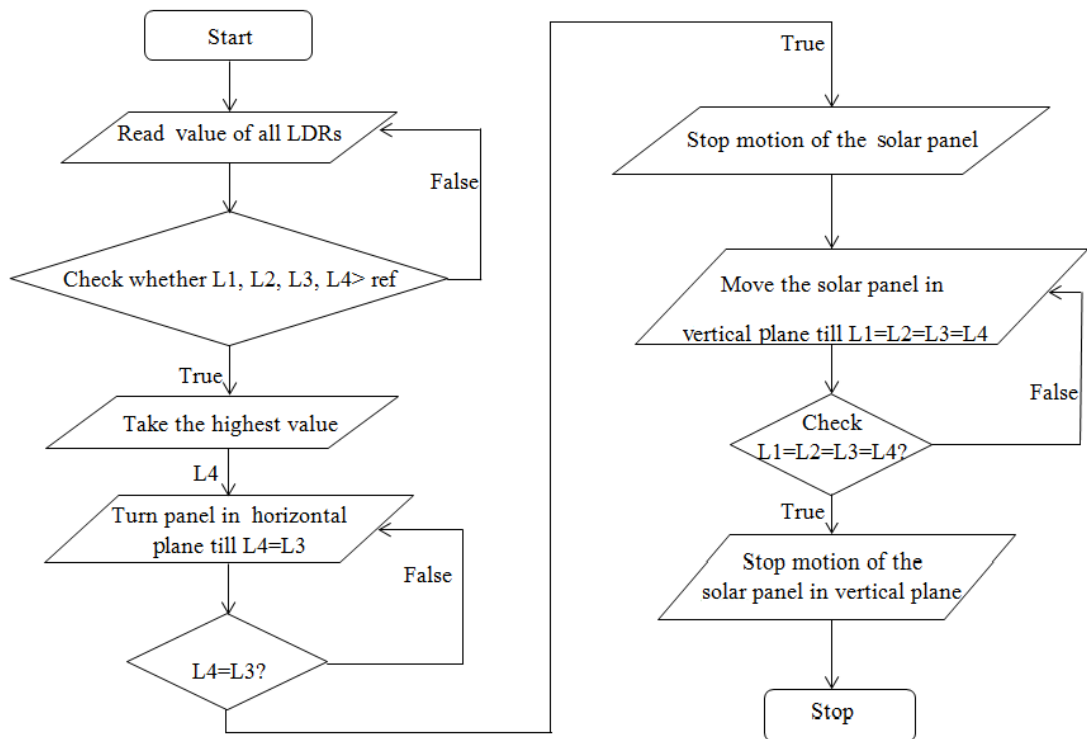


Figure 3: Program flow chart

“ref” is the reference value which starts the operation of the solar tracker and assume L4 receives the highest radiation intensity when the Arduino program starts the execution.

### 2.3 Hardware structure:

Hardware structure consists of several types of materials. Low cost, light weight and hard materials that can bear the weight of the whole structure were chosen. Structure which holds the solar panel and can rotate in horizontal plane using 2 ball bearings (number 4, Figure 4) was fabricated using 40 mm, 1000 kpa PVC. Steel structure (number 1, 2 and 3) holds the whole PVC structure. Horizontal motion is controlled by motor M1 which is a 12 V, 60 rpm high torque gear motor. Movements in vertical plane is controlled by motor M2 (12 V, 80 rpm) with the help of thread bar mechanism (number 5, 6 and 7 in Figure 4).



Figure 4: Hardware structure solar tracking system

## 3. RESULTS AND DISCUSSION

### 3.1 Results

Voltage output of solar panel of the garden lamp was measured before and after the solar tracking system was fitted. Output voltage values of the solar panel were measured hourly for a time period of 12 hours, starting from 6.30 a.m. in the morning till 6.30 p.m. in the evening. Observed voltage values were tabulated as shown in Table 1.

Table 1: Output voltages of the solar panel measured before and after the installation of solar tracking system.

Time	Output Voltage (V) of Solar Panel Test1		Out Voltage (V) of Solar Panel Test2	
	Before	After	Before	After
6.30 a.m.	9	11	9.3	9
7.30 a.m.	15	15.5	15	15
8.30 a.m.	15.3	17	15.7	15
9.30 a.m.	18	17	17	16
10.30 a.m.	18	17.5	18.1	18.8
11.30 a.m.	18	19	18	18
12.30 p.m.	19	19	19.3	20
1.30 p.m.	20	19	19	20
2.30 p.m.	19	20	20	20.4
3.30 p.m.	19	20	20	20
4.30 p.m.	17	17.1	16	15
5.30 p.m.	13	13	14.5	15
6.30 p.m.	11	8.7	8	9

### 3.2 Discussion:

With the results in Table 1, it shows some improvement in output voltage of the solar panel. But to obtain best performance and results, solar tracker must be tested in different lighting conditions (sunny days and days with cloudy skies) and different geographical locations. And to test its durability in all weather conditions, it needs to be further tested in high winds and rainy conditions.

## 4. CONCLUSION

This research discusses a method to increase the intensity of solar radiation incident on to a PV module. This prototype active solar tracking unit is capable of aligning the PV module automatically to an optimal position with the change of solar radiation intensity which will make the radiation collecting process efficient. Fitted with low cost solar tracking system, company can explore in to new market with this “Enhanced Solar Powered Garden Lamp”. System can be improved further with light weight strong material for the structure.

### **ACKNOWLEDGEMENTS**

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## INDICATE THE GAS LEVEL IN LIQUID PETROLIUM GAS CYLINDER

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### ABSTRACT

Liquefied petroleum gases (LPG) are substances such as propane and butane, which are transported and stored in the liquid phase in tanks under sufficiently high pressure. It is generated as a by-product either of oil and gas production or refining. The composition components of LPG are much simpler than that of gasoline. LPG is thought to be a cleaner fuel because it has less impact on air quality. Liquefied petroleum gas or commercially known as LPG is a group of hydrocarbons derived from crude petroleum processes or natural gas, which are gases at normal temperatures and atmospheric pressures but which become liquid with either a moderate drop in temperature or pressure, or both. Most of the users having trouble of finding mass quantity inside the closed metallic cylinder. In this research study we expect to design new electronic technique to implement a gas level indicator by using the physical relationship between the difference of the temperature and the flow rate of the LPG cylinder.

**Keywords:** *Analog Temperature sensor, Cylinder bank, Gas level indicator, Liquefied petroleum gas (LPG),*

### 1. INTRODUCTION

High rise building apartments as well as the tourists hotels are not given the permission to use separate cylinders in own apartments. Therefore they need to use pipe laying system for gas distribution along with the usage of cylinder manifold where this manifold regulate an appropriate pressure in a constant level according to the output usage of the gas. Majority of the Liquid Petroleum gas users do not use regular manifold system. Most of the small bakers



(For gas Owens) use one or two cylinders or less than five cylinders manifold. They are facing the issue of not knowing the gas level inside the cylinders until the cylinder get empty and indicate the pressure at 0 PSI. It is a considerable issue for a system or for an Industry which use fuel in LPG cylinder without maintaining maintain an extra manifold. Further with the high usage of LP gas for bakeries the gas flow rates are also high where manifold system can be get empty within a comparatively short period of time. The system of identifying the gas level inside the cylinders will be a good solution for the above problem where the application is going to be introduced to the bakery industry and hotels, where it is not for the domestic usage.

Typically, the manifold is designed to have half the number of cylinders supplying the application, and the other half on standby waiting to replace empty cylinders. The arrangement of the cylinder Room consists of more than 20 industrial cylinders where the number of the cylinders can be varied according to the requirements of the client.

The arrangement of the manifold consists of valves and regulators where a suitable gas pressure is maintained to facilitate the distribution. The manifold pressure is usually constant as the pressure inside the gas cylinder always maintain in a constant level. The higher flow rate showed the faster changes in vapor phase and followed by the lesser flow rate. After the change into vapor phase, the increase in temperature at high flow rates are faster<sup>1</sup>. This is different for low flow rates where the rate of decrease and increase in temperature were almost similar.

## **2. EXPERIMENTAL**

### **2.1 Measurement of temperature**

When flow rate of a liquid is high, physically internal pressure is dropped, then temperature is decreased according to the Boil's and Charll's Theory. Liquid needs heat to convert into the vapor phase. During this process liquid absorbs heat from surrounding area and therefore the temperature get decreased. This temperature difference is used to design the proposed device. LM 35 Analog temperature sensor is used to identify the temperature which is linearly output proportional to the temperature. Mainly two Analog sensors are placed in the gas cylinder surface. One is at top of the cylinder, another one is at bottom of the cylinder. LM35 output is analog voltage which are converted to the temperature in Celsius by using microcontroller. Temperatures were compared between Top and bottom of the cylinder

by using analog sensors. According to the system, if bottom temperature is lower than another liquid level is not passed the analog sensor level. The temperatures are same, gas level has been passed above conditions. It is indicated by an alarm.

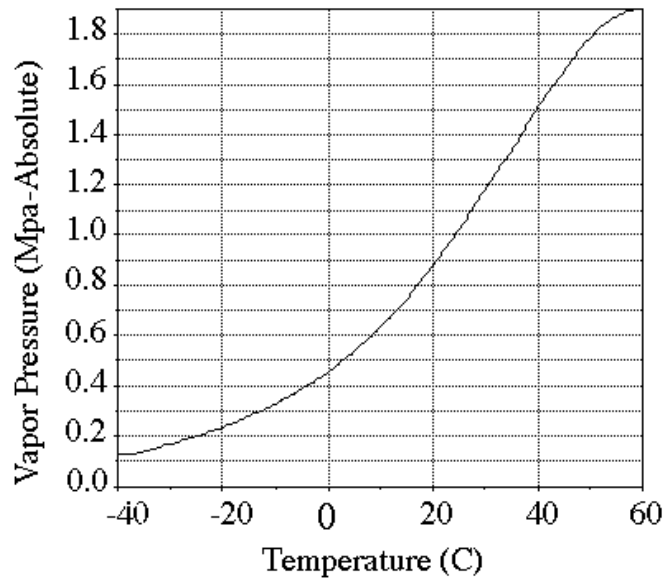


Fig 2.1: Vapor pressure verses temperature<sup>2</sup>

When the flow rate is high the pressure is dropped.in that condition gas vapors try to maintain the pressure, so liquid get heat and evaporate.

### 3. RESULT AND DISCUSSION

Table 3.1: Temperature of different type usage

Cylinder Type	Place/cooker size	Top temperature©	Bottom Temperature©	Room Temperature©
2.5kg	Domestic	28.6	28.4	29.2
12.5kg	Domestic	26.9	26.5	27.5
12.5kg	High pressure burner	29.9	28.7	30.1
37.5kg	Havelock city	29.1	29	29.3
37.5kg	Nawaloka hospital	31.2	28.7	31.3

According to the above table, high pressure burner in the bakery and the cylinder at the Nawaloka hospital showed a clear temperature difference between top and bottom than cylinders at the other places. That clear temperature difference can be used in the identification of the gas limit.

The gas level of consumer (LPG) at bakers for lager flow rate usage could be identified gas level in the closed cylinder.

### 3.1. Advantages of the proposed system

The hotel and bakery industry can gain many advantages by using this system.

- Able to know the gas level inside the gas cylinder and after alarm indication can count down the time for total emission of gas with the remaining level to fix the next cylinder on time.
- The system is easy to use.

## 4. CONCLUSION

This study was carried out in order to design a new, low cost equipment to measure the gas quantity inside the cylinder to be implemented in the industry level. In this stage temperature sensors were used. But the temperature sensors are less accurate due to improper/less efficient contact of the sensor with the gas inside a closed cylinder. These problems can be solved by replacing ultrasonic sensors where it get the more accurate readings in quantifying the gas level correctly. Ultra sonic wave transmit into the cylinder where ultra-sonic waves indicate a time difference for the transmission in liquid and gas phases<sup>2</sup>

## ACKNOWLEDGEMENTS

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## MICROWAVE LINK OPTIMIZATION

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### ABSTRACT

This paper presents a method to optimize microwave link alignment using a microcontroller. A microwave link provides the connection between base stations of mobile communication networks. Failures in microwave link occur due to various reasons such as wind, causing breakdown in mobile network. The general practice of aligning microwave link is manual process by monitoring the signal strengths. This study proposes a method to automate the microwave link alignment. This system stores the initial alignments of the microwave antenna. When changes are occurred, re-alignment can be done easily selecting the initial location and the antenna will aligned automatically. The proposed system increases the efficiency of re-storing breakdown networks due to miss-alignment of microwave link.

**Keywords:** Microwave link, Base Transceiver Station, Signal Strength, Stopper Motor

### 1. INTRODUCTION

Telecommunication industry currently experiences an exponential growth in technological advancements. New Technologies demand new regulations and the regulator is forced to keep abreast with its regulations, especially with the burden of installation at a level field. A microwave connection is very important to a telecommunication network because a fault of the link may drive the sites out of control. Microwave link alignment is a somewhat difficult task in the microwave installation and maintaining process, because it is done manually. In the installation process a lot of problems can occur. Sometimes manual alignment cannot find the most accurate aligned position.<sup>5</sup>

In the existing method, industry uses manual system for resetting the most of system. Especially they used very hard & manual way to link alignment. Because they had to reset the link alignment until detect the each signals correctly. But it was a very hard way and this designed system is to overcome this circumstances.

This research is to propose and design a prototype system to minimize the alignment time and to simplify the operator's job in the installation and aligning the microwave link in the telecommunication field. Initially manual way is utilized to detect of different highest strength levels of signal. Stepper motor is used to analyze the degree of the angle. Using the microcontroller, degree of the angle of the link is stored and they are used to rotate the link for different angles. Finally the highest strength signal is detected login to the link. As a result of this study it helps to minimize the work load for adjusting the link alignment to detect the suitable signal to each link.<sup>5</sup>

## 2. EXPERIMENTAL

The block diagram of the proposed system for the microwave link optimization is shown in the figure 1.

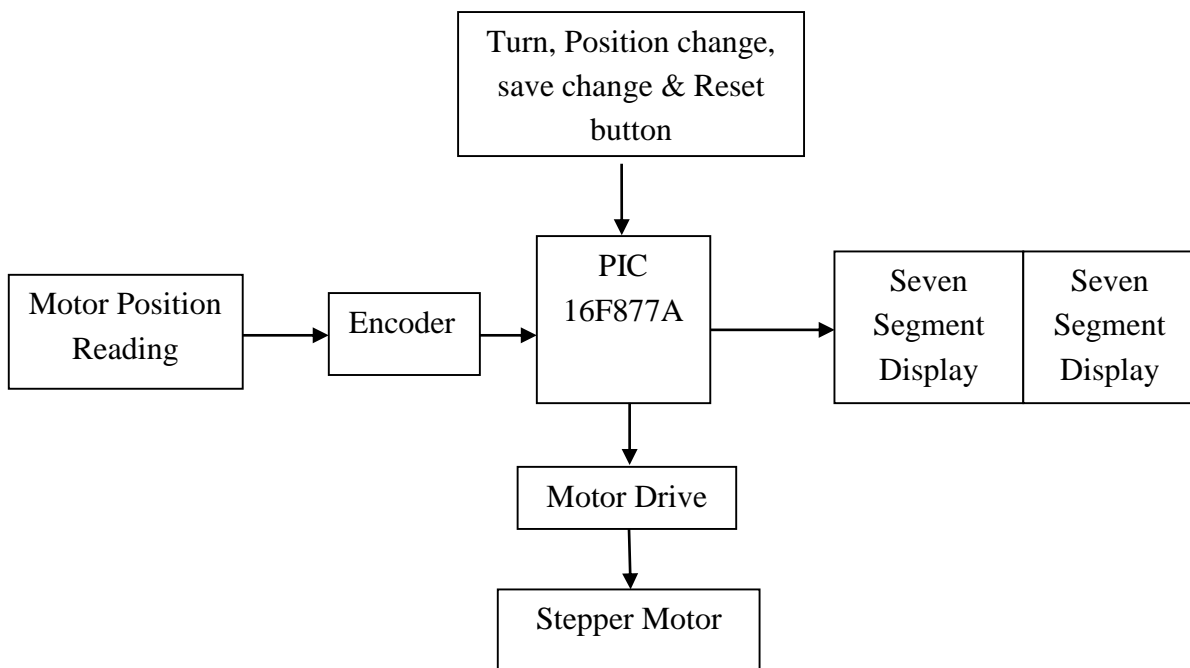


Figure 1 : Block diagram of the system

Turn, Position change, save change & Reset buttons are used to perform rotation for a particular position, change the saved number, save the changed number and reset the system respectively.

Encoder and IR sensor are used to identify the position where the identified positions exist.

The main part of the proposed system is PIC micro controller 16F877A. In this micro controller, set of the pre-defined receiving levels are manually saved. The maximum receiving levels are identified and saved them in the PIC 16F877A.

Those saved values are displayed by using seven segment displays from the beginning to the end respectively. If there is an issue in misalignment, the required position will be given to the system by manually entering the relevant number of the required position to the system. Then the link will be positioned in to the correct position automatically.

Stepper motor is used to rotate the microwave link automatically to the required position. L293D IC (Motor controller) is used to control the stepper motor.

### 2.1 Circuit Design of the System

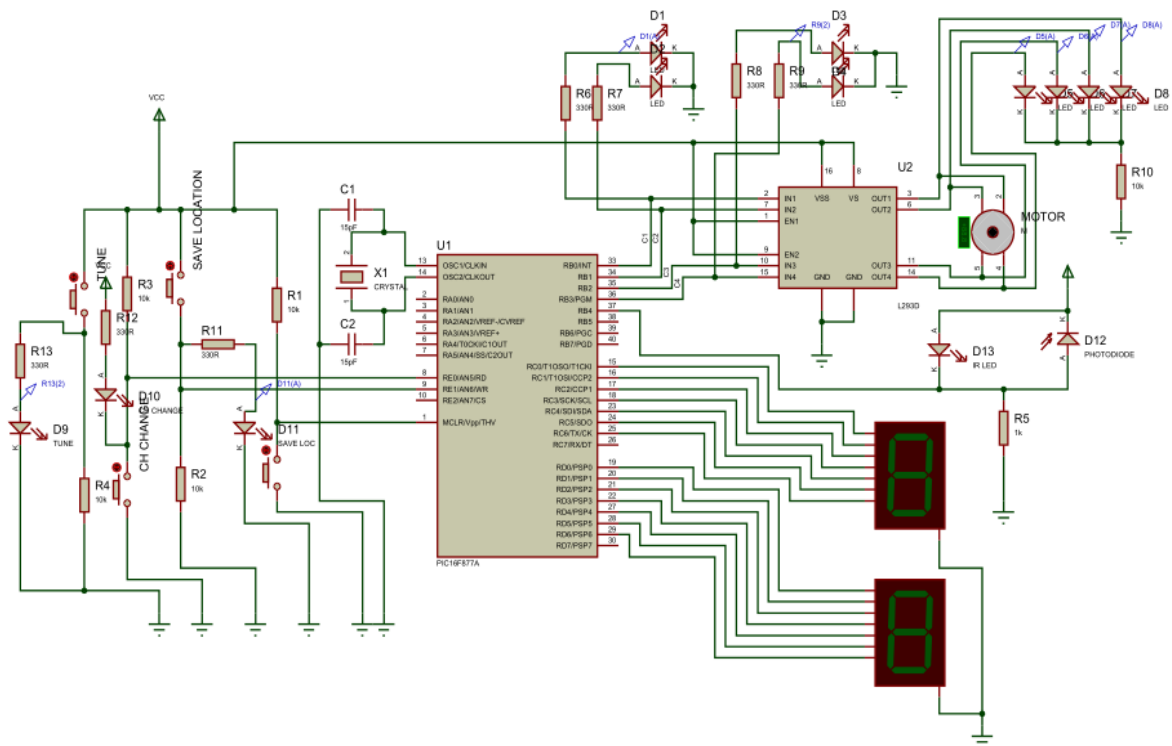


Figure 2: Circuit Design of the System

When the Position change button is pressed once the motor is goes to its initial position and display the number which indicated as one. Then the button is pressed twice the motor goes to second step and display the number two. Same as when a button is pressed number of times the motor will goes to their suitable position. These are displayed in the seven segment display.



### **3. RESULTS AND DISCUSSION**

At the initial stage of the proposed system, all the signal positions within 40 degrees are identified by logging into link. Several numbers of set of receiving levels from both upper and lower sides of the maximum level are taken. Those identified positions are saved and numbered one by one, starting from one. Saved number will be displayed on the seven segment display. Link will be positioned for a particular position when the operator enters a previously saved number.

This system is very useful to any service provider because it decreases their labor cost as the maintaining time and the required number of labors will get reduced. Also this is the solution for detecting RX level change due to environmental condition. Furthermore, the link can be automatically adjusted to right position at any time such as at night time. The solution proposed by the research requires only an initial investment cost to implement the solution.

As the drawbacks of the solution, when the number of the signal link increases, the total investment may be also increased due to the fact that the developed device to optimize the microwave links should be installed to each and every microwave antenna. This initial investment is draw back when the research goes for the implementation. And also, high powerful stepper motors are required to rotate the link for each developed device. Normally, in a single tower there are around 20 to 30 microwave links.

### **4. CONCLUSION**

Telecommunication services which use microwave link needs continuous maintenance to keep the microwave linked aligned between base stations. Alignment issues occur due to various reasons such as wind and rain. We proposed a method to re-align the microwave links when issues are occurred. This solution helps to recover the miss-aligned microwave link quickly, thus minimize the breakdown time of mobile telecommunication services saving large amount of money.

### **ACKNOWLEDGEMENTS**

We would like to thank staff at ATSL International (Pvt) Ltd for the support given for this project.

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## **IMPLEMENTATION OF MACHINE MONITORING SYSTEM FOR A PRODUCTION LINE**

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### **ABSTRACT**

Improper machinery and electricity usage is caused to incur undesired financial losses to most of the companies in Sri Lanka. This problematic situation cannot be resolved using an automated system which can be bought nowadays since such systems are very costly. So most often, manual checking is carried out in maintaining proper machinery and electricity usage. Machine Monitoring System is a cost effective system through which working states of the subjected machines will be displayed in the main indication panel. Radio frequency (RF) communication was used as the main communication technology in the Machines Monitoring System. In rapidly growing industry, undesired and unexpected costs should be cut down and productivity should be increased to sustain in the competitive industry nature. Using the developed system, machinery and electricity usage can be handled properly and financial wastage for machineries and electricity can be cut down to a minimum level while improving productivity of the company.

**Keywords:** Machines Monitoring System, Radio frequency (RF) communication,  
Microcontroller.

### **1. INTRODUCTION**

Tos Lanka Co. (Pvt) Ltd currently possesses eighteen machines relevant to its productions. Most of them are used throughout the day. Switching on and off each machine is done by its operator. In this situation, some machines will be forgotten to switch on or switch off as predetermined. So improper machinery and electricity usage will occur and due to that huge maintaining costs had to be incurred by the Tos lanka Co. (Pvt) Ltd.

As a solution for this major problem of the company, automated machine's monitoring indication system was developed. The developed system can be divided into two basic parts. They are the main indication panel as the master and machine side circuits as the slaves of the system. The main indication panel contains controlling circuit through which communication is handled while producing digital signal to the LED indication panel through which final outputs are displayed. A machine side circuit is to observe the working state of the machine to which it has been attached and sending data to the main indication panel when the data is requested.

Through this system, company will be benefited in various ways. Some of them are minimizing electricity wastage due to improper machine usage, reducing machinery maintaining costs while enhancing machine's life time with proper machine usage, reducing production delays while increasing productivity of the company.

## **2. EXPERIMENTAL**

### **2.1 Used Technologies:**

Radio frequency wireless communication technology, Microcontroller technology and printed circuit board technology were used as the main technologies for this system. nRF24L01 transceiver and nRF24L01+PA+LNA SMA antenna transceiver<sup>1</sup> were used appropriately for the radio frequency (RF) communication of the system. ATMEGA328P microcontroller<sup>2</sup> was used in each developed circuit of the system to handle RF communication, data processing and produce desired outputs. Printed circuit boards (PCBs) were designed using PROTEUS ARES software and PCBs were etched using Ferric Chloride ( $\text{FeCl}_3$ ) chemical etching process<sup>3</sup>.

### **2.2 Circuit Development:**

When developing the system, necessary programs were coded step by step. Then necessary circuit layouts were designed. Designed layouts were printed using an inkjet printer on to shiny sides of dumping papers or sticker papers. Designs on the printed papers were transferred on to well clean copper boards. The paper was ironed for about 15 minutes to get the design of the paper on to the copper board using an electrical iron. Paper from copper board was removed and copper board was washed carefully. Ferric Chloride ( $\text{FeCl}_3$ ) solution was used to etch the design. Unwanted areas of the copper board have been dissolved in the  $\text{FeCl}_3$  solution completely, PCBs were taken out from the solution and washed with soaps.

Etched PCBs were checked for desired connectivities and functionalities using a multimeter. PCBs were drilled using a drill machine and components were soldered into the PCBs. Completed PCBs were checked for desired functionalities. Finally, developed programs were uploaded to the microcontrollers and circuits were used in the system.

### 2.3 Project Design:

Machines Monitoring System can be basically divided into two main parts as the master that is the main indication panel and slaves that are machine side circuits. The basic functional design of the system is shown in figure 1 below.

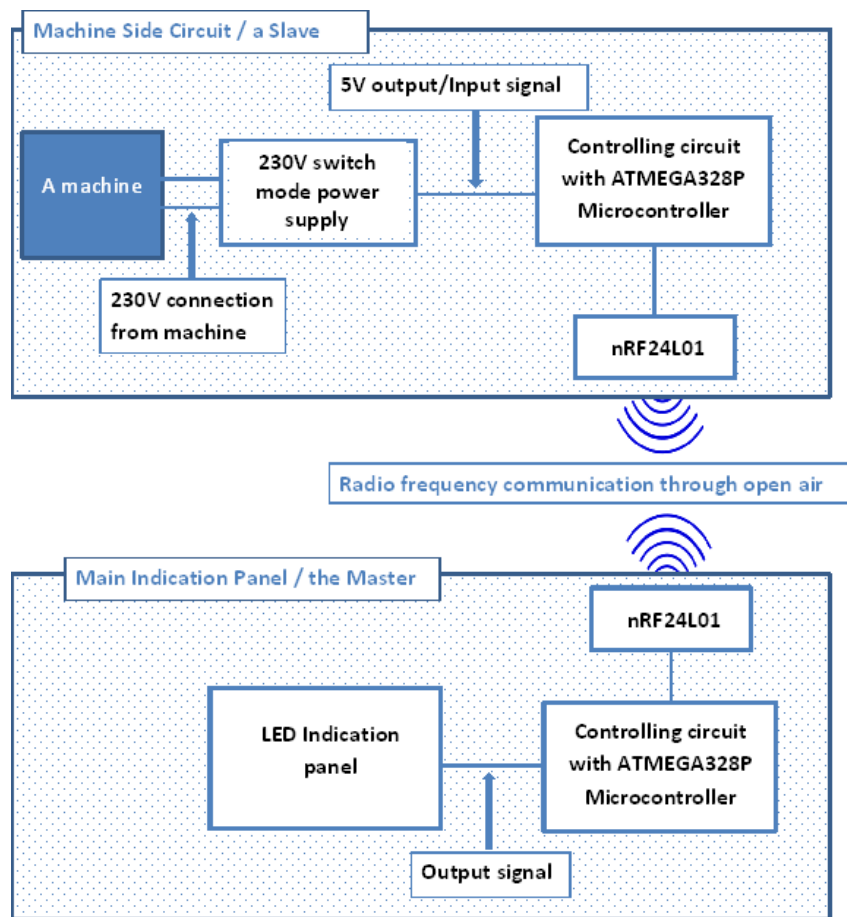


Figure 1: Schematic diagram of basic functional design of the system

In addressing technique, the master of the system was assigned the identity number 10. All machine side circuits were assigned multiples of 10 starting from identity number 20 that is main power (a slave). The RF communication of the system was configured to communicate

a data bundle with three parameters at a time. Figure 2 explains the communication pattern of the system within the RF transceivers.

Identity number of the sender Data = A multiple of 10	Identity number of the receiver. Data = A multiple of 10	Machine's working state information. Data = 5 or 250
First parameter	Second parameter	Third parameter

Figure 2: Communicating data bundle structure

To enhance the system functionalities while increasing system reliability and dependability, auto reset feature was added to each microcontroller program. If a circuit is get stuck functioning while in the communication, the circuit will be automatically reset after 8s.

Further, this system is able to handle power interruption situation properly. For that, main indication panel was powered using an uninterruptured power supply (UPS). At a power disturbance, main indication panel will indicate availability of main power as “NO SIGNAL” while keeping the other indications at working states of other slaves just before the interruption was occurred.

Developed system is consisted with three different circuits. They are LED indication panel, main indication panel controlling circuit and machine side circuit. The circuit designs of the system are shown in figure 3, figure 4 and figure 5 respectively.

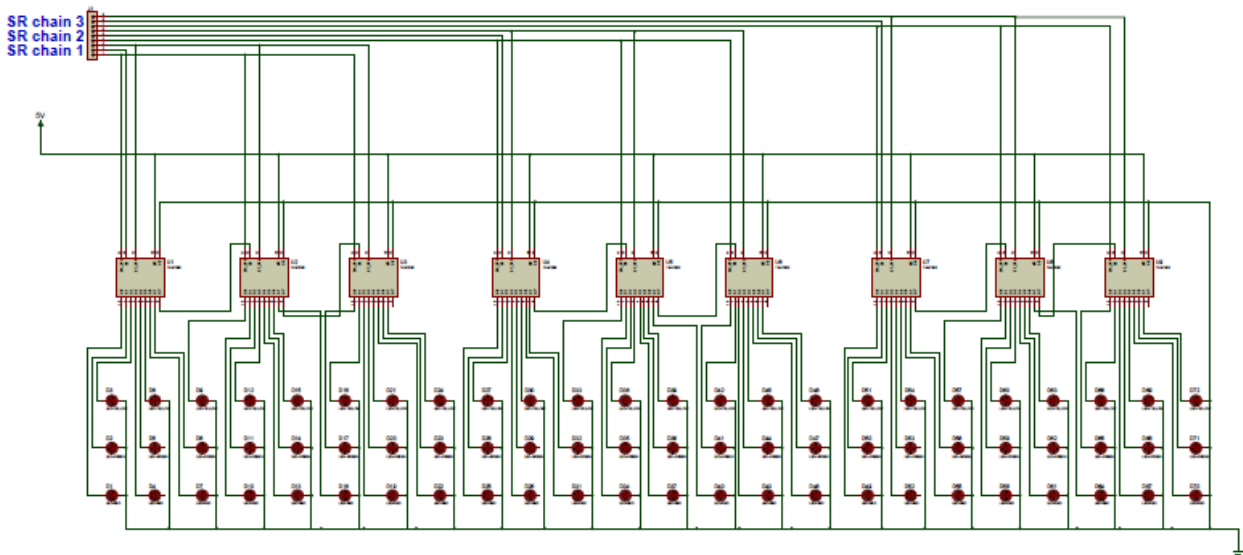


Figure 3: The circuit diagram of LED indication panel

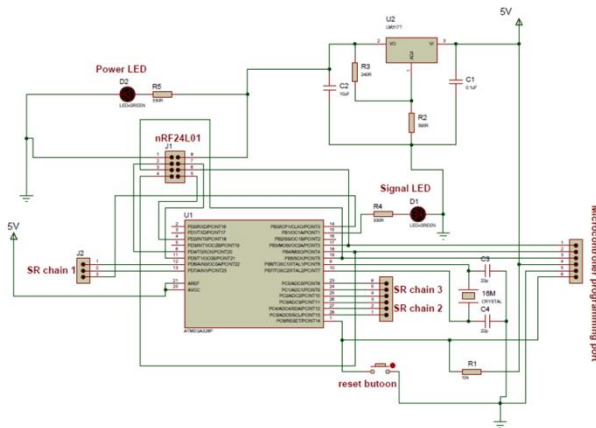


Figure 4: The circuit diagram of the / a machine side circuit panel controlling circuit

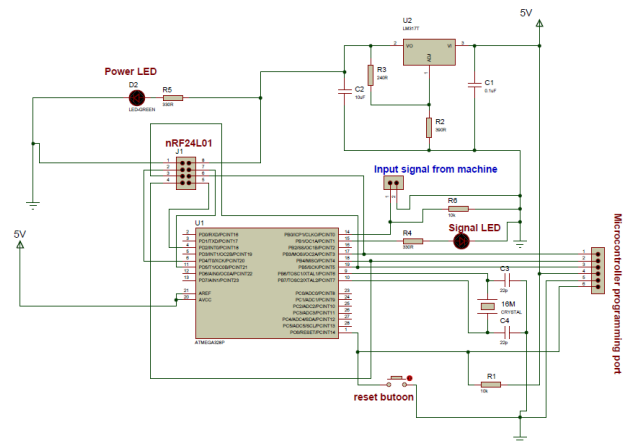


Figure 5: The circuit diagram of a slave / main indication

### 3. RESULTS AND DISCUSSION

#### 3.1 Results:

After compiling and launching the system, main indication panel was functioned properly as expected. The “OFF” state of a particular machine is indicated in green colour LED, the “ON” state of a particular machine is indicated in red colour LED and the “NO signal” state is indicated in orange colour LED in the main indication panel.

#### 3.2 Strengths of the project:

- No need to visit each machine to check the working states of the machines and those can be observed at the main indication panel.
- Cost effective
- Time saving
- Improve productivity
- Ease of use

#### 3.3 Limitations of the project:

- Panel indication has a 3 second delay after the working state of a particular machine has been changed.
- If another building with machines will be added to the company premises in the future, this system will not serve new machines since communication range of used RF modules is not sufficient.



- Only 24 machines can be served by developed system since main indication panel has spaces only for 24 machines.
- Indications on main indication panel can only be seen for couple of distances due to its inappropriate small size.

#### **4. CONCLUSION**

Machine Monitoring System is a cost effective solution for the problem of improper machinery and electricity usage. Working states of the subjected machines can be seen clearly using the developed system. With this solution, the company will be benefited financially by cutting down undesired expenses while improving the productivity.

#### **ACKNOWLEDGEMENTS**

Authors wish to extend their gratitude for the assistance given by Department of Electronics, Wayamba University of Sri Lanka and Tos lanka Co. (Pvt) Ltd, Biyagama.

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## **BUILDING MANAGEMENT SYSTEM FOR WHITE AWAYS BUILDING AT CENTRAL BANK**

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### **ABSTRACT**

This paper describes energy efficient building management system development for heating, ventilation and air conditioning in a building at central bank of Sri Lanka. A building management system would decrease labour, time for fault diagnostics and maintenance, and increase energy efficiency. This is achieved by the use of dedicated software for safety and control applications. The controlling unit in building management system automation is based on the Direct Digital Controller. The field devices are installed according to the point list and they are connected to the input output module. The system is a central monitoring facility to control a whole system from a single location. This allows instant operator interaction with building's system or many systems. They can provide a picture of what is going on in the building via a computer screen. They can also change system operation from the same central location.

**Keywords:** BMS, Direct Digital Controller, point list, input output module, HVAC system

### **1. INTRODUCTION**

Maintaining a building with a proper environment can be described basically with four variables such as temperature, humidity, pressure and ventilation. These factors should be maintained properly for the human comfort to do their work properly in a comfortable environment. The temperatures should not vary within single zone or change suddenly or drastically. Humidity is the presence of water vapor in air and it affects human comfort. It is recommended that normally the relative humidity (RH) to be maintained between 25 and 60%<sup>1</sup>. Ventilation is also a very essential factor to be maintained properly in commercial and work environment. The rooms and buildings typically have a slightly positive pressure to reduce outside air access. This helps in keeping the building clean.

Other than maintaining these basic requirement variables, having a system of monitoring and controlling in one place through a network will be an advantage for customers and other required people in the industry.

General features applicable to the BMS as a whole include:

1. Trend monitoring
2. Maintenance reminders
3. Security access
4. Protection during and after power failures
5. Lighting control systems
6. Automated fire and life safety security systems
7. Security system

A good automation has several advantages to the human being. Nowadays, the busy lifestyle of the average countrymen has left little time for even basic activities. This fast paced lifestyle demands efficient handling of everyday situations. Automation can cause an impact to this fast paced lifestyle in very efficient way. Need for less manpower, and accurate processes are the features of a good automation.

When awarded the white a ways building project was awarded the devices and controllers were selected according to the requirement of the customer. Then the point list was arranged very carefully by looking at the specifications. According to the point list the size and the complexity of the project could be determined. For this project two DDC panels were used. Controllers were selected by the point list. Schematic design was drawn using the AutoCAD 2014 by locating the field devices.

## **2. EXPERIMENTAL**

The basic layout of a BMS is shown in the following figure. It shows the plant room where all the controlling items are placed and how the system is integrate throughout the building.

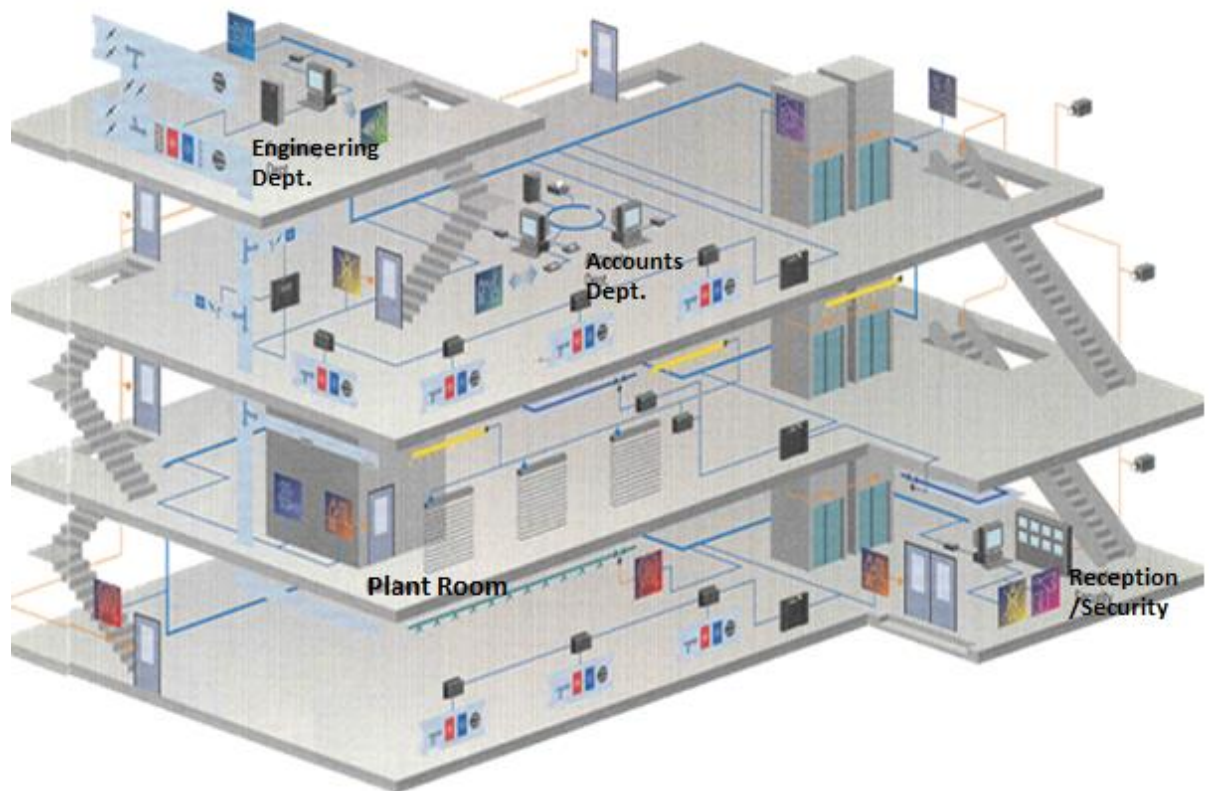


Figure 1: Block diagram of a typical Building Management System

Direct digital control (DDC) is the automated control of a condition or process by a digital device. These devices are separately programmable to fit the application. Also these devices are microprocessor based devices and capable of operating as standalone units, meaning that each device can monitor and control connected equipment independently from other devices of central station.

The controllers typically have analog and digital inputs that allow measurement of the variable (temperature, humidity, or pressure), and analog and digital outputs for control of the medium (hot/cold water and/or steam). Digital inputs are typically (dry) contacts from a control device, and analog inputs are typically a voltage or current measurement from a variable (temperature,

Humidity, velocity, or pressure) sensing device. Digital outputs are typically relay contacts used to start and stop equipment, and analog outputs are typically voltage or current signals to control the movement of the medium (air/water/steam) control devices.

According to the point list of the central bank, two chillers have been used. Most of the points are directly connected to the BACnet/MSTP interface. For the two chillers auto/manual status, on/off status, chiller trip alarm status is supplied by the HVAC contractor. Chill water supply flow status for two chillers is a dry contact having two binary inputs and it is taken from the flow switch. For the condenser water supply flow status is also a dry contact having two binary inputs. It is also using flow switch to get the binary status.

Chilled water by pass valve is used to control the motorized valve control and it is an analog output. The motorized valve feedback is analog input. Most of the cases butterfly valves are used.

Cooling tower condenser water supply & return temperature is measured by using in immersion type temperature sensor and these are obtained as the digital inputs to the controller.

There are six Air Handling Units in the building. For the six AHUs VSD can be programmed to adjust motor speed based on a variety of load inputs. Duct temperature sensors are used to measure the supply and return air temperature of the AHU. They are used as analog inputs as the temperature is an analog measurement. Return air CO<sub>2</sub> sensor is given as an analog input and used a duct mounted CO<sub>2</sub> sensor is used. Fresh air damper control is an analog output and fresh air damper feedback is an analog input.

### **3. RESULTS AND DISCUSSION**

The outcome of the project is that instead of a manual maintenance system the building can be automated. Therefore Heat Ventilation & Air Conditioning systems can be controlled and maintained from one place. Throughout the building it can be monitored via a BACnet/MSTP server. If there is a fault or something went wrong, via the server, it can be observed where the problem has occurred in the building.

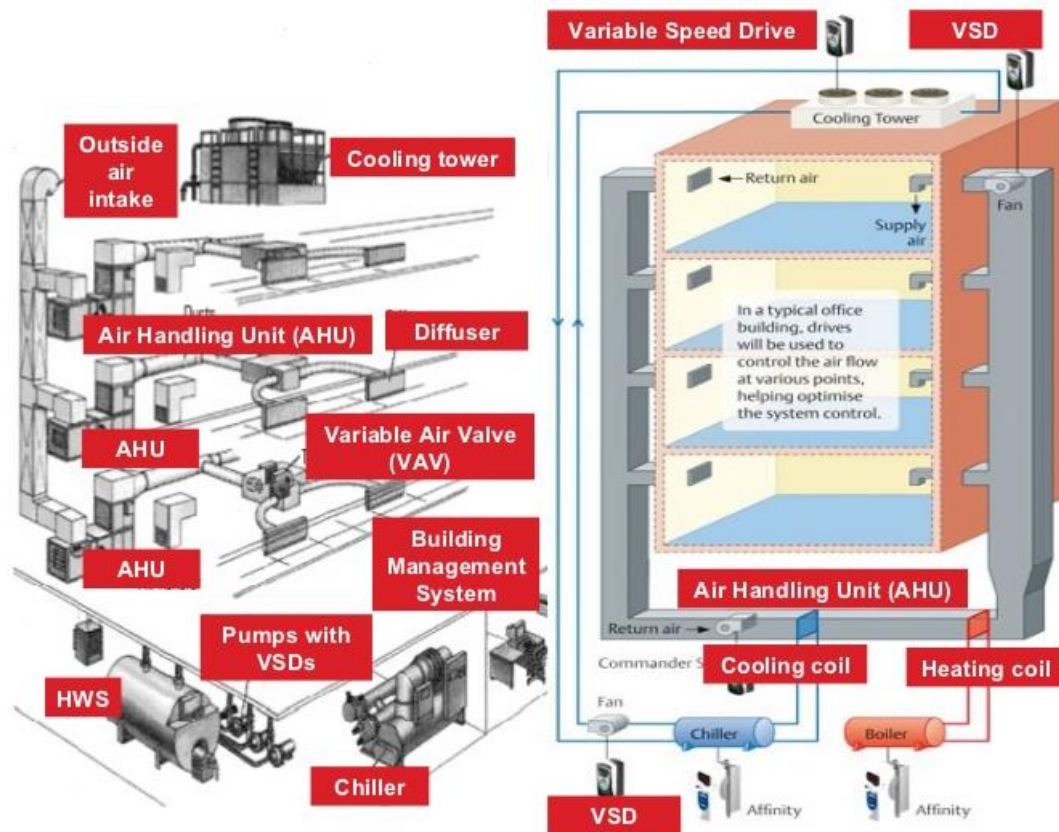


Figure 2: BMS system of the building

For the project the controllers used are Johnson Controls. There are some limitation when implementing it in the actual situation. The designs drawn has to be changed due to these conditions. There can be some limitations when programming the controllers with the Metasys software. Because outputs are not exactly what we get from the field devices, some errors or alarms would be generate in the interface.

#### 4. CONCLUSION

BMS was developed for the White Aways Building at the Central Bank. It shows clearly the approach of the BMS and how the implementation has been done. This project ensures less maintenance and reduces risk factor and also increases the efficiency in building management. For this work, Direct Digital Controllers and Supervisory Control and Data Acquisition were effectively applied.

## **ACKNOWLEDGEMENTS**

The authors would like to thank many individuals who helped and guided to complete industrial training at Metropolitan Engineering successfully. Gratitude is also conveyed to the staff of Department of Electronics, Faculty of Applied Sciences, Wayamba University of Sri Lanka.

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## TEMPERATURE AND MOISTURE SENSITIVE INVERTER MODULE FOR ENERGY EFFICIENT REFRIGERATOR

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### ABSTRACT

The paper describes the method to increase the energy efficiency of domestic refrigerator by a temperature and moisture controlled circuit. The energy used to power refrigerators is mainly supplied through burning of fossil fuels with an ever-increasing economic and environmental cost. Therefore, any reduction in energy consumption will result in reduced CO<sub>2</sub> emissions as well as reduced power bills for the end user of the refrigerator. The proposed method consists of temperature and moisture controlled circuit with an ATmega microcontroller chip that controls the speed of the three-phase motor inverter. This system is a potential low-cost solution to increase the power efficiency of domestic refrigerators.

**Keywords:** Temperature sensing, moisture sensing, three phase motor inverter, energy efficiency

### 1. INTRODUCTION

Refrigeration is technology which makes a major contribution to humanity in many ways including food preservation, control of indoor air quality, gas liquefaction, and industrial process control, production of food and drink and computer cooling. Without refrigeration, modern life would be impossible. About 15% of the world's electricity is used to drive refrigerating and air-conditioning systems<sup>3</sup>. Inefficient use of energy is a waste of valuable resource and contributes to global warming. Most of the global warming effect of refrigerating systems comes from generating energy to drive them. Only a small proportion comes from the release of certain refrigerants<sup>1</sup>. A refrigeration system extracts heat from the substance being refrigerated (cold reservoir) and rejects it to the ambient at a higher temperature (hot reservoir)<sup>2</sup>. This is analogous to the pumping of water to an elevated storage



tank. The energy consumption of a refrigerator is roughly proportional to rate of heat extraction (amount of water pumped) and to the temperature lift through which the heat is raised (height water is pumped). The energy efficiency of a refrigeration system is usually expressed as a Coefficient of Performance (COP) which is the ratio of the heat extraction rate to the rate of energy use. Whatever type of refrigerating system is being used, it is fundamental to minimize the required heat extraction and to keep the difference between  $T_c$  (condensing temperature) and  $T_0$  (evaporating temperature) as small as possible. Minimizing heat extraction is done by insulating the refrigerated room and low-temperature parts of the refrigeration system, minimizing ambient air infiltration (e.g. door openings and leakage) and reducing energy use in refrigerated applications (e.g. fans and forklifts). The temperature difference ( $T_c - T_0$ ) can be reduced by maximizing condenser and evaporator heat transfer performance and minimizing refrigerant pressure drops in suction and discharge pipelines<sup>5</sup>. In this work, difference of the temperature inside the refrigerator and the moisture change inside the refrigerator is detected by the sensors and use that difference to control the motor speed has investigated to reduce the power consumption of a refrigerator to save energy as today we are in the peak of the fossil fuel and under the threat of finishing it in near future.

## 2. EXPERIMENTAL

I have identified that; same as ( $T_c - T_0$ ) difference there are another way of changing the temperature inside a refrigerator. As an example if we need to get a bottle of water cool quickly we increase the cooling rate using the given adjustable cooler meter, at that time to maintain the required level motor should change its speed. Because the difference between the inside temperature and the adjusted temperature is high then to cool it down motor speed should be low. If temperature change, motor speed change according to that. It causes the energy consumption directly. If we can control this circle we can control the power consumption also. In this study we investigate to capture this temperature difference.

- Let's take inside temperature as  $T_i$  and user desire temperature as  $T_u$ ,  
then temperature difference is ( $T_i - T_u$ )
- ( $T_i - T_u$ )  $\propto$  1/Motor Speed
- Motor Speed  $\propto$  Power Consumption
- Motor Speed can be changed due to two reasons. They are ,  
  
1). Temperature difference ( $T_i - T_u$ )

## 2). Current motor speed of the refrigerator

To overcome this problems I decided to develop a temperature and moisture control circuit (Case 2) and a new inverter with a good motor (Case 1).

### Case 1: Motor Control

Normally single phase or two phase motors required more energy at the start up process of a refrigerator. Also it consumes more current during the change of the temperature due to switch mode operation.

### Case 2: Temperature and Moisture Control

This is the control circuit of the system. When we change the temperature using the adjustable cooler meter, circuit sense the temperature with the inside temperature and get the difference. Pulse frequency of the three phase motor inverter depends on this temperature difference. Motor rotation is programmed and controlled with the temperature difference. As we consider the temperature difference motor does not require more current when change is required. Since inside moisture could also affects the energy consumption, we have added a moisture sensor too.

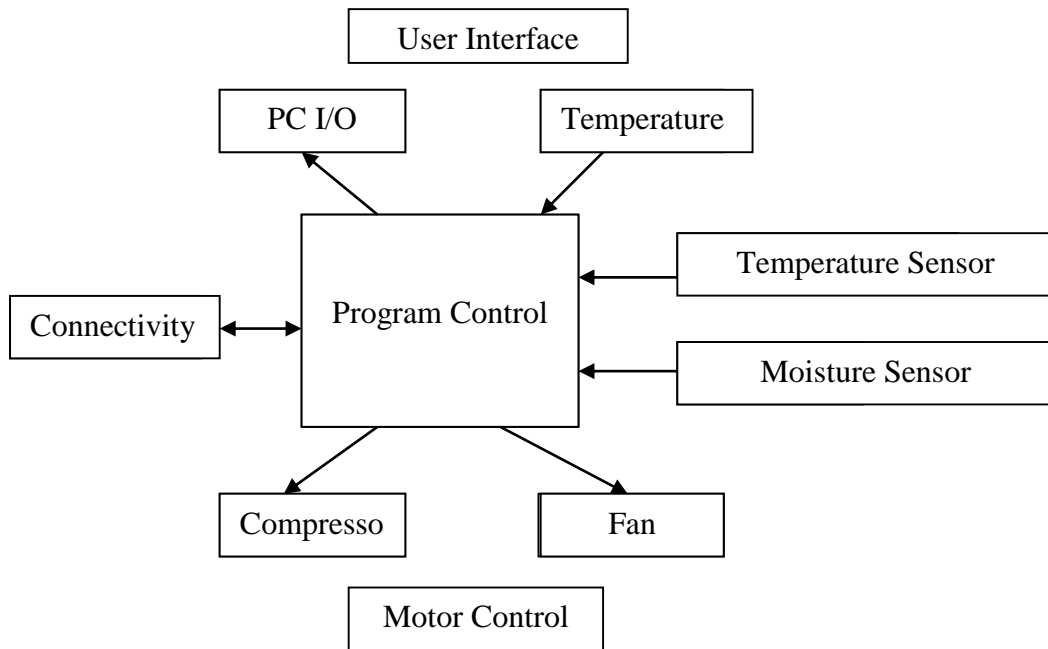


Figure 1: Block diagram of the new commercial product

### 2.1. Three phase motor inverter

Three phases is where we have 3 related voltage sources supplying the same load. It is a significant improvement over single phase or two-phase because the three voltage or current waves follow each other  $\frac{1}{3}$  cycle apart, and if we sum the currents together at any instant, we find that they perfectly balance. More importantly, the power is continuous and constant, so three phase motors run more smoothly. Three phase motor instead of single or two phases motor to control the power consumption as it has soft start due to rotational magnetic field has used for the device.<sup>4,5</sup>

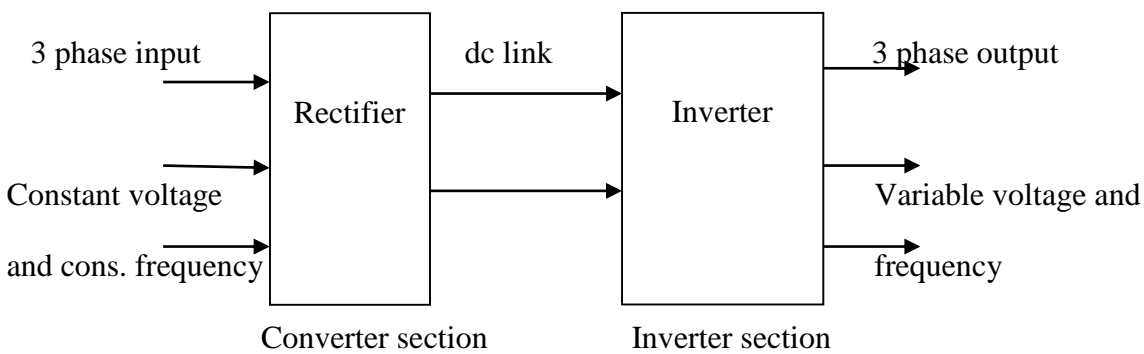


Figure 2: Three phase motor inverter

### 2.2. Temperature and moisture Control

This is the control circuit of the system. When we change the temperature using the adjustable cooler meter, circuit sense the temperature with the inside temperature and get the difference. Pulse frequency of the three phase motor inverter depends on this temperature difference. So motor rotation is programmed and controlled with the temperature difference. As we consider the temperature difference, motor does not require more current when change is required.

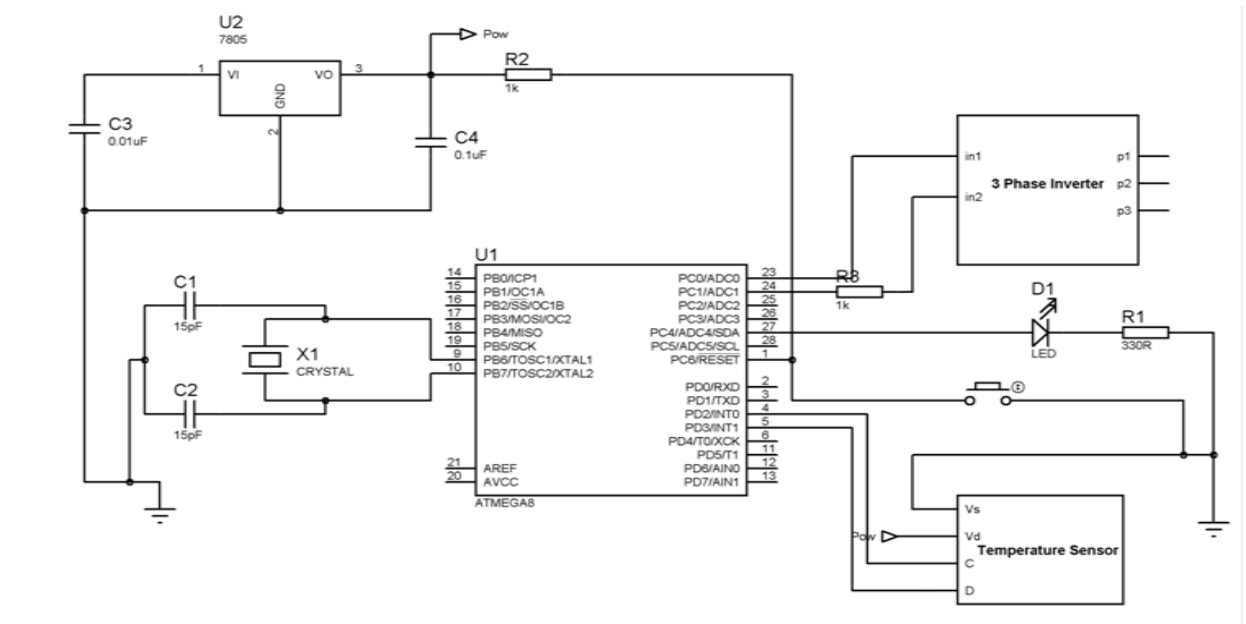


Figure 3: Circuit Diagram of the unit

### 3. RESULTS AND DISCUSSION

Single phase or two phase motors required more energy at the start up process of a refrigerator due to phase shift mode. Also it consumes more current during the change of the temperature due to switch mode operation. But three phase motor has soft start due to the rotational magnetic field.

Less vibration because it has rotating magnetic field, two phases are always in a motion when changes occur it simply pass the motion to the other phase.

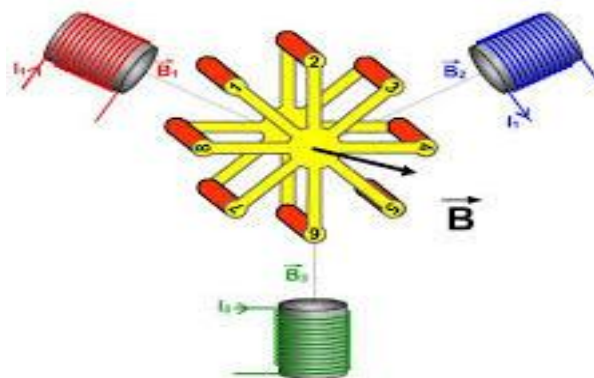


Figure 4: Three-Phase motor rotating field

Motor speed can be changed from one speed to another with minimal loss and Harmonic losses-minimized by an optimum choice of the PWM and the switching operations. Even though the product was developed under the name of ecofriendly, it cannot be achieved only by controlling motor speed considering only temperature, moisture and start up current.

### 3.1. Future developments

Even though the old refrigerators consume more energy customers are reluctant to buy a new one as its cost is high. So if this device can be fixed into an old product it is cost saving as well as saving energy.

## 4. CONCLUSION

We have designed a microcontroller based temperature and moisture control circuit to reduce the power usage of domestic refrigerators. The method described in this paper consists of temperature and moisture controlled circuit with an ATmega microcontroller chip that controls the speed of the three-phase motor inverter. This system is a potential low-cost solution to increase the power efficiency of domestic refrigerators.

## ACKNOWLEDGEMENT

We extend our sincere gratitude to IE Technics PTE Ltd for offering an opportunity to carry out a research during the industrial training placement.

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## ANALYSING NET METER VALUES

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### ABSTRACT

When we consider the industry, today solar power have become a necessity in human life. Therefore a high competition exists among solar power providers. Therefore they always try to introduce new additions for customers and to increase the usage of their products. Therefore in this paper a new service was introduced to the solar power providers, which is an analyzing net meter value system through the solar power. This analyzing net meter values system provides a useful tool to assess their own monthly electricity bill information anytime and from anywhere. This design is focused on the peoples who using solar power and who don't know calculate monthly electricity bill. Hardware of the proposed system are cubieboard as the minicomputer and small web cam to detect the import-export values of net meter. As further development company calculate monthly bill through the network system by using the import export values which are detected by web cam. After that company send monthly electricity bill to the customers through the network system. <sup>1</sup>

**Keywords:** Cubieboard 2, Image Processing, Monthly Electricity Bill, Net Meter Values

### 1. INTRODUCTION

Misreading of the measurements cause all other calculations to be wrong and it affect to future decisions. Also, if the company can get the import and export values of the readings then, they can do the necessary calculations after that the company can send the modified values to their customers through message or anyway to the mobile phones or any material. <sup>2</sup>

## 2. EXPERIMENTAL

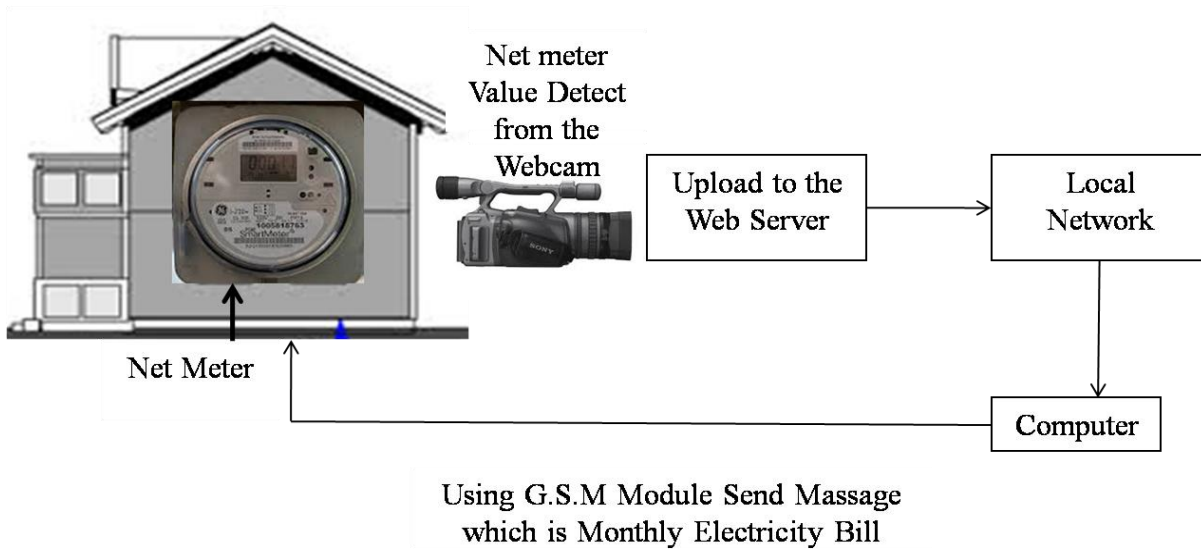


Figure 1: Block Diagram of Analyzing Net Meter Values

The main task of study was to build a device to analyzing net meter values. This device was created using an image processing method.

The magnitude of which is both values to be detected directly by that web cam. After analyzing the values, the circuit was designed by using a cubieboard2 for analyzing the values which have been obtained from the web cam and the outputs were uploaded to local network. <sup>3</sup>

The values were displayed on the computer screen through local Network. After analyzing values the monthly electricity bill can be created. The relevant bill can send to the customer home by using the computer. <sup>4</sup>

Where cubieboard2 represented as a minicomputer to indicate import and export values which is detected by image processing method. <sup>5</sup>

## 3. RESULTS AND DISCUSSION

For this project, it is difficult to find a best solution for the object of the project using image processing system at night time. But it can be solved by using light. There exists a limitation

of this system. Net meter authorize to the C.E.B. this limitation cannot be exceeding if it is not so, can be used serial port method to get the data.

Cubieboard2 was used for this experimental but relevant values can't be displayed, after that crasberyfy was used then the particular values can be displayed from that display.

### 3.1 How to Decide Monthly Electricity Bill

	Import	Export	Billing
7 <sup>th</sup> October	245	61	184
21 <sup>st</sup> October	463	251	212

#### 3.1.1 Electricity Bill for 14 Days

Average	Import	Export
14 Days	218 KWh	190KWh
Per Day	218/14 KWh	190/4 KWh
Per Day Generate Power	15.57/120 KWh	13.57/120 KWh
	0.129KW	0.113 KW
	129 W	113W

$$\text{Calculation of Units} = \left[ \frac{129 - 113}{1000} \right] \times 30 \times 120 = 57.6 \quad (1)$$



## **4. CONCLUSION**

The industrial training period is a very useful for the under diplomats because that is the first chance that we get to have an idea about how those theories we learned applied in the real world. Also it provides us a better idea to select our future carrier path and to identify our plus and weak points. Also we can identify to succeed in the industry what are the areas we have to improve.

During the training period I enhanced my ability to communicate with fellow workers and supervisors, enhanced the leadership skills, improved self-confidence and developed my planning and management skills. Also I got the working experience in Solar power installation and Solar panels installation, Net meter installation, How to connect wires.

At that training period I noticed that the company has to go customer's place to read net meter values, it will be very costly process to implement. So I selected that problem as my research topic and implemented an instrument of measuring Net meter import and export values without going customer's place and solve that problem.

## **ACKNOWLEDGEMENTS**

The authors would like to thank many individuals who helped and guided to complete this industrial training successfully. Mr. Oliver Jannel and other technical persons are acknowledged for their guidance during the stay at ASET Trading center.

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## VEHICLE ACCIDENT ALARMING SYSTEM USING IMAGE PROCESSING

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### ABSTRACT

In every day by day rate of accidents by vehicles upsurges. For year 2014 along there were 384,029 road accidents according to the Ministry of Internal Transport. More than 10% of accidents happened due to falling in sleep while driving. To reduce this there should be an alarming system in vehicles. Some luxury vehicles have some systems to avoid accidents. But there are no systems available which can be separately attached to the vehicle. The system developed in this study is easily attachable to any vehicle. This system detects the rate of eye blinking and gesture of the head. The two signals captured from a camera send to an onboard computer for processing of real-time images. The camera attached to the system is equipped with night vision technique, because much of these kinds of accidents happen at night time. If the driver falls asleep, the onboard computer detects and sends a signal to the speaker to make a warning alarm.

**Keywords:** *Real-time image processing, automobile accident alarming*

### 1. INTRODUCTION

With the rapid increase in the number of accidents seems to be increasing day to day. Therefore a need arises to design a system that keeps the driver focused on the roads. Driver in-alertness is an important cause for most accident related to the vehicles crashes. Driver tiredness resulting from sleep deprivation or sleep disorders is an important factor in the increasing number of the accidents on today's roads. Tired driver warning system can form the basis of the system to possibly reduce the accidents related to driver's sleepiness. Volvo escape route<sup>1</sup> is one of the many accidents avoiding system used in modern vehicles.

The purpose of such a system is to perform detection of driver tiredness. Accidents alarming system is developed for automobile safety. This system uses a night vision camera to detect eye blink rate and head gesture to identify whether the driver falls asleep or not. The pcDuino V2<sup>2</sup> is a small computer with a high processing power act as an onboard computer to process

image sent from the camera. If the above two parameters (eye blink rate and head gesture rate) fall down the threshold value, the pcDuino module will send a signal to alarming system. The warning sound can be user defined and both threshold values can be changed according to user. Volvo<sup>1</sup> escape route is one of the most sophisticated accidents avoiding system. The flow chart of the design is shown in the Figure 1.

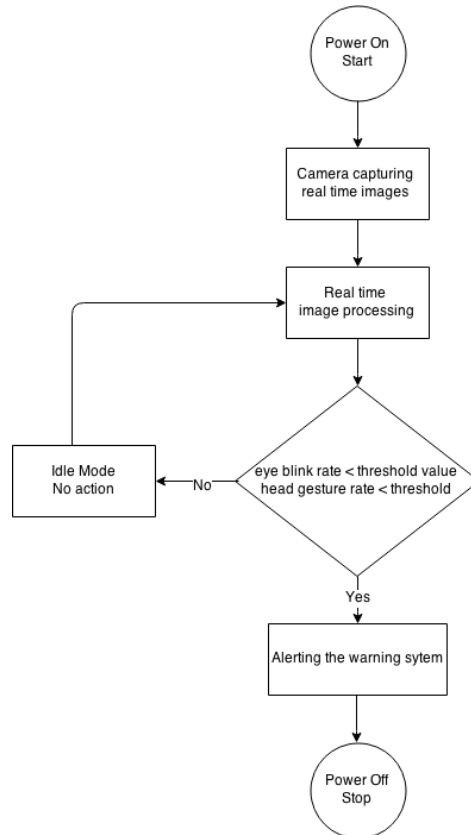


Figure 1: Flow Chart of the Accident Alarming System

## 2. EXPERIMENTAL

pcDuinov2 supported USB camera used to obtain real time images. pcdduino v2 is an open source language with high powered small computer module. System implementing begins with PcDuino v2 development board and Toshiba CNFA1B night vision camera module. First attempt was to detect the camera module by the pcDuino and convert images to gray scale. Gray scale is used because it uses less processing power than with colors. The gray scale image then uses to detect both face and eyes. The detected face and eyes are marked with a red square. If either no face or no eyes are detected, the system makes an alarm signal. The pcDuino model is powered by the vehicles cigarette's lighter. It needed 5V, 2A supply through a mini USB connector. The programming was done using python<sup>3, 4</sup>. The image processing library used was OpenCV<sup>5</sup>. For the debugging prepossess, HDMI connecter

connected between pcDuino and Laptop computer was used. For remote desk-toping VNC software was used.

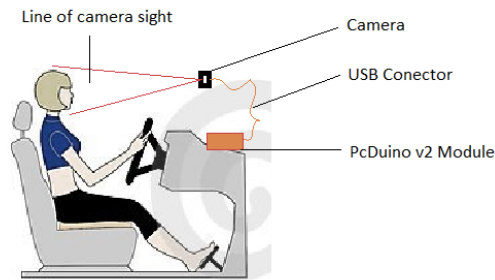


Figure 2: Assembly Schematics Diagram of the System inside a Vehicle

### 3. RESULTS AND DISCUSSION

Implemented system is processing images according to the programmed code in python. The camera images size is not a problem because the device stores the images and deletes them after processing according to the code. Some algorithms should updated or written to improve the accuracy of the system. The difference between two real time images is one millisecond. The threshold value of eye blinking rate defined is 25 per minute and head gesture rate is adjusted to low range, because if it's high RAM will overloads and reduces the processing power of the pcDuino.

For testing purposes the camera was mounted on the sun visor of a vehicle and minicomputer module was held on the dash board. The laptop computer that connected to the pcDuino held in the front passenger's seat. The system was tested while car's ignition ON in the neutral gear for safety. Both eyes open, both eyes closed and no driver cases were tested and got expected outputs.

The camera images are very clear in both day and night. The access speed of the data card directly causes to the starting of the device. For debugging purposes HDMI cable was connected to between Laptop computer and pcDuino. Cost of the pcDuino V2 is Rs.9000.00 and camera module is Rs.2500.00.

### 4. CONCLUSION

This system can attach to any vehicle regardless of their type. The techniques used are real time image processing using python and OpenCV libraries. The performance of this device

works fine regardless of situation (if ignition is ON and no driver the system gives the warning).

This accidental alarming system was designed using the state of the art techniques. The camera module can be changed to get better quality images because higher the quality of the image will require less the processing power. Also pcDuino can be replaced with Raspberry Pi development module<sup>6</sup>. But the Raspberry Pi module is less speed when compared to pcDuino.

The present system is not self-starting, the programme should run through an external computer via HDMI cable. However as the further development, this can be improved by artificial intelligence to detect driver's gesture and make more accurate decisions.

#### **ACKNOWLEDGEMENTS**

The authors would like to acknowledge and extend heartfelt gratitude to the persons who have helped to make this project success.

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## **NOVEL PERSON DETECTION TRIGGERED WIRELESS HIGH DEFINITION SECURITY CAMERA**

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### **ABSTRACT**

Nowadays security camera systems occupy a large space inside buildings because their servers are bulky in nature. This research study proposes and implements a solution for this problem. A compact computer with limited resources and inherent software is matched with server possibilities and hence used as a compact server. This somewhat novel concept reduces the bulky nature of present day server systems as well the proposed local implementation reduces the cost of such important security systems. This system uses Linux operating system (OS) and a streaming server for the overall video sharing process. Wi-Fi or Ethernet media can be used to communicate with the external detector components in real-time scale. This lightweight system is based on a tiny computer called Raspberry Pi. This compact processing system is tactically used to host the streaming process and to communicate with the camera, with new software based modifications and with the implementation of region-of-interest (ROI) detecting novel software platform for better user friendly graphical user interfaces (GUIs) design. Since the streaming of the video starts by ROI detection the resource needs are less compared to ordinary systems<sup>1</sup>.

**Keywords:** Raspberry Pi, Real-time Streaming, Image/Video Signal Processing /  
Transmission, Acorn reduced instruction set computing (RISC) Machine (ARM) Architecture

### **1. INTRODUCTION**

Nowadays almost every security camera system uses a large server with a network. In order to solve this problem a compact computer with a network is used in this research study. This requires software platform for receiving/transmitting video data. Instead of using system architecture with several processors and bulky servers, in this research study a single 700MHz processor based compact computer and a high definition (HD) camera are used for

the whole streaming process and a Wi-Fi router is used for the networking process. This processor is based on ARM architecture. ARM architecture is a reduced instruction set architecture which is developed by Acorn computers Ltd (later ARM Co.)<sup>2</sup>. This ARM processor is an application specific architecture which is used in this research study for computing needs. Raspberry Pi is a lightweight computer system with an ARM processor and with a 512 mega bytes of random access memory (RAM)<sup>3</sup>. This is capable of running on an operating system suitable for ARM architecture and hosting a Webserver. This architecture provides programming capabilities in order to expand its functionality. Also the Raspberry Pi computer system has general purpose input output (GPIO) port that can be completely controlled by the developed software. The processing power of the compact computer is only required by the video sharing component (streamer) and the ROI detector. The advantage of connecting a compact computer to the proposed security system is that it can serve as an immediate agent for an HD camera; i.e. the HD camera can act as an IP camera module with WLAN or LAN networking feature and also it has video processing capability which can be economical and feasible solution for real-time monitoring.

## **2. EXPERIMENTAL**

This light weight computer is based on an operating system which offers Linux kernel and Linux compatibility for few software designs. This software includes streaming capability and capability to process images. Fig 1 shows the flow chart for the function of the proposed module.

The HD camera modules with high resolutions (can be bought for nearly Rs: 2000/= in Sri Lanka) can be directly connected to the compact computer via its CSI (Camera Serial Interface) port<sup>4</sup>. In order to configure the camera to work in the raspbian operating system, the camera feature should be enabled first using the basic input/output settings (BIOS). Initialization of parameters is required by the camera module to record the video stream. HD camera and connected compact computer alone can be a video recorder but it does not provide video sharing or processing since video sharing is not included in default. In order to achieve video sharing, a video streamer is used which hosts the recording video through a protocol that can be viewed remotely. This streamer can be programmed using a software programming language (ex. C++/C). Here, the advantage is that the video stream can be processed programmatically. In this project, video processing has considered as advantageous

for triggering input (such as streaming starts with person detection). This will not occupy the total bandwidth of the local area network (LAN). For the verification of proposed system and data experimental conditions are streamed through Category 5 (CAT5) LAN and through a Wireless LAN (WLAN). For these experiments bandwidths of the network feature is important. The bandwidths of two LAN protocols and the face detection time are considered here for the system feasibility evaluation purposes.

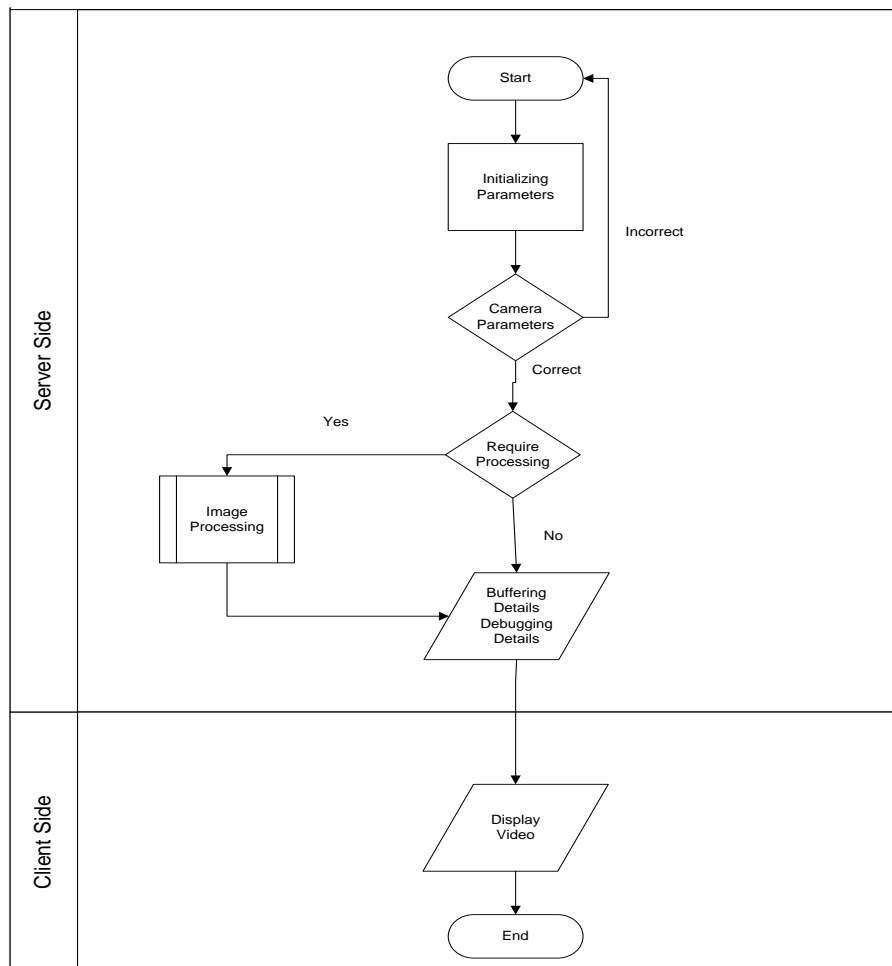


Figure 1: Flow chart of the implementation of proposed system

### 3. RESULTS AND DISCUSSION

#### 3.1 Available bandwidth for CAT5 LAN in the proposed system

In table 1 the bandwidth for five times are obtained for a CAT5 Ethernet network.



Table 1: Bandwidth data through a CAT5 LAN in proposed system

Term	Speed(Mbits/s)
1	94.7
2	94.7
3	94.8
4	95
5	94.7

These bandwidth data are obtained using ping command and the time taken for a single ping.

### 3.2 Available WLAN bandwidth for the proposed system

These bandwidth data usually changes with respect to the quality of the wireless adapters used with our proposed system. In general, these bandwidths relate nearly to the other wireless technologies.

Table 2: Bandwidths through a WLAN using 11N adapter in proposed system

Term	Speed(Mbits/s)
1	13.3
2	13.5
3	13.2
4	13.3
5	13.6

### 3.3 Image processing time measurements

Image detection time is important when streaming the video since processed each image should be sent to the network. The shared video stream has a delay of nearly 1-10 seconds. This is because the face detection time in this system is comparatively a significant number. Following table shows a list of ROI detection time in this compact computer for few frames in 320x240 resolutions.

Table 3: Obtained ROI detection time for the proposed novel system

Frame	Speed(Mbits/s)
1	316.143 ms
2	315.175 ms
3	312.001 ms

4	320.629 ms
5	318.168 ms

### 3.4 Quality of Received Video

The data compression of the recorded video stream using our proposed system is h264 scheme. As usual the delay of the video stream is nearly 1 second for the resolution of 640x480. When the resolution increases the delay is also increase. Since the open source libraries for raspberry pi does not support high frame rate processing, all the image processing are done with frame rate of 15frames/second. Fig 2 shows the video frames captured while streaming the recording video. When the frame rate increases to 30 frames/second the compact computer restarts due to resource insufficiency. The delay for 1920x1080 video streams is nearly 7 to 10 seconds. For a high speed processing for high precision security purposes and higher frame rates this system would require higher processing power. This would be achievable with new raspberry pi models. Since the security camera does not consider about the delay attached with it, this is nearly possible outcome for a low volume using HD security camera.

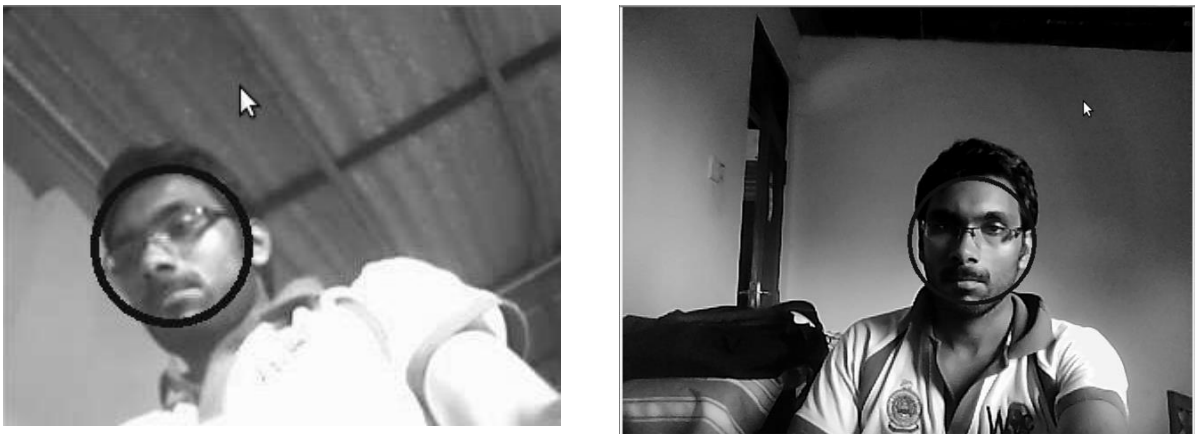


Figure 2: Video frames captured while streaming through WLAN using proposed novel system

## 4. CONCLUSION

Even though, the study shows a relatively slow streaming. This can be used as a HD video sharing security camera with minimal space and minimum power which includes ROI detection since this system has processing capability. This proposed system features person detection and would be feasible for video storage since processed video/images occupy less storing space in the hard disk(in megabytes). Since the streaming process is to be started with

person detection/ROI detection the rest of the video is not necessary to store for further analysis.

## **ACKNOWLEDGEMENTS**

Authors wish to extend their gratitude for all the staff members of department of electronics and department of computing and information systems, Wayamba university of Sri Lanka, Kuliyaipitiya.

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## SMART ELECTRICAL METER

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### ABSTRACT

The measurement of electricity usage in all aspects is a very important factor due to the high cost of electricity bills. At the end of a month, each traditional analog meter and prepare the electricity bill after reading the meter. The main problem is until the bill is received customers cannot see their monthly usage and cost of electricity. The requirement has arisen since the power wastage is getting higher in this modern society which has been identified as a main problem in all nations. Therefore identifying the unit consumptions will facilitate house owners to manage and reduce their monthly electricity usage and the bill. Smart electrical meter is a flexible, cost effective and durable electricity consumption meter. In this work phase current transformer sensing technology was used to detect and monitor a magnetic field around our household electricity power cable. It measures the usage of current in amperes. The phase wire of the current line was attached to the sensor and read all the values to a microcontroller. The calculation of the amount of power usage was done by reference to the system voltage and the current. Those values were displayed in a LCD screen attached to the microcontroller. The microcontroller was programmed to display the total current being used and monthly electricity bill. Smart electricity meter is a very useful application for electricity users since it will notify the user daily electricity usage and the cost by short message services (SMSs) with the aim of reducing the overall electricity usage of the nation.

**Keywords:** Electricity usage, Smart electricity meter, Microcontroller, Current sensor

## 1. INTRODUCTION

The main purpose of this project is to find solutions for an existing higher electricity consumption problem to obtain better outcome. The objective of the project is to design a “low cost electrical meter” which will satisfy customer requirements by identifying the electricity consumption and the monthly bill<sup>1</sup>. House owners can reduce the bill by switching off unnecessary lamps and electrical appliances in the house.

The primary objective of this project was to develop a product to provide a solution to reduce the wastage of electricity by observing how much power is consumed. The intended objectives, which expected to be achieved on the completion of the project, are to make a unit to measure the usage of electricity in day today life.

The residences, business or electrical power uses need to measure their electrical energy consumption by using an electrical meter. Electricity meters are typically calibrated in billing units, the most common one being the kilowatt hour. Periodic readings of electrical meters establish billing cycles and energy used during a cycle. Most of them are analog electricity meters. But in this project is expected to develop digital electrical meter which replaces typical analog electrical meter to monitor the consumption of electricity in a house.

Low cost “Smart Electrical Meter” helps house owners to view their monthly bill on their own. So it will motivate house owners to consume low electricity and thereby reduce their monthly electricity bill which will limit the unnecessary electricity usage.

This unit can be used to demonstrate the functionality of a real system. The deliverables can be fulfilled after the finishing the project. Following functions are delivered throughout the project.

1. The system is designed to display the values on LCD screen.
2. Display the usage of current and voltage.
3. The mains voltage is almost constant and therefore system is designed to display the usage of power.
4. To display the number of units consumed.
5. By using some calculations how much is bill being updated.
6. Daily usage is informed to the house owner by sending a SMS.
7. The device can control (ON / OFF) using the house owner’s mobile phone.

## 2. EXPERIMENTAL

The Smart Meter measures both the current and voltage of the test circuit. Two types of sensors are used in this project in order to measure the voltage and current. They are the voltage sensor and the current sensor. Then this voltage travels across bridge rectifier which does AC to DC conversion. The system overview is shown in figure01.

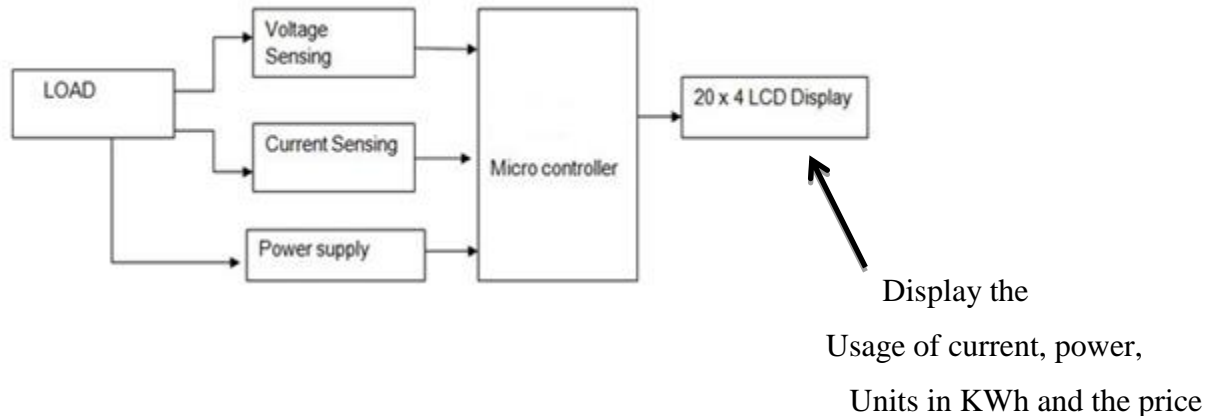


Figure 1: System overview

The output signal then adjust to 0-5V voltage level by using variable resistor, this provides an interface into the microprocessor. Current in the same way down to 5A by using current transformer and adjusted to 0-5V level, and it make an interface into the microcontroller.

In the interface both current and voltage signals are input into two channels of the on-board 13-bit ADC. Digital data for the input ports is used to calculate the power factor, which is calculated by the designed firmware. Results obtained again used to calculate the number of power units 1 unit = 1kWh. Here some calibration needs to be done. Using number of units rupee value of energy consumed is calculated. At last 20x4 LCD display connect to the microcontroller to display the number of units and the rupee value of the consumed energy.

## 3. RESULTS AND DISCUSSION

Hardware and software testing of the system were done separately. Hardware testing was done by simulating the circuit design in the Proteus software. Proteus Ares was used to develop the printed circuit board (PCB) layout of the system. Chemical etching process using  $\text{FeCl}_3$  can be employed to etch the PCB design. The regulator output was 5V and it was fed to the microcontroller. In the bridge circuit capacitor is used to smooth the AC (alternative current) signal it is also observed with an oscilloscope. Simple program was written with C compiler and run and identified whether the LCD is working. And the program required for

the project was written in C language. ATMEGA328P microcontroller<sup>2</sup> basically controls the functionalities of the system. TC35 module<sup>3</sup> can be used to control systems through short message services (SMSs). ACS712<sup>4</sup> current sensor and LM2596 voltage sensor<sup>5</sup> can be used for the systems to measure current and voltage measurements respectively since these two sensors have adequate accuracy for cost effective systems. Finally real time testing was done and the output was observed on the LCD screen. Block diagram of the circuit of the system is shown in figure 02 below.

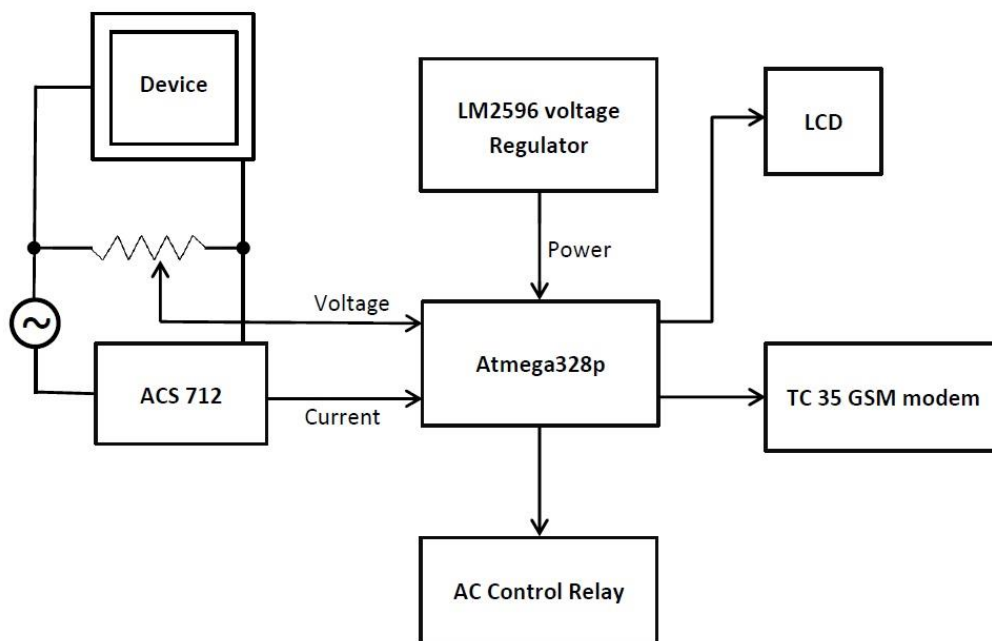


Figure 2: Circuit diagram of the system

Resolution of the system can be calculated as  $2^{10} = 1024$ . Step size of the analog to digital voltage conversion can be calculated as the  $5 \text{ V} / 1024 = 0.00488\text{V}$  and step size of the analog to digital current conversion can be calculated as  $20 \text{ A} / 1024 = 0.0195\text{A}$ . The measurable maximum voltage of the system was  $500 \text{ V}$ . So step size of the measurable voltage can be formulated as  $500 \text{ V} / 1024 = 0.488 \text{ V}$ .

The calculation of the amount of power usage is done by reference to the system voltage and the current. Those values are displayed in a LCD screen attached to the microcontroller. The microcontroller is programmed to display the total current being used. By using several commands and by using some buttons attached to the advanced electric meter house owner can see the electricity usage and the monthly electricity bill.

The circuit design of the smart electrical meter is shown in figure 03.

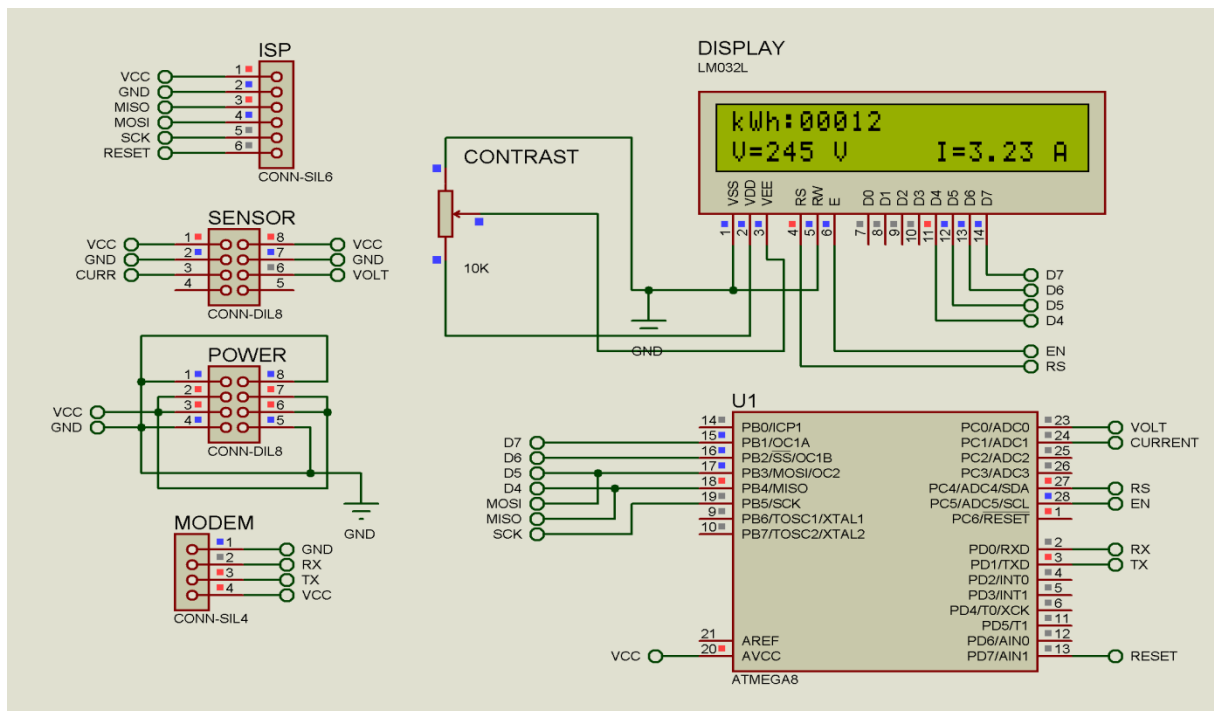


Figure 3: Designed Circuit

Smart electrical meter is a flexible, cost effective and durable electricity consumption meter. Generating a text messages about the electricity consumption as a short message service is a very useful feature of the project since it can help user to have an idea about his electricity consumption and the electricity cost. It will help the user to manage the monthly electricity usage while saving power. Further the user can get to know the electricity usage time by the text messages. This system can be applied to the industrial companies as well to monitor and control the electricity usage. The developed system can comfortably be used to measure the electricity usage with its smaller device and circuit size. This system can be plugged to the places where electricity is used with maximum of 20A. At the same time, this can be identified as a drawback of the project as well since this system cannot be applied to the places in where current of the system is more than 20A. Developed system cannot be employed at the places where three phase electricity is used and which can be identified as another disadvantage of the system.

As the future improvements, the developed system can be upgraded to use this system in places where three phase electricity is used. Further this system can be improved by developing a database to store users' electricity usage data and those data can be used in decision making regarding electricity consumption and electricity usage predictions.



#### **4. CONCLUSION**

Smart electrical meter is a flexible, cost effective and durable electricity consumption meter with which electricity consumption can be monitored effectively. Through the LCD display the analyzed data of the system can be viewed. Short message service will increase the usefulness of the system to monitor and control the electricity usage and the electricity bill.

Phase current transformer sensing technology is used to detect and monitor a magnetic field around our household electricity power cable. It measures the usage of current in amperes. The phase wire of the current line is attached to the sensor and read all the values to a microcontroller.

#### **ACKNOWLEDGEMENTS**

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## **INTERFERENCE CANCELLATION BY A MODIFIED PRECODER FOR MULTIPLE USERS**

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### **ABSTRACT**

In multiple access channels, when users know each other's channels, precoders can be designed utilizing channel information to cancel the interference at the receiver without sacrificing the diversity or the complexity of the system. Recently, it was shown that when there are only two users, a receiver can completely cancel the interference of the two users and provides full diversity for each user. Unfortunately, the scheme only works for two users. In this paper, a system is proposed to achieve interference cancellation and full diversity with low complexity for any number of users. The main idea is to design precoders, using the channel information, to make it possible for different users to transmit over orthogonal directions. Then, using the orthogonality of the transmitted signals, the receiver can separate them and decode the signals independently.

**Keywords:** Multi-user detection, multiple antennas, interference cancellation, precoder, orthogonal designs

### **1. INTRODUCTION**

Multiple-input multiple-output (MIMO) wireless channels, created by deploying antenna arrays at both transmitter and the receiver, promise high capacity and high quality wireless communication links. A lot of attention has been given to multi user detection schemes with simple receiver structures. The multiple transmit and receive antennas are used to improve the gain, rate and reliability of wireless system<sup>1</sup>.

In this paper a multiple antenna multi access scenario where interference cancellation is achieved by channel information is considered. When there is no channel information at the

transmitter, simple array processing methods using orthogonal space-time block codes (OSTBC) and quasi-orthogonal space-time block codes (QOSTBC) have been proposed<sup>2</sup>.

The common goal and the main characteristics of the above multi user system require less number of receive antennas and low complexity array decoding. However by using maximum likelihood detection, full diversity for each user is achieved. But maximum likelihood detection is usually not practical, as number of transmit and receive antennas increases, the number of users and bandwidth efficiency is also increased<sup>3</sup>. To overcome this drawback, channel information is utilized at the transmitters to increase the diversity of the system while keeping the low complexity of the decoding<sup>6</sup>. In other words, unlike the above mentioned methods, receive antennas are not used to cancel the interference. Instead, the channel information at the transmitter is used to design precoders that align different groups of signals along orthogonal directions<sup>4</sup>. As a result interference suppression is achieved without utilizing the receive antenna resources and therefore full diversity is achieved naturally.

## 2. EXPERIMENTAL

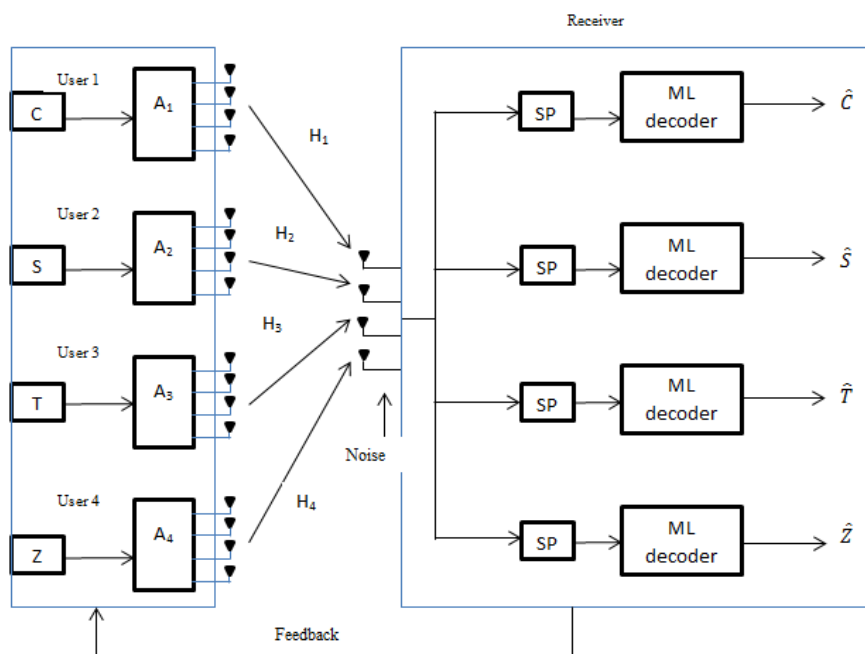


Figure 1: Block diagram of proposed system

In this paper, a quasi-static flat Rayleigh fading channel model is assumed. The path gains are independent complex Gaussian random variables and are fixed during the transmission of one block. In addition, a short term power constraint is assumed. For the sake of simplicity, the

scheme is only presented for four users each with four transmit and one receive with four receive antennas. The block diagram of the system is shown in Figure 1. The channel matrices for users 1, 2, 3, 4 are assumed as<sup>3</sup>,

$$H_1=[h_1(i,j)]_{4 \times 4}, H_2=[h_2(i,j)]_{4 \times 4}, H_3=[h_3(i,j)]_{4 \times 4}, H_4=[h_4(i,j)]_{4 \times 4} \quad [1]$$

respectively. At the  $l$ th time slots  $l=1, 2, 3, 4$  the precoders for user 1,2,3,4 are,

$$A^l_1=[a^l_1(i,j)]_{4 \times 4}, A^l_2=[a^l_2(i,j)]_{4 \times 4}, A^l_3=[a^l_3(i,j)]_{4 \times 4}, A^l_4=[a^l_4(i,j)]_{4 \times 4} \quad [2]$$

In every 4 time slots, Users 1, 2, 3, 4 send QOSTBCs<sup>5</sup>,

$$C=\begin{pmatrix} c1 & -c2 * & c3 & -c4 * \\ c2 & c1 * & c4 & c3 \\ c3 & -c4 * & c1 & -c2 * \\ c4 & c3 & c2 & c1 \end{pmatrix} \quad S=\begin{pmatrix} s1 & -s2 * & s3 & -s4 * \\ s2 & s1 * & s4 & s3 \\ s3 & -s4 * & s1 & -s2 * \\ s4 & s3 & s2 & s1 \end{pmatrix}$$

## 2.1 Encoding:

According to the block diagram encoding and decoding parts are there along with the channel, as the channel is a quasi-static flat Rayleigh fading channel model. In this paper for results and for explanation only 4 users have been used. That is 4 users one receiver and 4 receiving antennas.

The four users at four different time slots suppose as  $l=1, 2, 3, 4$ . At the  $l$ th time slots  $l=1, 2, 3, 4$  the input output equation can be written as,

$$\begin{aligned} y_l &= \sqrt{E_s}(H_1 A^l_1 C(l) + H_2 A^l_2 S(l) + H_3 A^l_3 T(l) + H_4 A^l_4 Z(l) + n_l) \\ &= \sqrt{E_s}(H^l_1 C(l) + H^l_2 S(l) + H^l_3 T(l) + H^l_4 Z(l) + n_l) \end{aligned} \quad [3]$$

Where  $H^l_i = H_i A^l_i$  and  $y_l$  denotes the received signals of the four receive antennas at time slot  $l$ .  $E_s$  denotes the transmit energy of each user;  $n_l$  denotes the noise at the receiver at time slot  $l$ . Rearranging Equation (3), we have,

$$\bar{y} = \sqrt{E_s} \left( \overline{H1} \begin{pmatrix} c1 \\ c2 \\ c3 \\ c4 \end{pmatrix} + \overline{H2} \begin{pmatrix} s1 \\ s2 \\ s3 \\ s4 \end{pmatrix} + \overline{H3} \begin{pmatrix} t1 \\ t2 \\ t3 \\ t4 \end{pmatrix} + \overline{H4} \begin{pmatrix} z1 \\ z2 \\ z3 \\ z4 \end{pmatrix} \right) + \bar{n} \quad [4]$$

Where,

$$\bar{y} = \begin{pmatrix} y1 \\ (y2) * \\ y3 \\ (y4) * \end{pmatrix} \quad \bar{n} = \begin{pmatrix} n1 \\ (n2) * \\ n3 \\ (n4) * \end{pmatrix}$$

Now precoders have been chosen that can realize full diversity and interference cancellation for each user. To realize interference cancellation, a straight forward idea is to transmit the symbols of the four users along four orthogonal directions. By doing so, it is easy to achieve interference cancellation at the receiver using zero-forcing<sup>2</sup>. However, the difficulty lies in how to achieve full diversity as well. Here comes the concept of precoding technique which helps in improving the diversity and also removes the interference for four users. At each of the first 2 time slots, 1, 2, 3 and 4, precoders have been designed such that symbols of User 1 and symbols of User 2 are transmitted along two orthogonal directions respectively. Similarly precoders have been designed for Users 3 and 4, such that the transmit directions of their signals are orthogonal to each other. Finally after combining 1, 2, 3, 4 they all will not interfere because of the individual choosing of precoders symbols for 1,2 and 3, 4. As shown in the figure 2 they are placed in orthogonal structure in vector space.

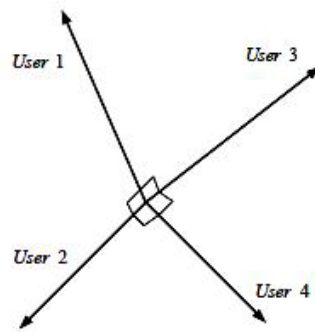


Figure 2: Orthogonal structure of signal vectors in 4-dimensional space.

## 2.2 Decoding

Using the pre-coders, Equation (3) becomes,

$$\bar{y} = \sqrt{Es} \left( \overline{H1} \begin{pmatrix} c1 \\ c2 \\ c3 \\ c4 \end{pmatrix} + \overline{H2} \begin{pmatrix} s1 \\ s2 \\ s3 \\ s4 \end{pmatrix} + \overline{H3} \begin{pmatrix} t1 \\ t2 \\ t3 \\ t4 \end{pmatrix} + \overline{H4} \begin{pmatrix} z1 \\ z2 \\ z3 \\ z4 \end{pmatrix} \right) + \bar{n} \quad [5]$$

Here  $\bar{y}$  and  $\bar{n}$  are the same with  $y$  and  $n$  in Equation (3). Note that using the pre-coders, each column of matrix  $\overline{H1}$  is orthogonal to each column of matrices  $\overline{H2}, \overline{H3}, \overline{H4}$ .

In order to decode symbols from User 1, both sides of Equation (5) is multiplied by matrix  $\overline{H^+}_1$  to achieve,

$$\overline{H^+}_1 \bar{y} = \sqrt{Es} \overline{H^+}_1 \overline{H1} \begin{pmatrix} c1 \\ c2 \\ c3 \\ c4 \end{pmatrix} + \overline{H^+}_1 \bar{n} \quad [6]$$

Similarly for user 2, 3, 4 we can multiply both sides of the equation (5) with matrix  $\overline{H}^{+2}$ ,  $\overline{H}^{+3}$  and  $\overline{H}^{+4}$  respectively to remove the signals of other user and use Maximum Likelihood Decoding to complete the decoding<sup>6</sup>. Here, it can be proved that full diversity can be achieved using this precoding scheme. Proof for User 1 is presented, since the proof for Users 2, 3, 4 is the same. Diversity is defined as:

$$d = - \lim_{\rho \rightarrow \infty} \left( \frac{\log Pe}{\log \rho} \right)$$

Where ‘Pe’ denotes the SNR and ‘ρ’ represents the probability of error.

### 3. RESULTS AND DISCUSSION

The performance of the proposed scheme is shown in Figure 3. The proposed scheme cancels the interference completely but provides a diversity of 16 by utilizing the channel information at the transmitter.

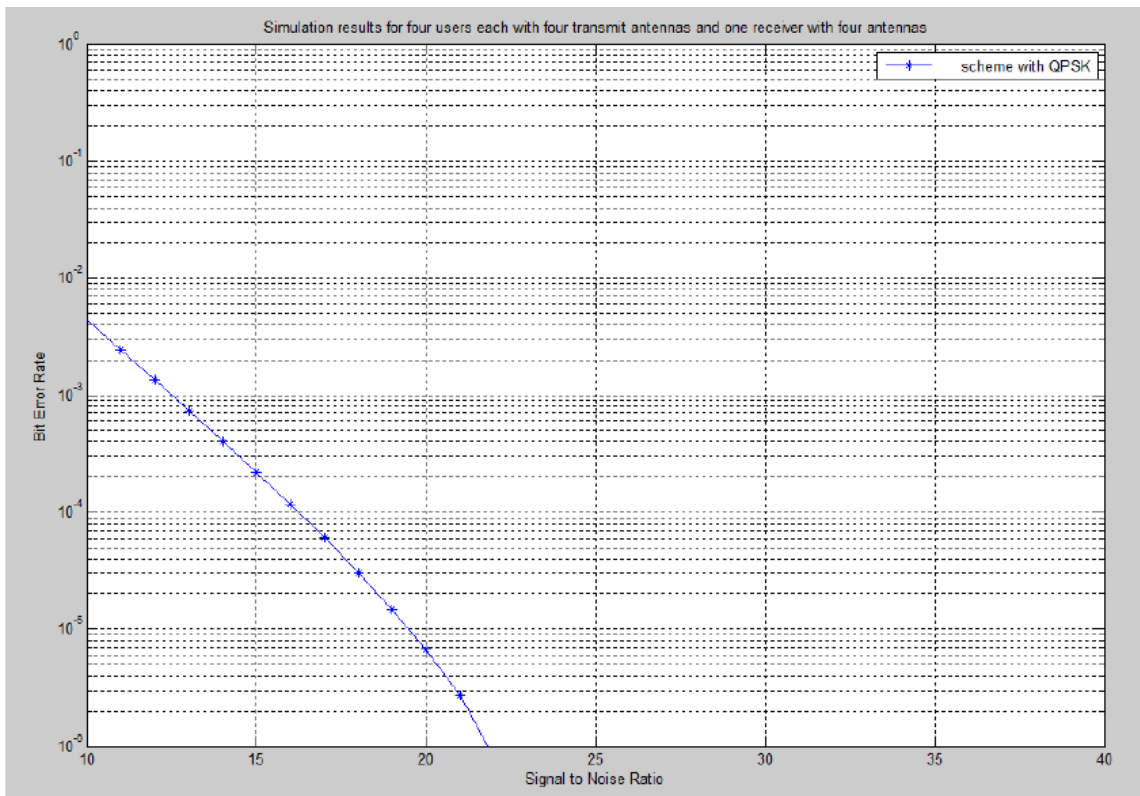


Figure 3: Simulation results for four users each with four transmit antenna and one receiver antenna.

### 4. CONCLUSION

In this paper, interference cancellation for a system with 4 users each with 4 transmits antennas and one receiver with 4 receive antennas have been considered. When users know all channels, a scheme was proposed to achieve Interference cancellation and achieve

maximum possible diversity with low complexity. The main idea is that each user transmits signals along a direction that is orthogonal to direction of other users. This is achieved by designing precoders. Then the receiver can separate signals of different users using the orthogonality of the transmitted signals and Maximum Likelihood Decoding.

## **ACKNOWLEDGEMENTS**

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## **HARDWARE IMPLEMENTATION OF VGA CONTROLLER ON FPGA**

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### **ABSTRACT**

As a standard display interface Video Graphics Array has been widely used. This paper presents the design and implementation of VGA controller on Field Programmable Gate Array (FPGA). Most VGA controllers are used software drivers. However, FPGA are increasingly used in hardware acceleration and video processing, it is required to directly display video output on VGA. Therefore, it is required to implement VGS controller in FPGA hardware. We used Verilog hardware description language to design the VGA controller and tested it with random walk algorithm.

**Keywords:** VGA Controller, FPGA, Verilog, Xilinx ISE

### **1. INTRODUCTION**

Field-Programmable Gate Arrays (FPGAs) are digital integrated circuits (ICs) that contain configurable blocks of logic along with configurable interconnects between these blocks.<sup>1</sup> Specifically, an FPGA contains programmable logic components called logic elements (LEs) and a hierarchy of reconfigurable interconnects that allow the LEs to be physically connected. LEs can be configured to perform complex combinational functions, or merely simple logic gates like AND and XOR. In most FPGAs, the logic blocks also include memory elements, which may be simple flip-flops or more complete blocks of memory.<sup>2</sup>

VGA (video graphics array) is a video display standard. It provides a simple method to connect a system with a monitor for showing information or images. As a standard display interface, VGA has been widely used. There is more and more need in displaying the result of the process in real time as the fast development of embedded system.<sup>2</sup>



Diffusion-limited aggregation (DLA) is the process of cluster growth by particles undergoing a random walk due to Brownian motion. The theory of DLA, proposed by Witten and Sander in 1981, is useful in explaining the aggregation of particles in any system where diffusion is the primary means of transport. Several methods are available to accomplish this. One approach is to place particles in a lattice of any desired geometry and to simulate their aggregation due to sticking together while they perform a random walk. The project mainly focused on developing random walker for implementation of DLA. VGA interfaced is also developed for the showing of position of the random walker.

VGA Controller module and random walker position generator module are written in Verilog HDL using Xilinx ISE. Once the simulation is succeeded, the program will be burnt into Xilinx Spartan 3E, which will process the VGA Controller module and random walker module and display the image on LCD screen.

### 1.1 VGA principal

The monitor screen for a standard VGA format contains 640 columns by 480 rows of picture elements called pixel. An image is displayed on the screen by turning on and off individually pixels. Turning on one pixel does not represent much, but combining numerous pixels generates an image. The monitor continuously scans through the entire screen, rapidly turning individual pixels on and off. Although pixels are turned on one at a time, we get the impression that all the pixels are on because the monitor scans so quickly. This is why old monitors with slow scan rates flicker.

Referred to Figure 1, the scanning process starts from row 0, column 0 in the top left corner of the screen and moves to the right until it reaches the last column. When the scan reaches the end of a row, it retraces to the beginning of the next row. When it reaches the last pixel in the bottom right corner of the screen, it retraces back to the top-left corner and repeats the scanning process. In order to reduce flicker on the screen, the entire screen must be scanned 60 times per second. This period is called the refresh rate. The human eye can detect flicker at refresh rates less than 30 Hz. To reduce flicker from interference from fluorescent lighting sources, refresh rates higher than 60 Hz are sometimes used in PC monitors. During the horizontal and the vertical retraces, all the pixels are turned off [3].

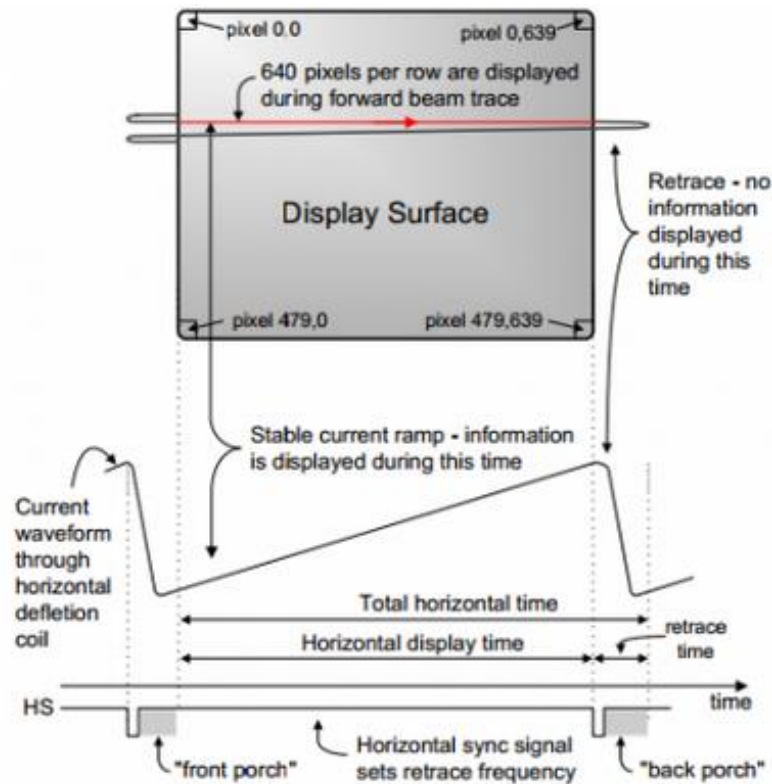


Figure 1: Scanning pattern of VGA controller

### 1.2 VGA interface signal

The VGA monitor is controlled by 5 signals: red, green, blue, horizontal synchronization, and vertical synchronization. The three color signals, collectively referred to as the RGB signal, control the color of a pixel at a given location on the screen. They are analog signals with voltages ranging from 0.7 to 1.0 volt. Different color intensities are obtained by varying the voltage. For simplicity, these three-color signals are treated as digital signals, so we can just turn each one on or off.<sup>3</sup>

### 1.3 Timing Control

To obtain the  $640 \times 480$  screen resolution, a clock with a 25.175 MHz frequency is used. A higher clock frequency is needed for a higher screen resolution. For the 25.175 MHz clock, the period is as below.

$$\frac{1}{25.175\text{MHz}} = 0.0397\mu\text{s per clock cycle}$$

#### 1.4 Random Walker

The random walker is generated using module called Linear Feedback Shift Register Module LFSRM that uses XOR gate logic operation and data shifting both for generate random walker position. And the random walker address is 15bit value.

## 2. EXPERIMENTAL METHODOLOGY

In figure 2 the function of “clock generator” block is to reduce the frequency of input clock from 50 MHz to 25 MHz. Meanwhile, “vga\_sync” block is used to generate timing and synchronization signals. The “h\_count” and “v\_count” indicate the relative positions of the scans and essentially specify the location of the current pixel while the “h\_sync” signal specifies the required time to scan a row, and the “v\_sync” signal specifies the required time to scan the entire screen. “vga\_sync” block also generates the “video\_on” signal which indicates whether to enable or disable the display. Besides that, “address generator” block is used to generate address for the “img\_data” block by using the “h\_sync” and “v\_sync” signal. “img\_data” block will get the index data (q) from the UCF file according to the address generated. Note that the index data are connected to the “img\_index” block to use as the address. The “img\_index” block will get the RGB data (q) from UCF file according to the address generated (index data). The RGB data consist of 24-bits, whereas “q [23:16]”, “q [15:8]” and “q [7:0]” indicate the “R\_data”, “G\_data” and “B\_data” respectively. [2]

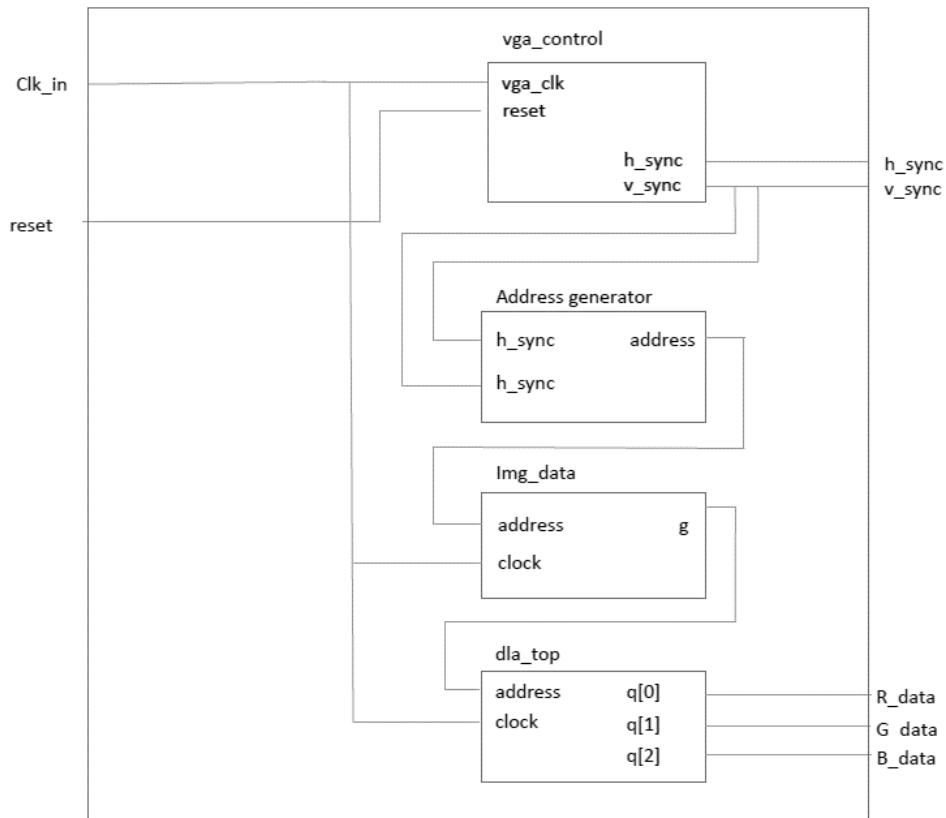


Figure 2: Block diagram of VGA controller

### 2.1 Design flow of VGA Synchronization signal

First and foremost, reset is sensed. If reset is equal to 1, “h\_count” and “v\_count” will be reset to 0. If reset is equal to 0, it will check whether the value of “h\_count” is equal to 799 or not. If the value of “h\_count” is not equal to 799, it will be increased by 1. Meanwhile, if the value of “h\_count” is equal to 799, it will be reset to 0. This is due to one complete horizontal scan is start from 0 to 799. Then, it will check whether the value of “v\_count” is equal to 524 or not. If the value of “v\_count” is not equal to 524, it will be increased by 1. If the value of “h\_count” is equal to 799, it will be reset to 0. This is due to one complete vertical scan is start from 0 to 524.

### 2.2 Random walker

Every time the top module accesses the Linear Feedback Shift Register Module(LFRM) module to get random walker position. The LFRM module generates the 15bits of random walker address and fed to the top module. After processing the data in top module, the top module fed that data into VGA interface. The process is done by real time therefore no memory involved.

### 3. RESULTS AND DISCUSSION

In this paper we implemented a VGA controller directly on FPGA hardware. To test the system a random walker is generated displayed on the VGA monitor. To display the random motion of a particle on VGA display, we used 128x128 pixel area due to lack of Block RAM of the FPGA. Figure 3 shows the screen shot of the random walker.

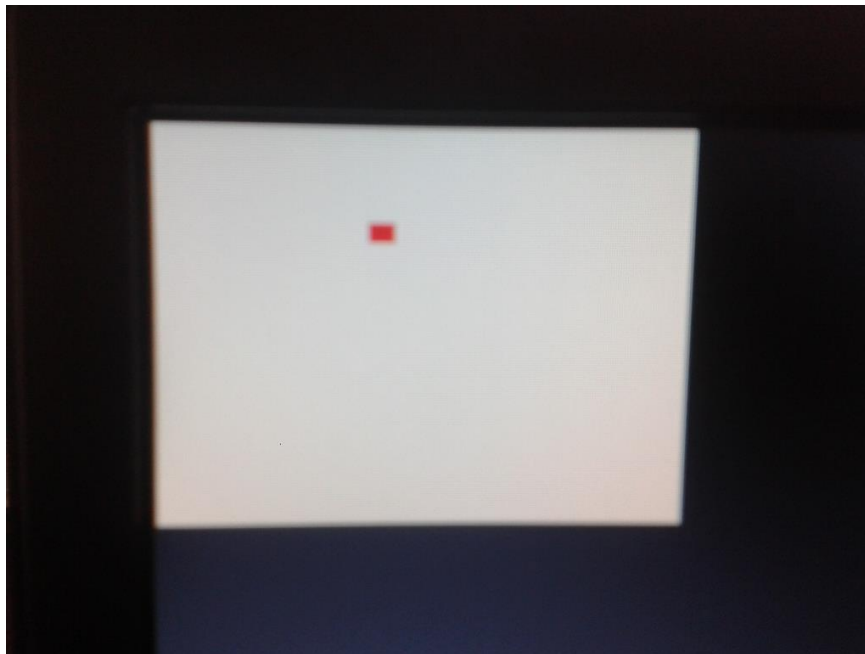


Figure 3: VGA output

Following simulation figure represent the linear feedback shift register to display the random numbers for the given address.

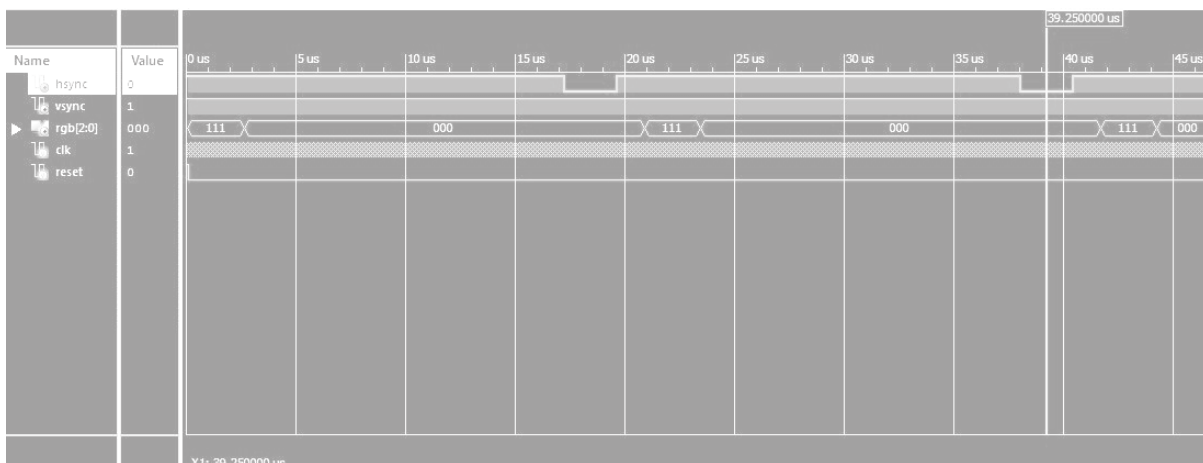


Figure 4: Simulation results for VGA controller

### 4. CONCLUSION

We implemented VGA controller on FPGA hardware using Verilog Hardware Description Language. To test the system a random walker algorithm was generated and position of the walker displayed on the screen real-time. This system can be used to display outputs of video processing and machine vision application where FPGA hardware is used.

### **ACKNOWLEDGEMENTS**

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## **AUTOMATIC LAP COUNTING SYSTEM FOR ATHLETIC**

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### **ABSTRACT**

The present day inventions relate generally to counting systems, and more specifically to technologies for counting athletic laps and providing feedback to racers in athletic events. Lap counting is the most important part of the athletic and race working events. This system can easily count the lap in number of athlete's and display the details of athletes during events. Some countries including Sri Lanka use the manual human involved systems for lap counting. It can caused some errors in counting laps. Our country use human involved manual systems in which the athletes' laps are written down on the paper. Thus human errors can result or confusion with missing the exact number of laps. The proposed novel low cost system can minimize such errors of missing laps. The main objective of this research study project is to design a low cost, user friendly and reliable lap counter system for athletes as well as judges. Using the proposed monitoring system the comprehensive details of the athlete and required information about competitor can be accurately recorded and can be obtained any time. Not only for the athletic competitions but also it can be used in practice sessions and coaching camps etc. The manufacturing cost gain of our proposed locally designed system is about 10 percent lower than that of imported sophisticated one. Also, the newly designed automatic lap counting system can be easily adoptable for Sri Lankan athletic style.

**Keywords:** Automatic Lap Counting system for Athlete, RFID based detection System

### **1. INTRODUCTION**

The commercially available lap counting systems were developed using various technologies, nevertheless majority of them consisted of major drawbacks and limitations. The Literature related to existing lap counting systems are described below. Lap Counter with Bell method can be used to calculate the number of rounds of only one athlete<sup>2</sup>, surrounded by the number of count. Figure 1 shows the leading player lap counter and but he can't identify his current lap. Here in this indicator contains 10 numbers from 0-9. This is a manual system. Photo



finish system<sup>3</sup>, photo-finish<sup>1</sup> occurs in running race when multiple competitors cross the finishing line at nearly the same time. As the naked eye may not be able to distinct the exact approach to indicate between which of the competitor crossed the line first, second and so on. Then a photo or video taken at the finish line can be used for a more accurate post. But in the prevailing system which can be used in Sri Lanka detect the motion of any part of the body even hand motions are can be detected in this system<sup>1</sup>.

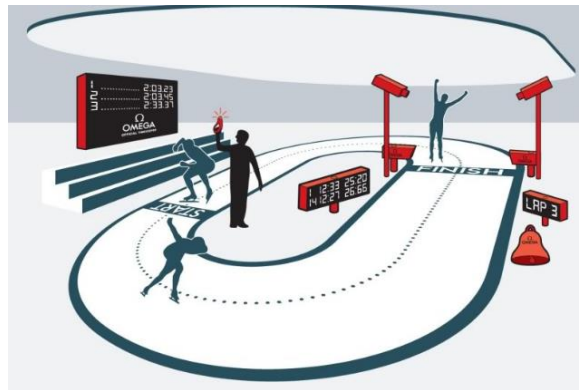


Figure 1: Photo finish system<sup>1</sup>

## 2. EXPERIMENTAL

Before designing the main circuit, the internet surfing was used to obtain understanding for different types of wireless data transferring methods in sports events. Then literature about data transmitting/receiving using radio frequency and its functionality were studied. The following basic schematic diagram given below can be used to describe the system.

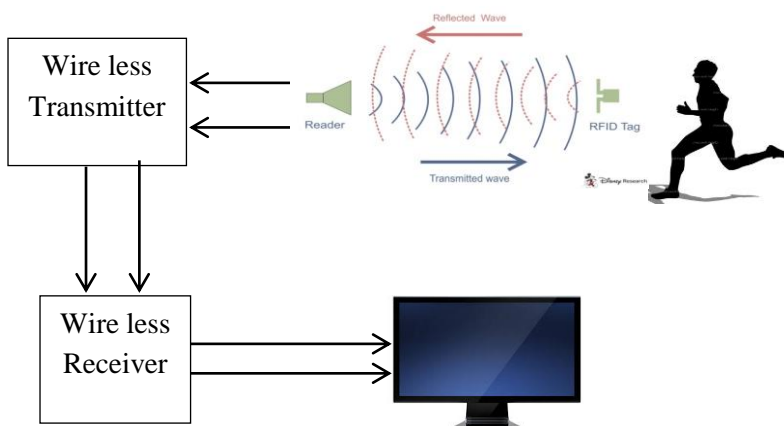


Figure 2: Schematic of the system design

In the illustrated system, when the race started a signal is sent to the main system. After the athlete reached the starting position again and when it is just passed (after completed 1<sup>st</sup> lap) the RFID reader is used to approach signal from the RFID tag in the athlete body. Then, detected signal is sent to the wireless transmitter. After that, it transmits to the main system after detecting at wireless receiver. Finally the microcontroller based system display is used to display the final processed data after microprocessor based analysis.

### **3. RESULTS AND DISCUSSION**

After designing and implementing the complete proposed automated lap detection system, evaluation stage of it is implemented in two steps. Initially, the data receiver unit is evaluated to verify whether the section modules of the proposed system is functioning properly. Subsequently error of the transmission unit is evaluated to verify that counting measurements are transmitted without any interference or error.

This proposed system measure number of laps and athlete parameters such as the best (minimal) time record of the athlete, ground record time, event record time in high accuracy and clearly. This proposed RFID technology is difficult to use for measuring such time dependent events with linear RFID systems<sup>6</sup>, the performance of this systems can be improved in order to measure time in more accurate manner.

### **4. CONCLUSION**

Using the proposed Automatic Lap Counting system for athletic events it can be developed to count number of laps that an athlete completed more accurately. In this work, a prototype simulation system was designed and constructed. With high accuracy number of laps and athlete details are gained by improving system designs and using high end devices, such as heart beat sensor, line detection IR sensors etc. Compared to the cost for imported commercially available Automatic Lap Counting system (such as photo detection system) which is approximately 50000LKR, the cost benefit of implementing this system is nearly 10% .Furthermore, the reliability and usability of this system is improved by using wide range RFID readers/tags which cost nearly 500LKR each.

### **ACKNOWLEDGEMENTS**

Authors wish to extend their gratitude for all who have supported to make this project a success.

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## **DIGITAL POWER MONITORING SYSTEM WITH POWER LINE COMMUNICATION**

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### **ABSTRACT**

The monitoring of electric power helps to identify the important power quality problems such as voltage sags and swells, interruptions, harmonics, and high-frequency noise, consistently seen in industrial and household applications. Troubleshooting these problems requires accurate measurements and analysis of power quality with monitoring instruments that can effectively locate issues and identify solutions. A digital power meter to measure power consumption of home appliances could be an ideal solution for this. This report focused on digital power monitoring device with power line communication (PLC). The complete system is divided into two units and they are measuring unit and transmission unit. Measuring unit measures the voltage and frequency applied to the appliance (or voltage drop across the load), current through the appliance, power factor and most importantly the power consumption of the appliance when the appliance is plugged into the device. A sensor module is used to sense the current and LCD displays are used to display measured values. To observe the measured data at two different outlets in two different locations Mamba shield – narrow band power line communication modules are used to establish communication between two power outlets.

**Keywords:** Power Line Communication, Transmission, Arduino, LCD

### **1. INTRODUCTION**

The commercially available power monitoring systems were developed using Joulemeter<sup>6</sup> projects, We-Mo insight switch (Wi-Fi enabled system)<sup>4</sup>, using circuit level power measurements and etc. Due to high initial cost, lack of portability, inaccurate measurements lead them to failures in this matter. Most power meters that already exist in the market suffer with a few number of distinct design shortcomings. Another fact is that, most power meters

are not facilitated with observing the measured data at two different outlets in two different locations. It is possible to achieve that using this power meter, if both locations get supply over the same phase line and use the power distributed by the same grid substation. The device works under the basic functions as shown in Figure1.

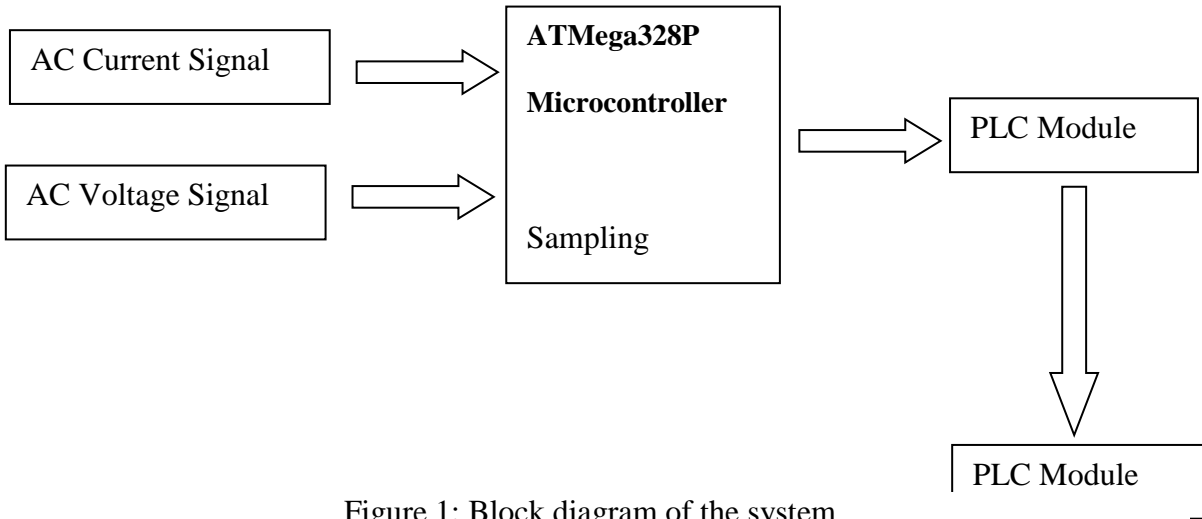


Figure 1: Block diagram of the system

## 2. EXPERIMENTAL

Before designing the main circuit, different types of power meters available in the market and existing industry used power meters are evaluated, even the wireless power meters that use Bluetooth technology are analyzed to find functionality and operation. There were systems given for both digital and analog circuits. Theoretically or manually power can be calculated using the basic equation,  $P = VI$ . Therefore it would be so easy to calculate power if the RMS values of voltage and current could be measured. Voltage refers to the voltage signal applied at the load/appliance and the current refers to the current signal that flows through the load. Thus the power dissipated by the load can be easily calculated through the Arduino supported components. (Arduino – an open source language with highly available electronics modules). Device is plugged in to the power outlet and appliance is plugged in to the device. Supply AC voltage signal is reduced by the simple voltage divider circuit and the reduced signal is fed to the Microcontroller. ACS712<sup>5</sup> Current sensor module is used to sense and feed the AC current signal passing through the appliance to microcontroller. ATmega328P<sup>1</sup> microcontroller with an Arduino Uno board is used for sampling and fast analog to digital conversion. 16x2 LCD is programmed to display the measured and calculated parameters. Mamba shield<sup>3</sup>– narrow band power line communication modules are used to establish communication between two power outlets. One shield transmits these data displayed on the

measuring unit display and the other shield receives them. The received data are again displayed on a 16x2 LCD available in the transmission unit at the receiving outlet. In order to program this LCD, separate Arduino<sup>4</sup> is used. Two Arduino boards are used with these 2 PLC modules (one for each). The approach for the complete power monitoring device has been taken in two steps. First approach is to finalize the measuring unit to check whether the required readings could be obtained precisely at a single outlet before moving on to the transmission unit. The second approach is to finalize the transmission unit/ communication part. Once the required parameters could be measured at one outlet, then it's all about transmitting data to another outlet. Also this device is only applicable in 220V/230V single phase systems. Descriptive diagram of measuring unit is shown in the Figure2.

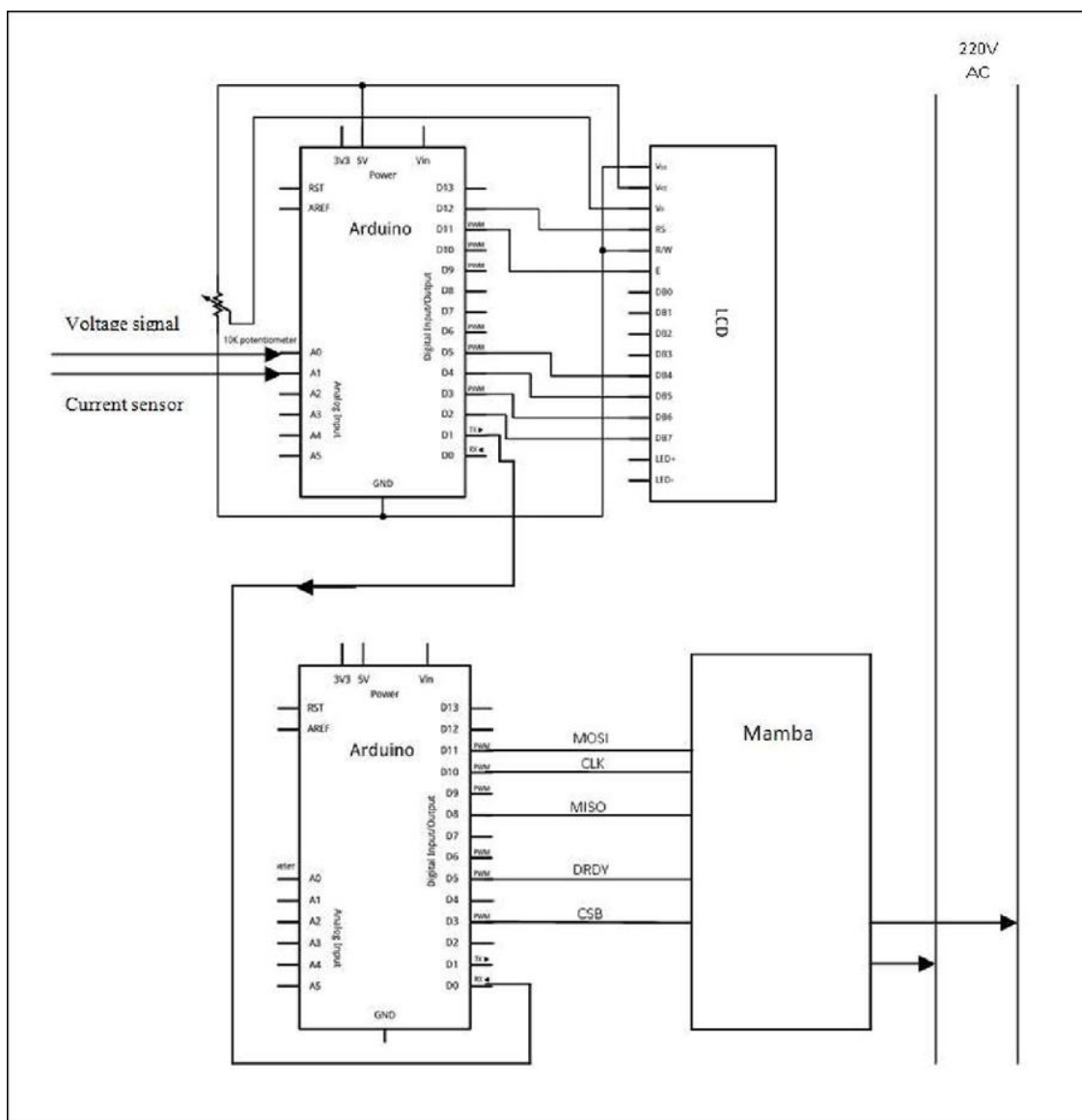


Figure 2: Schematic diagram of measuring unit

### **3. RESULTS AND DISCUSSION**

After designing the complete device, evaluation of the system is implemented in two parts. Initially the measuring unit is evaluated to verify that the unit is functioning properly and measuring the readings accurately. Subsequently the transmission unit is evaluated to verify that the readings are transmitted over power lines between any two outlets without any interference. During the measuring unit evaluation process, digital multimeter is used to measure the supply AC voltage from the outlet. Then the measuring unit is directly plugged in to measure the supply voltage. In this case the current is displayed “0.000A” since no appliance is connected to the unit so that the inner circuitry gets open circuited resulting no current flow through the current sensor. Developed system measured power quality parameters when it attached to household appliances.

### **4. CONCLUSION**

Digital power monitoring with PLC system can be developed to measure three phase power quality parameters by improving system designs and using high end devices. Utilizing surge protector in power monitoring systems is an added advantage. A surge protector is a system designed to protect electrical devices from voltage spikes. A surge protector attempts to limit the voltage supplied to an electric device by either blocking or by shorting to ground any unwanted voltages above a safe threshold. In this present system is not capable of filtering surges in the grid. However as the further development this device can be improved to filter voltage fluctuations and power abnormalities when they appeared in the grid using a surge filter. As a result of this, appliances can be protected from lightning/surges and protection against overloads as well. Furthermore protection for short circuit issues can be reduced by using those filtering systems. By providing required voltage and current, appliances can be utilized longer life without defects. Therefore improved power monitoring systems provide great reliability on home appliances with necessary details about their behavior.

### **ACKNOWLEDGEMENTS**

Authors wish to extend their gratitude for the assistance given by the Electronics department of Wayamba university of Sri Lanka and thank all who have supported to make this project a success.

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## VEHICLE ACCIDENT PREVENTION USING EYE BLINK SENSOR

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### ABSTRACT

Drowsiness is one of the major causes for highway accidents. These types of accidents occur due to drowsiness and driver being not able to control the vehicle. Drowsiness can be identified by the eye blink and blinking frequency through infrared sensor worn by the driver by means of a spectacles frame. IR sensor detects blinking and inform the driver through alarm buzzer.

**Keywords:** Infrared sensor (IR), Vehicle accident, Eye blink

### 1. INTRODUCTION

Driver drowsiness is recognized as an important factor in vehicle accidents. It has been demonstrated the driving performance deteriorates with increased drowsiness with resulting crashes constituting more than 20% of all vehicle accidents<sup>1</sup>. But the life lost once cannot be re-winded. Advanced technology offers some hope to avoid these up to some extent. This project involves measuring the eye blink using an IR sensor. The IR transmitter is used to transmit infrared rays. The IR receiver is used to receive the reflected infrared rays from the eye. If the eye is closed the output of IR receiver is high otherwise the IR receiver output is low. This is to know whether the eye is closed or at open Position. This output is given to logic circuit to activate an alarm.

Drowsiness features

The drowsiness features are characterized by the blinking frequency of the eye.

\*Awake-conscious-normal

\*Blinking frequency low

\*Drowsy-less conscious-risky

\*A sleep-out of conscious-at extreme risk

## **2. EXPERIMENTAL**

### 2.1 eye blink detection

This project involves measuring the eye blink using IR sensor. The IR transmitter is used to transmit the infrared rays to the eye. The IR receiver is used to receive the reflected infrared rays from the eye. Theoretically if the eye is closed the output of IR receiver is high otherwise the IR receiver output is low. This is to know whether the eye is closed. This output is given to logic circuit to indicate the alarm. However it is not easy to implement. Because emitted IR power is not enough to be received by a photo diode. Emitted ray should be completely reflected from the eye. Although practically it is difficult to get that readings. Received voltage is given to the arduino board. Opening and closing values were obtained to implement Arduino program. This project helps in controlling accidents due to unconsciousness through manufacturing Eye blink. Here one eye blink sensor is fixed in vehicle where if driver loses consciousness, then it is indicated through alarm.

The method of eye blink recording utilizes infrared (IR) photoelectric sensors. This approach measures IR light reflected from the surface of the eye. A typical IR eye blink measurement device consists of an IR light emitting diode (LED), which illuminates the eye surface, paired with an IR photodiode that detects IR light reflected back from the eye. An ideal IR eye blink detector should have several important properties. To detect the full range of eyelid movement, the IR LED should completely illuminate the surface of the fully opened eye, and in addition, the field-of-view of the IR photodiode should encompass the whole eye area.

TCRT5000 is an IR Emitter and an IR Photo Transistor packaged together. The Arduino TCRT5000 is designed to sense the distance to an object using Infra Red light waves. It can also identify the difference between white and black based on the contrast of an object and its reflective properties.

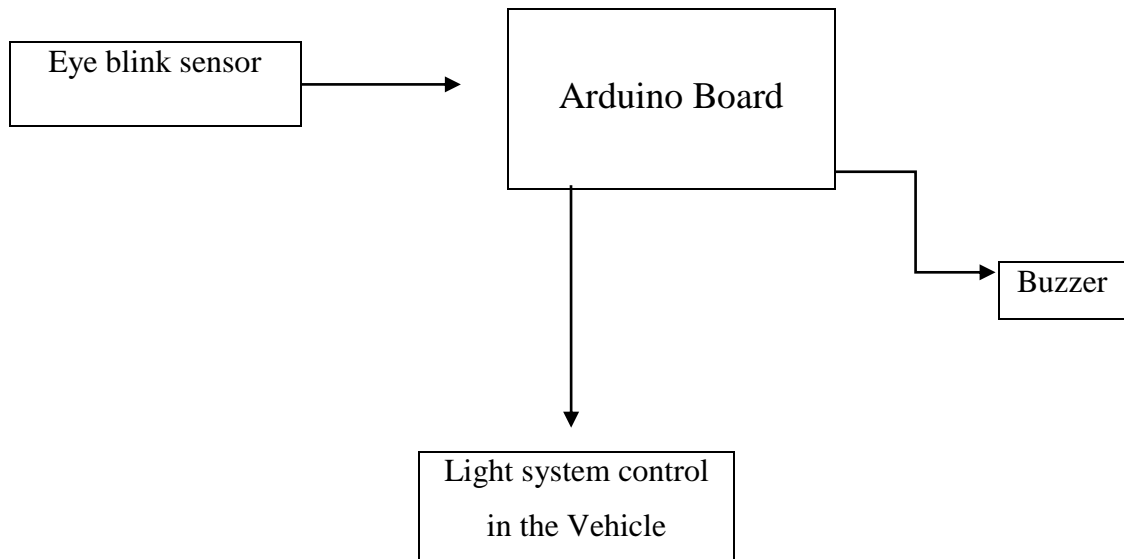


Figure1: Block diagram of the system

### 3. RESULT AND DISCUSSION

Following analog sensor values were obtained using Arduino. The result of the system is for change in the eye surface.

Table 1: IR Sensor output

No of person	Eye Closing sensor value(mV)	Eye Opening sensor value(mV)
01	820	880
02	830	900
0	8	8
3	0	7
	0	0
04	820	850

Above values changed between 800mV and 900mV. 840mV value was used to identify the open and closed positions of the eye.

The emitting power should be reduced. Because IR rays produced heat. It is not good for the eye. Therefore emitter IR intensity was reduced using 1k ohms resistor.

An ideal IR eyeblink detector should have several important properties. To detect the full range of eyelid movement, the IR LED should completely illuminate the surface of the fully opened eye, and in addition, the field-of-view of the IR photodiode should encompass the whole eye area.



Figure2: Photograph of developed system

#### **4. CONCLUSION**

The study and the implementation is very useful to persons driving at night. This system will be useful to prevent accidents due to drowsiness and can be implemented at a low cost.

#### **ACKNOWLEDGEMENTS**

Author would like to take this opportunity to thank everyone who helped to complete this study successfully.

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## ALCOHOL DETECTION SYSTEM FOR CAR DRIVERS

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### ABSTRACT

The motor car accident is a major public problem in many countries, particularly Sri Lanka. Despite awareness campaign, this problem is still increasing due to rider's poor behaviors such as speed, drunk and without sufficient sleep driving. The numbers of death and disability are very high because of late assistance to people who got the accident. These cause huge social and economic burdens to people involved. Therefore, the system is to find some solution to one from those poor behaviors. It is design with the circuit to alcohol detection. System can reduce drunk driving; minimize the amount of accident on road while improving the efficiency of the drivers.

**Keywords:** Alcohol Detector, Microcontroller System, mikroC, PIC

### 1. INTRODUCTION

Generally, the main goal of the project is to design and construct the alcohol detection system with alcohol sensing circuit. Therefore, to achieve this goal there are many scopes for this project, which contains many aspects. The scopes contains in this project is about the alcohol sensing circuit, relay driver circuit, microcontroller and programmable code.

There used an alcohol detector to detect the presence of alcohol consumed by the driver. Moreover, this project is design for people who are going to drive with drunker. It is also an advantage for people because microcontroller reject drunken drivers and LCD display will help them to avoid driving. This project also consists with relay driver circuit. When the alcohol sensing circuit automatically senses the alcohol then relay driver circuit active. The ignition is connected to relay will control through the microcontroller. The processes are continuing with simulation, modification and construct the circuit to the board. This project is involved on PCB and casing design. As well as the PIC16F877A are used in order to program the LCD display and to make sure that the circuit that had been design are function as needed. The software involved in this process is Proteus and mikroC PRO for PIC. <sup>1</sup>

## 2. EXPERIMENTAL

The system consists of cooperative components of an alcohol sensor, microcontroller, Liquid Crystal Display (LCD), relay driver circuit and keypad. Alcohol sensor detects that driver's consuming limit of the alcohol & microcontroller decides that the driver can drive or not. If it is impossible ignition system of the motor car is off.

### 2.1 Designing of the System

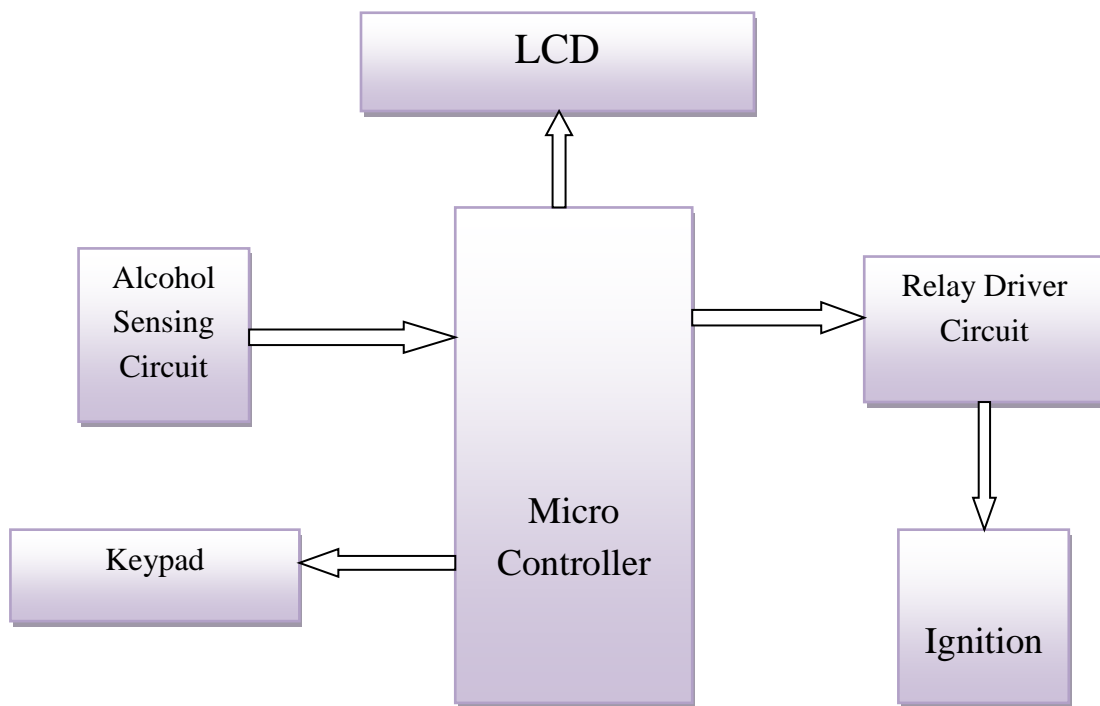


Figure 1: Design of the System

At the first it must set the alcohol limit to the system using keypad. That limit must be an effective to safety drive. When the drunken driver get on to the car the system is on. Then the alcohol sensing circuit measures the level of alcohol of the drunken driver. That alcohol level is display on the LCD. Then the previous setting limit and true alcohol level of driver compare using the microcontroller. If the true alcohol limit is higher than previous setting limit it will cause to off the ignition system. The circuit will sense the alcohol level and active the relay of ignition. The ignition is connected to relay and it will control by using the microcontroller. All the status will be displayed on the LCD.

## 2.2 System Design

First set the alcohol limit for the system. Then automatically, the circuit will sense the alcohol level of the driver and active the relay of ignition. If alcohol limit greater than the alcohol level of the driver then automatically ignition system on it mean user can drive. If alcohol limit less than the alcohol level of the driver automatically ignition system off it means user can drive.

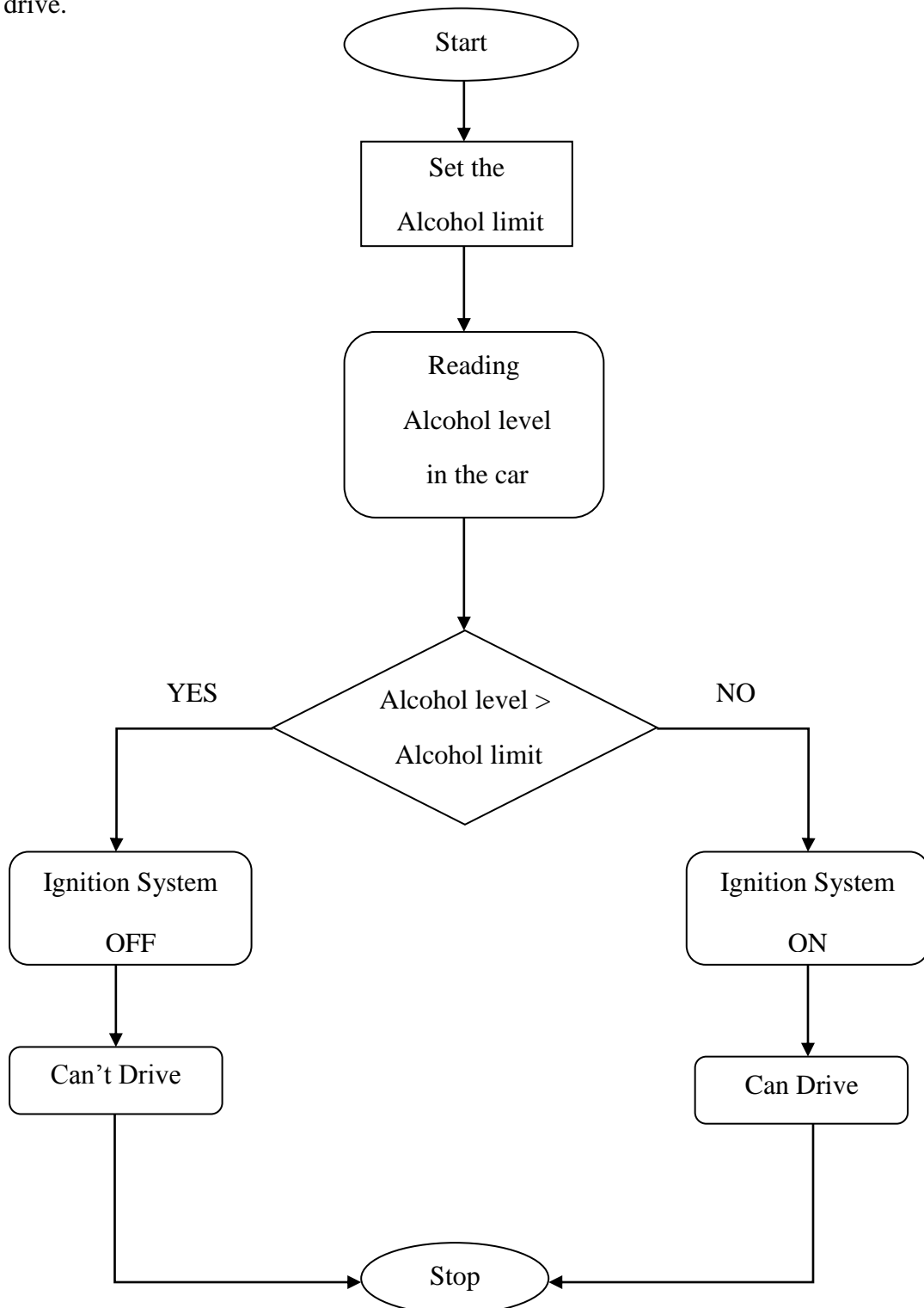


Figure 2: Flow Chart of the System



### 2.3 Printed Circuit Board

The Printed Circuit Board (PCB) layout is as follows.

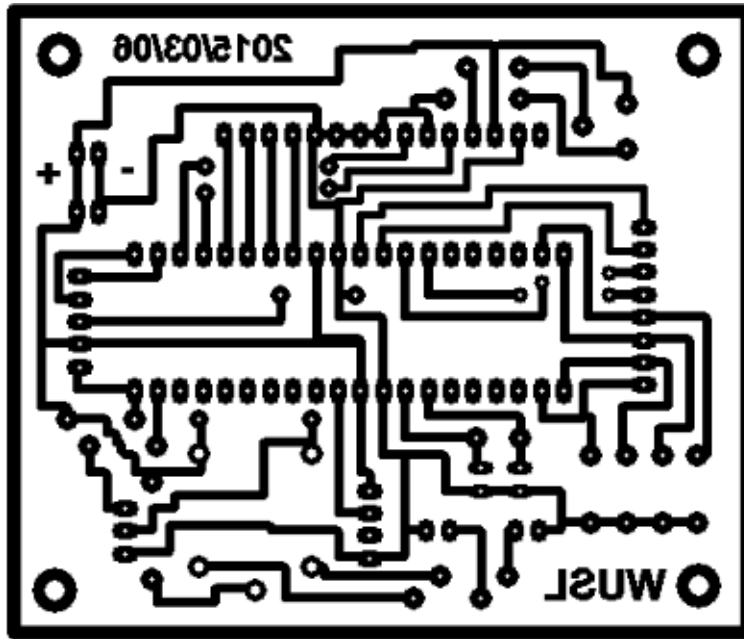


Figure 3: PCB Design of the System

The designed PCB board with components is showing as follows.

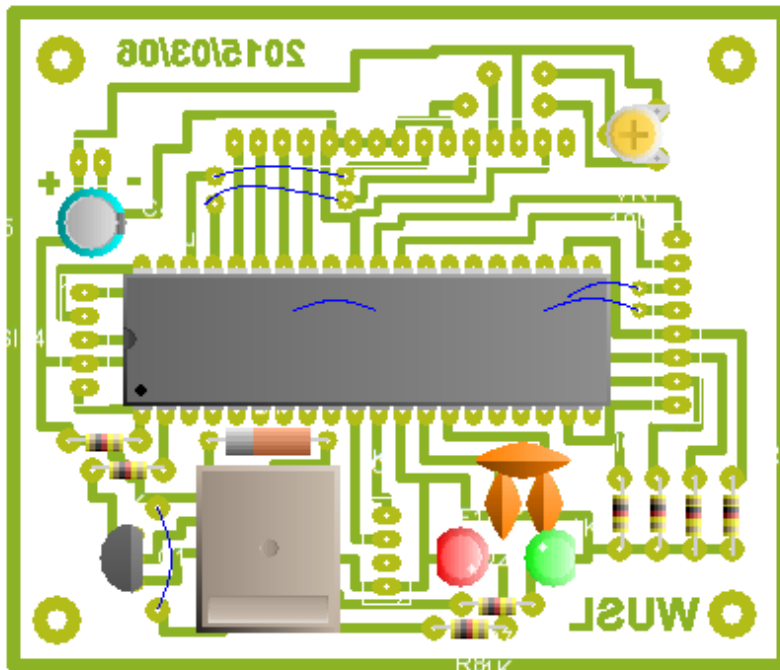


Figure 4: PCB Design with the Components

### **3. RESULTS AND DISCUSSION**

This project is called the alcohol detection system for car drivers. Alcohol sensing circuit is the perfect solution to testing alcohol limit of the driver who has get alcohol. This circuit can be used to detect the alcohol limit and give a chance to drive or not. The final outcome of this project is minimizing the road accident by dunked drivers. The features of this alcohol detection system are low cost, easy operation & save life. Intelligent systems are in used with every aspect of systems, CARs are the critical systems which are real time and lives are involved. Alcohol detection is the vital and of great importance from the perspective of passenger safety and traffic safety. Impact detection and notification is also one of the life saving and critical information provider system. System which is describe in this paper more efficient, reliable & effective. Develop such kind of system with all the useful utilities, this will help drivers, Police, Rescue Squad and other authorities do their work more efficient and effective.

### **4. CONCLUSION**

It is due to the driver's fatigue, traffic accidents keep with a yearly increasing of a high rate. This paper shows the new fatigue detection algorithms & techniques using alcohol sensor. In this technique the fatigue will be detected immediately and stop the vehicle without ability of driving. Through research presented in this paper, author proposes an alcohol detection system for car drivers to accident prevention and making the world a much better and safe place to live.

### **ACKNOWLEDGEMENTS**

Author likes to express his indebt gratitude to the staff of Department of Electronics, Faculty of Applied Sciences, Wayamba University of Sri Lanka.

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## **FPGA BASED CAMERA INTERFACE FOR REAL TIME VIDEO PROCESSING**

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### **ABSTRACT**

This paper describes the design and implementation of a camera interface on a Field Programmable Gate Array (FPGA). An FPGA contains configurable logic resources, which can be used to implement algorithms in hardware for speed performance than software implementations. Real-time video processing is a field that demands higher processing power, and FPGAs are ideal candidates for video processing applications. However, most cameras come with software drivers, which are not suitable for high performance video processing in FPGAs. In this study we present a hardware camera interface for a cheap camera module (OV7670) using an Altera Cyclone IV FPGA (EP4CE15). The designed system captures continuous video streams from the camera module and displays on the VGA display. The system uses about 3% of total logic elements of the FPGA. The rest of the logic resources can be used to implement different functions in hardware for real-time video processing.

**Keywords:** FPGA, OV7670, NIOS, CYCLONE

### **1. INTRODUCTION**

Real-time video and image processing is used in a wide variety of applications from video surveillance and traffic management to medical imaging applications. These operations typically require very high computation power. Standard definition NTSC video is digitized at 720x480 or full D1 resolution at 30 frames per second, which results in a 31MHz pixel rate. With multiple adaptive convolution stages to detect or eliminate different features within the image, the filtering operation receives input data at a rate of over 1 Giga samples per second. Coupled with new high-resolution standards and multi-channel environments, processing requirements can be even higher. Achieving this level of processing power requires multiple

processors. A single FPGA with an embedded soft processor can deliver the requisite level of computing power more cost-effectively, while simplifying board complexity.<sup>1</sup>

And the other hand video processing using software platforms is very time consuming and the Hardware for the computers must be in high level. In this project a hardware interface for camera module was developed. The implementation was based around a small camera module using on the OmniVision 7670 CMOS VGA Camera Chip, OV7670. The OV7670 is a low voltage CMOS image sensor that provides the full functionality of a single-chip VGA camera and image processor in a small footprint package. The OV7670 provides full-frame, sub-sampled or windowed 8-bit images in a wide range of formats, controlled through the Serial Camera Control Bus (SCCB) interface. This product has an image array capable of operating at up to 30 frames per second (fps) in VGA with complete user control over image quality, formatting and output data transfer. All required image processing functions, including exposure control, gamma, white balance, color saturation, hue control and more, are also programmable through the SCCB interface. In addition, Omni Vision camera chip use proprietary sensor technology to improve image quality by reducing or eliminating common lighting/electrical sources of image contamination, such as fixed pattern noise (FPN), smearing, blooming, etc., to produce a clean, fully stable color image.

A custom Altera FPGA NIOS CYCLONE IV EP4CE15 development board was used for the development of hardware interface. The Altera development board is based on NIOS Cyclone IV EP4CE15F17C8N FPGA chip. The development board is equipped with SDRAM 256Mbit (16M\*16bit), SRAM: 4Mbit (256K\*16bit), Serial FLASH: 64Mbit (EPCS64), Parallel FLASH: 32Mbit (4M\*8bit), Crystal: 50MHZ and 40MHZ, 110 of I/O and AS and JTAG as download debug port.

This paper presents the implementation of hardware interface between OV7670 camera module and a VGA monitor for real time video processing.

## **2. EXPERIMENTAL METHODOLOGY**

The OV7670 camera module is a low voltage CMOS image sensor that provides the full functionality of a single-chip VGA camera and image processor in a small footprint package. The OV7670 provides full-frame, sub-sampled or windowed 8-bit images in a wide range of formats, controlled through the Serial Camera Control Bus (SCCB) interface. This product

has an image array capable of operating at up to 30 frames per second (fps) in VGA with complete user control over image quality, formatting and output data transfer.

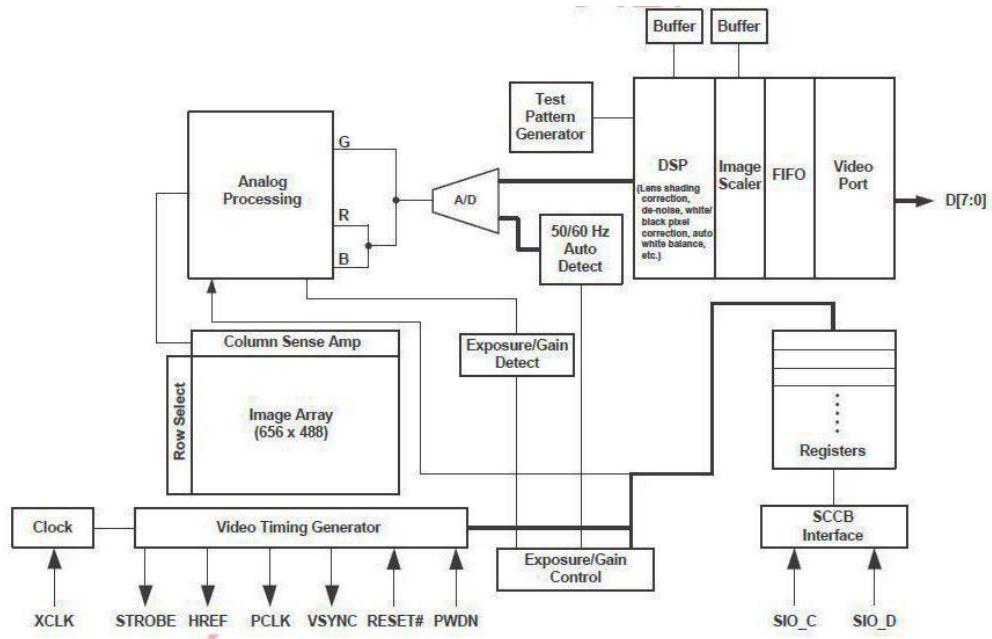


Figure 1: Functional Block Diagram of OV7670

The camera is interfaced with the FPGA board for which the controller module and capture logic module have developed as shown in Figure 2. With the help of controller module and capture logic module the camera is interfaced with the FPGA board for data capturing and streaming it in the display unit. Frame Buffer storing the pixel information in the Simple Dual Port RAM of FPGA and streaming them to the VGA monitor as 12bit output.

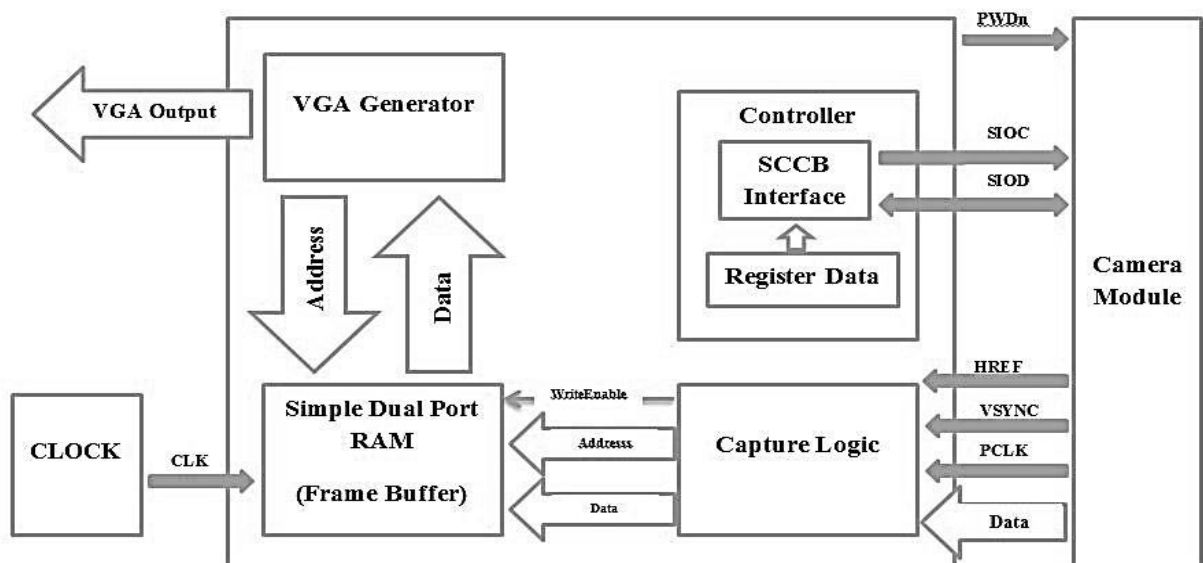


Figure 2: Block diagram of interfacing camera module with FPGA

The developed complete program loaded to the target device using USB Blaster device. Once the FPGA board is configured the Camera module starts capturing the real time video and displays it the VGA monitor interfaced with the FPGA board. For the storage purpose in this system uses Simple Dual Port RAM. It is capable with Read and Write function at a time. Therefore the system able captures each and every frame without missing. Due to this reason the output is really smooth. Following figure 3 shows the complete system.

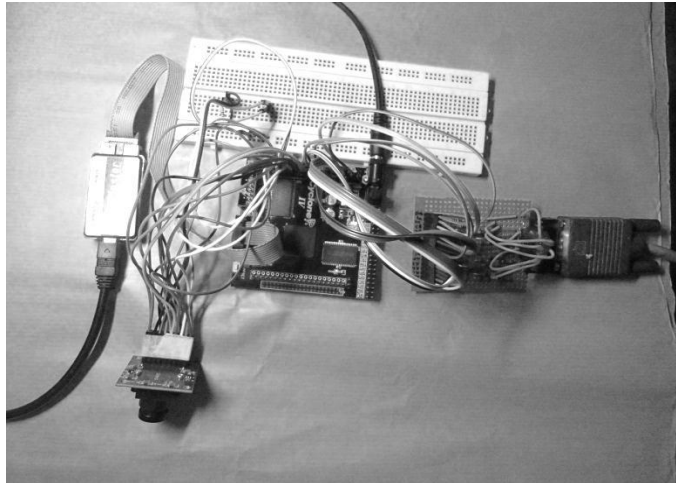


Figure 3: Complete system of the Hardware interface for camera module

### 3. RESULTS AND DISCUSSION

The design of the hardware interface for OV7670 is done in Verilog and VHDL. Design and testing of SCCB module has been carried out. The simulation result of OV7670 SCCB communication is shown in figure 4.

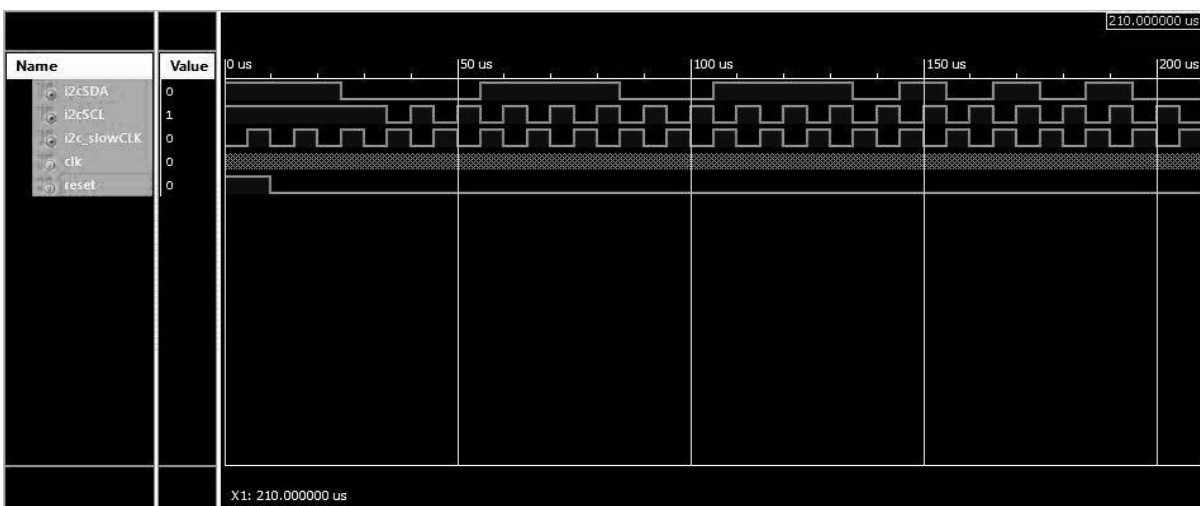


Figure 4: Simulation result of OV7670 SCCB module

The camera interface controller reads the 12 bit data from the camera module and storing in Simple dual port RAM. At the same time VGA controller reads the Simple dual port RAM and data were sent to the VGA monitor. Following figure 3 shows the result.

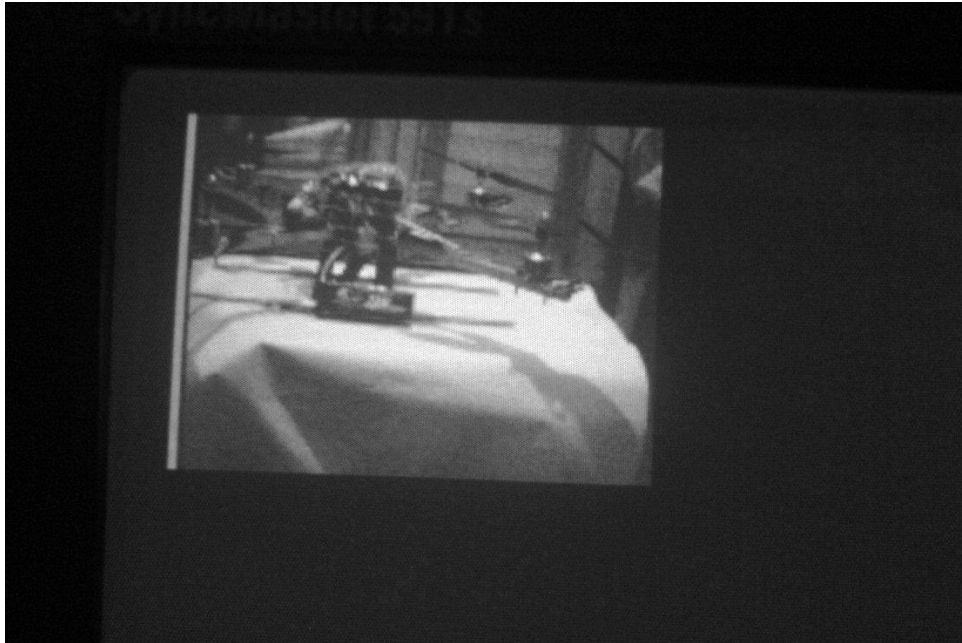


Figure 5: Final output of the complete system

Following Table 1 shows the maximum resources that uses in FPGA for the complete system.

Table 1: Device utilization summary for project

Quartus II 32-bit Version	13.1.0 Build 162 10/23/2013 SJ Web Edition
Revision Name	camInterface
Top-level Entity Name	camInterface
Family	Cyclone IV E
Device	EP4CE15F17C8
Total logic elements	422 / 15,408 ( 3 % )
Total combinational functions	389 / 15,408 ( 3 % )
Dedicated logic registers	180 / 15,408 ( 1 % )
Total registers	180
Total pins	75 / 166 ( 45 % )
Total virtual pins	0
Total memory bits	236,544 / 516,096 ( 46 % )
Embedded Multiplier 9-bit	0 / 112 ( 0 % )



elements	
Total PLLs	1 / 4 ( 25 % )

The Table 1 shows the recourse utilization of the FPGA for the system. Synthesis of the designed camera interface reports, the total number of logic elements utilized by the design as 422(3%) with 180 registers (1%). Total number of pins configured with the inputs and outputs of the design as 75 from 166 pins with 236544 memory bits (46%) has been used and from total PLLs, only one is used. According to above table, the utilization of resources of FPGA is lower than 25% of its total capacity. Therefore, the rest of the logic resources of the FPGA could be used for video processing applications.

#### 4. CONCLUSION

Real-time video processing is required in many applications such as industrial automation, machine vision systems, and robotics. FPGA logic resources can be used for implement high-speed, real-time video processing systems. As the first step, we demonstrated the design and implementation of a camera interface on an Altera Cyclone IV FPGA for OV7670 camera module. The results show that less amount of FPGA logic resources were consumed by the system and large amount of logic resources are available for implementing video processing algorithms in FPGA hardware. As an extension of this study, we intend to implement real-time edge detection algorithm for object inspection in industrial machine vision system.

#### ACKNOWLEDGEMENTS

Authors wish to convey their profound gratitude to all individuals who extended their helping hand to accomplish the implementation of this project. Specially, the invaluable guidance given by Mike Field, Engineer (hamster@snap.net.nz) is highly acknowledged.

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## **IR 3D SCANNER**

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### **ABSTRACT**

The aim of this project is to design and construct a low cost and high efficient 3D Scanner with some handy features. 3D Scanner is a device which has the ability to get a 3D structure of the particular object. Generally a 3D scanner consists of a source of electric current, a camera and a PC user interface for controlling the scanner and acquiring data via an Ethernet connection. But my 3D scanner consists of IR sensor, PIC 16F877A microcontroller, and Stepper motors and a Motor controller IC. This 3D scanner facilitates 360-degree scans through the implementation of a rotating sample platform. Each position of rotation is scanned using a linear actuator to increase resolution. And our scanner is capable of producing all data necessary to compute and construct 3D representations.

Other kind of 3D scanners used so far in the world, operated using a laser beam. But since our 3D scanner uses IR sensor, it is cheaper than the others. This module is also controlled using a PC interface (Serial port communication).

This project is called the Designing a 3D scanner. This is a perfect solution for the commercial industries such as Aerospace, Automotive, Consumer Products, Manufacturing, Heavy Industries, Medical, Oil and Gas, Power Generation. This sensor can be used to detect the 3D structure of a particular object. The features of this 3D IR scanner are low cost, Efficient and easy operation.

**Keywords:** Microcontroller, 3D scanner, personal computer

### **1. INTRODUCTION**

This project is to design a low cost, highly efficient, user friendly and accurate IR 3D scanner. This IR 3D scanner can be used to fulfill the requirements of some industries such as, Aerospace, Automotive, Consumer Products, Manufacturing, Heavy Industries, Medical,

Oil, Power Generation. Since the system is fully automatic, users will be able to enjoy the closest solutions for their requirements.

Generally, the main goal of the project is to design and construct the IR 3D scanner with advanced controlling system. Therefore, to achieve this goal there are many scopes for this project, which contains many aspects. The scopes contains in this project is 3D object scanning, hardware and electronic circuit.

The first scope is about network installation and technique. In this project, focus will be given to the given object for scanning. Moreover, this project is design for people who involve seriously in various fields. This project also involves on hardware and electronic circuit basic and the technique. The electronic basic involves on design the related circuit such as stepper motor controller circuit and power control circuit. The processes are continuing with simulation, modification and construct the circuit to the board. This project are involved on PCB and casing design.

In this project, the PIC16F887 are used in order to program the scanning process and to make sure that the circuit that had been designs function as needed. The software involved in this process is Proteus and micro PRO for PIC.

## **2. EXPERIMENTAL**

When an object is placed on the platform of the scanner, IR sensor emits the IR ray towards the object and the reflected rays received by the sensor are recorded and analyzed. The platform is rotated horizontally up to 360 degrees, then the scanner reads both x and y coordinates. After completing 360 degrees the IR sensor moves vertically taking z coordinates, and continues horizontal readings continuously and then again takes vertical readings for every point of the particular object. After taking all the x, y, and z coordinates they are analyzed by the software and plot all the observed points. After joining the points on the plot the scanned 3D image is created. The details of the components are as follows.

## 2.1 Microcontroller

The 40 pins make it easier to use the peripherals as the functions are spread out over the pins. This makes it easier to decide what external devices to attach without worrying too much if there are enough pins to do the job including 33 I/O lines, eight 10-bit ADCs, two PWM Channels and runs at 16MHz. This is mostly used in many applications<sup>2</sup>.

## 2.2 IR Sensor

An Infrared (IR) sensor is used to detect obstacles in front of the robot or to differentiate between colors depending on the configuration of the sensor.

The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, its resistance and correspondingly, its output voltage, change in proportion to the magnitude of the IR light received. This is the underlying principle of working of the IR sensor<sup>3</sup>.

## 2.3 USB –TTL

The TTL-232R-3V3 is a USB to TTL serial converter cable incorporating FTDI's FT232RQ USB - Serial UART interface IC device, the latest device to be added to FTDI's range of USB UART interface Integrated Circuit Devices. It is designed to allow for a fast, simple way to connect devices with a TTL level serial interface to USB<sup>4</sup>.

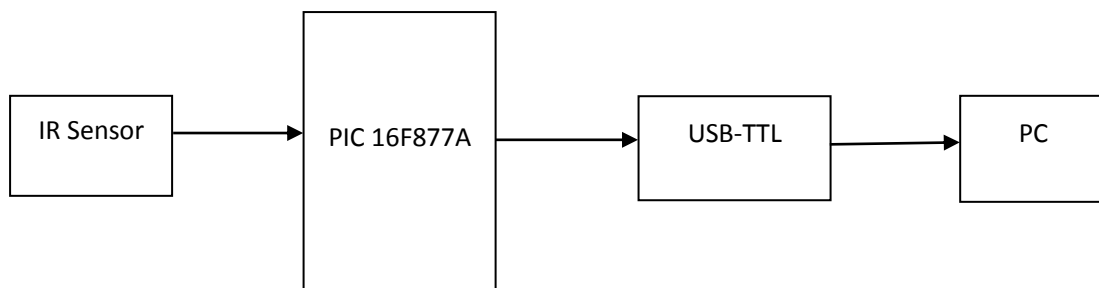


Figure 1: Block Diagram of the System

### **3. RESULTS AND DISCUSSION**

- A 3D scanner is a device that scans three – dimensional objects.
- 3 Dimensional coordinates can be taken as the final output of the project.
- The 3 dimensional data will be saved as a text document in the computer.

Advantages of the project

- System independent (civil engineer, same business, using in the same films, )
- Manual quality assurance can be automated using the system.
- Cost effective
- Accuracy
- Process speed controllable
- Easiness of making virtual object using real word objects coordinates

When an object is placed on the platform of the scanner, IR sensor emits the IR ray towards the object and the reflected rays received by the sensor are recorded and analyzed. The platform is rotated horizontally up to 360 degrees, then the scanner reads both x and y coordinates. After completing 360 degrees the IR sensor moves vertically taking z coordinates, and continues horizontal readings continuously and then again takes vertical readings for every point of the particular object. After taking all the x, y, z coordinates they are analyzed by the software and plots all the observed points. After joining the points on the plot the scanned 3D image is created.

### **4. CONCLUSION**

The project is done according to the 3D measurements which required for the scanning. The outcome is clearly mentioned and the way to scan a document is clearly described in the paper. Designing level is clearly mentioned and components also gathered according to the requirements.

### **ACKNOWLEDGEMENTS**

Convey the gratitude to academic and non-academic staff members in Department of Electronics, Faculty of Applied Sciences, Wayamba University of Sri Lanka, and Kuliypitiya.

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## LOW COST PUMP TO REGULATE DELIVERY OF DRUG INFUSION

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### ABSTRACT

This paper describes the design of a low-cost drug delivery system to regulate the drug infusion. Drug delivery system is a small infusion pump used to gradually deliver drugs, at low doses and at a constant or controllable rate of drug to a patient who needs to take a drug-dose regularly in a specific period. Commercially available drug delivery systems imported from foreign countries and they are expensive. Moreover, repairing of these systems are difficult and general practice is to replace it with a new one. The. The designed system consists of a microcontroller to control the mechanical part, which applies pressure to the syringe pump. The rate of infusion of the drug can be set by the keypad, which will be used to calculate the RPM of the stepper motor attached to the shaft. The results show that the prototype design works well for controlling the infusion rate that can be used in medical service.

**Keywords:** Drug delivery system, Microcontroller, Stepper motor, LCD

### 1. Introduction

Programmable Drug Delivery Systems have been used to deliver very small quantities of drugs over long periods of time. They are also commonly called Syringe Pumps. Infusion is a method of delivering fluids, medication or nutrients into a patient's Circulatory system and it is generally used intravenously, although the subcutaneous, arterial and epidural infusions are occasionally used. Infusion pumps are typically found in hospitals and other point of care environments.<sup>1</sup>but commercially available syringe pumps are very expensive, unreliable and operating manually. They are not available commonly in some hospitals and unable to repair when it is damaged. This project was to implement a low cost drug delivery system using microcontroller technology. This system will deliver specific amount of medication dose gradually to the patient in regular periods of time. The design had been achieved by using microcontroller that drives a stepper motor in specified period of time proportional to the dose Rate required to be injected by syringe

pump system. The most popular use of my system is in palliative care to continuously administer drugs such as analgesics (painkillers), and in delivering of the insulin solution to patient who is suffering from the Diabetes disease, to deliver the desferrioxamie solution to patient having Thalassemia disease, antiemetic (medication to suppress nausea and vomiting), hormones, or other medicines, such as opiates.<sup>2</sup>

## 2. METHODOLOGY

### 2.1 System Overview

We have designed and implemented a prototype of basic drug delivery system whose functional block diagram is show in Figure 1. The keypad is used to enter the dose and the time period required and input values and the remaining time are displayed on the LCD. The Dipswitch is used to turn on the system. The main controlling part of the system is a microcontroller. We use Arduino Mega microcontroller since the board consists of required input/output connections. The microcontroller drives the stepper motor through the driver IC (L298) according the rate entered using the keypad. The stepper motor is connected to the mechanical shaft to apply pressure to the syringe.

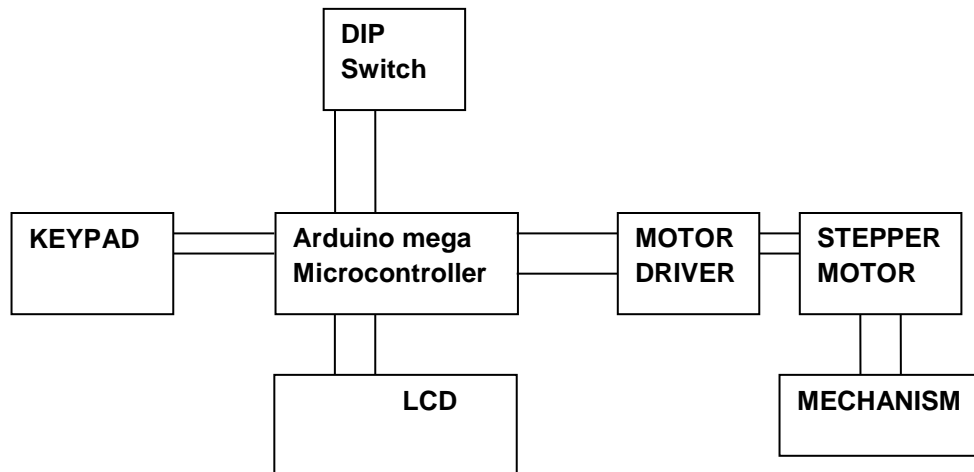


Figure 1: Block Diagram of the system

## 2.2 Mechanical part of the system

Linear actuator is used to move the piston of the syringe. It consists of screw rotation moving mechanism as shown in figure 2. Thread bar is directly connected to the stepper motor. The rate of movement of the actuator depends on the speed of stepper motor.

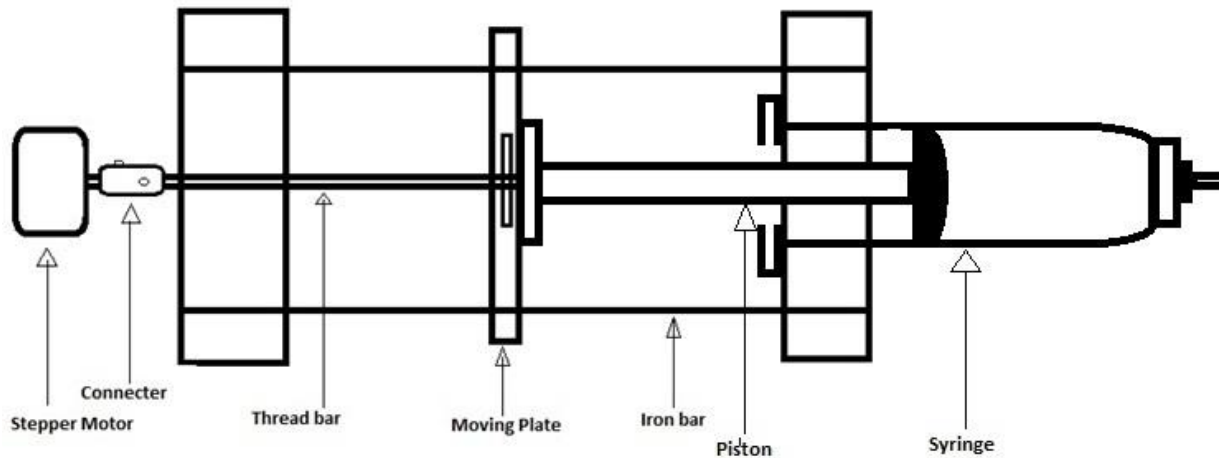


Figure 2: Mechanical part of the system

## 2.3 Circuit Diagram

The circuit consists of data input (keypad), display (LCD), and stepper motor driver parts as shown in the Figure 3. All the processes are done by Atmega 2560 microcontroller<sup>4</sup>. Keypad is connected to digital input pins and LCD is connected to digital output pins of the Arduino board. Bipolar stepper motor needs 4 input signals with different sequence of data to generate its rotation. We use L298 Motor Driver IC to drive the stepper motor which provides the required power requirements to the stepper motor.

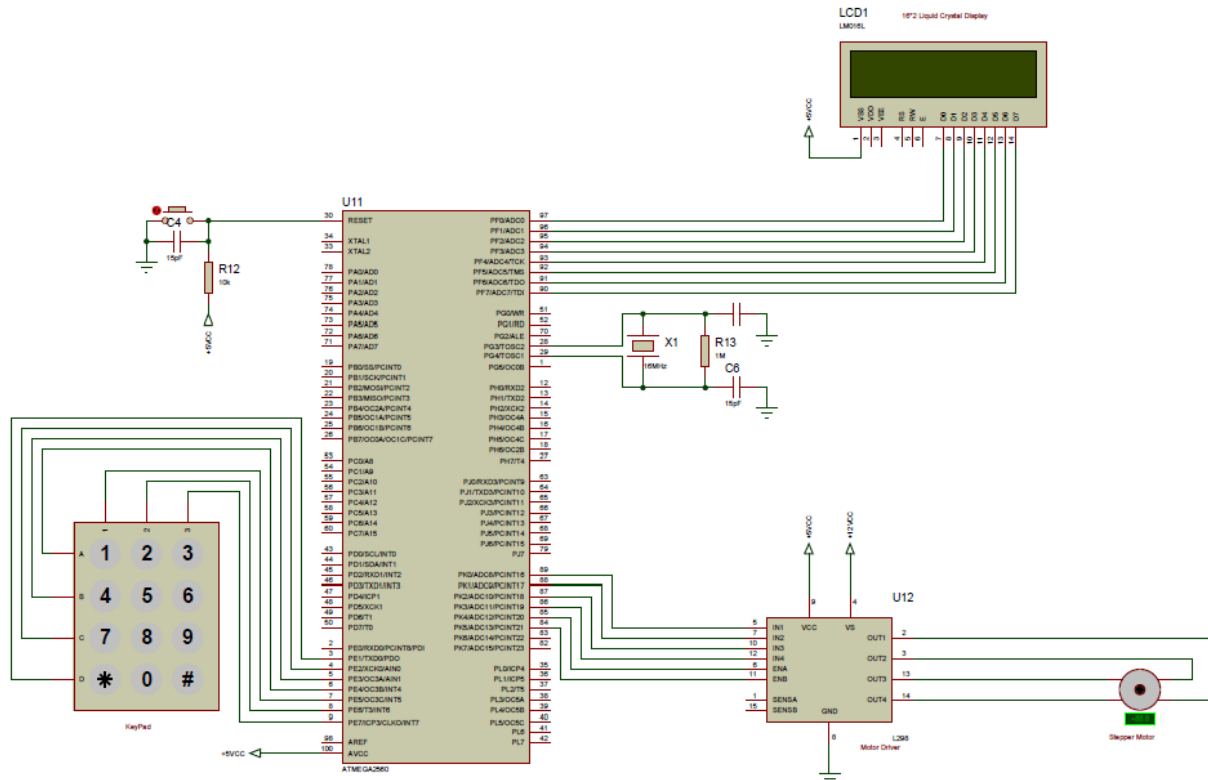


Figure 3: Circuit diagram

- |                                |                           |
|--------------------------------|---------------------------|
| A -Atmega 2560 Microcontroller | X1 -Crystal Oscillator    |
| B -Dial Pad                    | R12 -10k Resistor         |
| C -L298 driver IC              | R13 -1k Resistor          |
| D -Stepper Motor               | S1 -Dip Switch            |
| E -Liquid Crystal Display      | C1,C2,C3 – 10nF Capacitor |

The Figure 4 shows the part of the prototype design. It contains 16 inputs keypad and 16\*2 LCD for value input and display, motor drive circuit and stepper motor for mechanical part and Atmega microcontroller for processing part. The stepper motor directly connected to the mechanical part.

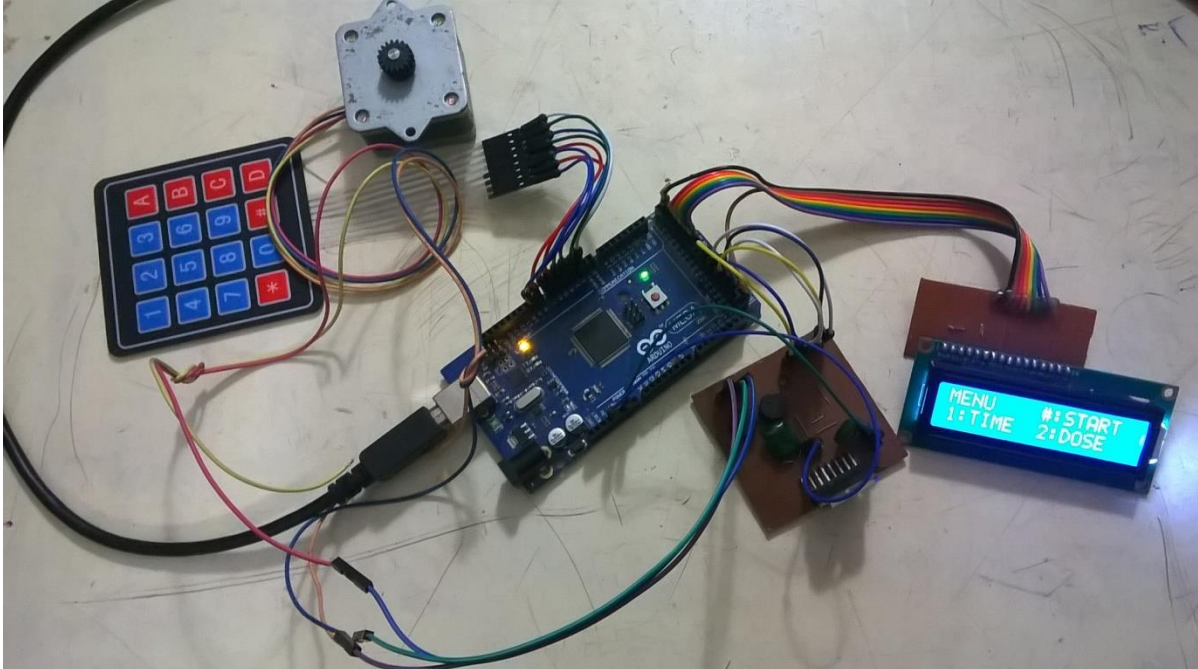


Figure 4: Electronics of the prototype design of the drug delivery system

#### 2.4 Microcontroller Programming

Microcontroller is programmed to determine the rotation speed of the stepper motor based on the given volume and time period using the keypad. The following simple formula is used to determine the rotation speed of the stepper motor.

Volume in milileter (V) and Time in minutes (T) taken as the user inputs

Stepper motor run time =  $T * 60 * 1000$  (micro seconds)

$1\text{ml} = 1\text{cm}^3$

Cross sectional area (A) is constant in a given Syringe

Total Volume of the syringe =  $A * D$ , where D is the length of the syringe

Length is propotional to the volume  $D \sim V$

Stepper motor speed(s) =  $D/T$

### 3. Results and Discussion

The results show that the microcontroller system controls the stepper motor rotation speed to move the shaft so that the syringe releases liquid according to the required rate. A sample set of calculated rotation speeds of the stepper motor is given in the Table 1. The first two columns

show the RPM for different volumes of liquid to be delivered within one hour and the last two columns show the RPM for different time period of constant volume of a liquid.

Table 1: RPM calculation of stepper motor

Constant time 1 hour		Constant volume 50 millileters	
Volume	RPM of Stepper	Time	RPM of Stepper
10ml	0.0167	60 min	0.833
20ml	0.0333	50min	1
30ml	0.05	40min	1.25
40ml	0.0667	30min	1.667
50ml	0.0833	20min	2.5

The cost for the entire system was about 8000/= Sri Lankan Rupees. This value is very low compared to the similar systems imported for the use in Sri Lankan hospitals.

The main advantage of the system is that it can be programmed to deliver the required rate very easily. After all it consists of a microcontroller, which can be programmed using a personal computer to change the firmware as required. So the modifications can be done very easily.

The prototype works with an uninterrupted power supply. Any power failure causes the system to lose current data and needs the system to restart. It does not continue from the point where it stopped. This weakness could be removed with the use of FLASH memory or an SD Card to store the data.

#### 4. CONCLUSION

We described the design of a prototype system to regulate the delivery of drug infusion as required for a given situation. The system consisted aArduino microcontroller board as the main processor which controls the pressure applied to the syringe to regulate the rate of liquid flow. The results show that the system can be further improved to use in hospitals. The total cost for the prototype system is about 8000/= Sri Lankan Rupees which is very lower than the systems available in the market.

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## LOW COST SPEED DETECTOR

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### ABSTRACT

The aim of this project was to design and construct a Low Cost system to detect over speeded vehicles. This is a device can be installed in roads temporally. Basically this device has three units, consisting two motion detecting units and a handheld speed monitoring device. Both of motion detection units separately consists with an Arduino, a motion detecting sensor and a wireless RF transceiver module. The motion sensor attached to Arduino detects when a vehicle passed through it and sends a given signal via NRF24I01 to hand held device. The distance between two sensors is 1m .The purpose of having Arduino is to control both of motion sensor and NRF module using given instructions. The developed system can detect the speed up to 100 kmh<sup>-1</sup>. The speed range can be increased by replacing high speed industrial movement sensors for movement sensors. This project used coding in C++ language to provide a very efficient algorithm for carrying out required task.

**Keywords:** *NRF24I01, Arduino, RF transceiver*

### 1. INTRODUCTION

Most of the speed detecting systems are using radar methodology to capture the speed of vehicles. But still these systems have set of defects which cannot be avoided. The developed system will be capable of detect the speed in highest accuracy, enables traffic officer to use in bended roads, Make the handheld device is more smaller and light weight than the laser gun and Low power consumption.

Although most of the existing systems has some failures. Most of the speed detecting devices are using radar signals to capture vehicle speeds. Devices which are used radar signals have some defects. Rain can refract part of the signal so it does not return. Radar measures speed in relation to the unit, so it is most accurate when traveling directly towards, or directly away from the unit. As the angle between the object and the radar unit increases, so does the error

rate is also increases. This is called a "cosine effect", and is mathematically measurable<sup>1</sup>. Radar works by sending out a signal (sine wave) at a known frequency. This sine wave continues until it is reflected, refracted, or absorbed. Dense objects reflect, softer objects such as a tree full of leaves will absorb the signal. Rain would refract it, much like looking at a pencil in a glass of water. If the sine wave reflects off a stationary object, it does not change. If the object is moving, the frequency changes at a constant rate, in relation to the speed. This change is the same if it is moving towards the unit, or away. The unit reads the changed frequency, does the math, and registers the speed<sup>2</sup>. As far as the range, that can vary, but the power is reduced by what is called the "inverse square rule". This means as the distance doubles, the signal strength reduces by half. A large, flat object will reflect back a bigger portion of the signal. For this reason, the car closest to the radar unit always changes the speed. A large object behind a small sports car will return a stronger signal<sup>3</sup>. To overcome these effects, drawbacks, an improved version of low cost over speed detector was introduced.

## 2. EXPERIMENTAL

The block diagram of the designed system for low cost over speed detector is shown in figure1.

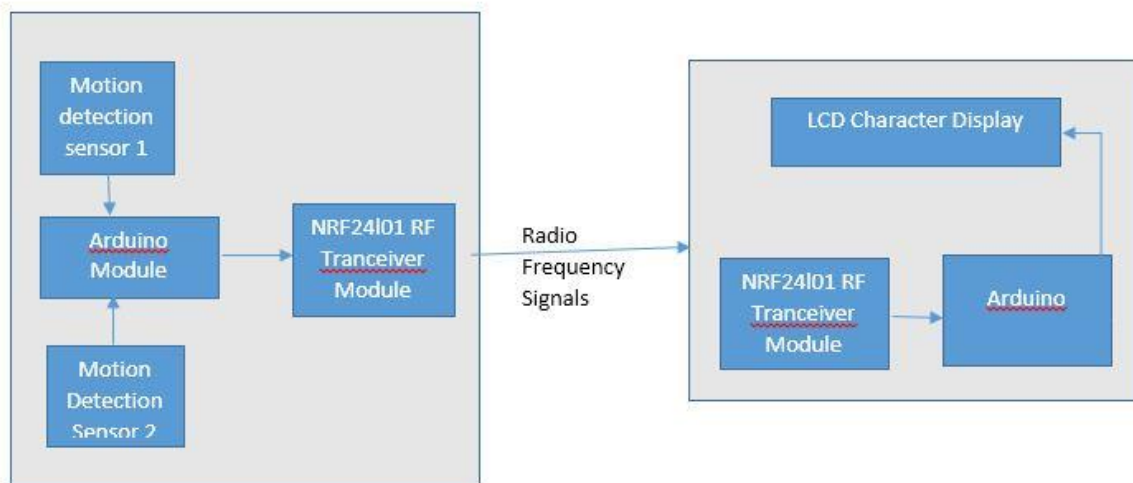


Figure 1: Block diagram of Proposed Low Cost over Speed Detector

To establish wireless connection between motion detectors and hand held device two NRF modules were used. NRF module is a device which can act as a transceiver and it operates in 2.4GHz RF signals. When a vehicle passes one of the motion detecting sensor, it sends a

signal to NRF module which installed in handheld device. The Arduino installed in handheld device calculates time taken to arrive two signal. Then it can calculate the time between two pulses. Using this the device can determine speed of the vehicle.

At the development of the stage C++ language was used to write the code and Arduino software was used as IDE.

### 3. RESULTS AND DISCUSSION

At the development stage of the system is designed to detect the maximum speed of 100kmph. The distance between two motion detectors have to be kept as 1m(one meter). When a vehicle passed 1<sup>st</sup> sensor it send a signal to handheld device, When the same vehicle passed 2<sup>nd</sup> sensor it also sends a signal to handheld device. Using time between two signals and the distance between two sensors speed can be measured using following simple equation.

$$\text{Speed} = \text{distance} / \text{time}$$

$$\text{Speed} = 1\text{m} / \text{time taken to pass 1m.}$$

The device tested by moving toy cars because the system was developed as a prototype. At each of the testing case the speed was given as expected.

The Arduino Uno (ATMEGA328) , NRF24I01 and sensors used were shown in following figure 02.

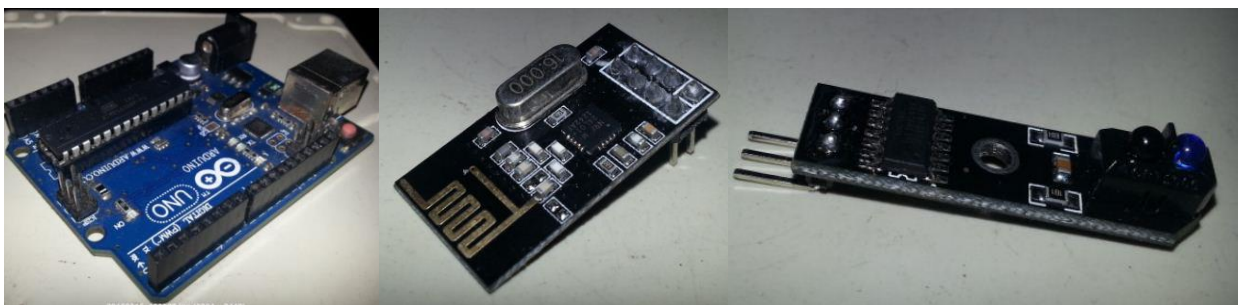


Figure 2: The electronic components used

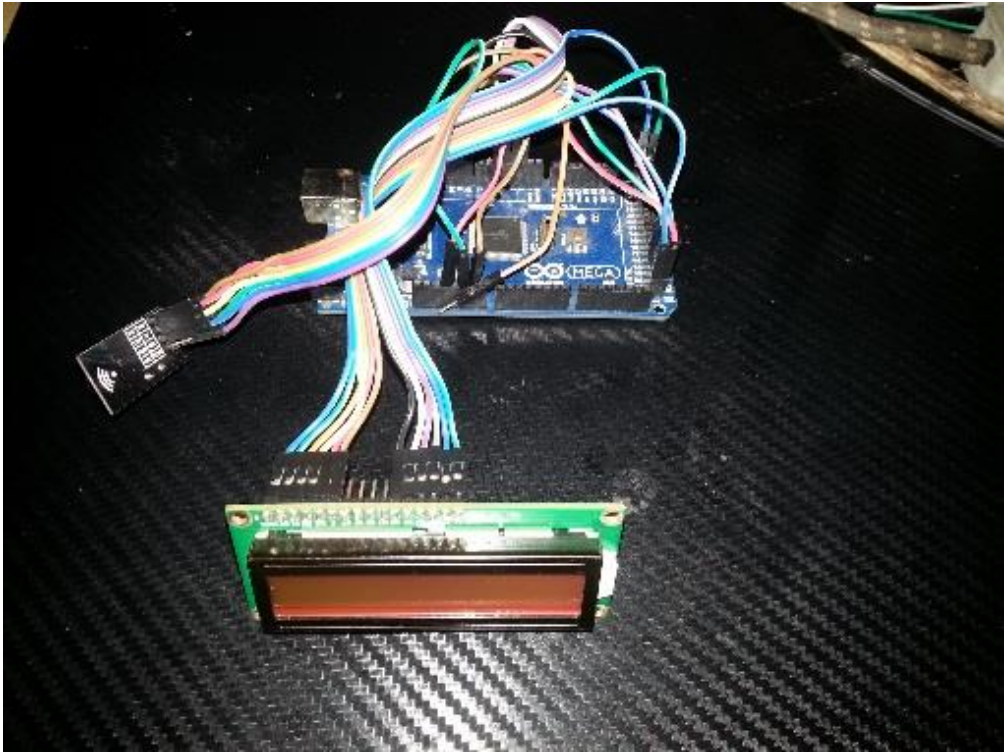


Figure 3: Circuit view of main unit

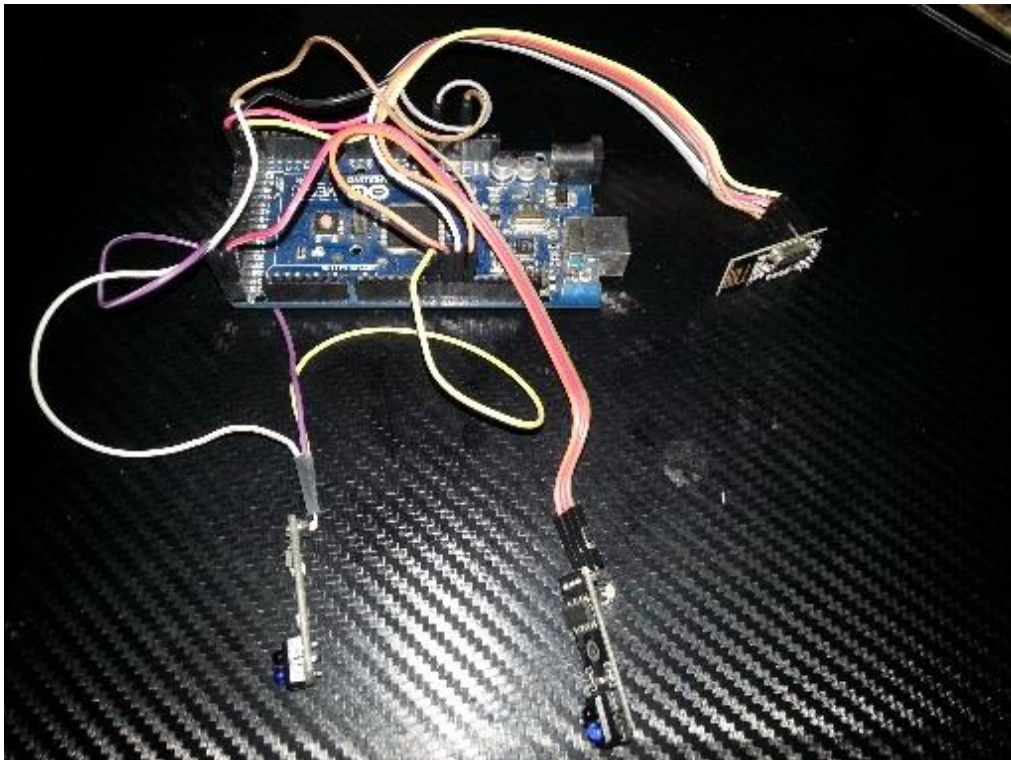


Figure 4: Circuit View of Hand held Unit



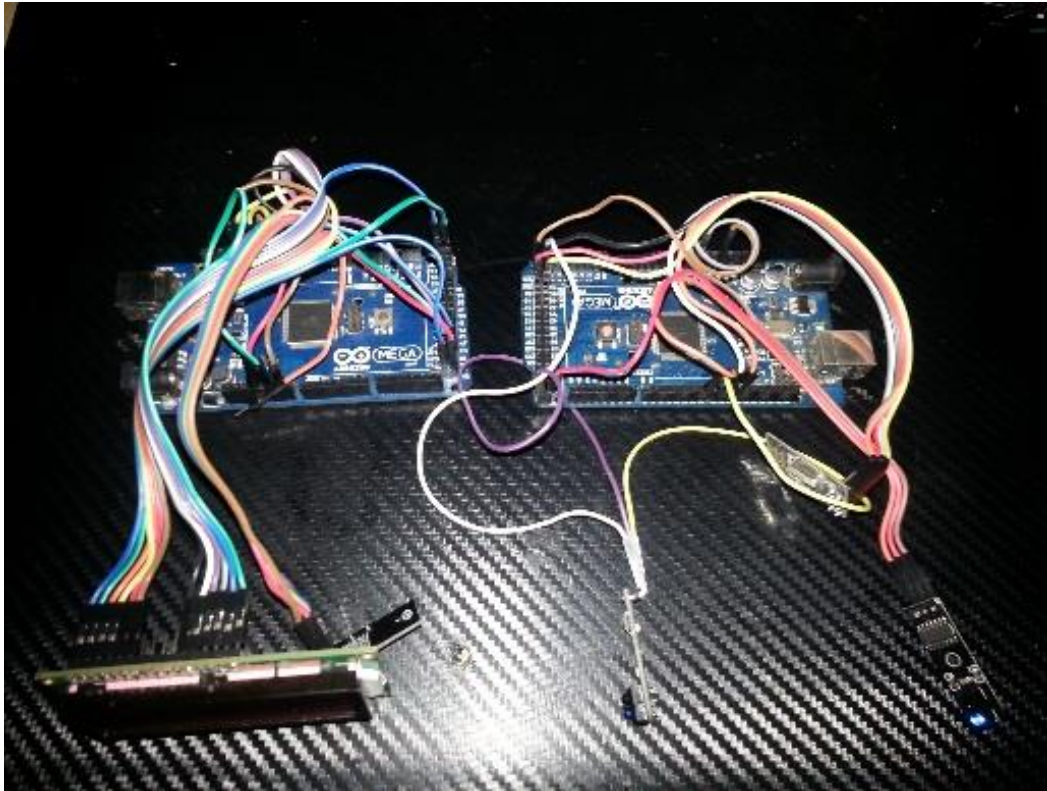


Figure 6: Circuit of the system

#### 4. CONCLUSION

The main purpose of this project was to develop a system to detect speed of the vehicles. At the development stage it was only developed as a prototype. In practical scenarios it can be developed using industrial IR sensors. To do this motion detecting sensors and power supply replacement is must. Mainly this project was targeted to avoid errors existing systems and it will help traffic offices to capture speed of vehicles and punish over speeded vehicle owners. Also this system is having an ability to determine the speed in bending.

The main issue of the developed system is, when a vehicle passed the motion detector, the sensor cannot detect the vehicle if the vehicle speed is very high. To ignore this error high sensitive industrial motion detecting sensors should be applied.

## **ACKNOWLEDGEMENTS**

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## INVESTIGATION OF n-Cu<sub>2</sub>O QUANTUM DOTS ON A p-Cu<sub>2</sub>O THIN FILM

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### ABSTRACT

This research consists of two steps. In the first step p-type Cu<sub>2</sub>O nano-surface is obtained using thermal oxidation method, in the second step prepared p-type Cu<sub>2</sub>O samples were quenched in a 0.1 M CuSO<sub>4</sub> solution and investigated for presence of n-type Cu<sub>2</sub>O quantum dots on the p-type Cu<sub>2</sub>O thin film. p-type Cu<sub>2</sub>O thin films were fabricated using two thermal oxidation methods. In 1<sup>st</sup> method p-type Cu<sub>2</sub>O nano-surfaces were fabricated by heating of well cleaned Cu plates (98.9% purity) up to 300°C for 30min maintaining a heating rate of 100°C/min. In 2<sup>nd</sup> method well cleaned Cu plates (98.9% purity) were kept in oven chamber for less than 2min, while keeping oven chamber temperature in 900°C. Sample was characterized with diffuse reflectance measurements and calculated direct band gap of p-type Cu<sub>2</sub>O was 1.96eV. After the verification of p-type Cu<sub>2</sub>O nano-surface, quenching in 0.1 M CuSO<sub>4</sub> solution was carried out for p-Cu<sub>2</sub>O thin film samples fabricated by both methods. After quenching samples were kept in the CuSO<sub>4</sub> solution for time periods 48, 24, 12 and 6 hours. Diffuse reflectance spectrum and VI characteristics of quenched samples were taken and results were investigated for formation of n-type Cu<sub>2</sub>O quantum dots on p-type Cu<sub>2</sub>O thin film.

**Keywords:** p-type Cu<sub>2</sub>O, n-type Cu<sub>2</sub>O, Quantum dots, Thermal oxidation, Quenching

### 1. INTRODUCTION

Technology and material used in photovoltaic devices are changing from time to time over the past decade till now, as the need for clean and renewable energy rises. With the advancement of technology industry has a tendency to explore new ways to fabricate low-cost material for solar energy conversion devices. Bulk semiconductor solar cell, dye sensitized solar cell materials were fabricated and quantum dot sensitized solar cells are emerging in the industry to meet the requirement. Quantum dots are semiconductor



nanocrystals which contains a small finite number (of the order of 1-100) of conduction band electrons, valence band holes, or excitons<sup>2</sup>. Unlike traditional semiconductors which have limitations, where their optical and electronic properties are not easily adjustable as their band gaps are not easily changeable. But Quantum Dot (QD) band gaps can be changed by changing their size<sup>3</sup>. Electronics properties QDs display unique electronic properties intermediate between electronic properties of bulk semiconductor and discrete molecules. QDs confines the motion of conduction band electrons, valence band holes or bound pairs of conduction band electrons and valence band holes (excitons) in all three spatial directions<sup>4</sup>. QDs are capable of Multiple Exciton Generation (MEG) or Multiple Carrier Generation, where single photon creates more than one exciton<sup>5</sup>.

This study discusses a method to fabricate n-type Cu<sub>2</sub>O quantum dots on a p-type Cu<sub>2</sub>O thin film. Thermal oxidation method was used in fabricating p-type Cu<sub>2</sub>O, while quenching method was used in fabricating n-type Cu<sub>2</sub>O quantum dots on p-type Cu<sub>2</sub>O film. Cu<sub>2</sub>O is naturally p-type conducting semiconductor material with “Reddish Brown” color and has direct band gap energy of 2.1 eV<sup>1</sup>.

## 2. EXPERIMENTAL

### 2.1 p-Cu<sub>2</sub>O preparation with thermal oxidation:

Method 1: A 25mm x 15mm Cu plate (98.9% purity) was well cleaned using sand paper, detergent and distilled water to remove oxide layer, oil and dust. Cleaned Cu plate was placed in the furnace (Carbolite ELF11) and heated with 100°C/min heating rate until furnace chamber temperature goes to 300°C. Sample was kept in 300°C for 30min to grow p-Cu<sub>2</sub>O on top of the Cu substrate; temperature profile shown in Figure 1 was followed.

Method 2: Oven chamber temperature was set to 900°C with 100°C/min heating rate. After oven chamber has risen to 900°C, well cleaned 25mm x 15mm Cu plates (98.9% purity) were placed in the oven for very short time periods (less than 2min) to grow p-Cu<sub>2</sub>O on top of the Cu substrate.

### 2.2 Fabrication of n-Cu<sub>2</sub>O quantum dots on p-Cu<sub>2</sub>O thin film by quenching method:

(10<sup>-1</sup>) M CuSO<sub>4</sub> (aq) solution was prepared (CuSO<sub>4</sub>.5H<sub>2</sub>O molar mass=249.68gmol<sup>-1</sup>), 100ml of prepared (10<sup>-1</sup>) M CuSO<sub>4</sub> (aq) solution was taken to a beaker, after sample has completed the set time in the oven to grow p-Cu<sub>2</sub>O thin film, it is taken out and quenched in the CuSO<sub>4</sub> solution taken to the beaker. Samples were kept in the CuSO<sub>4</sub> solution for 6h, 12h, 24h and

48h before taken out, cleaned using distilled water and then subjected to study their diffuse reflection spectrum and VI characteristic curves.

### 2.3 Experimental techniques:

Diffuse reflectance spectra of fabricated p-Cu<sub>2</sub>O samples and n-Cu<sub>2</sub>O QD sensitized Cu/p-Cu<sub>2</sub>O samples were obtained using Shimadzu UV-visible 1800 spectrophotometer. Photochemical characteristics were obtained using HOKUTU DENKO HA-301 potentiostat/galvostat with three-electrode configuration having Pt as counter electrode and AgCl/Ag as the reference electrode, (10<sup>-2</sup> M) KI (aq) solution was used as the electrolyte. All chemicals used for the experiment were analytical grade.

## 3. RESULTS AND DISCUSSION

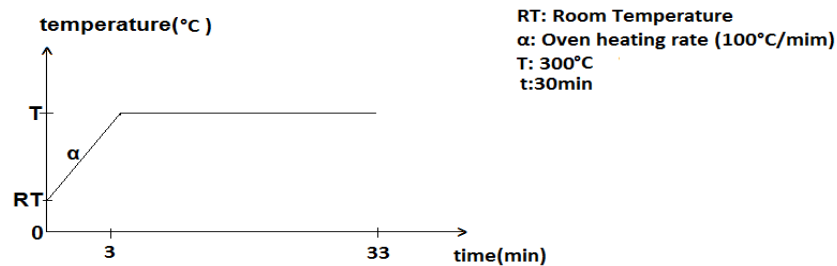


Figure 1: Temperature profile p-Cu<sub>2</sub>O fabrication Method 1

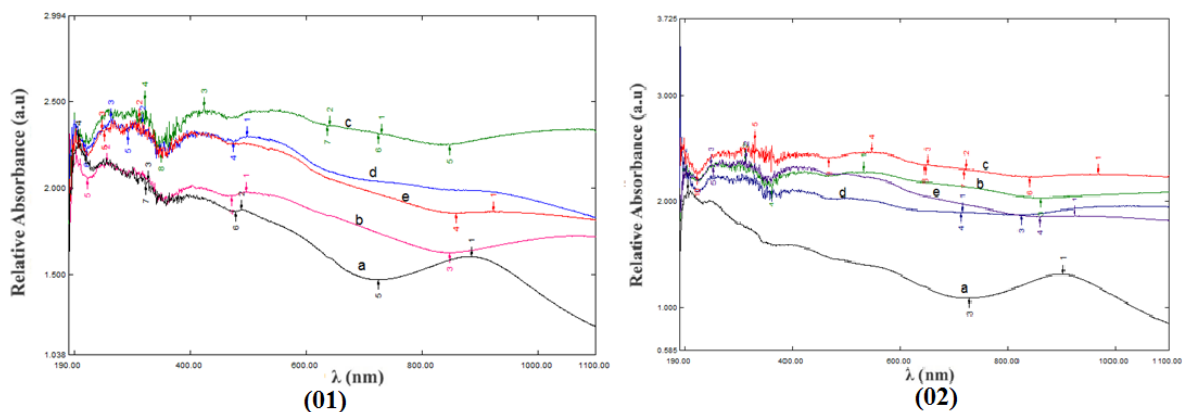


Figure 2: (01) Diffuse reflectance spectra of Cu/p-Cu<sub>2</sub>O (p-Cu<sub>2</sub>O thin film fabricated with 300°C time 30min)(a) Not (b) 6 h quenched, (c) 12 h quenched, (d) 24 h quenched and (e) 48 h quenched, (02) Diffuse reflectance spectra of Cu/p-Cu<sub>2</sub>O (p-Cu<sub>2</sub>O thin film fabricated with 900°C, time 1min 16sec) (a) Not quenched (b) 6 h quenched, (c) 12 h quenched, (d) 24 h quenched and (e) Cu/p-Cu<sub>2</sub>O 48 h quenched

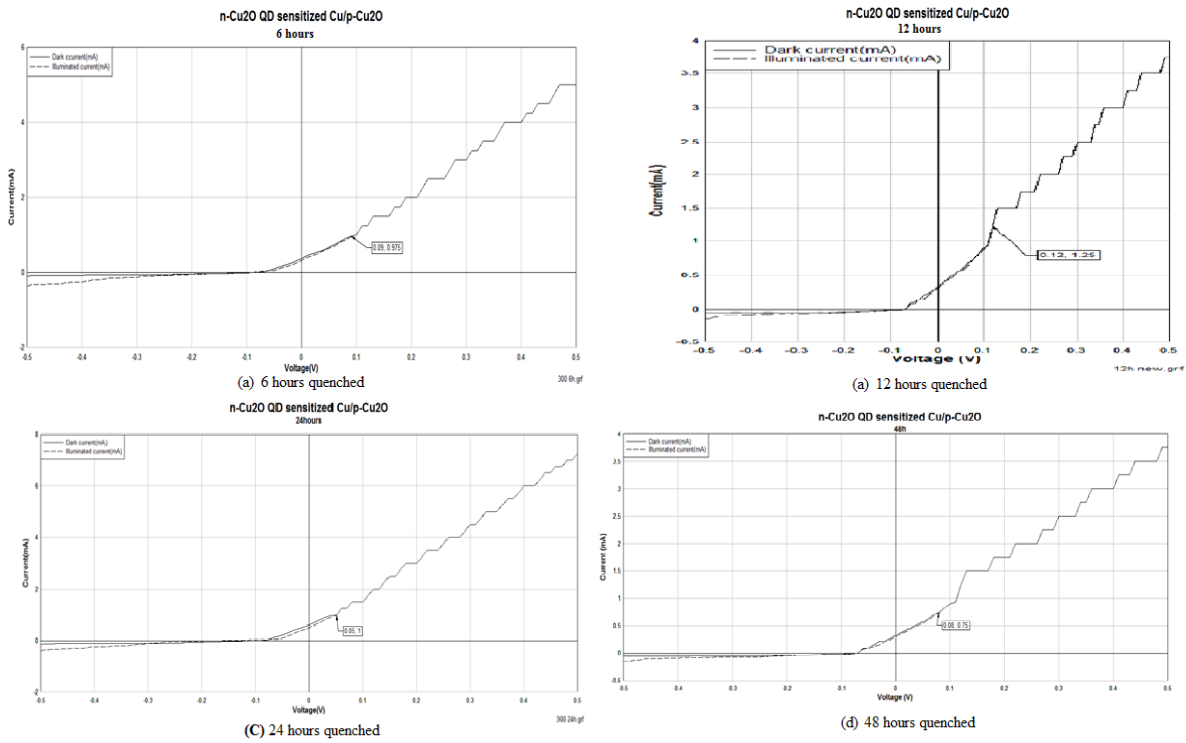


Figure 3: V-I characteristics of Cu/ p-Cu<sub>2</sub>O/ n-Cu<sub>2</sub>O QD for various quenching time periods (p-Cu<sub>2</sub>O thin film fabricated in 300°C time 30min) in the presence of (10<sup>-2</sup> M) KI/I<sub>2</sub> redox couple (dotted curves-illuminated current, solid curves-dark current)

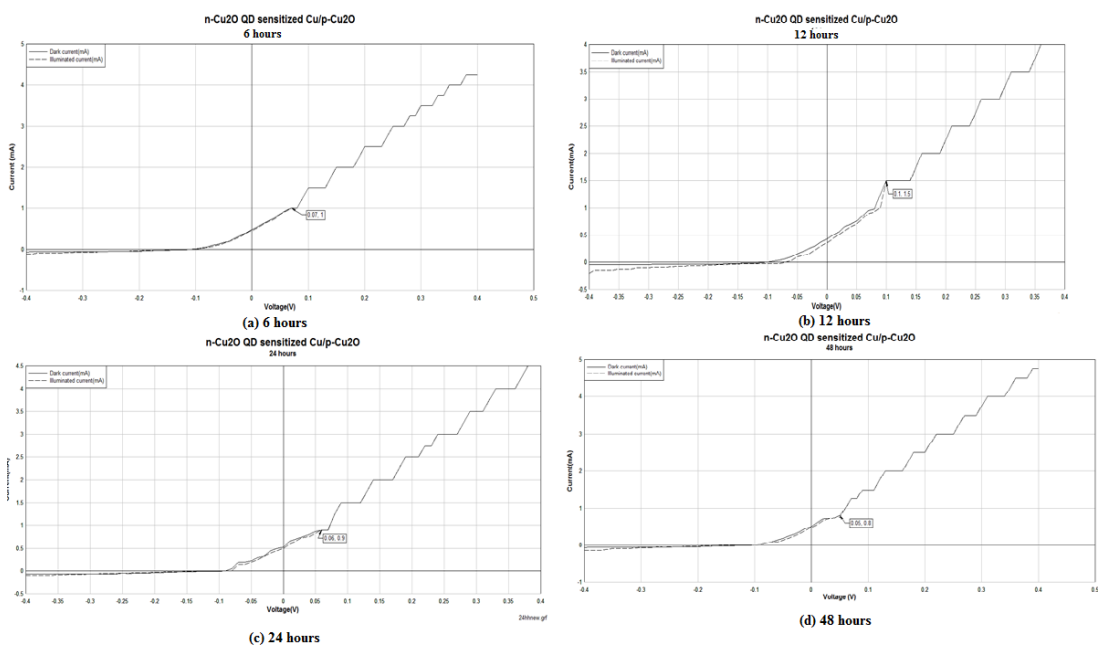


Figure 4: V-I characteristics of Cu/ p-Cu<sub>2</sub>O/ n-Cu<sub>2</sub>O QD for various quenching time periods (p-Cu<sub>2</sub>O thin film fabricated in 900°C, time 1min 16sec) in the presence of (10<sup>-2</sup> M) KI/I<sub>2</sub> redox couple (dotted curves-illuminated current, solid curves-dark current)

### 3.1 Sample characterization:

Brick red colored surface can be observed from the samples which were prepared using two thermal oxidation methods described in experimental section. It was visually confirmed that the yellowish brown Cu substrate has been changed to brick red fabricating p-Cu<sub>2</sub>O layer on top. After quenching samples surface color turned in to grayish pink. Analysis of diffuse spectra of p-Cu<sub>2</sub>O samples which were prepared with both methods displayed peak band edges between 630nm and 645nm.

Figure 2 (01) shows diffuse reflectance spectra of Cu/p-Cu<sub>2</sub>O (fabricated with 300°C for 30min) quenched in (10<sup>-1</sup>) M CuSO<sub>4</sub> (aq) solution for 6 hours, 12 hours, 24 hours and 48 hours. These quenched Cu/p-Cu<sub>2</sub>O samples displayed a peak edges between 665nm (band gap 1.86 eV) and 690nm (band gap 1.80 eV). Analysis of diffuse reflectance spectra of quenched Cu/p-Cu<sub>2</sub>O samples clearly shows that all quenched samples have some amount of p-Cu<sub>2</sub>O. 12 hour sample shows a broad symmetric peak which is clear sign of n-Cu<sub>2</sub>O quantum dot formation. But when time is increased symmetric property vanishes with formation of bulk n-Cu<sub>2</sub>O.

Figure 2 (02) shows diffuse reflectance spectra of Cu/p-Cu<sub>2</sub>O (fabricated with 900°C for 1min and 16sec) quenched in (10<sup>-1</sup>) M CuSO<sub>4</sub> (aq) solution for 6 hours, 12 hours, 24 hours and 48 hours. Quenched Cu/p-Cu<sub>2</sub>O samples displayed a peak edge between 650nm and 680nm. Same as the previous case diffuse reflectance spectrums show existence of both p-Cu<sub>2</sub>O and n-Cu<sub>2</sub>O quantum dots. Also in this sample set 12hours sample shows the most broad and symmetric peak which shows the existence of n-Cu<sub>2</sub>O quantum dots.

### 3.2 V-I characteristics:

V-I characteristics of Cu/ p-Cu<sub>2</sub>O/ n-Cu<sub>2</sub>O QD for various quenching time periods (for p-Cu<sub>2</sub>O thin films fabricated from both methods) are shown in Figure 3 and Figure 4. Shape of the dotted and solid curves show typical V-I characteristics under dark and illumination. V-I characteristics studies were carried out in the presence of KI/I<sub>2</sub> redox couple. Results are shown in Table 1.

Table 1. On-set potentials and on-set currents for all quenched samples

Quenched time (hours)	For p-Cu <sub>2</sub> O prepared with temperature profile 300°C, time 30min		For p-Cu <sub>2</sub> O prepared with temperature 900°C, time 1min 16sec	
	On-set potential (V)	On-set current (mA)	On-set potential (V)	On-set current (mA)
6	0.09	0.975	0.07	1
12	0.12	1.25	0.1	1.5
24	0.05	1	0.06	0.9
48	0.08	0.75	0.05	0.8

From quenched p-Cu<sub>2</sub>O samples which were prepared from both methods, 12 hours quenched samples show the highest on-set potential and the on-set current.

#### 4. CONCLUSION

Method to fabricate n-type Cu<sub>2</sub>O quantum dots on p-type Cu<sub>2</sub>O thin film discussed in this study is simple and cost effective. Before fabricating n-type Cu<sub>2</sub>O on p-type Cu<sub>2</sub>O film, two different methods were used to fabricate p-type Cu<sub>2</sub>O. P-type Cu<sub>2</sub>O fabricated in both methods showed a direct band gap around 1.9eV. 12 hours quenched sample in both methods displayed the best results for existence of n-type Cu<sub>2</sub>O quantum dots on p-type Cu<sub>2</sub>O thin film.

#### ACKNOWLEDGEMENTS

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## MIXED CATION EFFECT ON THE PERFORMANCE OF DYE SENSITIZED SOLAR CELLS BASED ON PMMA GEL POLYMER ELECTROLYTE

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### ABSTRACT

Gel polymer electrolyte (GPE)s have received a considerable attention to be used for dye sensitized solar cells(DSSC) as they do not exhibit the drawbacks of liquid electrolytes. It has been realized that cations in the salt of GPE play a great role in determining the efficiency of DSSC s. This paper reports about the effect of mixed cations on the performance of dye sensitized solar cells based on polymethylmetacrylate (PMMA) based gel polymer electrolyte. Two cations of dissimilar size were used for preparing the gel polymer electrolytes in the DSSCs. A mixture of zinc iodide ( $ZnI_2$ ) with tetrapropylammonium iodide ( $Pr_4NI$ ) was used in this regard. Conductivities of the GPES with only  $Pr_4NI$  and  $ZnI_2$  alone exhibited values of  $6.87 \times 10^{-3} Scm^{-1}$  and  $5.62 \times 10^{-3} Scm^{-1}$  respectively. But the mixed system showed a conductivity of  $6.78 \times 10^{-3} Scm^{-1}$ . Solar cells of configuration FTO/ $TiO_2$ /Dye/electrolyte/Pt/FTO were fabricated using a mesoporous Titanium dioxide ( $TiO_2$ ) electrode sensitized with a Ruthenium dye. The cells with  $Pr_4NI$  and  $ZnI_2$  alone gave efficiencies of 1.4% and 0.57% respectively. Mixed system showed an efficiency of 1.14%. This shows that lower efficiency of a DSSC fabricated with a salt like  $ZnI_2$  can be improved using salt having a bulky cation.

**Keywords:** PMMA, Dye-sensitized solar cells, mixed cation effect, Gel polymer electrolytes.

### 1. INTRODUCTION

Dye sensitized solar cells (DSSCs) were introduced by Gratzel in 1991<sup>1</sup>. A typical DSSC consists of a photo-electrode with a dye-sensitized mesoporous Titanium dioxide ( $TiO_2$ ) layer coated on an indium–tin oxide(ITO) glass and a liquid electrolyte containing an

iodide/triiodideredox mediators. A platinum(Pt) metal is used as the counter electrode. Such DSSCs sensitized with ruthenium based dyes work well and show good efficiencies.

Some of the major problems with the liquid electrolyte based DSSCs is their poor long term stability due to evaporation, leakage and flammability of the liquids as well as decomposition of the dye. It has been understood that problems can be solved by using polymer based gel type electrolytes as they have reasonable ionic conductivities and mechanical flexibilities resulting satisfactory performances.

Iodide salts are used in most GPEs based DSSCs and hence the iodide ion conductivity in the electrolyte is major factor that determines the short circuit current density ( $J_{SC}$ ) and also the efficiency of a DSSC<sup>2</sup>. Salts containing large cations such as tetrapropyl ammonium iodide ( $Pr_4NI$ ), tetra-n-butyl ammonium iodide ( $Bu_4NI$ ) and 1-Methyl-3-propylimidazolium iodide ( $IM_3PII$ ) are widely used as ionic salts to increase the iodide ion contribution. It is due to the fact that bulky cations in those salts are weak in mobility and therefore iodide ions are freed to move and they give rise to higher performance of DSSCs.

## 2. EXPERIMENTAL

### 2.1 Preparation of gel polymer electrolyte

Polymethylmetacrylate(PMMA, ALDRICH), Ethylene Carbonate (EC, ALDRICH), Propylene Carbonate (PC, ALDRICH), Tetra Propyl Ammonium Iodide ( $Pr_4NI$ , ABCR), Zinc Iodide ( $ZnI_2$ , ALDRICH) were used as received. Iodide ( $I_2$ , Breckland Scientific Suppliers) was also used without any treatment.

The electrolyte samples were prepared by keeping the weights of PMMA (0.02g), EC(0.03g) and PC( 0.03g) unchanged and changing the individual weights of  $Pr_4NI$  and  $ZnI_2$  so that their total weight remain at 0.04g. The weight of iodine ( $I_2$ ) was taken to be 3% of the total mole amount of salts.

Then, the required amounts of PMMA, EC, PC,  $ZnI_2$  and  $Pr_4NI$  were weighed and the mixture was stirred magnetically while heating at 60 °C for a time period of one hour. After that  $I_2$  was added. Then, the hot viscous mixture was pressed in between two well cleaned glass plates and

put in the vacuum desiccator overnight. It was possible to get a stable film free from holes. All the samples were prepared changing amounts of  $ZnI_2$  and  $Pr_4NI$ .

## 2.2 AC impedance measurements

The ionic conductivities of the gel polymer electrolyte samples were determined by the computer controlled MetrohmAutolab Impedance Analyzer M101 in the frequency range of 20Hz-10Hz. Disc shaped electrolyte samples were loaded between two polished stainless steel electrodes inside a sample holder. Impedance measurements were taken at room temperature.

## 2.3 DC Polarization test

The GPE was put in to the sample holder. Then current through the GPE film was measured as a function of time by applying 1 V potential to the GPE film. DC polarization gives the nature of ionic conductivity corresponding to the compositions. Ionic transference was measured using following equation.

$$\text{Ionic Transference } (T_{\text{ion}}) = (I_T - I_E) / I_T$$

## 2.4 Fabrication of DSS cells

First Fluorine doped Tin Oxide (FTO) glass strips (5mm\*20mm) were cleaned using standard method and boiled in propanone-2-ol.

Titanium dioxide ( $TiO_2$ , Degussa) was weighted and grinded for about one minute without adding anything. Then 3 drops of acetic acid were added and grinding was done for few minutes. After that 1 drop of Triton X and 3 drops of acetic were added and mixture was grinded until it became a pulp. Then 6 drops of acetic acid and few drops of ethanol were added into the mixture and grinding was continued until all  $TiO_2$  particles were grinded well. Ethanol amount in the mixture were kept in a certain limit by adding few drops time to time while grinding.

After preparing the paste, electrodes were prepared by blading it on FTO glass strip and those glasses were kept to dry in open air. When paste was completely dried, (5mm\*5mm) area was created by scratching off excess  $TiO_2$  paste. Finally above electrodes were sintered at  $450^{\circ}C$  for 45 minutes. Sintered electrodes were dipped in Ruthenium dye for 24 hours before use for solar cells.



Solar cell was prepared by sandwiching electrolyte in between two electrodes in configuration FTO-TiO<sub>2</sub>-Dye-Gel polymer electrolyte-Pt-FTO. Above procedure was repeated for following GPE compositions.

- PMMA,EC,PC and Pr<sub>4</sub>NI
- PMMA,EC,PC and ZnI<sub>2</sub>
- PMMA,EC,PC, ZnI<sub>2</sub> and Pr<sub>4</sub>NI

### 2.5 Characterization of DSS cells

Photo current – voltage curves were obtained for three cells under the illumination of 100W.

## 3. RESULTS AND DISCUSSION

### 3.1 Characterization of the gel polymer electrolyte

The compositions of the PMMA based gel polymer electrolyte, containing I<sub>2</sub> and different percentages of the binary iodide mixture Pr<sub>4</sub>N<sup>+</sup>I<sup>-</sup> and ZnI<sub>2</sub>, PMMA: EC: PC. The conductivity variation with temperature for different electrolyte compositions are shown in Figure 1 in the form conductivity (on log scale) plotted against the reciprocal temperature. The electrolyte containing only ZnI<sub>2</sub> as the salt has the lowest conductivity at all measured temperatures. This electrolyte has a conductivity of  $5.62 \times 10^{-3} \text{Scm}^{-1}$ . The electrolyte containing only Pr<sub>4</sub>NI shows the highest conductivity of  $6.87 \times 10^{-3} \text{Scm}^{-1}$ .

Table 1: Room Temperature conductivity

Composition	Room Temperature conductivity ( $1 \times 10^{-3} \text{Scm}^{-1}$ )
Pr <sub>4</sub> NI	6.87
ZnI <sub>2</sub>	5.62
Pr <sub>4</sub> NI + ZnI <sub>2</sub>	6.78

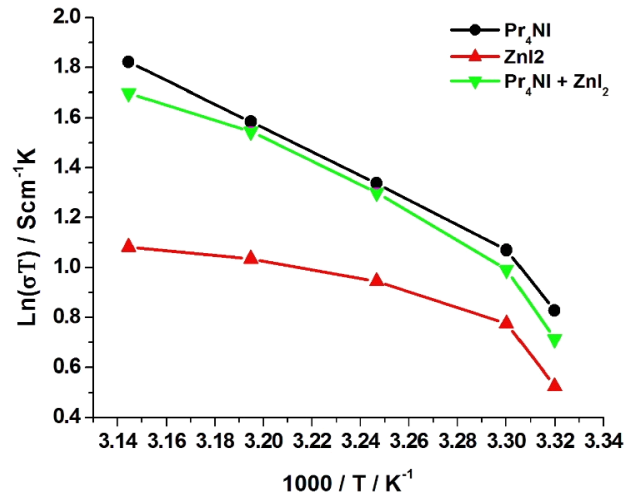


Figure 1: the variation of ionic conductivity vs. temperature

The ionic conductivity of the gel type electrolyte results mainly from movement of ions dissociated in the “trapped” EC/PC co-solvent in the PMMA polymer matrix.

### 3.2 DC Polarization test

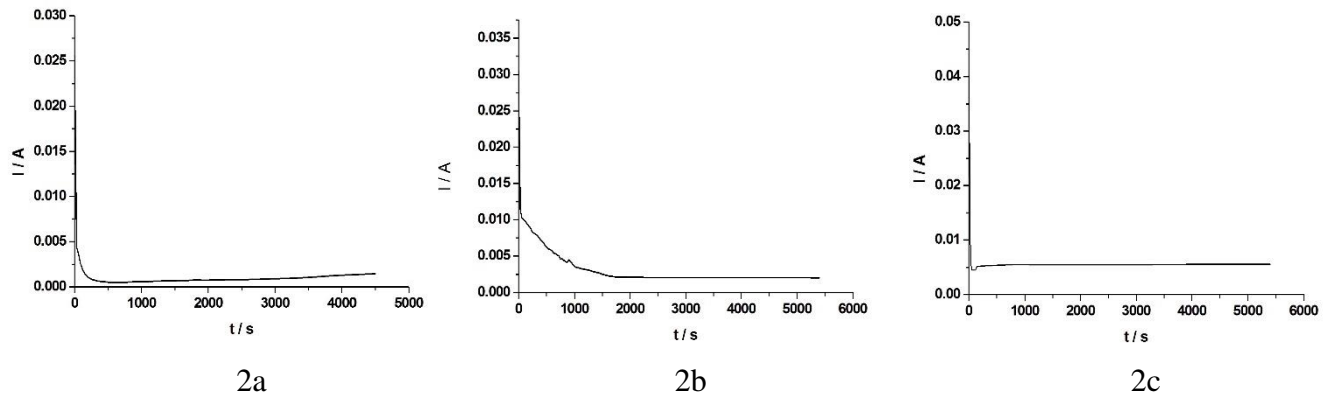


Figure 2: DC Polarization

According to the above graphs and corresponding to current variation with time for the cell configuration stainless steel (SS) Electrode / Gel Polymer electrolyte / stainless steel (SS) electrode 2a – Pr<sub>4</sub>NI system  $t_{ion} = 0.98$  2b - ZnI<sub>2</sub> system  $t_{ion} = 0.93$  2c – Mixed system  $t_{ion} = 0.92$ .

### 3.3 Characterization of DSSC

Under the irradiation of 100 W, the open circuit voltage (  $V_{oc}$  ) and the short circuit current density (  $J_{sc}$  ) were measured. In addition, the fill factor (FF,%) and efficiency ( $\eta\%$ ) were calculated for all the cells studied. The fill factor was calculated using

$$FF = J_{opt} V_{opt} / J_{sc} V_{oc}$$

Where  $J_{opt}$  and  $V_{opt}$  are the current density and voltage respectively at maximum power output.

$\eta$  was calculated using

$$\eta = J_{sc} V_{oc} FF / \text{Total incident power density}$$

Table 2: parameters of solar cells

compositions Parameters	Pr <sub>4</sub> NI	ZnI <sub>2</sub>	Pr <sub>4</sub> NI + ZnI <sub>2</sub>
V <sub>OC</sub> (mV)	438	246	425
J <sub>M</sub> ( $\mu$ Acm <sup>-2</sup> )	14.4	11.2	12.4
I <sub>SC</sub> ( $\mu$ A)	7.1	2.8	5.2
J <sub>sc</sub> ( $\mu$ Acm <sup>-2</sup> )	28.4	11.2	20.8
Fill factor (%)	36	66	41
Efficiency (%)	1.4	0.57	1.14

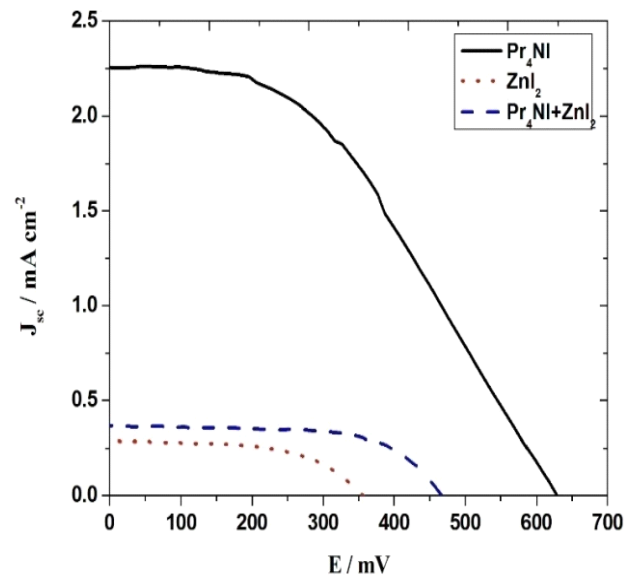


Figure 3: I-V curves

Table 2 shows the parameters of solar cells with three different electrolytes and figure 3 shows the current-voltage characteristics of the three different types of solar cell. Considering three compositions, highest  $V_{oc}$  value can be seen at the  $\text{Pr}_4\text{NI}$  system. Although  $\text{ZnI}_2$  system has the lowest  $V_{oc}$ . But  $V_{oc}$  value can be increased by mixing  $\text{ZnI}_2$  with  $\text{Pr}_4\text{NI}$ . It may be due to the mixed cation effect. Also  $\text{Pr}_4\text{NI}$  system has obtained the maximum efficiency than the other two systems.

#### 4. CONCLUSION

Polymer gel electrolytes were synthesized by hot press method taking poly (methyl methacrylate) (PMMA) as polymer, (EC + PC) ethylene carbonate +propylene carbonate as solvents and polymethylmetacrylate ( $\text{Pr}_4\text{NI}$ ) and zinc iodide ( $\text{ZnI}_2$ ) as salt. Different samples were prepared by taking alone  $\text{Pr}_4\text{NI}$ ,  $\text{ZnI}_2$  and  $\text{Pr}_4\text{NI} + \text{ZnI}_2$ .

The dye-sensitized solar cells fabricated with PMMA based polymer electrolytes with a binary iodide salt system consisting of a small alkali cation ( $\text{Zn}^+$ ) and a bulky cation ( $\text{Pr}_4\text{N}^+$ ) show efficiency enhancement which can be attributed to the mixed cation effect.

It should be noted that current density and efficiency of gel based DSSCs are not determined by the total ionic conductivity of the electrolyte but by many factors. In fact the net result of several competing factors in the electrolyte determines the net short circuit current density and hence the efficiency such as the number of free I<sup>-</sup> ions and their mobility, the number Zn<sup>+</sup> ions and their mobility, the number of Pr<sub>4</sub>N<sup>+</sup> ions and their mobility, the number of ion aggregates and the viscosity of the electrolyte solution. The combination of this entire rise to the maximum efficiency with the 1.14%.

## ACKNOWLEDGEMENTS

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## VARIATION OF IONIC CONDUCTIVITY AND SOLAR CELL CHARACTERISTICS OF A GEL POLYMER ELECTROLYTE BASED ON DIFFERENT IODIDE SALTS

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### ABSTRACT

Solar power has a great potential as a source of renewable energy due to decrease of fossil supply. Solar cell is a device that directly converts light energy into electrical energy through the photovoltaic process. The performance and effectiveness of a solar cell device mainly depend upon its design and the properties of the photo voltaic materials. In this study, gel polymer electrolyte (GPE) based on polyvinylidene fluoride (PVdF), ethylene carbonate (EC) and propylene carbonate (PC) has been investigated to be used for solar cells. GPE was prepared by using different iodide salts RI ( $R^+ = \text{Pr}_4\text{N}^+, \text{K}^+, \text{Mg}^{2+}, \text{Zn}^{2+}, \text{Na}^+$ ) using hot pressed method. The effect of  $R^+$  in GPE on the variation of the ionic conductivity and the performance of dye sensitized solar cells (DSSCs) were studied in this investigation. The composition, 100 polyvinylidene fluoride (PVdF) / 400 ethylene carbonate (EC) / 400 propylene carbonate (PC) / 100 Tetrapropylammonium iodide, ( $\text{Pr}_4\text{N}^+\text{I}$ ) showed the conductivity of  $3.73 \times 10^{-3} \text{ Scm}^{-1}$  at  $28^\circ\text{C}$ . The cell in the form glass/ FTO/  $\text{TiO}_2$ / Dye/ GPE/ Pt/ FTO/ glass showed an average open circuit voltage of 693 mV. The average short circuit current was 3.1 mA.

**Keywords:** Gel polymer electrolyte; Hot pressed method; Polyvinylidene fluoride; Tetrapropylammonium iodide

### 1. INTRODUCTION

During the past decades, there was a lot of effort done on developing gel polymer (GPEs) electrolytes to compete with liquid counterparts. GPE has a solid like cohesive property and liquid like diffusive property. They are generally prepared by adding a polymer to a liquid electrolyte. A salt is dissolved in polar solvent/s to prepare a liquid electrolyte. Ethylene

carbonate (EC), propylene carbonate (PC), diethyl form amide (DMF), diethyl carbonate (DEC), diethyl carbonate (DMC) etc. are generally used as solvents. Solvents are usually of low molecular weight which increases the conductivity by providing a locally mobile coordination environment for ion motion<sup>5</sup>. The salt provides ion for conduction and it should have low activation energy. The macro-molecular polymer provides the mechanical strength to the system. Polymers like poly (acrylonitrile) (PAN), poly (methyl methacrylate) (PMMA), poly (vinylidene fluoride) (PVDF) etc. are generally used for preparation of GPEs.<sup>2</sup>

Polymer gel electrolytes have high ionic conductivities as required for device application such as lithium batteries, super-capacitors and electrochemical devices. Another interesting and emerging area for possible applications is in the dye sensitized solar cells (DSSCs). The major drawback of DSSCs using liquid electrolytes is the less long-term stability due to the volatility of the electrolyte.<sup>2</sup> Other than that, safety issues and less design flexibilities have been considered as some crucial issues for the use of liquid electrolytes in DSSCs. To overcome those problems, GPEs are being investigated to substitute the liquid electrolytes as they exhibit good ionic conductivities while maintaining solid state nature.<sup>3</sup>

In this work, the variation of ionic conductivity and the cell performance of DSSCs with GPEs prepared using different iodide salts RI ( $R^+ = Pr_4N^+I, K^+, Mg^{2+}, Zn^{2+}, Na^+$ ) were investigated.

## 2. EXPERIMENTAL

### 2.1 Preparation of GPE

Materials polyvinylidene fluoride (PVdF, ALDRICH), ethylene carbonate (EC, ALDRICH) and propylene carbonate (PC, ALDRICH) were used as received. For the purpose of measuring variation of the conductivity due to different iodide salts several GPE films were prepared by adding constant quantity of different iodide salts RI ( $R^+ = Pr_4N^+I, K^+, Mg^{2+}, Zn^{2+}, Na^+$ ) to the composition. The mixture was stirred magnetically at 100 °C for 30 min until the entire salt has been dissolved. Required amount of PVdF was added to the above mixture and heated up to 120 °C and kept for 15 min while stirring for PVdF to fully dissolve and then iodine was added. The weight of iodine was taken to be one tenth of the total mole amount of the iodide salts. Finally, the homogeneous, hot mixture was pressed in between two well cleaned glass plates. Samples were prepared by varying the RI.<sup>1,4</sup>

## 2.2 AC impedance measurements

A circular shape sample of 14 mm diameter was cut from a prepared GPE film and was sandwiched in between two stainless steel (SS) electrodes in a spring loaded sample holder. Impedance data were gathered in the frequency range, 100 kHz – 0.01 Hz from room temperature to 50 °C using Metrohm Autolab Impedance analyzer.

## 2.3. DC polarization measurements

A circular shape sample was loaded in between two platinum (Pt) electrodes and current drop with time was measured for 2 hours under a dc potential of 1 V.

## 2.4. Photo electrode preparation

Fluorine-doped conducting tin oxide (FTO) strips were cleaned and boiled in Propone-2-ol. 3 drops of Acetic acid and 1 drop of Triton x were added and mixture was grinded until it become a pulp. Ethanol amount in the mixture were kept in a certain limit by adding few drops time to time while grinding. Electrodes were prepared by doctor blade method FTO glass strips and those glasses were kept to dry in open air and 10mm\*10mm area was created by scratching off excess TiO<sub>2</sub> paste. Electrodes were sintered at 450 °C temperature for 45 minutes and dipped in Ruthenium dye for 24 hours.<sup>2,5</sup>

## 2.5. DSSC fabrication and characterization

Three samples were selected for cell fabrication. The DSSCs having the configuration glass/ FTO/ TiO<sub>2</sub>/ Dye/ GPE/ Pt/ FTO/ glass were fabricated by sandwiching the gel polymer electrolyte in between the dye sensitized TiO<sub>2</sub> electrode and a Pt glass. Open circuit voltages and short circuit currents were measured using a digital multimeter. Charging discharging characteristics were observed under the illumination of 100 W.

# 3. RESULTS AND DISCUSSION

Table 1: Conductivity of different salts at room temperature

Sample	Conductivity at room temperature (28 °C) (10 <sup>-3</sup> Scm <sup>-1</sup> )
KI	12.0
Pr <sub>4</sub> NI	3.73
ZnI <sub>2</sub>	2.44
NaI	2.68
MgI <sub>2</sub>	1.17



### 3.1. Ionic conductivity of GPEs

Three samples that result high room temperature conductivities which are selected based on 1<sup>st</sup> and the 2<sup>nd</sup> group of the periodic table are shown in Figure 1 (a).

There are two very clear features in the figure and they are,

#### I. Conductivity increases with increasing temperature.

When temperature increases, viscosity goes down resulting conductivity increment. Also some researchers have disclosed these phenomena as due to hopping mechanism between coordinating sites, local structural relaxations and segmental motion of polymer.<sup>2</sup>

#### II. Conductivity temperature behavior can be explained by Vogel – Tamman – Fulcher (VTF) equation.

When conductivity is correlated by VTF, it is said to be depending on free volume theory. That is, the mobility of charge carriers is governed by polymer segmental motion by providing sufficient free space. As per the observation in Figure 1 (a) it can be suggested that polymer segmental motion imparts a considerable effect on conductivity of the GPE. In literature there are some reports about GPEs that have shown Arrhenius behavior instead of VTF.<sup>3, 6</sup>

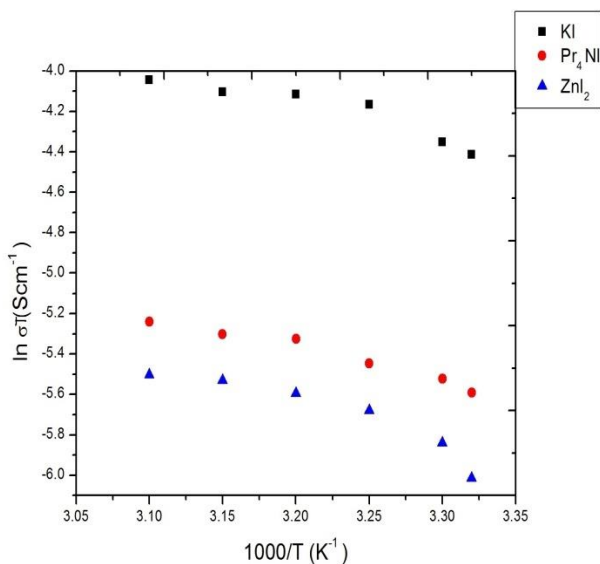


Figure 1 (a): Variation of conductivity with inverse temperature

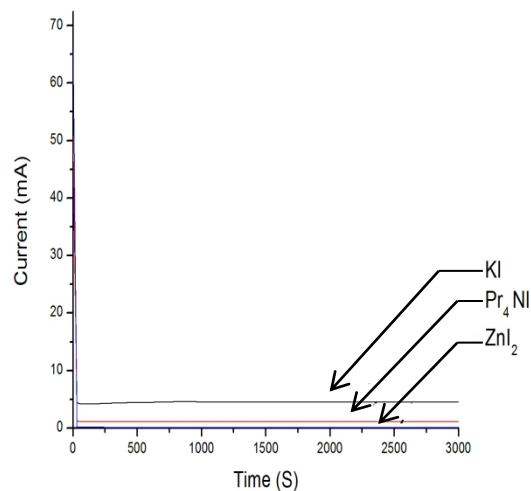


Figure 1(b): DC polarization curve taken with blocking electrodes

### 3.2. DC polarization test

Since the electrodes are blocking ions, Figure 1 (b), the sudden drop of current is due to ions and the steady state constant current is due to electrons. Ionic transference number  $t_{ion}$  was calculated as;  $(t_{ion}) = (I_T - I_E)/I_T$  <sup>5</sup>

The value of  $t_{ion}$  has been calculated and found to be 0.9. This value clearly shows that overall conductivity of GPE is pure ionic. <sup>3</sup>

### 3.3. Solar cell characterization

Even though conductivity of KI is higher than  $Pr_4N^+I^-$ , overall cell efficiency of  $Pr_4N^+I^-$  is higher than KI. When the cation of the salt is larger, it becomes less mobile. Due to this, anion movement increases and hence, anion contribution for cell performance improves. <sup>5,6</sup>

Table 2: System comparison for the solar cells for the selected three samples

	System 1		
	KI	$Pr_4NI$	$ZnI_2$
$V_{oc}(*10^{-3})$ V	661.2	693	593.8
$I_{sc}(*10^{-3})$ A	2.08	3.1	1.68
FF	0.367	0.473	0.489
$\eta$	82,873	162,345	80,224

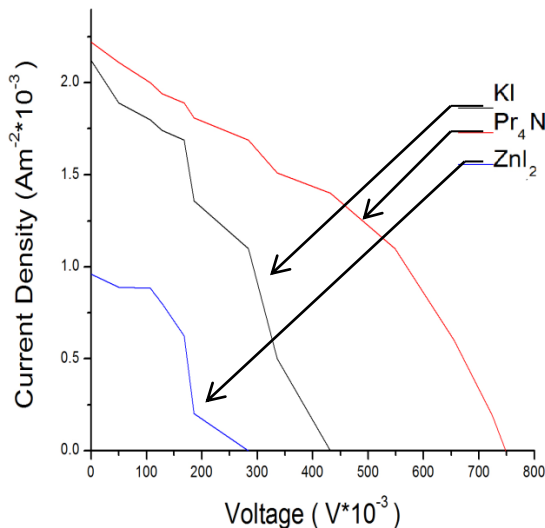


Figure 2 (a): IV Characteristic curves for the DSSC of the configuration FTO/TiO<sub>2</sub>/ Dye/ GPE/ Pt/ FTO.

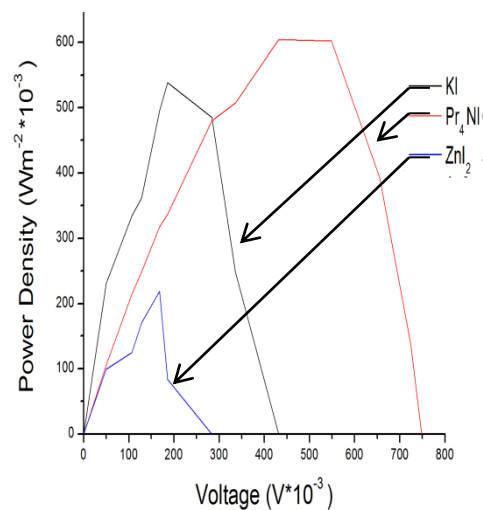


Figure 2 (b) PV Characteristic curves for the DSSC of the configuration FTO/TiO<sub>2</sub>/ Dye/ GPE/ Pt/ FTO.

#### **4. CONCLUSION**

Among the GPEs studied, the system with KI shows the highest conductivity. But Pr<sub>4</sub>NI based GPE which has the second highest conductivity shows the best solar cell performance. This elucidates the fact that conductivity and the solar cell performance are not directly related to each other. Due to mono valency of K and I, system based on KI can show higher conductivity. In Pr<sub>4</sub>NI though Pr<sub>4</sub>N<sup>+</sup> and I<sup>-</sup> are mono valent ions, due to bulky size of Pr<sub>4</sub>N<sup>+</sup>, conductivity of the system may be lower. But due to same reason, I<sup>-</sup> contribution for the cell performance increase in the later system.

#### **ACKNOWLEDGMENT**

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# INVESTIGATING THE EFFECT OF POLYMERIZATION CURRENT DENSITY OF CONDUCTING POLYMER CATHODE ON THE PERFORMANCE OF Cu BASED RECHARGEABLE CELLS

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## ABSTRACT

Conducting polymers have been identified as a promising candidate as cathode material in rechargeable cells. It has been clearly identified that current density ( $j$ ) used to polymerize the cathode has a great influence on the performance of polymer rechargeable cells. In this study, it is reported that preliminary work done on investigating the effect of polymerization current density on the performance of Cu based rechargeable cells. The cathode is a conducting polymer, polypyrrole (PPy). The gel polymer electrolyte was made with polymethylmethacrylate (PMMA), ethylene carbonate (EC), propylene carbonate (PC) and Copper trifluoromethanesulfonate (CuTF) as the salt. PPy films were galvanostatically polymerized on to a stainless-steel electrode. Then copper (Cu) rechargeable cells were assembled using a brass sample holder in the array of Cu/ Gel polymer electrolyte (GPE) / PPy. The effects of polymerization current density on the performance of rechargeable cells were investigated using cyclic voltammetry and continuous charge/discharge tests.

**Keywords:** Polypyrrole, Conducting Polymers, Cyclic Voltammetry.

## 1. INTRODUCTION

There has been a lot of interests on research and development of conducting polymer as a promising candidate for cathode material in rechargeable cells due to their favorable qualities such as wide range of electrical conductivity, mechanical flexibility and high thermal stability<sup>1</sup>.

When preparing conducting polymer cathode, factors such as cathode thickness, charge density and current density should be considered<sup>2</sup>. Out of them current density is utmost

important since it will directly effects for the cell characteristics such as open circuit voltage, capacity of the cell. To have high cycle life (charging – discharging time) and open circuit voltage simultaneously, selecting the most appropriate current density is vital in designing a polymer rechargeable cell. As the material for conducting polymer cathode, Lithium (Li) has been dominated in real world applications for a long period of time<sup>3</sup>. But Li batteries have severe health and safety problems and Li is highly reactive and disposal of batteries are not ecofriendly<sup>4</sup>. Copper (Cu) has been identified as a better material for the conducting polymer cathode since it is much ecofriendly while having favorable characteristics including excellent electrical conductivity, strength, hardness, ductility, low magnetic permeability and higher melting point(1083°C)<sup>5</sup>. In this study, the effect of polymerization current density of conducting polymer cathode on the performance of Cu based rechargeable cells is reported.

## **2. EXPERIMENTAL**

### **2.1 Polymerization of conducting polymer film:**

Sodium Dodecyl Benzene Sulphonate (SDBS, ALDRICH) and monomer-Pyrrole (ALDRICH) were used for polymerizations. The polymerization electrolyte was an aqueous solution of 0.05M SDBS and 0.1 M pyrrole monomer.

Three electrode configuration was used to polymerize the PPy film on to a stainless steel dies galvanostatically. In three electrode configuration, Ag/AgCl and Platinum (Pt) electrodes were served as reference and counter electrodes respectively. Stainless steel dice was used as the working electrode.

### **2.2 Preparation of the gel polymer electrolyte:**

Polymethylmethacrylate (PMMA, ALDRICH), ethylene carbonate (EC, ALDRICH), propylene carbonate (PC, ALDRICH), copper trifluoromethanesulfonate (CuTF, ALDRICH) and Acetone (ALDRICH) were used as the materials for preparing gel polymer electrolyte. PMMA and acetone was initially taken into a weighing bottle and solution was magnetically stirred well 45 minutes. After removing the excess acetone, EC, PC and CuTF were added to the mixture and heated at 80 °C for 1 hour. The hot mixture was pressed in between two well cleaned glass plates and a bubble free thin film was obtained. Composition of the GPE was chosen as 22.5% PMMA: 30% EC: 30% PC: 17.5% CuTF by weights.

### 2.3 Fabrication of the cells:

Cells were fabricated using a brass sample holder. A copper (Cu) plate that was fit with the sample holder was used as the anode of the cell. PPy film deposited on the stainless steel dice was used as the cathode. A circular shape membrane from the electrolyte was used as the separator. Then cell was assembled in the structure of Cu / PMMA:EC:PC:CuTF / PPyDBS.

### 2.4 Characterizations of the cells:

First, open circuit voltages of the cells were measured. Then linear sweep voltammetry was applied to the cell from open circuit voltage to the -0.01V. Thereafter, full cycles were performed within the potential window 0.7V to -0.02V. Scan rate was kept at 0.5mV/s while step potential was at 0.5mV. This procedure was repeated for all current densities. Thereafter these cells were tested for their ability to withstand continuous charge and discharge cycles. When following the charge – discharge test charging cutoff voltage was held at 0.5V and discharging cutoff voltage was held at 0V while the charging – discharging current was kept at 0.025mA.

## 3. RESULTS AND DISCUSSION

The observed open circuit voltages (OCVs) with respect to current densities are shown in table 1 below.

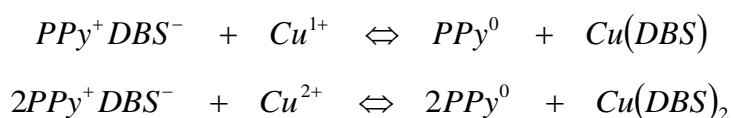
Table 1: Open circuit voltages with respect to current densities used to polymerize PPy film

Current density (j/mAcm <sup>-2</sup> )	Open circuit voltage (mV)
1.00	182.0
0.75	139.0
0.50	101.5
0.25	98.0

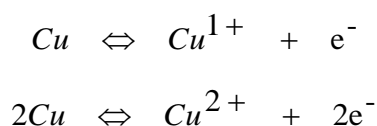
It can be clearly notice that with the current density, open circuit voltage has been increased. This result proposes to choose higher current densities for conduction polymer cathode to obtain higher voltage output from the batteries.

When the oxidation and reduction processes of the conducting polymer electrode are being carried out, electrochemical reactions will take place on the conducting polymer electrode due to ion movements. During charging and discharging of the cell, ion incorporation or emission occurs in PPy film<sup>6, 7</sup>. In this study PPy was doped with a large anion. It has been reported that when PPy is doped with large anions, cations are responsible for electrochemical

reactions.<sup>8</sup>. Therefore, cations in the electrolyte of the cell fabricated in the configuration Cu/GPE/PPy are supposed to participate in the oxidation and reduction process of the PPy cathode. Electrochemical reactions on the cathode can be formulated as follows,



At the same time, electrochemical reactions mentioned below will occur at anode.



Cyclic voltammograms obtained for experimented current densities is shown in figure 1.

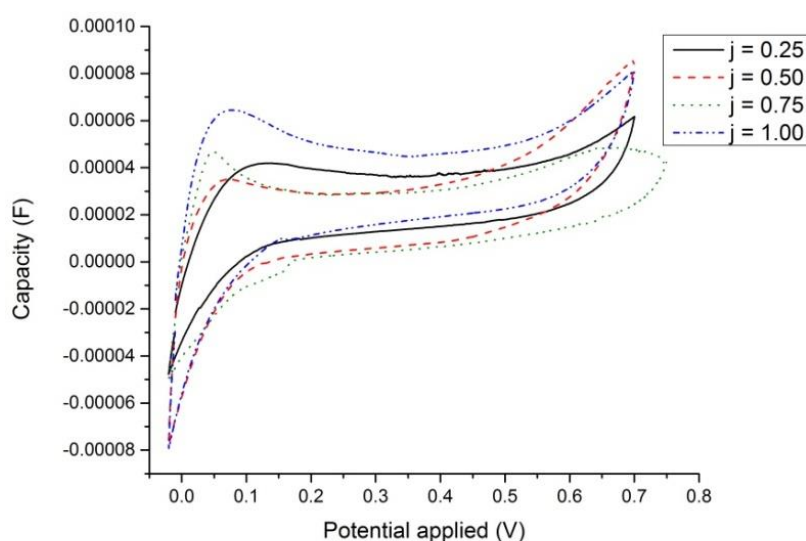


Figure 1: Cyclic voltammograms obtained for PPy films prepared with different current densities

The amount of average charge available during the cell reactions for different current densities were calculated from the area of the cyclic voltammograms and shown in table 2.

Table 2: Amount of average charge available in the cells during cycling with respect to polymerization current densities of PPy film.

Current density (j/mAcm <sup>-2</sup> )	Capacity x 10 <sup>-5</sup> (C/F)
1.0	4.51768
0.75	4.44080
0.50	4.14946
0.25	3.99661

Charging-discharging curves relevant to different current densities are shown figure 2.

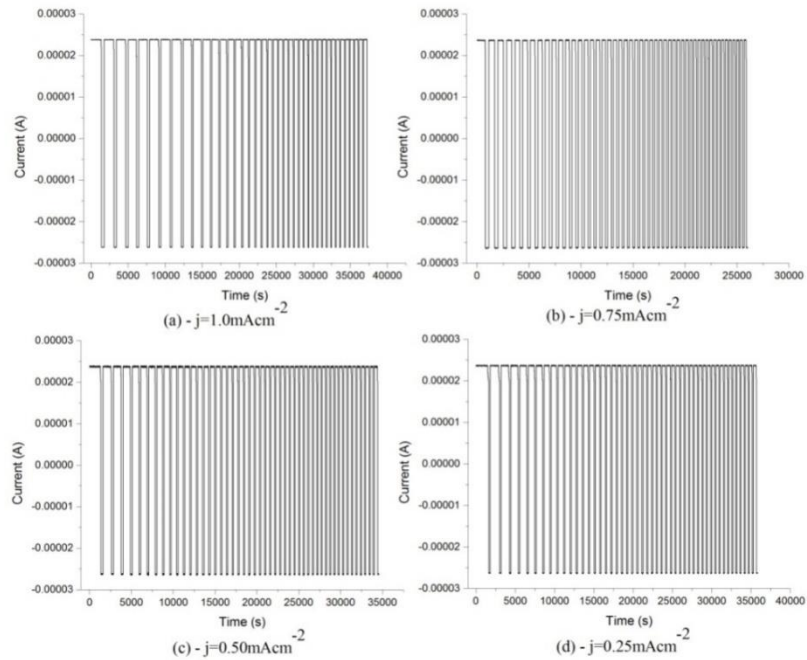


Figure 2: Charging-discharging curves relevant to cathodes prepared with different current densities

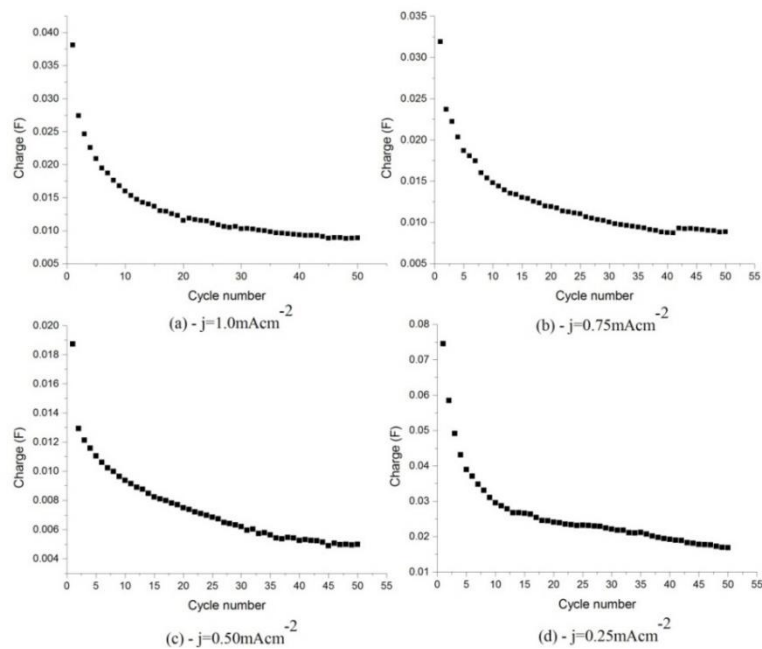


Figure 3: Variation of charge during discharging of the cells having cathodes prepared at different current densities

Available charge seems to be increased with the current density. This may be due to polymerization at high current density results morphology which helps the fast movement ions. Charging-discharging curves in figure 2 depicts that the cell assembled in Cu/GPE/PPy configuration seems to be almost stable for a longer period of time. Variations of charge with



cycle number for the cells having cathodes prepared at different current densities are shown figure 3. With the cycle number, capacity of the cells has been reduced. This may be due to the formation of a passive layer on the surface of the Cu electrode<sup>9</sup>.

#### 4. CONCLUSION

Even though the open circuit voltages of the Cu based cells were not very high, it is clear that current density of conducting polymer cathode affects the performances of the rechargeable cells. In this preliminary study, it has been found that amounts of average charge available of the cells can be optimized by selecting a high current density during the polymerization of the conducting polymer cathode.

#### ACKNOWLEDGEMENTS

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## **SYSTEM FOR HIGH -WAY OVER SPEED DETECTION WITH VEHICLE RECOGNITION**

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### **ABSTRACT**

This paper reports development of a message system with over speed detection and vehicle recognition for highways. The special feature of this system is creating a single message with speed detection, and vehicle recognition simultaneously. There are four main segments in this project. Vehicle speed calculation, Image capturing of vehicle, and if vehicle speed exceeded with reference speed then creates a message combine with above calculated speed with captured image. Finally sends this generated message to the particular destination over the network. Ultrasonic distance sensor is used to measure the distance of a vehicle passed within a specific time period. Distance between moving vehicle and sensor was calculated using an output pulse that corresponds to the time required for the burst echo to return to the sensor and echo pulse width. Using above parameter the speed was calculated. The records of speed and image are automatically entered to a database. After generating a combined message of speed and image, it will be send to the monitoring station. Implementation of this system will be able to increase the efficiency of traffic system in highways.

**Keywords:** Ultrasonic distance sensor, Burst echo, Echo pulse width

### **1. INTRODUCTION**

Transportation is most important factor for development of a particular country and it is mainly based on the road network. Highways should be in good condition with a smooth surface and road markings. There are lots of benefits that can be gained by using highways. Time saving is the most valuable benefit. Motorists should have better considerations about their driving speed and speed limits they can use. Already there exists a method to detect over speeds in highway. Traffic police is deployed with speed guns to check the speed of vehicles running on the express high-way. When a vehicle is detected with

exceeding maximum speed, the traffic policemen send a message to the next monitoring station over the phone. This process is less efficient and also it is difficult to identify particular vehicle. The main objective of this project is to overcome the above drawbacks through an accurate and efficiency manner with better evidences to proof speed of the relevant vehicle. This system can be placed at any point on the highway with proper positioning. Manual operators are not required to carry out this process.

## 2. EXPERIMENTAL

In this system, Ultrasonic distance sensor is the component used to measure the distance of a vehicle passed within a specific time interval. Ultrasonic distance sensor detects vehicle, by emitting a short ultrasonic burst and then detecting the echo, under control of a host microcontroller trigger pulse. The sensor emits a short ultrasonic burst (40 kHz). This burst travels through the air, hits on moving vehicle and then bounces back to the sensor. This sensor provides an output pulse to the host that will terminate when the echo detected, hence the width of this pulse corresponds to the distance to the target. Similarly it emits another subsequent ultrasonic burst according to the desired time period. After getting two distances, it calculates the difference of the distance. Moving speed of the vehicle is calculated using above parameter and time period of two emitted subsequent burst. Here microcontroller is used to calculate the speed using variance of the distance. Finally created message is sent to another point as an attachment by using DotNet(.NET) socket programming. Whole process in this project is combination of several separate processes.

### 2.1 Vehicle presences and speed detection

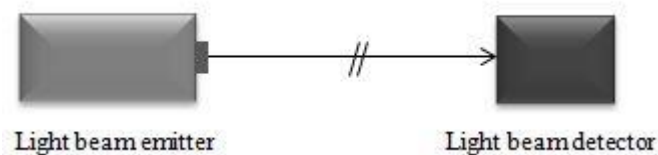


Figure 1: Schematic diagram of vehicle presence detector

An IR sensor is used to detect presence of the vehicle. Whenever IR ray is interrupted by a vehicle, the count up timer is stopped and sensor emits the ultrasonic burst according to the microcontroller trigger.

## 2.2 Image capturing process

Ultrasonic sensor enables by interruption of the light beam. And image capturing process of the camera is enabled for another trigger output of microcontroller.

## 2.3 Transmission of message to the monitoring station.

Created message with vehicles speed and image is sent to the monitoring station using DotNet (.NET) socket programming. DotNet is a new framework developed for web-based and windows-based applications within the Microsoft environment. The framework offers a fundamental shift in Microsoft strategy. It moves application development from client-centric to server-centric.

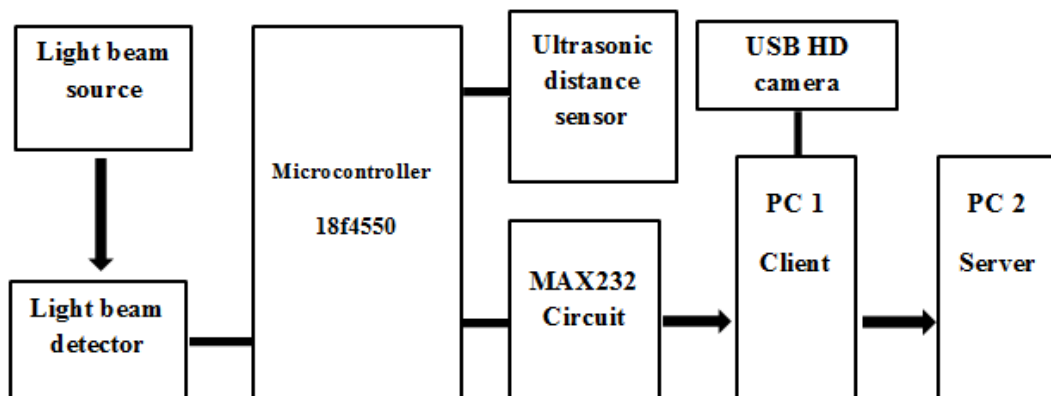


Figure 2: Block diagram of the system

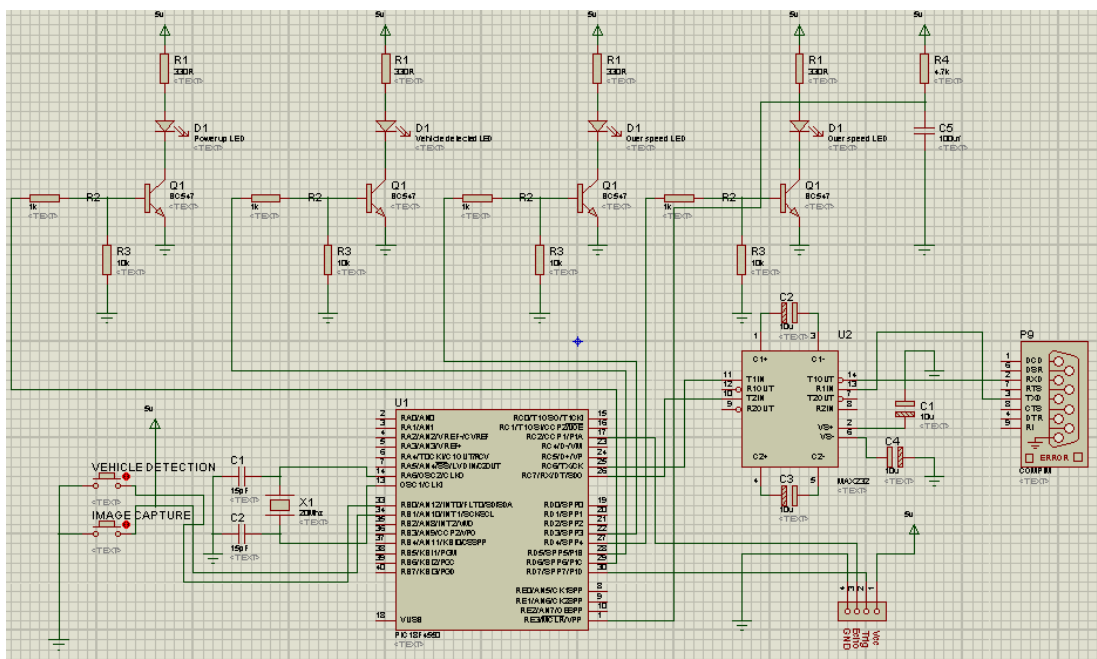


Figure 3: Circuit diagram of the system

### 3. RESULTS AND DISCUSSION

Sensor positioning is directly affected to the final result. If the sensor is more than 3 meters away from the vehicle, it cannot measure the accurate distance. Because the range of Ultrasonic distance sensor is 3 centimeters to 3.3 meters. Also it is need to give better consideration for reflective angle. There will not be reflections back towards the sensor for improper angles.

Speed of the sound waves are depends on surrounding temperature in air. In this project temperature is also affected to the measured distance between vehicle and sensor. But the variations of the distance have been used for speed calculation. Therefore temperature effect can be neglected in this situation.

The circuit has been tested by using a moving vehicle with known speed and observed the operation of system. Also more observations were obtained for a better verification of the system, by varying reference speed level (Maximum Allowable Speed)in the MikroC code. Below table shows the observations for a vehicle with  $40\text{kmh}^{-1}$  speed.

Table1: Observation for a moving vehicle with a known speed.

Reference speed level in the MikroC code ( $\text{kmh}^{-1}$ )	Image captured or Not
30	✓
38	✓
40	×
45	×
47	×
100	×

### 4. CONCLUSION

The project “*system for high-way over speed detection with vehicle recognition*” has been successfully designed and tested. This implementation is based on speed detection by using Ultrasonic sensor, image capturing and transmitting message from particular point to another destination. Maximum speed limit of this system can be adjusted by changing the variable of

reference speed in MikroC code. This system could be useful in increase efficiency of the vehicle tracking process and reduce risk of accidents in highways due to over speed.

### **ACKNOWLEDGMENTS**

Authors would like to acknowledge and extend heartfelt gratitude to all at Department of Electronics, Wayamba University of Sri Lanka.

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## INTELLIGENT WHITE CANE

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### ABSTRACT

Finding exact locations and the way is a real challenge for a blind person. Sometimes doorways and intersection points need to be counted to find exact locations. Usually most of them use traditional white canes for that purpose. Even if there are Braille signs a blind may not be able to find them. Most of the electronic canes currently at the market mainly aimed at obstacle detection purpose using sensor technology and not to find path or locations. Also visually impaired people will be helpless if they lose their way while travelling at outdoor. Through the project ‘Intelligent White Cane’ provides opportunity to identify predetermined locations and path using RFID technology. Also it utilizes GPS and GSM technologies to send a SMS message regarding current location details of the user to a preprogrammed mobile user if the blind lose the way while outdoor travelling. Intention of the operation is to provide extra protection to user by let him to get assistance from a friend or a relation if required.

**Keywords:** RFID, GPS receiver, GSM module, AT commands, Electronic travel aids

### 1. INTRODUCTION

People with various kinds of disabilities are part of our society and they truly need more attention and assistance from the rest of the society. Some have been disabled from their birth and some due to unfortunate accidents. In Sri Lanka for last few decades’ people faced a civil war and many soldiers and civilians lost their lives and some became disables.

The intension of this project is to pay more attention on visually disabled people. In Sri Lanka, generally most of the blind people use white canes. By using white canes they can identify path and objects (barriers), but it is not a reliable method to find locations. Also they become helpless if they lose their way while travelling at outdoor. So, after analyzing this necessity, the intention was to design an electronic device which helps blind people to find the path and locations exactly on their own and provides extra protection during outdoor/indoor trevally.



## 2. EXPERIMENTAL

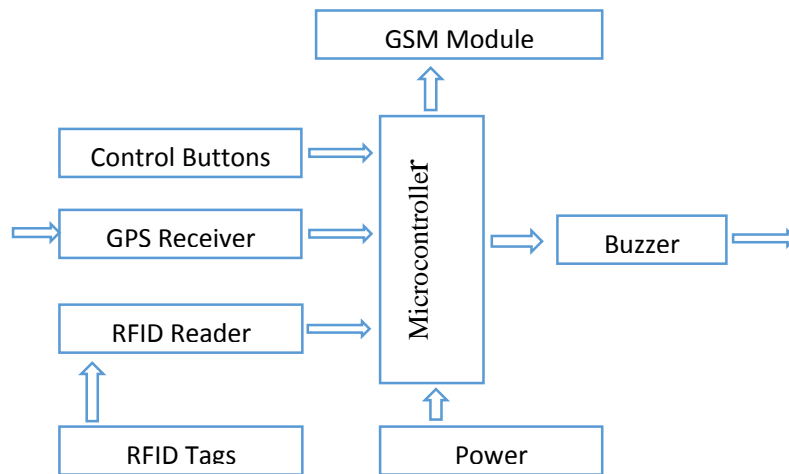


Figure 1: The Block Diagram of the model of Intelligent White Cane

Initially, all the equipment are checked by using the basic methods and confirm those are working properly. The GPS device's exact longitude and latitude of the locations were confirmed by using Google Map. Then all the components are step by step connected to the Microcontroller in a proper manner.

The GPS Receiver, RFID Reader and all the Control buttons (input devices) are identified and connected to the Microcontroller as inputs. After that the all output devices (GSM receiver and The Buzzer) are connected to the Microcontroller.

The microcontroller programed by using AT commands to fulfil the requirements. All the identified individual requirements are mentioned when programming the microcontroller. Finally, the RFID receiver detects signals from RFID tags when the experimental model moving closer to it. The receiver then sends that 'detected signal' as an input to the Microcontroller. Then it will make a specific output signal to the buzzer. An added feature to this device is the emergency key. When and if the blind person felt that he is lost or if he needs to share his location with someone he can press the emergency key. Then using the GSM module the device will send an automated SMS to specific number.

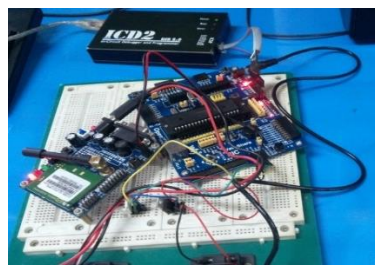


Figure 2: Interfacing components

### 3. RESULTS AND DISCUSSION

The intelligent white cane is developed for the blind persons to identify their path appropriately. Final outcome of this project is successful identification of the path by using the device.

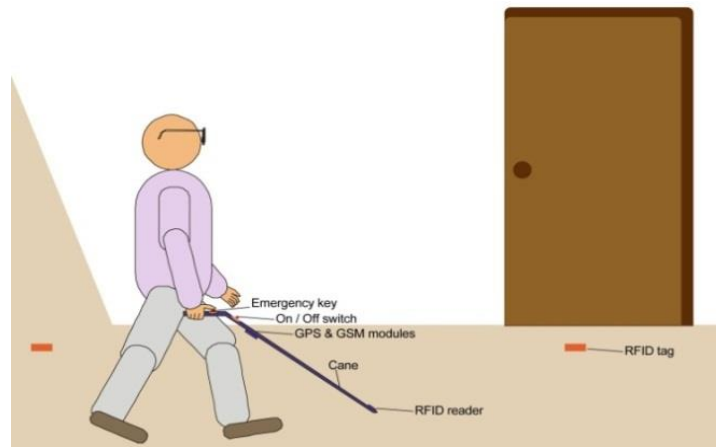


Figure 3: Use of Intelligent white cane.

It is created for indoor navigation but can also be develop it as an Outdoor navigator. It include a special emergency key, it helps the protection of the user. Cost of the used equipment is depending on the accuracy of the unit. The cost of making this unit is around Rs. 14000.00 (PIC18F4520 650.00, SIM300 4240.00, U blox NEO-6M 7600.00, RFID Tags and Reader 500.00)

### 4. CONCLUSION

The implementation of “Intelligent White Cane” using RFID, GPS and GSM is done successfully. It provides opportunity to find exact locations while indoor travelling and acknowledge a specific person via SMS to get assistance if the blind person lost his way during outdoor travelling. High frequency (13.56MHz) passive RFID<sup>4</sup> tags were used to place at required locations and they could be identified by the RFID reader as different beep sounds were provided by buzzer. Read range of used RFID reader was approximately 10cm which was not practical enough due to the difficulties in finding tags. One to two feet distance is an ideal read range for the device.

Also the buzzer can provide only a few numbers of different audio signals which eventually reduce the number of tags can be used. A GPS receiver<sup>5</sup>, GSM module<sup>3</sup> and an emergency key were included to the cane with the intension of sending location details to a preprogrammed mobile user. During the testing process when the emergency key is pressed, SMS regarding

location details could be received successfully. Then received location information were checked from Google maps and found an error of approximately 1km to the actual position.

To improve the accuracy and reliability of the system more accurate GPS receiver and a RFID reader with one to two feet readable range should be used. Also future developments of the system can be carried out in following ways<sup>1,2</sup>.

- Instead of buzzer a sound record and replay IC can be utilized to play recorded location names or a guide instruction when that particular location is identified by the system.
- Ultrasonic sensors can be placed at the bottom of the cane to detect obstacles which are in front of the user.

Finally the project “Intelligent White Cane” was implemented successfully up to a desired level.

## 5. ACKNOWLEDGEMENTS

The authors would like to acknowledge and extend gratitude to the person who has helped to make this project a success.

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## DESIGN OF AN MP3 PLAYER WITH TIME SCHEDULING

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### ABSTRACT

This paper describes the design and implementation of a new MP3 player with time scheduling features. Playing audio files are really important part of many applications. As an example almost all school in Sri Lanka play their school theme song, Observation of five precepts, and National anthem in every morning. But currently those recordings are manually played using a record player. We developed a new system that is capable of playing the recordings according to the schedule. Relevant audio file is played by the system exactly on the preset time, which enables to automate playing audio records in organizations such as schools.

**Keywords:** Decoder Module, Microcontroller, SD Card, Audio, Multilayer PCB

### 1. INTRODUCTION

There are so many Audio players available in the market. However, the main functions of those players are generally same. It can be used to play audio files one by one in the order, as files are stored in the SD card or in its internal memory. In those players, it cannot be changed the playing procedure without changing the order of the files in the SD card because they are starting the playing from the beginning and after that it moves to next file following the stored order in the SD card until reaching the last file. During this process it cannot be done anything other than moving to next or previous file, pause and stop. If anyone wants to play specific audio file it must be moved by pressing next or previous until reach the necessary file.

In this paper we describe the design and development of a new system to solve this above problem. The main feature of this device is time scheduling function. That means it can be scheduled the file playing time with respective audio file. That means this system has the facility to play audio file on specific time. User can select that which file should be played automatically in pre-scheduled time as well as the order. By using this device it can be set

few (Three) timers for playing respective files at a time. The system plays the audio files automatically according to the preset time schedule. This kind of system has many applications where audio recordings need to play on specific time such as in schools.

## 2. EXPERIMENTAL

We have designed and implemented a prototype of new MP3 player with time-scheduling features whose functional block diagram is shown in Figure 1. The main part of the system is an 8-bit Atmega microcontroller. Using the set of buttons on the control panel a user can set the time schedule to play audio files stored in the SD card. The MP3 decoder module is used to increase the quality of audio.

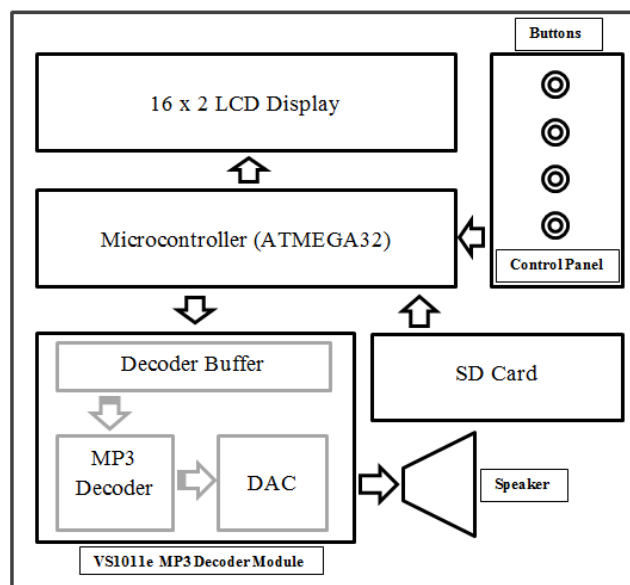


Figure 1: The Block Diagram of the System

### 2.1. PCB Designing

The entire system is built on four-layer Printed Circuit Board (PCB). A simple two-layer PCB is not sufficient to route the connections with proper use of signal integrity. Multilayer boards have many benefits over conventional double layer, singlelayer PCBs. The use of multilayer boards provides several benefits for applications where high levels of consistency in conductor wave impedance are required. In addition, multilayer boards offer superior reductions in distortion and signal propagation in applications where signal integrity and "cross talk" levels are critical<sup>2</sup>. The multilayer PCBs allow for considerable savings on space, allow for the easy, simultaneous shielding of large numbers of components, and cut down on the number of interconnection wiring harnesses that would be needed if separate circuit

boards were used. These interconnections represent a considerable addition to the space a circuit occupies and add substantially to the overall weight of the system also.

The layer stack up of the PCB is given below. The top and the bottom layers are routing layers where all the components are connected. Placing the ground plane and the power plane closed to routing layers minimize unwanted capacitive and inductive effects.

- Layer 1- RoutingPlane
- Layer 2- VCC Plane
- Layer 3- GND Plane
- Layer 4- RoutingPlane

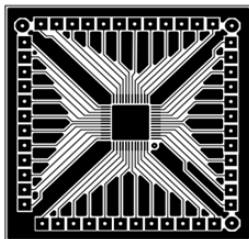


Figure 2: Adaptor

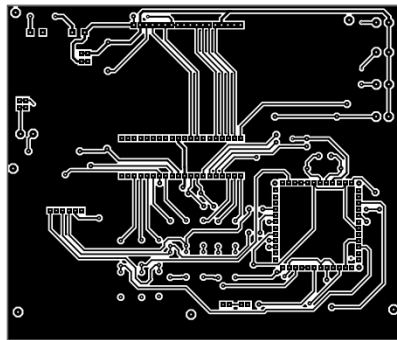


Figure 3 : Bottom View

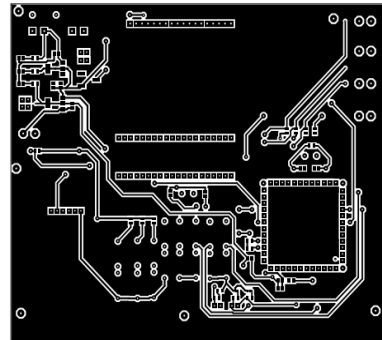


Figure 4: Top View

## 2.2. VS1011E Module

The VS1011 is a basic MP3 decoder chip of VLSI Solution. This module has a reliable and high-quality MP3 and WAV decoding engine with a combination of stereo D/A converter and earphone amplifier. Although intended as slave processor, the VS1011 also has a standalone mode that can be used to play audio files such as mp3, mp1, mp2, wav. Furthermore it Available in two difference packages as well<sup>3,4</sup>.

## 2.3. Decoder Module

The VS1011e device is based on a proprietary digital signal processor. It contains all the code and data memory needed for MPEG, WAV PCM and WAV IMA ADPCM audio decoding, together with serial interfaces, a stereo audio DAC and analog output amplifiers and filters<sup>3</sup>. It can play all MPEG 1.0, and 2.0 layer I, II and III files, as well as MPEG 2.5 layer III files, with all sample rates and bitrates, including variable bitrate (VBR) for layer III. That decoding of layers I and II must be activated separately<sup>4</sup>.

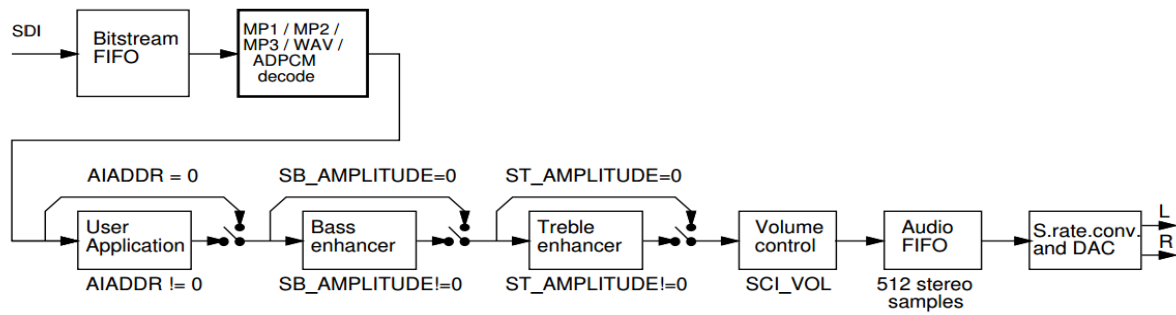


Figure 5: Data Flow of Decoder<sup>4</sup>

First, MPEG or WAV audio data is obtained from SD card through the SDI bus and then the received data is decoded by decode module as shown in above Figure 5. After decoding, if SCI\_AIADDR is non-zero, application code is executed from the address pointed to by that register. Then data may be sent to the Bass and Treble Enhancer depending on the value of SCI\_BASS register. After that the signal is fed to the volume control unit, which also copies the data to the Audio FIFO<sup>4</sup>.

The Audio FIFO holds the data, which is read by the Audio interrupt and fed to the sample rate converter and DACs. The size of the audio FIFO is 512 stereo (2×16-bit) samples, or 2 KB. The sample rate converter converts all different sample rates and feeds the data to the DAC, which in order creates a stereo in-phase analog signal<sup>4</sup>. Finally this signal is produced the sound as the result.

#### 2.4. ATMEGA32

It is a microcontroller with high-performance, low-power Atmel 8-bit AVR RISC-based microcontroller combines 32KB of programmable flash memory, 2KB SRAM, 1KB EEPROM, an 8-channel 10-bit A/D converter, and a JTAG interface for on-chip debugging. The device supports throughput of 16 MIPS at 16 MHz and operates between 4.5-5.5 volts. By executing instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed<sup>5</sup>. It has been used to develop this device especially considering the programmable memory.

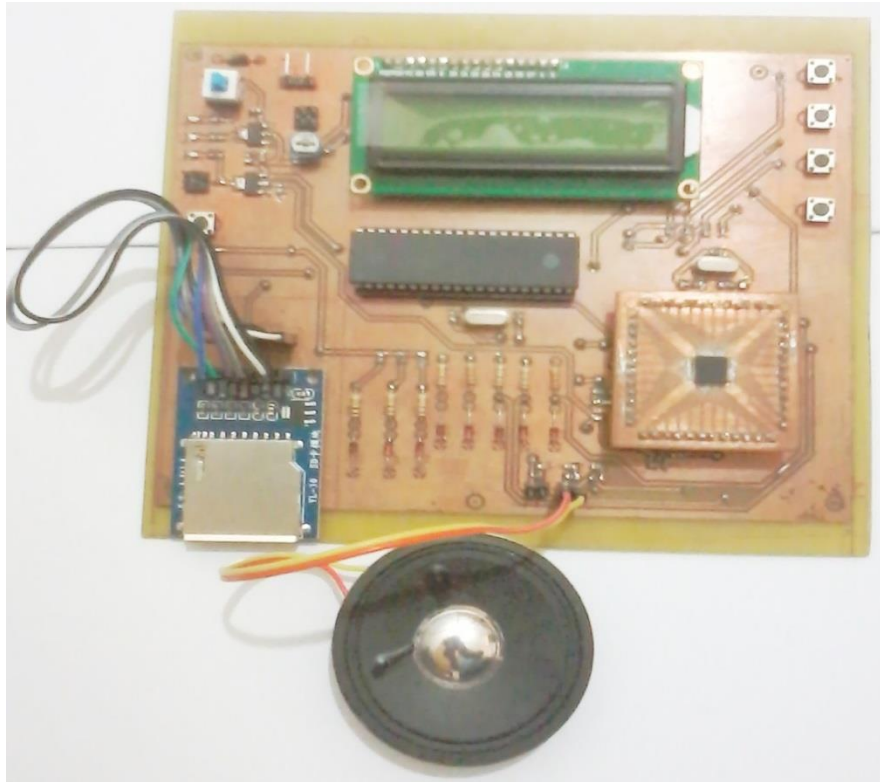


Figure 6: Prototype of the System

### 3. RESULTS AND DISCUSSION

This system can be used in any place where audio files should play easily. It has the feature to make a schedule to play audio file with respective time. So user should not be worried about the storing order and other things and it is easy to use anyone. SD card can be filled with mp3 or whatever audio files by using a PC.

At the beginning of this project we tried to play some audio files including mp3 by using microcontroller directly. Initial tests provided some important results.

- It is required higher memory to decode the mp3 and other audio files. Therefore microcontroller program memory is not enough for decoding such a file in a microcontroller.
- By using microcontroller program memory it can be play only wav formatted audio files with low quality such as 8 bit mono wav files having 22 kHz sampling frequency. That means the quality of that files very low and then the play with some noises.
- By adding external memory it can be done and can be played good quality wav files through microcontrollers. But its cost is somewhat high.



### 3.1. Limitations

There are some limitations of this system. The major problem is, it had to be limited the number of timers used because the memory usage of the Microcontroller. It is required more memory to increase the number of timers and as a future development, it can be increase the number of timers by using another microcontroller with higher memory such as ATMEGA 128, STM32 etc.

There is no any internal power backup system. Therefore, if there is any power failure, all timers will be reset and as the result of that, it must be rescheduled.

## 4. CONCLUSION

We have designed and implemented a new MP3 player with time scheduling features. The system consists of an ATmega microcontroller, which controls the main operations of the system. This system can be used to automate playing audio records at different time of the day. It is especially suitable for schools in which play many recordings during the school time.

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## INVESTIGATION OF p-CuI SENSITIZED QUANTUM DOT SOLAR CELLS

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### ABSTRACT

A low cost and simple solution for solar cells is obtained with immersing a well cleaned copper plate in a solution with KI and I<sub>2</sub> to prepare p-CuI colloidal layer and then boiled in a CuSO<sub>4</sub> to deposit n-Cu<sub>2</sub>O quantum dots on it. UV spectrophotometer and potentiostat were used to investigate the characteristics. Different sizes of quantum dots were tested aiming the best efficiency conversion level to gain most suited solution for a solar cell to enhance the photocurrent. Results showed that maximum photocurrent (0.5 mA) is obtained when Cu/p-CuI cell is boiled for 20 minutes in 0.003M CuSO<sub>4</sub>.

**Keywords:** p-CuI, solar cells, n-Cu<sub>2</sub>O, quantum dots

### 1. INTRODUCTION

The need for clean and renewable energy sources has encouraged the fabrication of low-cost materials for solar energy conversion devices<sup>1</sup>. Traditional semiconductors were not cost effective and have band gaps that are hard to be changed and also their emission frequencies are hard to be manipulated. Fabrication of p-n junctions with Quantum Dots (QD) is seen as the solution for these problems to overcome drawbacks in traditional semiconductors and probably would play an important role in future solar energy conversion devices.

A quantum dot is a portion of matter whose excitons are confined in all three spatial dimensions. Consequently, such materials have electronic properties intermediate between those of bulk semiconductors and those of discrete molecules. It was recently established that QDs generate multiple electron-hole pairs per photon, improving device efficiency<sup>2</sup>.

Currently the QD is a field which has gained more attention and more studies are focused in use of solar cells.

In this study preparation of p-CuI sensitized QD photovoltaic cells using an easy fabrication method was discussed. Photoelectrochemical characteristics were presented from V-I characteristics in presence of  $(10^{-4}\text{M}) \text{Fe}^{2+}/\text{Fe}^{3+}(10^{-2}\text{M})$  redox couple and absorption characteristics by diffuse reflectance spectra.

## 2. EXPERIMENTAL

### 2.1 Preparation of $\text{Cu}_2\text{O}$ QD sensitized Cu/p-CuI photo electrode

A commercially available 4cm x 8cm Copper plate was smoothed with sand papers till mirror like surface was obtained. That Cu plate was cleaned using a detergent and distilled water to obtain a well cleaned Cu plate. A solution of 75ml was prepared using 402mg of KI, an Iodine crystal, 6ml of Ethanol and distilled water. Cu plate was immersed in the prepared solution for 10 minutes to make CuI colloidal layer on top of Cu plate. Then CuI electrode was immersed in a 0.003M  $\text{CuSO}_4$  and boiled until a  $\text{Cu}_2\text{O}$  QD sensitized Cu/p-CuI photo electrode was prepared. The sizes of quantum dots were controlled with boiling time.

### 2.2 Experimental techniques

Absorption properties of the  $\text{Cu}_2\text{O}$  QD sensitized Cu/p-CuI samples were obtained using Shimadzu UV-visible 1800 spectrophotometer. For Photo electrochemical characteristics measurements, HOKUTU DENKO HA-301 potentiostat/galvostat was used with three-electrode configuration while having Pt as counter electrode and AgCl/Ag as the reference electrode. The light source used was a 100W tungsten lamp. All chemicals used for the experiment were analytical grade.

## 3. RESULTS AND DISCUSSION

### 3.1 UV-visible absorption analysis

Figure 1 shows the diffuse reflectance spectrums of Cu/p-CuI cell and boiling them in  $\text{CuSO}_4$  for different times. The peak edges ( $\lambda$ ) for  $\text{Cu}_2\text{O}$  were increased from 670 nm to 720 nm when boiling time was increased from 5 minutes to 20 minutes. When boiling time was further increased the peak edges were shifted to 640 nm due to formation of bulk  $\text{Cu}_2\text{O}$ . According to the results p-CuI cell boiled in 0.003M  $\text{CuSO}_4$  for 20 minutes can be taken as the best result.

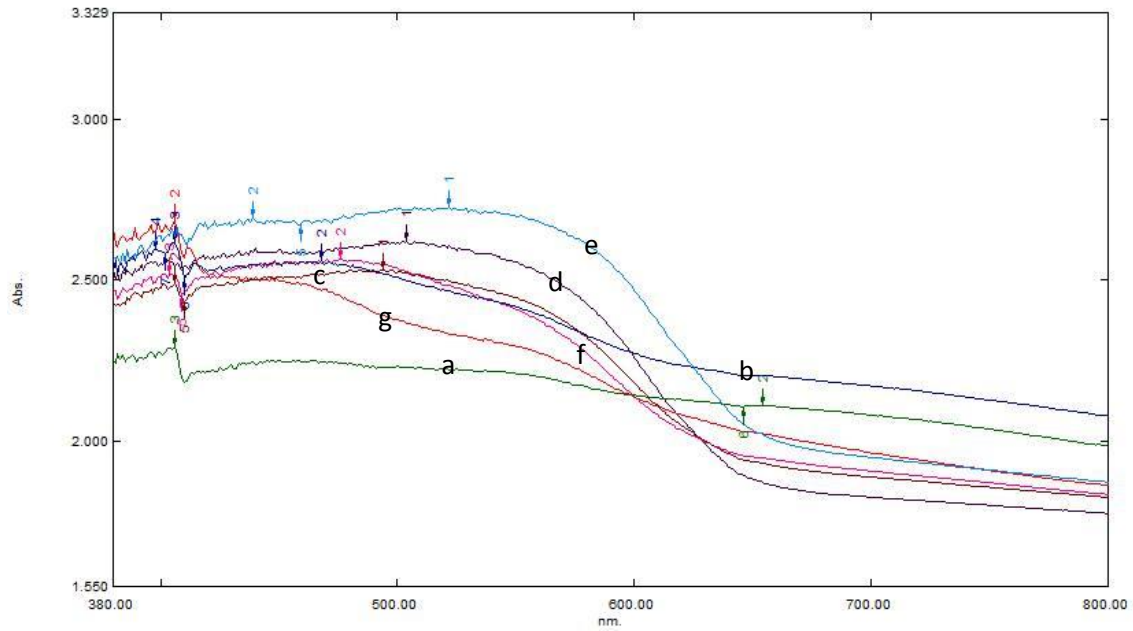


Figure 1: Diffuse reflectance spectra of Cu/p-CuI/n-Cu<sub>2</sub>O cells for various boiling time in CuSO<sub>4</sub> solution for make various n-Cu<sub>2</sub>O layers. (a)CuI (b)5 min (c)10 min (d)15 min (e)20 min (f)30 min (g)40 min

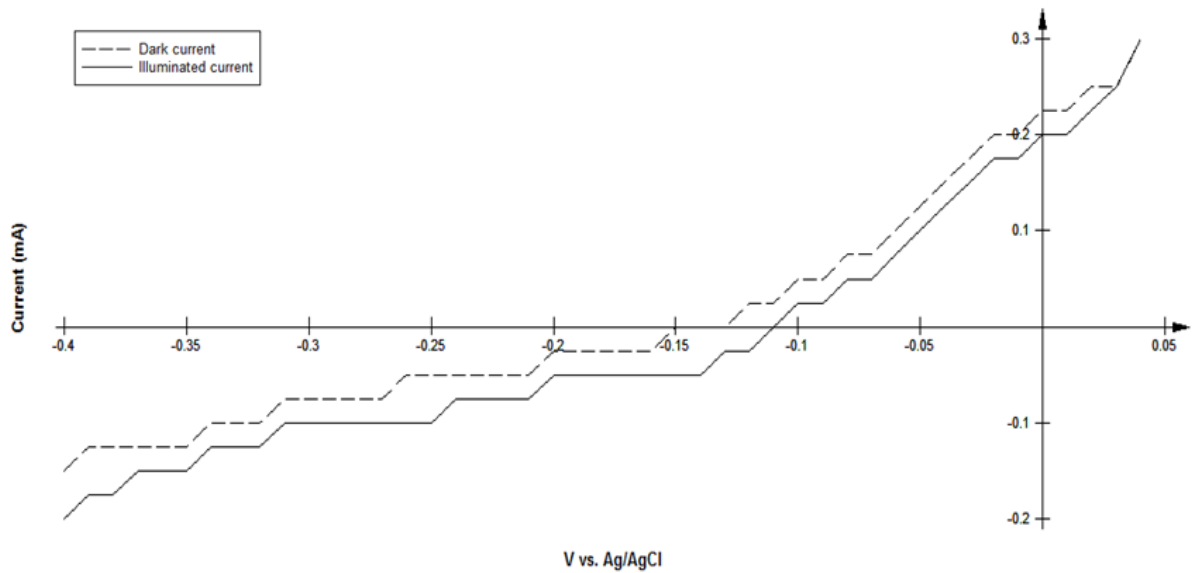


Figure 2: V-I characteristics of Cu/p-CuI cell in the presence of Fe<sup>2+</sup>/Fe<sup>3+</sup> redox couple.

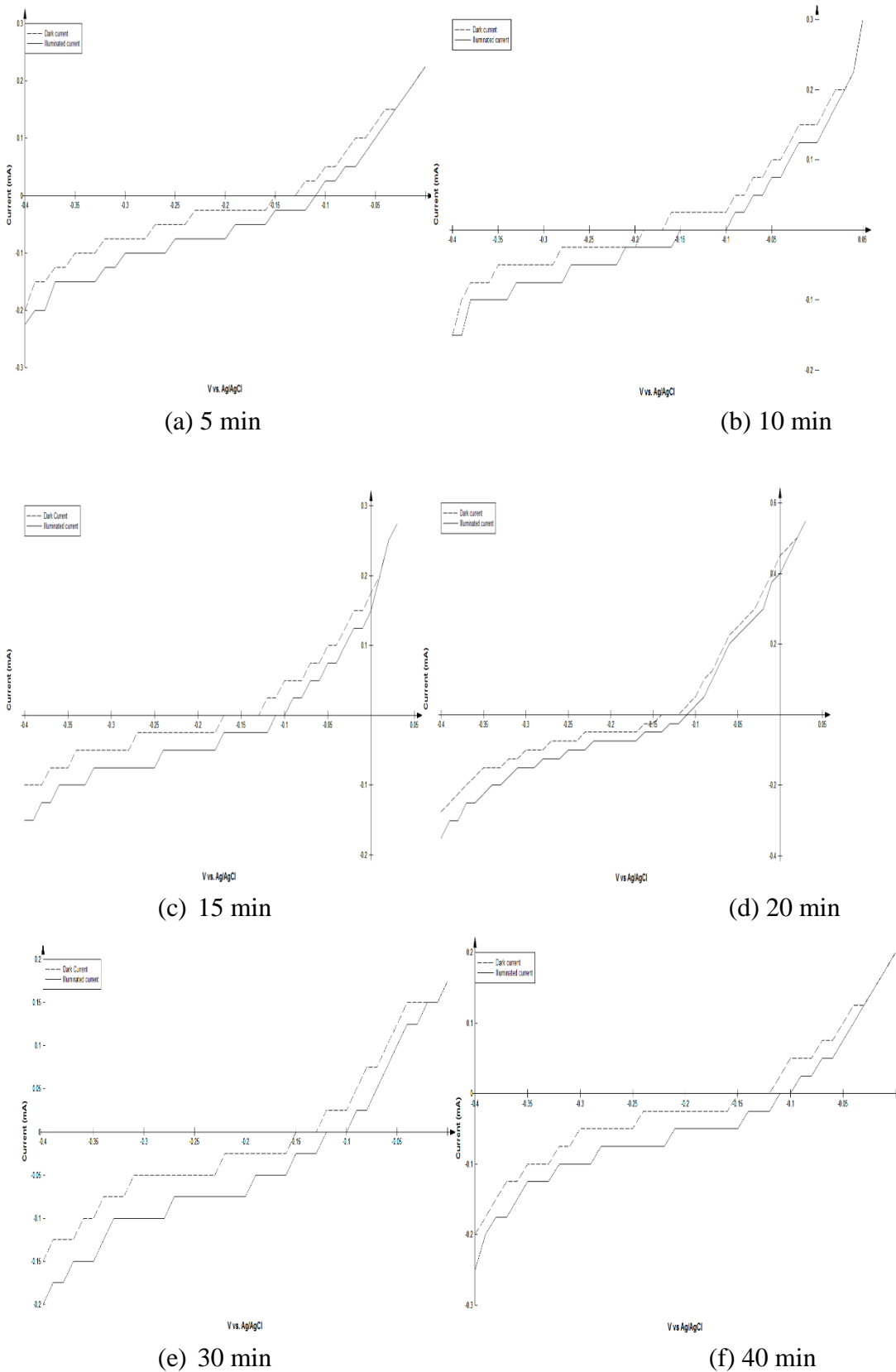


Figure 3: V-I characteristics of  $\text{Cu}_2\text{O}$  QD sensitized  $\text{Cu}/\text{p-CuI}/\text{n-Cu}_2\text{O}$  cells for various boiling time with  $\text{CuSO}_4$  solution.

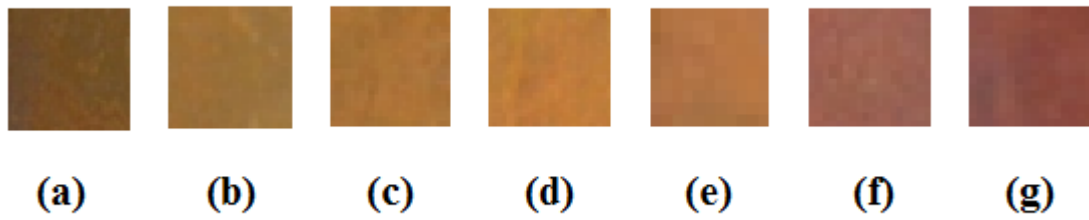


Figure 4: Color variation with boiling time in CuSO<sub>4</sub> solution for make various n-Cu<sub>2</sub>O layers. (a)p-CuI (b)5 min (c)10 min (d)15 min (e)20 min (f)30 min (g)40 min

Table 1: On-set potentials and currents for different boiling times

Boiling time in CuSO <sub>4</sub>	On-set potential (v)	On-set current (mA)
5	-0.01	0.15
10	0.02	0.75
15	0.02	0.2
20	0.01	0.5
30	-0.02	0.2
40	-0.03	0.175

### 3.2 V-I characteristics

According to Figure 2 V-I characteristics under 0.005M Fe<sup>2+</sup>/Fe<sup>3+</sup> electrolyte the on-set potential was observed at +0.03V (vs. Ag/AgCl) for Cu/p-CuI cell which is the flat band potential. Figure 3 shows the V-I characteristics for cells after sensitization of Cu<sub>2</sub>O QD at different boiling times in CuSO<sub>4</sub>. Onset potential didn't change considerably for boiling times up to 20 minutes. But for both 30 minutes and 40 minutes boiling times there observed a shift in onset potential from positive side to negative side as shown in Table 1. And the onset current was increased up to 0.5mA and then reduced due to formation of bulk Cu<sub>2</sub>O.

### 3.3 Schematic Structure of photo electrodes

After immersing the Cu plate in KI/I<sub>2</sub> the Cu plates turned ash in color. Then when it is boiled in CuSO<sub>4</sub> the ash color becomes yellowish ash. With the increase of boiling time in CuSO<sub>4</sub> the Cu/p-CuI cell is gradually turned from yellowish ash to red color as shown in Figure

4. This is due to the formation of Cu<sub>2</sub>O quantum dots and the diameter of those QDs increases with time and ultimately turn into bulk size Cu<sub>2</sub>O.

#### **4. CONCLUSION**

The application of QD for photovoltaic devices is vital due to their unique optoelectronic properties which are defined by sizes of QDs. The size of a QD easily controllable in preparing cells thus eliminates the drawbacks in traditional semiconductors. One of the essentials in fabricating photovoltaic cells is high stability, which was observed during this study.

#### **ACKNOWLEDGEMENTS**

Authors wish to extend their gratitude for the assistance given by research assistants in Nanotechnology Research Laboratory of Wayamba University of Sri Lanka.

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## **EFFECT OF DOPING ANION OF THE CATHODE ON THE PERFORMANCE OF Mg/PVdFMgTF/PPy RECHARGEABLE CELLS**

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### **ABSTRACT**

Today, Li rechargeable cells play a vital role in fulfilling low power requirements. However, some drawbacks of Li have lead finding alternatives for Li in rechargeable cells. Among many possible alternative metals that have been studied, Mg presences as a natural choice. However, it is required to find a better combination of electrodes and electrolyte for Mg rechargeable cells. Conducting polymers were identified as promising candidates for cathode materials in rechargeable cells due to their unique features. In this study, the effect of the anion used to dope PPy cathode on the performance of Mg rechargeable cells is reported. The cell structure was Mg as anode/PVdF:PC:EC:MgTF gel polymer electrolyte/PPy cathode doped with different anions. Cells were tested for their cycling ability at different scan rates using Cyclic Voltammetry and continuous charge-discharge tests at different voltages and currents. Open circuit voltages of the cells showed that they are suitable for low power requirements. Results also showed that cells can be cycled over a significant number of cycles without decaying much of the cycling capacity.

**Keywords:** Polypyrrole, Cyclic voltammogram, Continuous charge-discharge

### **1. INTRODUCTION**

The application of conducting polymers for both electrode and electrolyte materials in Li rechargeable cells has generated a lot of interest during the past few years<sup>1, 2</sup>. After many significant research studies, gel polymer electrolytes (GPEs) have been introduced as the electrolyte in Li rechargeable cells which have several advantages over liquid and solid electrolytes, including no shape restrictions, faster charging/discharging, and higher power density<sup>1, 3</sup>. Moreover, many different types of conducting polymers have been widely studied as cathode material for Li rechargeable cells and PPy has drawn more attention due to its



superior electroactivity, good electrical conductivity and chemical stability<sup>2,4</sup>. During the synthesis of PPy, different types of anions were introduced and it has been reported that the dopant anion plays an important role in the performance of Li rechargeable cells and PPy doped with larger anions are more suitable as cathode material<sup>4</sup>. However, the expensiveness, high reactivity, safety issues and environmental effect of disposing of Li has lead find alternatives for Li anode in rechargeable cells<sup>5</sup>. It has been reported that the thermodynamic properties of Mg make it a natural choice for use as an anode material in rechargeable batteries<sup>5</sup>. However, it is required to find a better combination of electrodes and electrolytes for Mg rechargeable cells. In this study, the effect of the doping anion used to dope PPy cathode on the performance of Mg rechargeable cells is reported. The cell structure was Mg as anode/PVdF/PC/EC/MgTF gel polymer electrolyte/PPy cathode doped with different anions.

## 2. EXPERIMENTAL

### 2.1. Preparation of Cathode:

The two anions Dedecylbenzenesulfonate (DBS<sup>-</sup>) and Trifluoromethanesulfonate (TF<sup>-</sup>) were used as dopants. To find the best suitable current density for each type of cathode, PPy/DBS and PPy/TF films were galvanostatically prepared on a Pt wire at current densities 0.25, 0.50, 0.75, 1 mA/cm<sup>2</sup> and characterized using Cyclic Voltammetry (CV) method. Most suitable current density for each type of doping anion was decided by analyzing the capacity of each cyclic voltammogram.

PPy/anion films for cathode electrodes were galvanostatically polymerized on a well-polished stainless steel dice with surface area of 1.095 cm<sup>2</sup>. Thickness of PPy films were maintained at 1 μm. The electrolyte was prepared with 0.1M Pyrrole monomer and 0.05M anion salt with deionized water. SDBS and MgTF were used as the anion salts for PPy/DBS and PPy/TF films respectively. An Ag/AgCl and a Pt electrode were used as reference and counter electrodes in three electrode setup. The current densities 1 mA/cm<sup>2</sup> and 0.25 mA/cm<sup>2</sup> were used for PPy/DBS and PPy/TF films respectively in accordance with the previous results.

### 2.2. Preparation of Electrolyte:

Gel polymer based on Polyvinylidene fluoride (PVdF), MgTF, Ethylene Carbonate (EC) and Propylene Carbonate (PC) was used as the electrolyte. Starting materials were magnetically stirred well and heated at 120 °C for 30 minutes. The hot mixture was pressed in between two

glass plates. Thereby, it was possible to obtain a bubble free thin film. Composition of the GPE was chosen as 0.5 PVdF: 1 EC: 1PC: 0.7 MgTF (by weight).

### 2.3. Fabrication of cells:

The PPy film deposited on the stainless steel dice with diameter 11.81mm was used as the cathode. A circular disc with same diameter as the cathode cut from the gel polymer electrolyte membrane was used as the electrolyte or the separator. Well-cleaned Mg strips were cut to the size of the same diameter served as the anode. The cell configuration was Mg as anode/PVdF: PC: EC: MgTF gel polymer electrolyte/PPy-anion cathode.

### 2.4. Characterization of cells:

First, open circuit voltages of the cells were measured using a digital multimeter. Cyclic voltammetry tests were carried out for the cells in the potential range 0.4 - 1.85 V using a computer controlled potentiostat / galvanostat. Here the PPy electrodes served as the working electrode, Mg was used as both the counter and reference electrodes. Cells were cycled at scan rate of 1mV/s. Thereafter these cells were tested for their ability to withstand continuous charge and discharge cycling. The cells were first galvanostatically discharged to 0.5 V, immediately subjected to a galvanostatic charge up to 2.0 V and maintained at that potential until the desired current (20% of maximum charge current) was reached and then discharged using a computer controlled charge-discharge setup. The maximum charge and discharge currents were set to 25  $\mu$ A.

## 3. RESULTS AND DISCUSSION

### 3.1. PPy on Pt wire with the variation of current density

Cyclic voltammetry studies were done for the films made of PPy/DBS and PPy/TF in Pt wire at different current densities. Cyclic voltammograms obtained for PPy/DBS and PPy/TF films at scan rate 10 mV/s are given in Figure 1.

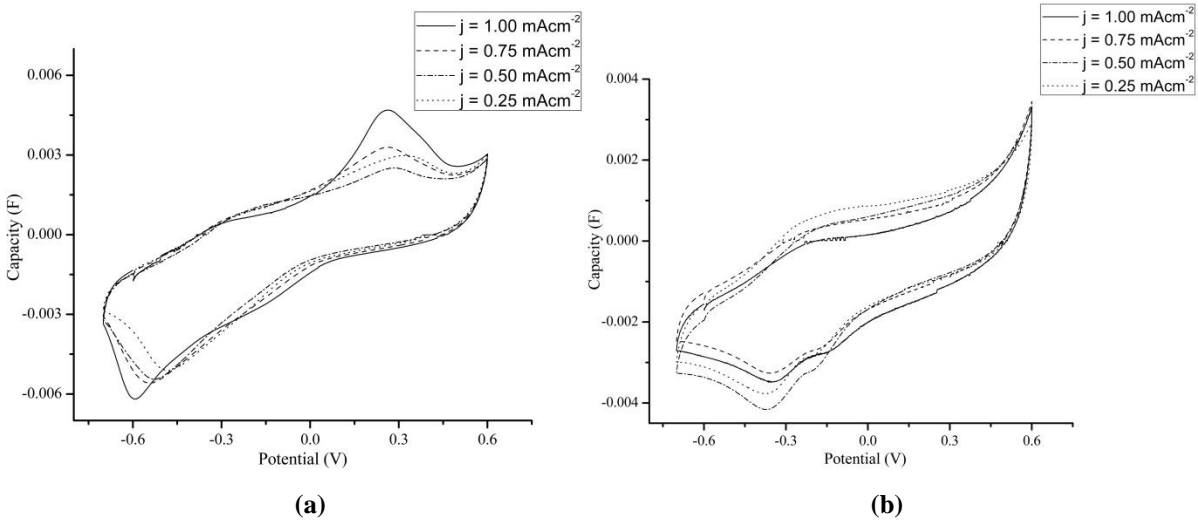


Figure 1: Cyclic voltammograms obtained for 0.25µm polymer films on Pt wire at different current densities. Scan rate 10mV/s (a) PPy/DBS, (b) PPy/TF

According to Figure.1 (a) PPy/DBS film prepared at current density 1mA/cm<sup>2</sup> exhibits the largest capacity of cyclic voltammogram. It was noted that the capacity of cyclic voltammogram reduces with the current density for films made of PPy/DBS. In contrast, according to Figure.1 (b) the capacity of the cyclic voltammogram grows when the current density reduces for PPy/TF films. Thus PPy/TF film prepared at current density 0.25mA/cm<sup>2</sup> exhibits the largest cyclic voltammogram capacity. However it was found that films made of PPy/DBS and PPy/TF exhibit the largest capacity of cyclic voltammogram at current densities 1.00mA/cm<sup>2</sup> and 0.75mA/cm<sup>2</sup> respectively.

### 3.2. Results of cells with the configuration of Mg/gel polymer electrolyte / PPy-anion

The open circuit voltages (OCV) of the two types of cells are shown in Table 1.

Table 1: OCV obtained for cells made of PPy/DBS and PPy/TF

Cell configuration	OCV / V	
	Cell 1	Cell 2
Mg/gel polymer/PPy:DBS	1.648	1.580
Mg/gel polymer/Ppy:TF	1.814	1.791

The resulting cyclic voltammograms for cells having PPy: X (DBS<sup>-</sup>/TF<sup>-</sup>) electrodes of 1 µm thickness are shown in Figure.2.

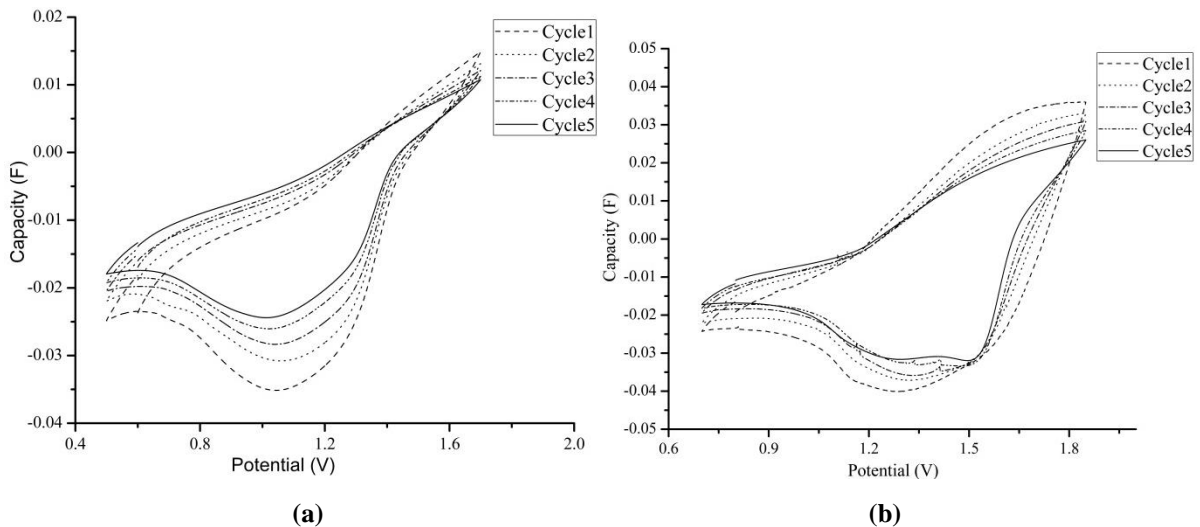


Figure 2: Cyclic voltammograms obtained for the cells with the configuration Mg / PVdF:EC:PC:MgTF / PPy:X. X: (a) DBS<sup>-</sup> ; (b) TF<sup>-</sup> varying the cycling number. Scan rate 1 mVs<sup>-1</sup>

The cathodic peak (negative current) of the cyclic voltammogram is assigned to the reduction and the anodic peak (positive current) is assigned to the oxidation at which redox reactions of the cells at charging (oxidation) and discharging (reduction) take place. If the reactions are fully reversible, the ion insertion and desertion to the cathode during charging and discharging occurs at identical potentials at each cycle. Hence, the corresponding peaks should appear at the same potential values resulting zero peak separation<sup>5</sup>. Here the cathodic peaks appeared well but anodic peaks were not very dominant. However, the peak separations in both cells are very smaller. The amount of charge available during the cell reactions exhibits from the area of the cyclic voltammograms<sup>4</sup>. Available charge seems to reduce upon cycling since the areas of the curves tend to decrease with increasing cycle number. It may be because upon cycling, the cell reactions may not complete fully, due to formation of passivation layers and corrosion of electrodes. The amount of charge available during the cell reactions were calculated from the area of the cyclic voltammograms. They are given in the Table 2 below.

Table 2: Charge associated in the cycling of the cells with respect to cycle number

Cycle Number	Charge / C	
	PPy/DBS	PPy/TF
1	0.017	0.036
2	0.015	0.031
3	0.014	0.028
4	0.013	0.026
5	0.012	0.025

Available charge seems to reduce upon cycling in both cells. Further, the amount of charging reduction seems to be getting reduced with the increasing cycle number. It was also noted that the charge of PPy/TF cell is about two times of PPy/DBS cell.

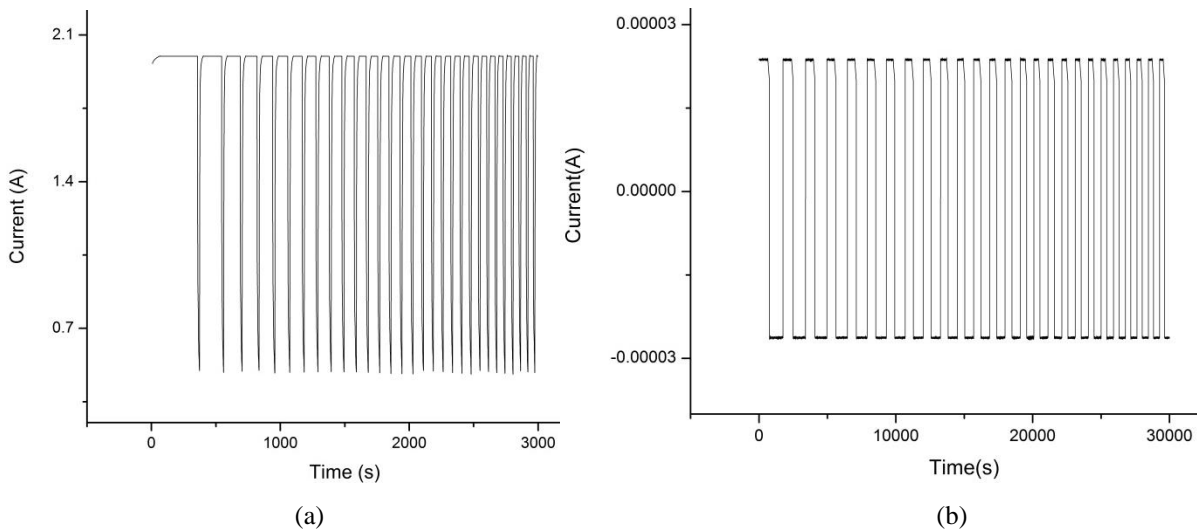


Figure 3: Continuous charge-discharge curve of the cell Mg/PVdF:EC:PC:MgTF/PPy:X with respect to time X: (a) DBS<sup>-</sup>, (b) TF<sup>-</sup>

Both cells could be continuously charge-discharge for over 60 cycles (it was limited because of the time constrain). Capacity variations with cycle no are shown in Figure 4.

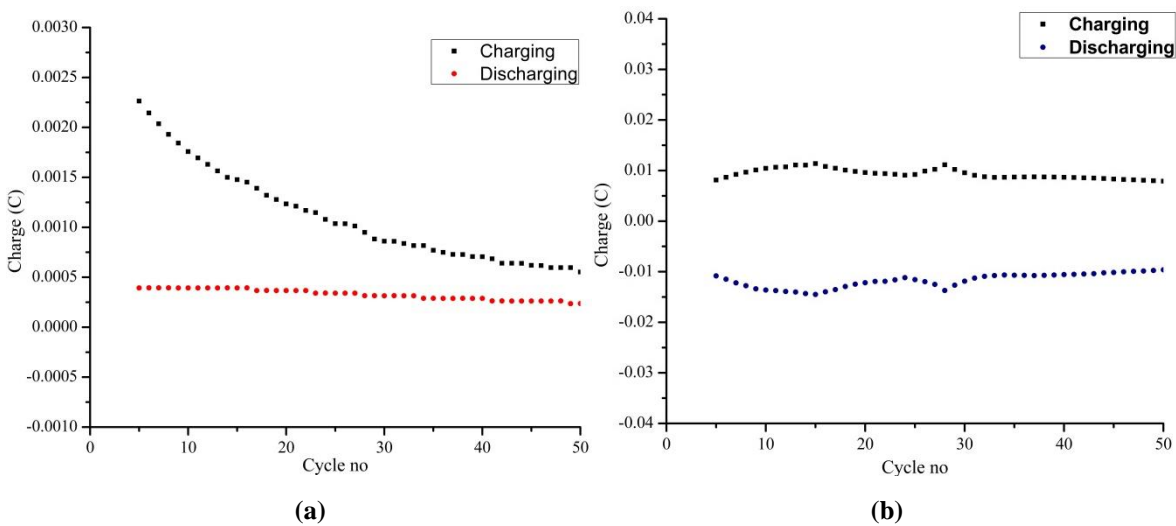


Figure 4: Capacity variation with cycle number for cells with PPy:X as cathode. X: (a) DBS<sup>-</sup>, (b) TF<sup>-</sup>

#### 4.0 CONCLUSION

Even though this is a preliminary study, the results predict the possibility of fabricating non Li cells for applications. Mg rechargeable cells with appreciable performances could be fabricated using PVdF:EC:PC:MgTF gel polymer electrolyte and PPy doped with DBS<sup>-</sup> or TF<sup>-</sup> as cathode materials with open circuit voltage around 1.6V and 1.8V respectively.

## ACKNOWLEDGEMENTS

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## LOW COST CAR PARKING MANAGEMENT SYSTEM WITH IMAGE ANALYSIS AND RFID TECHNOLOGY

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### ABSTRACT

Finding an unoccupied parking space in larger car park in a busy environment is a problem for many drivers. Even though, during last four decades, many vehicle parking models were introduced, still the models cannot solve vehicle parking problem satisfactorily. Due to unsatisfactory issues deal with parking systems such as improper (untidy) vehicle parking, insufficient care of security issues and safety aspects of vehicles, improper guidance to available slots in a semi-automated system, it is an essential issue to develop an enhanced system expressed under our topic. In some commercially available systems unavoidable, time consuming errors still exists. Some of the systems are care about security issues but not to give proper guidance to drivers. Some of the systems can give proper guidance to drivers but those systems are not designed to care about security issues. The study was carried out to find a peaceable solution for such issues. Thus, primarily aim of this study is to develop a car parking system which is able to care about both security issues and proper guidance to the drivers at the same time. The developed system is specially designed to use in urban private parking areas and only authenticated vehicles are allowed to enter the parking areas. The system is based on Arduino technology and the identification part is developed using image processing and RFID technologies. Both IN and OUT gates are controlled by servo motors. The display installed near to the main gate shows vehicle owner's name and ID after authentication. If the authentication is failed then the display shows "Unauthorized Access" message.

**Keywords:** Image processing techniques, Image feature extraction/Identification, Arduino development board, Car parking managements

### 1. INTRODUCTION

Time and cost are two important factors of human life, whether for an individual or a business organization. As quality of life increases, more and more people are inhabiting to commercial cities. Urban life requires centralized private facilities. With the population



growth and modernization with time, easily accessible and fully automated private parking places are becoming very important aspect as well a time saving attraction for company workers.

Among the various types of parking lots available in literature, multilevel parking, roadside, roadside with ticket and barrier gate and roadside with parking meter, the multilevel parking lot is the most preferred one for the patrons. Efficiency, low cost, safety, proximity, respectively are the main factors effect on patrons who are willing to choose a specific parking lot. Providing sufficient easily accessible parking spaces for workers is a complex issue in most of the urban company complexes. Offering automated and efficient parking lots with a sufficient number of spaces in urban areas as well as paying attention for handicapped drivers are a few of the factors which can be used to increase efficiency of workers and increase the security of company premises.<sup>2</sup>

The developed system is enabled to authenticate vehicles by using image processing technology and RFID technology<sup>1</sup>. After the completion of the authentication, the main LCD display installed near to the main gate shows vehicle owner’s name and identity while allowing them to enter the car park. Before entering vehicle to the park, the system also automatically guides drivers about available parking spaces.

## 2.0 EXPERIMENTAL

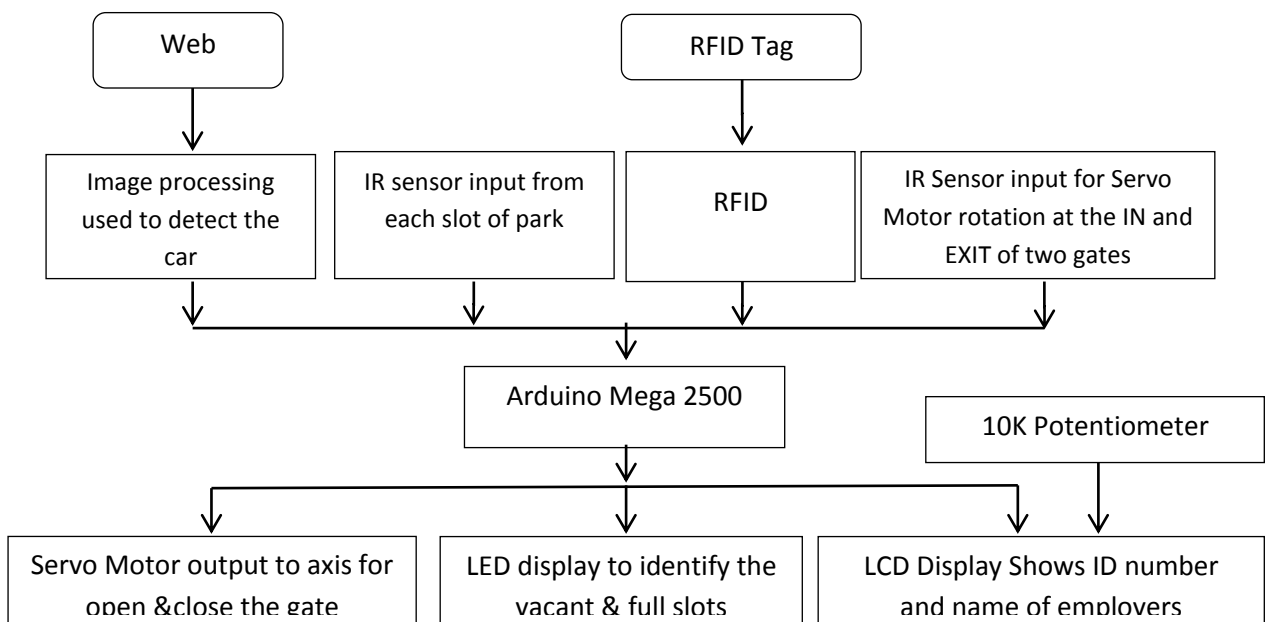


Figure 1: Block diagram of the car parking management System.

The simulated block diagram of the parking system is shown in figure 01. The RFID reader was connected to the Arduino Mega using pin 18, 19 to receive RFID tag input through serial monitoring. Arduino Mega was programmed using C language. Output of RFID reader was displayed in both serial monitor display of Arduino and LCD display. LCD display was used to show both name and tag ID of person has reached to entrance of the parking management system. Web camera output through the image processing was used to identify the vehicle reaching. The OpenCV software was used for image analysis. IR sensors were connected to Arduino mega using pin 2, 3, 4, 5, 6, 7 to get inputs and they were displayed in LED display. LED display has two colors of LEDs, they were green if vacant places are available and were red if the car park is full. IR sensors also used in entrance and exit point of gates.<sup>3</sup> Those IR Sensors were connected to Arduino mega using pin 23, 24. Servo motors were connected to pin 9, 10 of Arduino Mega and it was powered using Output of Arduino.

The PCB design of the developed system is shown in figure 02. The sketch was developed using proteus 8 Professional IDE.

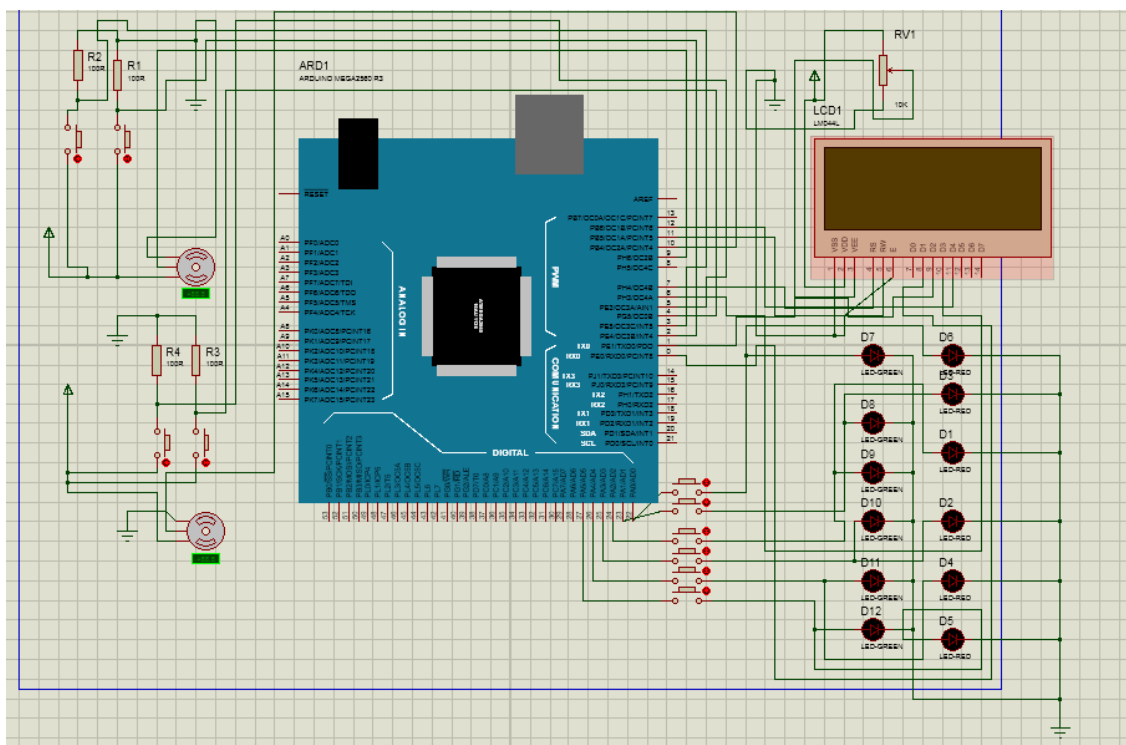


Figure 2: PCB design of Car Parking management System

### 3. RESULT AND DISCUSSION

Identification results were displayed on LCD as the tag ID number and name of employers with the use of function serial monitoring. LCD and the serial monitoring results were represented as in figure 03, 04 respectively. IR sensors were used to identify the vacant slots. LED's were represented the result of availability of slots. RFID reader is used to read the RFID tag as shown in figure5. Servo motor controlling was used as a purpose of opening and closing the gate.

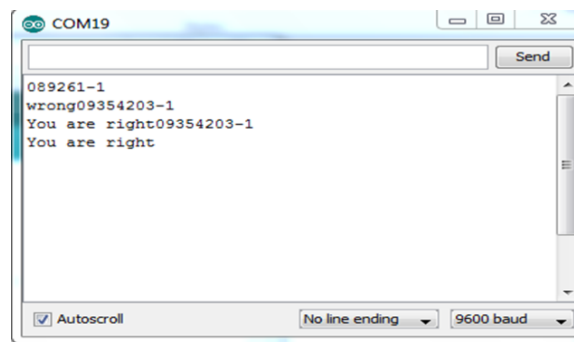


Figure 3: Serial monitor window



Figure 4: LCD display resulting message



Figure 5: RFID reader and tag

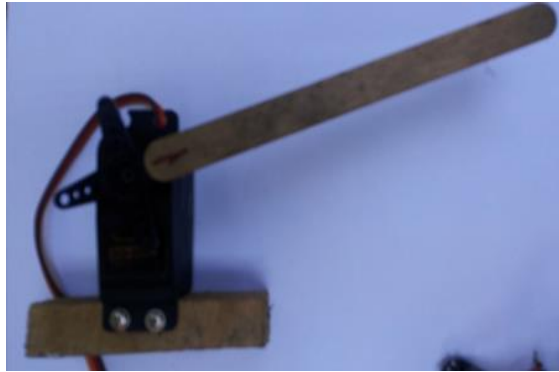


Figure 6: Servo motor controlled gate

Here, IR sensors were used for detecting the vacant and full slots of the car parking system. Arduino Mega was used as the main development board to control system of the parking management system<sup>5</sup>. IR sensors were also used to activate the rotation of the servo motors. RFID reader was used to read RFID tag using serial monitoring, it could read the 4 byte number in four times and it was displayed on the serial monitor window.

#### **4. CONCLUSION**

The main goal of this project was to design and implement a low cost car parking management system using image analysis techniques and RFID technology. The developed system can function to guide vehicles to available slots and it also enables to do the authentication part by using RFID and image processing technologies. The IR sensors used in the system can detect available vehicle slots. If the project need to be developed as an industrial application, only the IR sensors should be replaced by proximity or Industrial IR sensors. Using these sensors, the sensitive range of detection can be enhanced. All the coding of the project was written by using C language.

#### **ACKNOWLEDGMENT**

Authors would like to express thank to workers who have helped for the successful completion of the system.

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## CUSTOMIZABLE LED DISPLAY EDITOR USING ARDUINO

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### ABSTRACT

Advertising has been a major tactic in the modern world industries. Among many of the ways used to advertise, using LED name boards has been a very popular advertising made in the past few decades. Current LED name boards are programmed with specific programmers and specific software. They are somewhat troublesome to edit. This study suggests a simple programmer with tiny Arduino Uno development board and a PS/2 keyboard. The proposed prototype is done with an LCD character display with the intention to extend the study to a LED name board. The specialty of the proposed prototype device is that the message displayed on the display can be interrupted and paused at any time and then the required new message to be displayed can be entered on the screen without the use of bulky PCs. After that the device can resume the display with displaying the newly entered message. Every time we enter a new message, the EEPROM of the Arduino Uno's microcontroller is modified.

**Keywords:** Electrically Erasable Programmable Read Only Memory (EEPROM), LED name boards, character LCD modifying simple system

### 1. INTRODUCTION

LED name boards are vastly used for advertising in present days. People have turned to LED name boards because the existing traditional advertising boards have some constraints with the advertising space, amount of the information conveyable at a single time using a single advertising board, uniformity of the messages displayed and etc. Therefore people tend to use LED name boards in advertising.

#### 1.1 Existing Devices

The existing LED name boards are widely used to display a single set of messages. They are programmed for the first time and then established them in the required place to do the

required job. After that, the things displayed are could not be edited. That might be due to the unavailability of the programming software or the difficulty in reaching the places where the LED name board has been established. These commercially produced LED name boards come with a sealed container.

### 1.2 Significance of the Study

Nowadays super markets use LED name boards to display their products and the prices of them, passenger buses use LED name boards to convey their routes; their starting point and the destination with the cities via they reach the destination. The prices of the products might be changed regularly; the bus routes might be changed specially in CTB and private buses. Then those people have to frequently change the messages displayed. There may not be computers (PCs or laptops) at those places; they may not have the special software to programme. Then comes the importance of a simple portable programmer.

In this study, there are only a keyboard, Arduino Uno and a character LCD (for the prototype). Keyboard is there to interrupt the currently displaying message and to input the new message to be displayed, microcontroller in the Arduino Uno (AtMega 328) controls the displaying message and the EEPROM of the microcontroller<sup>(1)</sup> (has 1KB memory<sup>(2)</sup>) stores the new text or alpha numeric input and the LCD is to display the messages.

## 2. EXPERIMENTAL

### 2.1 Block Diagram of the proposed Device

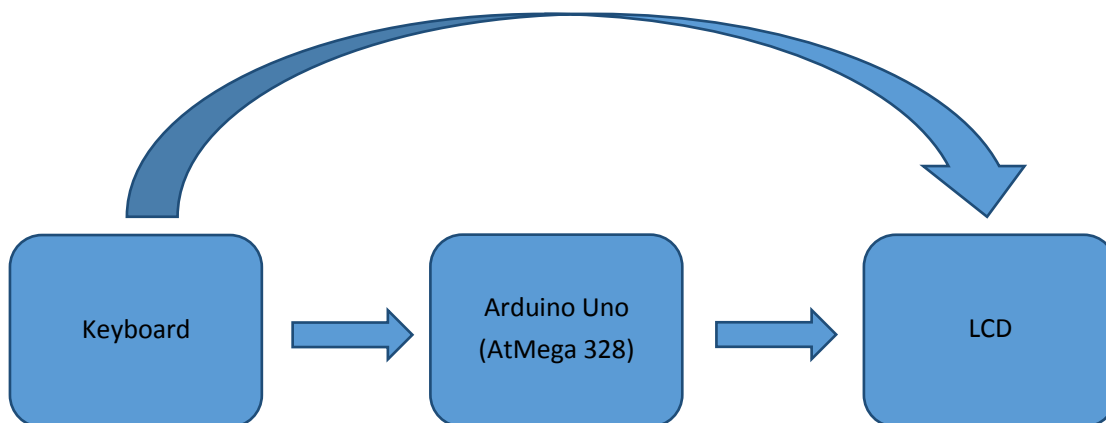


Figure1: Block diagram of the proposed device

The LCDs can display characters<sup>(3)</sup>. Here, the LCDdisplay does 2 types of things,

- i) The patterns with messages

ii) Instructions and the keyboard inputs

The EEPROM of the microcontroller is modified with the new message each time we enter a new message.

## 2.2 Functional Flow of the Device

At a time a certain message is displayed on the LCD, “Esc” key of the key board is pressed. At that time, the programme is set to an edit mode. There some instructions are given to:

- i) select a pattern to be displayed
- ii) enter the new message to be displayed

After entering the message, press “Shift+Enter” keys to save the new message to the EEPROM and restart the device. Then the new message is displayed in the selected pattern.

## 2.3 Hardware Platform and Programming

First, the Arduino Uno was interfaced with the LCD and then codes were written for some character display patterns. Codes for patterns were written using character wise operations. After that, a PS/2 keyboard was interfaced with the LCD through Arduino Uno and directly communicated with the LCD and given inputs were displayed. The microcontroller takes the new input message character wise. Then programme save the message in the EEPROM of the microcontroller. Now, the earlier values on the EEPROM are replaced with the new values. Then, after exiting from the edit mode, the new message is displayed as per the coding of the patterns.

## 3. RESULTS AND DISCUSSION

When a new message is entered according to the given instructions, the newly input message was started to display after saving the newly input message and restart the device.

Only few patterns were added.

This programmer is ideal for places such as super markets and buses where the messages have to be edited and changed regularly with low resources and within low time.

### 3.1 Further Development

Here, only the prototype was built. A simple programmer for the real situation can be built by making a LED display with LEDs connected each other with shift registers and current sinkers so that the each and every LED could be controlled separately. With the LCD screen



still there, the editing sequence can be monitored with it. For that, only have to interface the LED board with the Arduino Uno is sufficient.

#### **4. CONCLUSION**

The study suggests an ideal and a practical device to programme the LED name boards without facing much trouble. Advantages are; no need of bulky computers, no need of special software for programming. This device can be used in super markets, buses and other places where the editing of the LED name boards has to be done regularly.

#### **ACKNOWLEDGEMENTS**

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## V-I CHARACTERISTIC CURVE PLOTTER FOR POTENTIOSTAT

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### ABSTRACT

We use potentiostat for measuring characteristics of various materials, or to observe current values according to changing voltage values. The current and the potential cannot be controlled simultaneously, and we must choose which experimental variable is to be controlled. In voltammetry, the potential of an electrode is the controlled variable while the current is the observed variable. As voltammetric methods are more popular than galvanostatic methods, the focus of this work is on voltammetry. This project describes the way that readings are obtained from a potentiostat. It is developed for doing potentiometric work in an easy way. The PIC18F452 was used to read the output signal from the potentiostat and to process data. Produced data were sent to the computer through a Transistor-Transistor-Logic (TTL) module. The input data to the computer from the TTL module was processed by a computer program written in Java programming language and a comma separated values (CSV) file was generated as the final output of the system. Using the D-plot software the voltage vs. current graph can be plotted manually.

**Keywords:** potentiostat, V-I plotter

### 1. INTRODUCTION

Most students in an instrumental analysis course are already familiar with basic electrochemical concepts as taught to them in a high school or introductory college level chemistry course. They have already been exposed to half reactions, formal potentials, reference electrodes, the Nernst equation, free energy calculations, and simple dual electrode cells. Most of the calculations that students have performed in these early courses deal with the subject of potentiometric.

The basic function of a potentiostat is to maintain the potential of a working electrode (WE) at a desired fixed value or to control that potential under a defined functional variation with respect to a reference electrode (RE).

This potential should be maintained or controlled regardless of any fluctuations of electrolytic current, solution resistance, temperature, or other factors. The potential ( $V_{WE-RE}$ ) of WE is measured against RE when RE is placed very near to WE via an apparatus such as a lugging capillary. A desired potential is preset into the potential control circuit.  $V_{WE-RE}$  is then read and balanced against this preset potential. The difference or error signal is fed back into the control amplifier. The resultant control signal varies the output of the power amplifier (counter electrode, CE) as necessary to maintain the preset potential. Because of the extremely high input impedance (more than  $10^{11}$  ohms) of the electrometer, which is built in to sense the potential of the reference electrode(RE), essentially no current is drawn through RE, and its potential remains stable.

The principle function of a potentiostat is to control potential and measure current. The conventional three-electrode potentiostat is connected to the working, reference, and auxiliary electrodes immersed in the test solution. It controls the potential of the working electrode with respect to the reference electrode while simultaneously measuring the current flowing between the working electrode and the auxiliary electrode. Note that the potentiostat's internal feedback circuits prevent all but a very small current from flowing between the working and reference electrodes.

The potential of working electrode is maintained independently of the other and with respect to the reference electrode. Only an insignificant current flows through the reference electrode. Because the very basis of voltammetry is the control of electrode potential, a function generator is required to provide the potential sweep or pulse sequence to be applied to the working electrode. Most modern potentiostats include a built-in sweep and/or pulse generator, and those which are interfaced to a computer usually rely on the computer to generate the desired waveform. But those modern potentiostat devices are very expensive. An external function generator can also be used by connecting its output to an input on the potentiostat. This latter option is used with potentiostats that have no internal sweep/pulse generator or whenever highly specialized waveforms are required.

The voltage and the current signals can be obtained from the potentiostat as its basic output signals. The PIC18F452 was used to Read those output signal from the potentiostat and to analog to digital conversion. Produced data were sent to the computer through a Transistor-Transistor-Logic (TTL) module. The input data to the computer from the TTL module was processed by a computer program written in Java programming language and a comma separated values (CSV) file was generated as the final output of the system. Using the D-plot software the voltage vs. current graph can be plotted manually. Developed system can be controlled by two push button by selecting auto and manual operations. LCD display was used to show the produced data.

## 2. EXPERIMENTAL

### 2.1 Data Acquisition unit

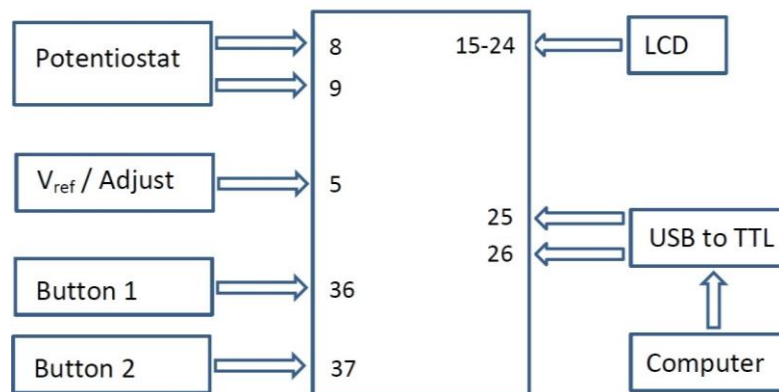


Figure 1: Functional block diagram of the system

PIC microcontroller is used here to convert analogue voltage to digital. The potentiostat output pins are connected to pin number 8 and 9 of the PIC. Then the analogue values are compare with the reference voltage that was given by user. Here I used reference voltage to increase the resolution of the final output. Reference voltage is connected to pin number 5 of the PIC. Finally the digitalized values are send via 25 and 26 pin of the PIC to USB to TTL module. The calculation used in the PIC microcontroller to calculate voltage value are below.

$$\text{Reference Voltage (V}_{\text{ref}}) = \text{Analogue reading of the pin 5}/1023 \dots \dots \dots (1)$$

$$\text{Input Voltage (V)} = (\text{Analogue reading} / 1023) * \text{V}_{\text{ref}} \dots \dots \dots (2)$$

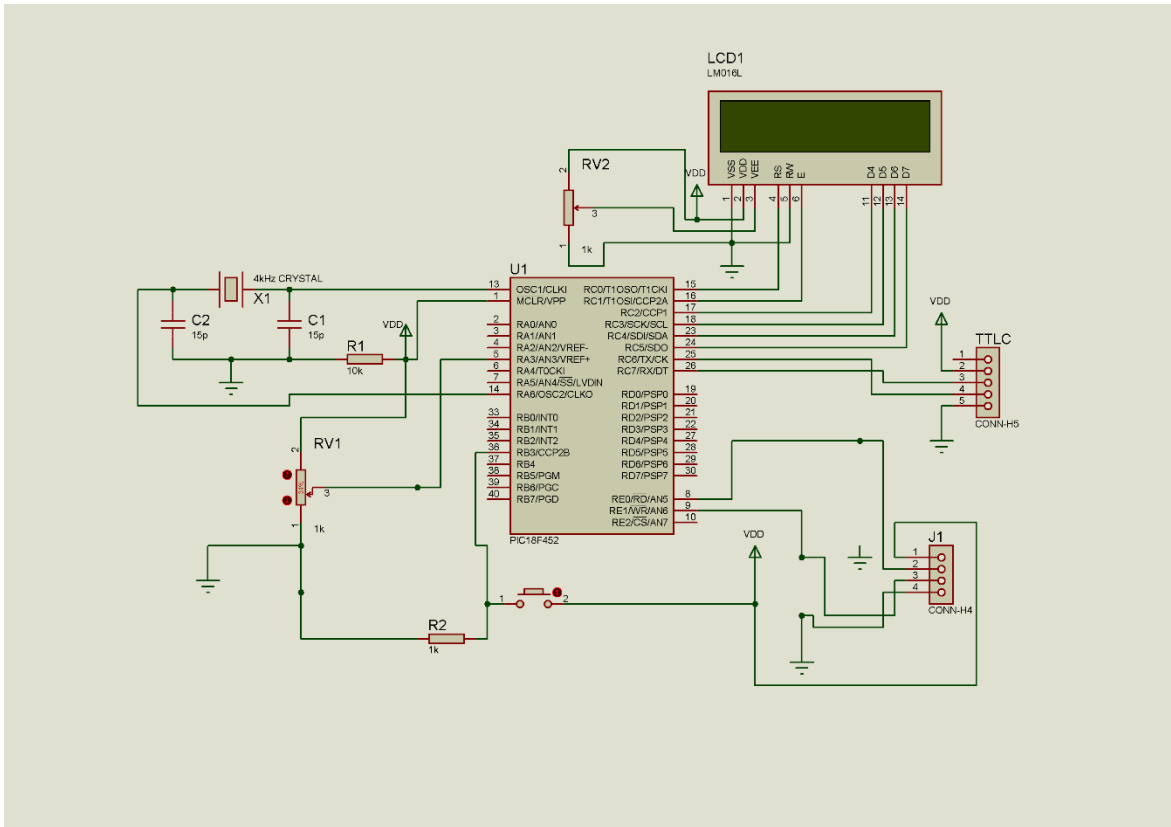


Figure 2: Design of the system

### 2.2 Programming the PIC 18F452

A simple program was written in microC compiler for proper analog to digital conversion (ADC) and to send RX/TX data serial to USB-to-TTL converter module. The program was compiled to make HEX file. The generated HEX file was programmed to the PIC 18F452 microcontroller using PICKIT2 programmer. Flow chart of the PIC program is shown in figure 3.

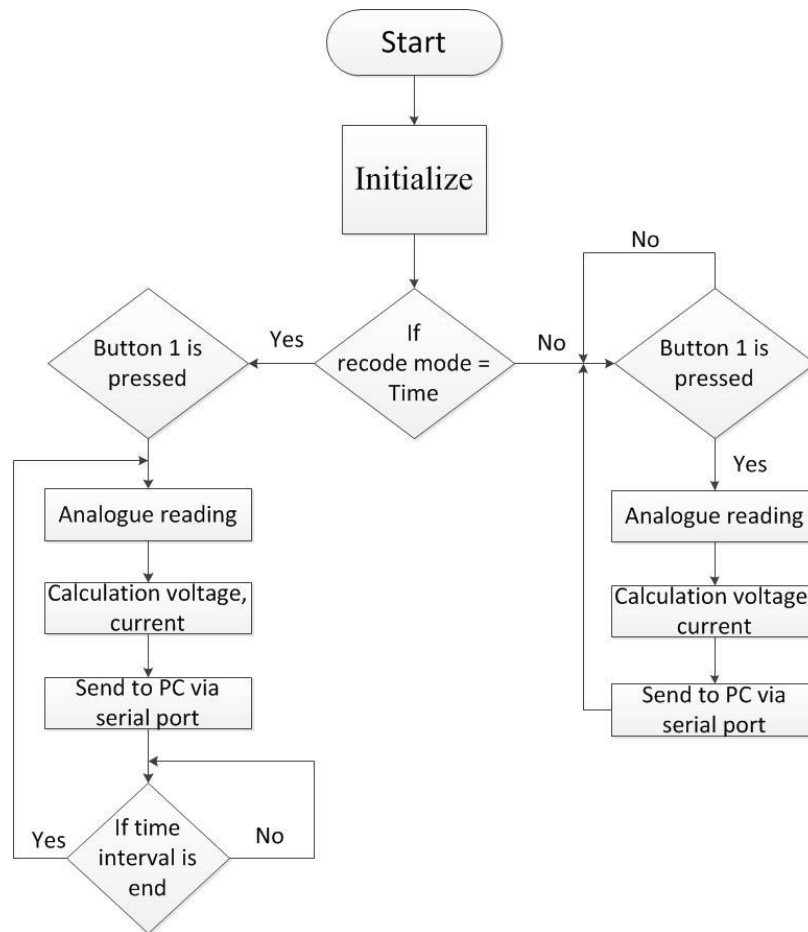


Figure 3: Flow chart of the PIC program

### 3. RESULTS AND DISCUSSION

The features of cost effectiveness, better data acquisition and compatibility with PCs and laptops were prioritized. This system has been design using PIC18F452 microcontroller for monitoring the varying signals. Microcontroller send the data to PC or laptop and by using program that convert the data in to text file which contains x y coordinates separately. The processed data are collected to a comma separated values (CSV) file for each predefined time intervals. These time intervals can be changed to 100ms, 200ms, 300ms, 400ms, 500ms and 1s.

The accuracy of the system is about 90% when considering the ADC. An observed VI characteristic graph is shown in figure 4.

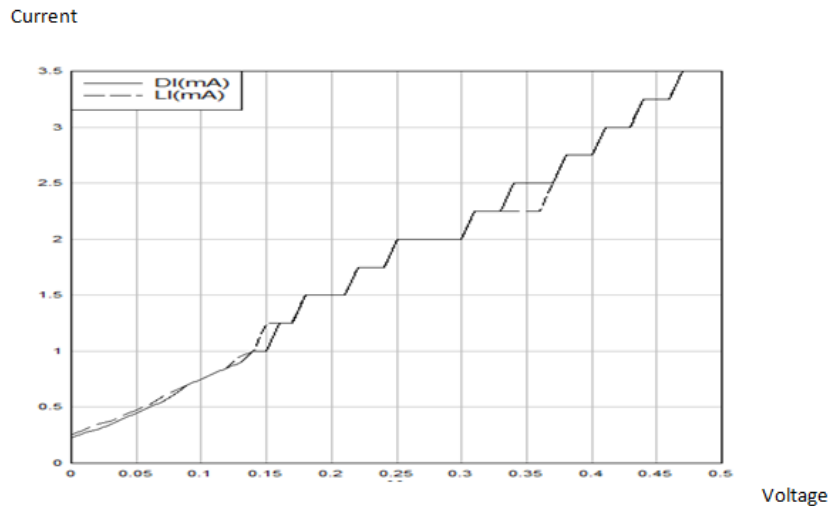


Figure 4: Observed VI characteristic graph

Time variations provided is not much accurate since there is no direct way to generate accurate time delays. ADC is not accurate since the ADC was done only using a PIC18F452 microcontroller. The developed system can be future improved by using self-calibration ADC integrated circuit like ADC1241. Another drawback of the system is VI characteristics on negative voltages cannot be observed using the developed system.

#### 4. CONCLUSION

The design is a low cost, simple and compatible to PCs and laptops, as USB port is very common these days. This will be very useful in research and practical laboratories when acquisition of number of observation is high. Also help to measuring, monitoring and graphical representation of data. It can also be developed with more features.

#### ACKNOWLEDGEMENTS

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