DESIGN AND CONSTRUCTION OF AN AUTOMATED STREET LIGHTING SYSTEM

By

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15PCJ01023

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HND (Computer Engineering) (Owo)

15PCJ01023

A PROJECT SUBMITTED TO THE SCHOOL OF POST GRADUATE STUDIES OF COVENANT UNIVERSITY, OTA, OGUN STATE NIGERIA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF POST GRADUATE DIPLOMA (PGD) DEGREE IN COMPUTER ENGINEERING, IN THE DEPARTMENT OF ELECTRICAL AND INFORMATION ENGINEERING, COLLEGE OF ENGINEERING, COVENANT UNIVERSITY, OTA, NIGERIA.

SUPERVISOR

DR. ISAAC SAMUEL

MAY, 2018

ACCEPTANCE

This is to attest that this Project is accepted in partial fulfilment of the requirement for the award of the degree of **Post Graduate Diploma (PGD) Degree in Computer**

Engineering in the Department of **Electrical and Information Engineering**, College of Engineering, Covenant University, Ota, Nigeria.

Philip John Ainwkhai   ..………………

Secretary, School of Postgraduate Studies   **Signature & Date**

Prof. Samuel Wara   ..…………..……

Dean, School of Postgraduate Studies   **Signature & Date**

DECLARATION

I hereby declare that I carried out the work reported in this Project in the Department of

Electrical & Information Engineering, Covenant University, under the supervision of Dr. Isaac Samuel. I also solemnly declare that to the best of my knowledge, no part of this Thesis has been submitted here or elsewhere in a previous application for the award of a degree. All sources of knowledge used have been duly acknowledged.

AWODEYI, AFOLABI IFEDAYO

(15PCJ01023)

CERTIFICATION

This is to certify that this Project titled "Design and Construction of an Automated Street Lighting System" is an original work carried out by AWODEYI, Afolabi Ifedayo (15PCJ01023), in the Department of Electrical and Information Engineering, College of Engineering, Covenant University, Ota, Ogun State, Nigeria, under the supervision of Dr. Isaac Samuel

Dr. Isaac Samuel   **...………………**

   Supervisor   **Signature & Date**

Dr. Victor Matthews   **...…………..……**

Head of Department   **Signature & Date**

DEDICATION

This project is dedicated to God Almighty for his faithfulness, love, and Grace towards me and to my parents Mrs Veronica Ebunoluwa Awodeyi and Professor Amos Fola Awodeyi for making sure I get the best Education.

ACKNOWLEDGEMENT

All thanks are due to Almighty God, the Lord of the universe, the only source of knowledge, for his divine inspiration and grace that guided me throughout the writing of this project. I am thankful to the Chancellor of Covenant University, Dr. David Oyedepo whose vision to establish this University has provided me the opportunity to embark on the Post Graduate Diploma (PGD) Programme.

My gratitude goes to my supervisor, Dr. Isaac Samuel who inspired me to work harder through his help and support throughout this project. I am also thankful to my Head of Department Dr. Victor Matthews for making his M2M and Embedded Systems Laboratory available for me to carry out my research work and the prototype building. I am also thankful to Mr. Akindele Ayoola, the M2M laboratory Research Technologist who has been always there to listen and give advice that helped me focus my ideas and further improve the quality of the work. I must not fail to acknowledge the encouragement of my lecturers at some point; Dr. Ndijuiba Charles, Dr. Badejo Joke, Professor Adetiba Emmanuel, Dr. Orovwode Hope, Professor Idachaba Francis, Professor Adoghe Anthony, Dr. Awelewa Ayokunle, Dr. Abdulkareem Ademola, Mr Omoruyi Odewingie, Dr. Daramola Adebayo, Dr. Agboje Oboyerulu and others whom I have not mentioned here.

Most importantly, none of this would have been possible without the love, patience, moral and financial support of my parents; Professor Amos and Mrs. Veronica Awodeyi. Thank you all and God bless.

ABSTRACT

This Project report presents details of the design and construction of a microcontroller-based automated intelligent street lighting system. The circuits are designed specifically for self-intelligence and fault detection of the system.

The street light system consists of two circuit boards; the main printed circuit boards and the street light pole printed circuit board.

The major components of the main printed circuit board are PIC microcontroller, GSM module, voltage translator, multiplexer integrated circuit, resistors, and capacitors, while the major components of the street light pole circuits are the light dependent resistor circuit sensors, infrared sensors, PIC microcontroller, capacitor and resistors.

The Light Dependent Resistor is used for Automation, the Infrared sensor is used for Intelligence; sensing movement and taking the LEDs to a full ON state and the GSM module for fault detection.

The Printed Circuit Board circuits and their components are housed in its physical framework. The circuit for the main board and the circuit for the street light pole were tested and worked properly as intended.

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

LDR   Light Dependent Resistor

IR   Infrared Resistor

I/O   Input / Output

RX   Receive

RXD   Receive Data

TX   Transmit

TXD   Transmit Data

MCU   Microcontroller Unit

PIC   Peripheral Interface Controller/Programmable Interface
               Controller/Programmable Integrated Circuit

IC   Integrated Circuit

PCB   Printed Circuit Board

CHAPTER ONE

INTRODUCTION

1.1 Introduction

A well-outlined street lighting system allows road users move around freely in the evening with great visibility, in well-being and comfort and improve the presence of the area. Lighting framework that is inadequately composed can prompt poor visibility which is not useful for any person on foot or driver. Regularly road lighting is ineffectively designed and not appropriately maintained which suggests that there are a substantial number of flawed and dead lights and uses out of date lighting innovation which expends a lot of vitality and monetary assets. Provision of street lighting is a standout amongst the essential duties of a city.

Automated Street lighting System is fundamentally utilized as a proficient method for power conservation and maintenance cost. Light Dependent Resistors are attached to the circuits for the LEDs. When the LEDs come ON, the GSM module reports status of faults

to the control centre. With this set up in place, the worker now can without much of a stretch find the specific light to be taken care which limits search and repair time.

This Project makes utilization of an LDR sensor which detects light to go to an ON state, IR sensor which detects movement variations and takes the LED to a FULL ON and when idle takes the LED to a HALF ON state. The current sensors report issues to the Microcontroller which at that point sends a message to an assigned GSM number/control unit. This street lighting system is a vital method for increasing street wellbeing around evening time. It enhances the personal satisfaction by preventing wrongdoing and makes individuals feel safe. Lighting is used for enhancing the environment; this is monetarily advantageous for the environment.

1.2 Aim

The Project aims to Design and Construct an automated Intelligent Street Lighting system based PIC Microcontroller.

1.3 Objectives

The following objectives to achieve this aim are itemized:

- To design the main circuit board for the street light main board where all operations are carried out, such as: Controlling the activities of the street light PCB, Communications between the PIC microcontroller and the GSM module, Sending fault detection messages to an assigned GSM number, Communications between the PIC microcontroller and the circuit board for the street light poles.

- To design a circuit board for the street light poles where the operations for the street light module are carried out, such as: Automation of the LED through the use of the LDR sensor, Dimming of the LED through the use of the IR sensor

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1.4 Statement of problem

It is very unfortunate that despite the fact that Nigeria enjoys a large amount of sunlight in most of her cities throughout the year, our streets are still in darkness as a result of poor electricity supply. This deprives the country of some economic activities that can take place at night, such as ornamental beauty of our streets and hence exposes her people to danger and other nefarious activities

1.5 Motivation

- Power Conservation: Power is conserved for the street lighting when the LEDs are at a dim state.

- Automated Operation: the street lighting system is automated hence LEDs switches ON/DIM/OF

- Real time fault detection/instant maintenance: Fault is detected through the use of a GSM module which sends fault detection messages to a control centre stating location of faulty LED hence immediate maintenance.

- Intelligence: the street light has the ability to the ability to switch ON/DIM/OFF without human intervention.

1.6 Methodology

The primary phase of this project begins from writing a literature Review of various automatic street lighting systems and how the street lighting system and various types of sensors are integrated.

The following stage is the research on various street lighting control systems which is summarized for simplicity and understanding of the concept of the system.

The design of the system is carried out with a PIC microcontroller. This project will make use of components such as PIC18F26K22 microcontroller for coordinating the activities of the system, IR sensor for dimming the LEDs, LDR sensors for automation and a GSM module for fault detection identification. A model of this project is constructed and tested.

1.7 Thesis Organization

The organization of this project report is stated as follows;

Chapter 1 gives the general introduction of the work, statement of problem, aim and objectives, motivation and methodology

Chapter 2 gives a review of the project; lighting, microcontrollers, overview of components and literature review of previous works, critically analyzing them

Chapter 3 gives a detailed description of the system design detailing the circuit diagram for the system design, system design components, their working description and circuits

Chapter 4 gives details of the implementation of the project and results obtained. The results are also compared to some selected previous researches

Chapter 5 gives discussions, conclusions, and recommendation for the development of the project in the near future.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This Chapter gives an introduction to the overview of components used for this Project; microcontrollers and its advantages, PIC microcontrollers, types of programmable integrated circuits, Light Dependent Resistors, Infrared sensor and a Review of Previous Works on Street Lighting System.

Automated Street Lighting system efficiently controls wastage of power and turns ON and OFF. The system utilizes two sensors. These are the LDR and IR. The sensors are placed inside the street light which is controlled by the PIC18F26K22 microcontroller. The system is designed based on a system technique which entails that there is fault detection with the end goal that when a street light is bad, a message is sent to a designated number or to a designated control unit. The system is fundamentally comprised of GSM module, Relay switch, LED, Power Supply. The system architecture comprising of all the components is shown in figure 2.1.

Figure 2.1 System Architecture

2.2 Microcontroller

Microcontrollers are common components found in electronic systems. It is utilized to the point that it is practically difficult to work in hardware without its utilization. A microcontroller integrates a number of microprocessor components into a single microchip. Microcontroller is a type of microprocessor which emphasizes on self-sufficiency and viability of cost. Microcontrollers contain memory and interfaces for input and output. A microcontroller has the following; [33] a central processing unit,

memory, input and output. Microcontrollers also combines the following; timer module which allows the microcontroller perform task within a certain time period, a serial port for input and output to enable flow of data between devices and the microcontroller, an analog to digital converter which allows the microcontroller acknowledge the processing of analog data.

2.2.1 The I/O Port

The controller communicates with the environment through the digital input and output ports. Microcontrollers are configured as input bits or output bits. Microcontrollers are utilized in a wide number of electronic systems such as; the keyboard of a PC, Electronics measurement instrument, Printers, phones, Televisions, radio, CD players, tape recording equipment and Hearing aids.

2.3 Advantages of Using Microcontroller

The upsides of utilizing microcontrollers are itemized below:

- A microcontroller can be quick

- Microcontrollers have a lot of features which also include analog to digital converter, serial ports, flash controller and USB support.

- Microcontrollers are better in reliability than a central processing unit in a PC.[25]

2.4 PIC Microcontroller

PIC Microcontroller which is also known as Programmable Integrated Circuit or Programmable Interface Controller is a microcontroller which has the following functions; stores instructions, switches output devices to an on state responding to input signals, programming and erasing of programs.

2.4.1 Types of PICs

* Flash Programmable PIC: This is the most common form PIC which is erasable for up to about one hundred thousand times, it is reprogrammable by downloading a new programme into the integrated circuit.

* One Time Programmable Integrated Circuit; these circuits are reprogrammable just once and are suited for mass production.

2.5 Overview of components

* Light Dependent Resistor

Light dependent resistors which is called a photoresistor or LDR is a resistor whose resistance increases or decreases based on light intensity or degree of darkness. LDR is an exceptionally valuable component in an LDR circuit. An LDR can have a variety of resistance and function. An illustration is a point at which it is used to turn a light to an ON state when the LDR is in darkness or to turns off a light during day time. [25 34]

* Infrared Sensor (IR)

IR sensors are small, inexpensive, low powered sensors that sense motion. It is utilized in detecting when a human has moved in or out of the sensor range. These sensors are frequently referred to as pyroelectric or IR movement sensors [25]

* Current sensors

Current sensor is a device used to distinguish between current in a wire and to generate a flag corresponding to it. The signal which is generated could be an analog voltage or current. It is used in displaying current in an ammeter and can also be used for control purposes.[25 33]

In this project, a signal is generated which is sent to the microcontroller when the current sensor recognizes that a LED isn't lit up by the current. The microcontroller takes this as an error and an SMS is generated by the GSM module and sent to a designated

number/control unit.

2.6 Review of Previous works

[23] discussed that power could be saved in street lights. Six components were used; PIC16ff877A Microcontroller, LCD Display, Current Transformer, GSM Module, Dual Tone Multi-Frequency(DTMF). PIC16ff877A Microcontroller; used for interfacing all other components together, GSM Module; used for sending SMS to the control station, LCD used to display Value of the load, DTMF used to Dim and Brighten the LED, Time to switch the LED is set by DTMF. The primary target was the control of the road light (dim at dawn and also to brighten at night) using Dual Tone Multi-Frequency (DTMF). Engineers based at the Electricity Board controlled the street light. In the event of an overload, there was a disconnection while information was transferred to the electricity board through GSM. In the event of grievances from consumers, Data was sent to the electricity board through an RFID Reader, which was fixed on a street light pole where the tag was given to all consumers. An error message was sent to the EB server through GSM.   In conclusion, this system proposed a new method for reducing power consumption. The period of recovery from power failure was reduced. Streetlight maintenance, load maintenance and other complaints which regarded power was intimated through the GSM module. The authors expressed that the Electricity divisions would embrace this system keeping in mind that the end goal is power conservation and time. This system could be extended such that the time taken to prepare a new power association demand could be limited by using RFID.

[10] discussed on a street light system which was optimized management and efficiency. A lot of sensors were utilized for a better and efficient system control. The IR sensor sensed a movement. Street lights were switched ON when a person was detected within detection. The system used a GSM module which allowed for more efficient street lamp

management and system control. The state of the street light was checked and the GSM module sent a fault message to the control centre. The system aided a substantial amount of energy to be saved. This increased the performance and the maintainability of the system.

[12] aimed at designing an embedded system for energy conservation of street light. This research gave a good alternative for wastage of electrical power. Operation of the manual lighting system was totally wiped out in this research. Two sensors were utilized which were the Light Dependent Resistor used for indicating day and night and IR sensor which was used to detect movement on the street. PIC16F877A microcontroller was used to control the street light. This programming language used was the C language.The system was implemented on a prototype version. LDR sensor and the IR sensor were the two sensors used in the working of the circuit. Each sensor controlled the automation of each the lighting column. The street light was successfully implemented using a microcontroller.

[19] explained that wireless sensor network could be used with a GSM module for the monitoring and control of a street lighting system. The system gave remote access for the system control and maintenance. It discuses about the system would take automated decisions for luminous control which were ON, OFF and Diming. The system additionally detected various parameters such as the temperature of the surrounding, mist, emission from carbon, and intensity of noise. Power theft control was additionally incorporated into the same system.

[1] gave an alternative solution for wastage of electrical power. This research also wiped out manual operation for the street light. The system provided a means of saving energy. This was accomplished when the IR sensor sensed a moving vehicle. After detecting the motion of vehicles, the sensor transmited the signal to the microcontroller. Correspondingly when the vehicle or an obstruction leaves the Light gets turned OFF. The street lighting could easily be accessed from anyplace and whenever via the internet. The implementation was achieved with an embedded system that controlled the street

light when vehicles or obstacles were detected on the road. When an obstacle was detected on the road, the LED automatically turned ON or OFF and the information was accessed through the internet. The information of the street light in real time could be accessed anywhere and anytime using the internet. This project was described as cost effective,eco-friendly and the safest means to conserve energy. It tackled two issues; energy conservation and incandescent lamp disposal. As discussed in this paper, the innitial drawback of this system could be the cost initially and maintenance. The LEDs had long life, emitted cool light and did not emit any toxic material.

[16] designed a system where light sensors were placed in circuits for light poles which was responsible for automation. When the LEDs were switched on, current sensors reported the status of challenges to a centralized system. This was done with the GSM module. The status was accessed in the centralized system. The workman now could locate the faulty street light to sort out. This minimized search and repair time. A database was also maintained by the system for storing important information from each LED.

[5] designed a system that provided a safe environment in the night for road users and pedestrians. The main objective was to use a low cost microcontroller like an Arduino and to save energy. The modes used were controlled by an LDR and IR. The system could automatically automate LEDs according to the flow of traffic. The system worked during the night and concentrated at a concentrated street at an intersection. The LED came to an ON state when movement was detected otherwise it turned off. According to the research, this design saved an awesome measure of power. Maintenance cost was reduced and lifespan of the system was increased.

[3] designed a system that used a module for sensing real time. The intensity of the LED could also be changed using the module. The circuit had a disadvantage; maintenance was high. Dust easily accumulated on the sensor and occasional clean up was required. The authors proposed that wireless communication could be incorporated for automated detection of fault based on central system. the use of a timer circuit was another proposed

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method by the authors for light intensity variations which used a thyristor to change the of the brightness of the LED based on the atmospheric conditions and the day to night of the environment.

[4] designed a system that monitored street light and detected faults with the aid of an RF technology. A drawback of this system was that it was expensive but when its advantages were considered, the high price of the lamp post were compensated by cheaper wiring and power network availability. Maintenance was also very low. The main goals of this research was reduction in the consumption of power and atmospheric emissions which were harmful. The system had versatility and could be extended to user needs.

[17] designed a lighting system that targeted the saving of energy and autonomous operation with an immediate response to faults. Consumption of the street light for a specific area could be accounted for from the system. Errors that occurred from manual operation was also eliminated. The system could also be controlled from a PC at the control station or could be automated. The design was based on the installation of light sensors in the circuits for the poles. Current sensors reported status to the central system using GSM module; with the fault status, the workman could easily locate the faulty street light thus reducing the time it would have taken to search for faulty lamps. Information was collected at the end of each day and stored in the data base. The information collected and stored in the database was made up of details of power consumption, number of burning hours, interruptions and fault detection details; the location of faulty street light, time of fault and time of repair. The system accomplished the feat of reducing the time taken to repair faults compared to manual system where faults took days or months to be detected for repairs was carried out.

[6] designed a solar Photovoltaic panel based street lighting systems which maximized the efficiency for street lighting system and conserved the use of energy. LDR was used for automation. The pulse width modulation and IR sensor controlled the intensity of the LED. The resistance of the LDR decreased when light encroached on it.

[24] designed a system that enumerated on the fact that controlling street light was of significant importance to reduce power consumption. This research paper used different technologies; clock-timer, photodiodes, Light Emitting Diodes (LED) and transistors. The IR sensors issued commands for the LEDs to glow. Pulse width modulation was also used for intensity control based on the movement detected.thus intensity changed dynamically. This design saved a lot of energy.

[20] designed and implanted an automatic street light control system based on UA741 operational amplifier which is configured as a Schmitt trigger and a light dependent resistor (LDR). Amid the day the LDR faculties enough illumination and the security light goes OFF. Furthermore, when darkness comes, resistance of the LDR increases tremendously and causes the light come "ON'. Additionally, a transistor switching a 12V Relay is deployed to provide the switching mechanism to activate the street lights connected in parallel. The need for manual operation of the security lights is completely eliminated and much energy is saved that would have been otherwise wasted if the user were to forget to power "OFF" the light at any point in time. [20]

[22] designed a system based on GSM. The lighting system was designed to target the reduction in consumption of power and autonomous operation. This was achieved by the installation of chips on the circuit for the LED. The chip was made up of a microcontroller, sensors, GSM module which was used for transmission of messages to the PC. The programme was designed to ensure that consumption of energy was at its minimum. Atmospheric emissions were also detected through the CO_2 sensor used. Electricity theft was also detected.

[18] designed a system where the LEDs switches to an ON state when vehicle movement is detected. The LED turns off after some seconds. The system consisted of 5 highlights. It automatically controlled the street light. i.e turned off during the day and turned on during the night utilizing the LDR. It controlled the street light intensity through diming and brightening on detecting an object. Objects were detected using PIR sensors. The system had a camera for security purposes. Automatic fault detection i.e on failure of the

LEDs, fault messages are automatically sent to the to the authorities using the GSM module technology. The feature of switching manually with the use of a GSM device was also incorporated.

[21] designed a system where the street LEDs lit up automatically at night and turned off at daybreak. The light dependent resistors were also used to indicate the condition of the LEDs for effective maintenance. This system was designed to run on automatic node. This automatic mode controlled the algorithm for the sunrise and sunset and intensity of light.

2.7 Summary

This chapter reviewed various journal papers on automated street lighting systems. The analysis of the designs, results and implications obtained in the literature review supports the fact that LED lighting with automation and fault detection is more efficient than the traditional lighting system in terms of cost, power consumption, and fault detection. It also shows that maintenance cost is reduced because of the reduction in physical manpower required. Components used for the construction of this project was also reviewed in this chapter

CHAPTER THREE

SYSTEM ANALYSIS AND DESIGN

3.1 Introduction

This chapter deals with the design of an Automated street lighting system. From the design specifications, the system is divided into two parts; the main circuit board and the light pole circuit board.

3.2 System Specifications

The street lighting system has the following specifications which are outlined as follows;

- The main PCB which has the PIC18F26K22 microcontroller and the GSM module operates on a 5 volt DC.

- The street light PCB which has the LDR, IR, and LED operates on a 5 volt DC

- The GSM module operates on a 4 volt DC.

- The power pack is a 5-volt pack which converts 230 volts to 5 volts.

- Fault messages are sent to a designated GSM number

3.3 Operation of the Main Circuit Board

The main circuit board comprises mainly of the PIC18F26K22 microcontroller and the GSM module. The PIC microcontroller coordinates the activities of the system. It is responsible for instructing the GSM module send a fault detection message to the assigned GSM number when a fault is detected. The PIC microcontroller also communicates with the circuits for the street light pole. These modules are explained below;

3.3.1 PIC Microcontroller

PIC Microcontroller is used for the development of interactive tools, which takes inputs from various switches or sensors, and controls a variety of lights, motors, and other physical outputs. The PIC microcontroller is the brain of the system where instructions are carried out for the Automated Intelligent Street Lighting System. This

Microcontroller is made up of CPU, RAM, ROM, I/O Ports. PIC18F26K22 Microcontroller is the preferred microcontroller in this project. This is because there are more I/O pins [27]. The circuit diagram is shown figure 3.3.1.
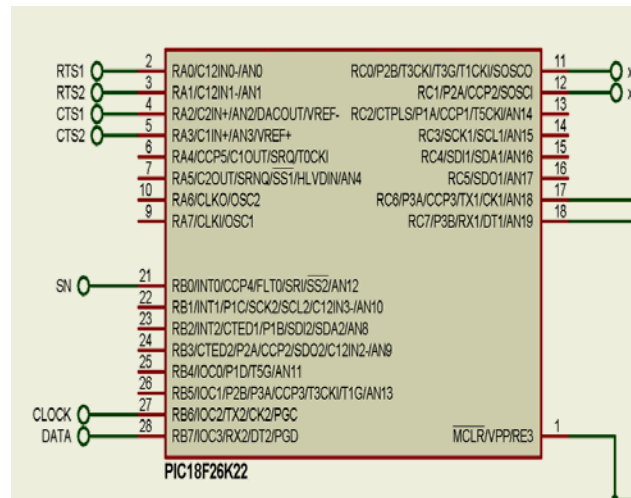

Figure 3.3.1 Circuit Diagram of the PIC18F26K22 Microcontroller pin configuration

3.3.2 GSM Module

GSM module is connected to the microcontroller. Its pins such as RXD (Receive Data) are connected to TXD (Transmit Data) of other device and vice versa, whereas GND (Ground) are be connected to other device's GND pin to make ground common for both systems. This is the modem which sends fault messages to the control station/designated GSM number. [25] The circuit diagram for the GSM module is shown in figure 3.3.2
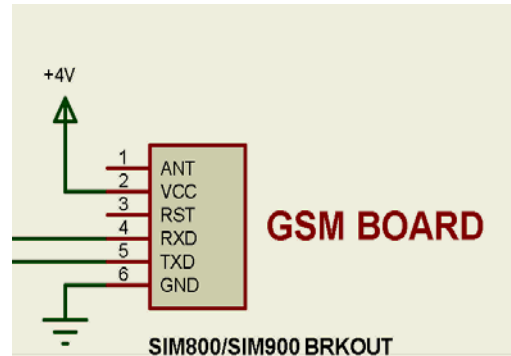
Figure 3.3.2 Circuit Breakout Diagram for GSM Module

3.3.2.1 GSM Configuration

GSM modem is interfaced with the microcontroller with the aid of a PNP transistor. To successfully interface the GSM with the microcontroller, it is important to ensure that the transmit (TX) and the Receive (RX) pins of the GSM module and the microcontroller are compatible. The maximum input voltage for the RXD pin is 3v and the maximum output voltage is of the transmit (TXD) is 2v. The voltage at the transmit and receive pins of the PIC microcontroller is between 4 – 5 volts. The PNP transistor is used to amplify the voltage of the transmit pin of the GSM module from 2v to 4 – 5 volts which is a high logic for the receive pin of the PIC microcontroller in order to ensure compatibility. The GSM module uses between 3.6v – 4volts for the supply voltage(VCC).

3.4 Operation of the Street Light Pole Circuit Board

The street light pole circuit board comprises of a PIC18F26K22 microcontroller, Light Dependent Resistor, Infrared sensor and LED. The PIC microcontroller on the circuit board coordinates the activities of the LDR, IR and LED before communicating with the circuit for the main board. The PIC microcontroller coordinates the LDR to bring the LED to an ON state when darkness is detected, coordinates the IR sensor to DIM and

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brighten the LEDs at intervals when darkness is detected. These modules are explained below

3.4.1 Light Dependent Resistor

The working principle of an LDR is photoconductivity. When the light is absorbed by the material then the conductivity of the material reduces. At the point when the light falls on the LDR, the electrons in the valence band of the material move to the conduction band. But the photons in the incident light must have energy superior to the band gap of the material to make the electrons jump from one band to another (valence to conduction). LDR is an electronic sensor that senses the presence of light. When light falls on the top surface of the LDR, its resistance becomes lower and when there is low light, its resistance becomes higher. The resistivity is inversely proportioned to the intensity of light exposed on LDR active surface. This change in resistance can be used to determine changes in voltage and current. [26] LDR is responsible for Automation of the project prototype. The diagram for the LDR is shown in figure 3.4 below
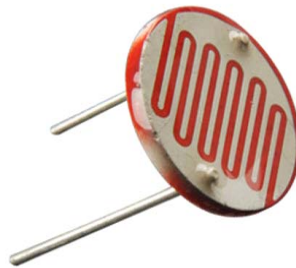
Figure 3.4 LDR Resistor Diagram

3.4.2 Infrared Sensor

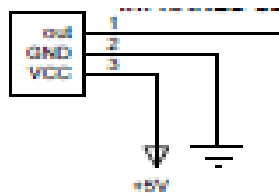**Figure 3.4.2a Diagram of an IR sensor**

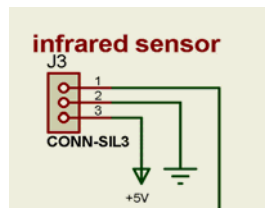
Figure 3.4.2b Pin Configuration of IR Sensor

Figure 3.4.2bii Circuit Breakout of IR Sensor

The pin configuration of the IR sensor is shown in the figure above. IR sensor comprises of three pins; ground pin, signal pin and power pin along the edge or base. The IR sensor power is dependent upon 3.3v - 5V. It is extremely basic and simple to interface the

sensor with a microcontroller. The output of the IR is usually digital output which either low or high. The IR sensor circuit comprises of three pins, power supply pin, output signal pin, and ground pin. At whatever point a person (even a warm body or object with some temperature) goes through the field of the perspective of IR sensor, the infrared radiation discharged by the warm/hot body movement is detected. The infrared radiation detected by the sensor generates an electrical signal that is used to activate the Full ON state in the system.

3.4.3 Switch

A switch is an electromagnetic switch operated by a relatively small electric current that can switch on or switch off a much larger electric current. The heart of the switch is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). A switch is a kind of electric lever that switches on with a tiny current. It switches on another appliance that uses a greater current. Sensors are sensitive pieces of electronic equipment and produce only small electric current but are often needed to drive bigger pieces of apparatus that use bigger currents. A switch bridges the gap, making it possible for small currents to activate larger ones. Thus switches amplifiers small currents into larger currents. [30 31]

3.4.3.1 Working principle of a switch

Switches open and close circuits electromechanically or electronically. A switch controls one electrical circuit by opening and closing contacts in another circuit. As the circuit diagram shows below, when a transfer contact is typically open (NO), there is an open contact when a switch is not energized. At the point when the switch contact is Normally Closed (NC), there is a closed contact when the switch is not energized. Applying electrical current to the contacts will change their state. A switch is used to switch smaller currents in a control circuit. Switches can control larger voltages by having an amplifying effect because a small voltage applied to a switch can result in a large voltage being switched by the contacts. The switch which is located on the street light pole is

used in this project to switch the LED on/off.

3.4.4 Light Emitting Diodes (LED)

A light-emitting diode (LED) is a PN junction diode, which emits light when activated. When a voltage is applied across its leads, electrons recombine with holes within the LED, releasing energy in the form of photons which gives light. Hence, it is a two-lead semiconductor light source. Light emitting diodes represents the lighting system and the amount of light emitted by it is directly related to the detection or non-detection of motion which amounts to a Dim ON state or a Full ON state. [31, 32]

3.4.4.1 Principle of operation of an LED

Light-emitting diode (LED) emits visible light when an electric current passes through it. It has two sides; one with an abundance of electrons called "n-type semiconductor" & the other with a bunch of holes that need to be filled by electrons known as "p-type semiconductor ". With the help of these p-n junctions, these semiconductors can control the direction of the flow of electricity. The LED works on the principle that when electrons lose energy, they move from a higher orbit to a lower orbit. The energy lost is in the form of light photons. The color of the light emitted depends upon the frequency of the light photon released. The higher the frequency, the greater is the energy release.[31, 32]

3.4.4.2 Application of LED

- Backlight; white LEDs are used in flat-panel computer displays.

- Remote Controls of televisions, DVD players, and other domestic appliances: Infrared LEDs are used here.

- Automotive Lighting; LEDs are used in brake lights, turning signals & indicators.

- Traffic Signals; Groups of LEDs are packaged into arrays & arranged to form a

traffic light.

- Street Lighting

3.5 Circuit Diagrams for the PCB boards

Connectors to Aux. Boards

Main Controller

InCircuit Serial
Programming Input

Power Circuit

+5V power Input
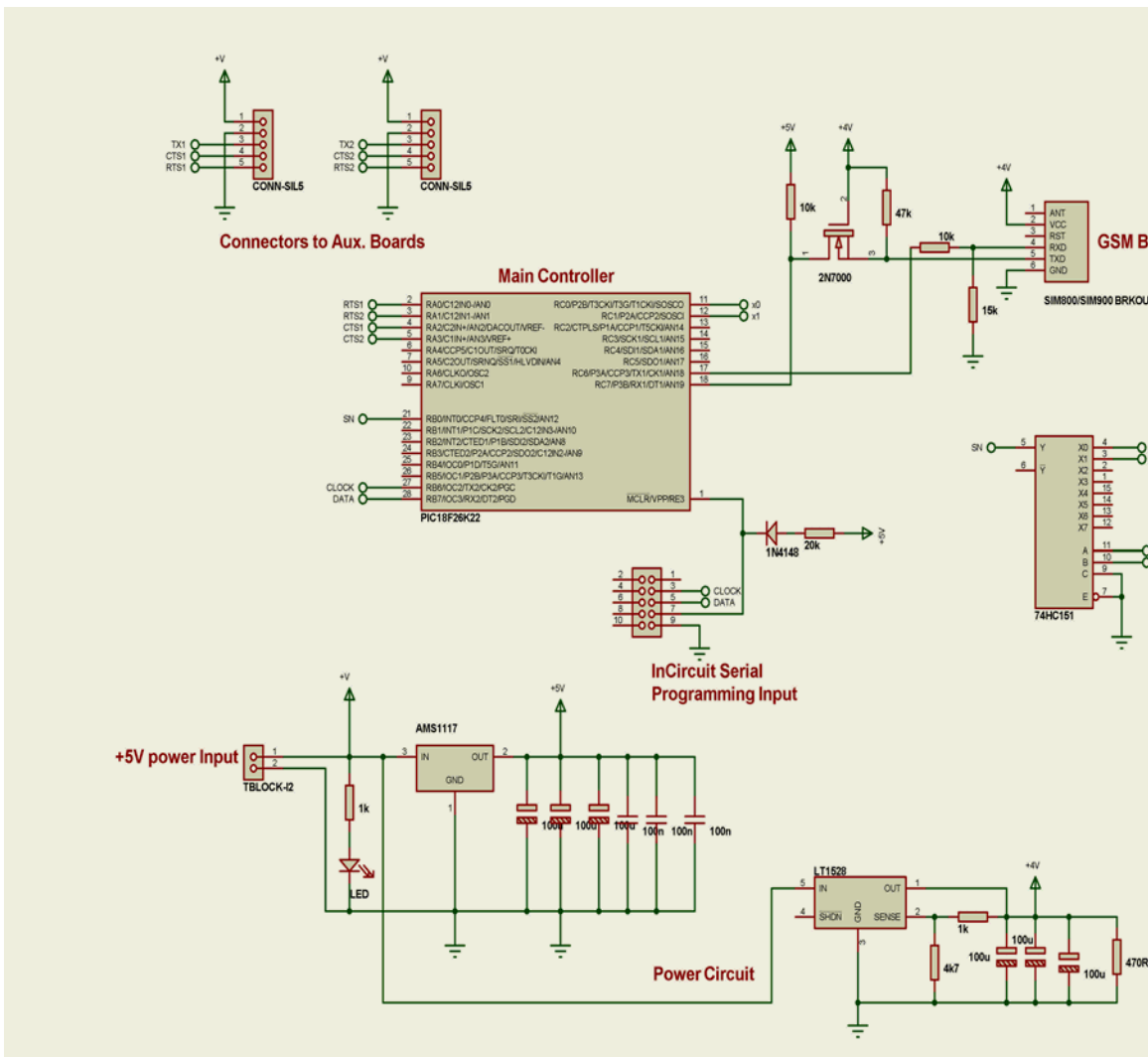
Figure 3.5a Circuit diagram of the Street Light Main Board

infrared sensor

Main Controller

High Flux LEDs

LDR

Fault Switch

InCircuit Serial
Programming Input

+5V power Input

Connector to Main Board

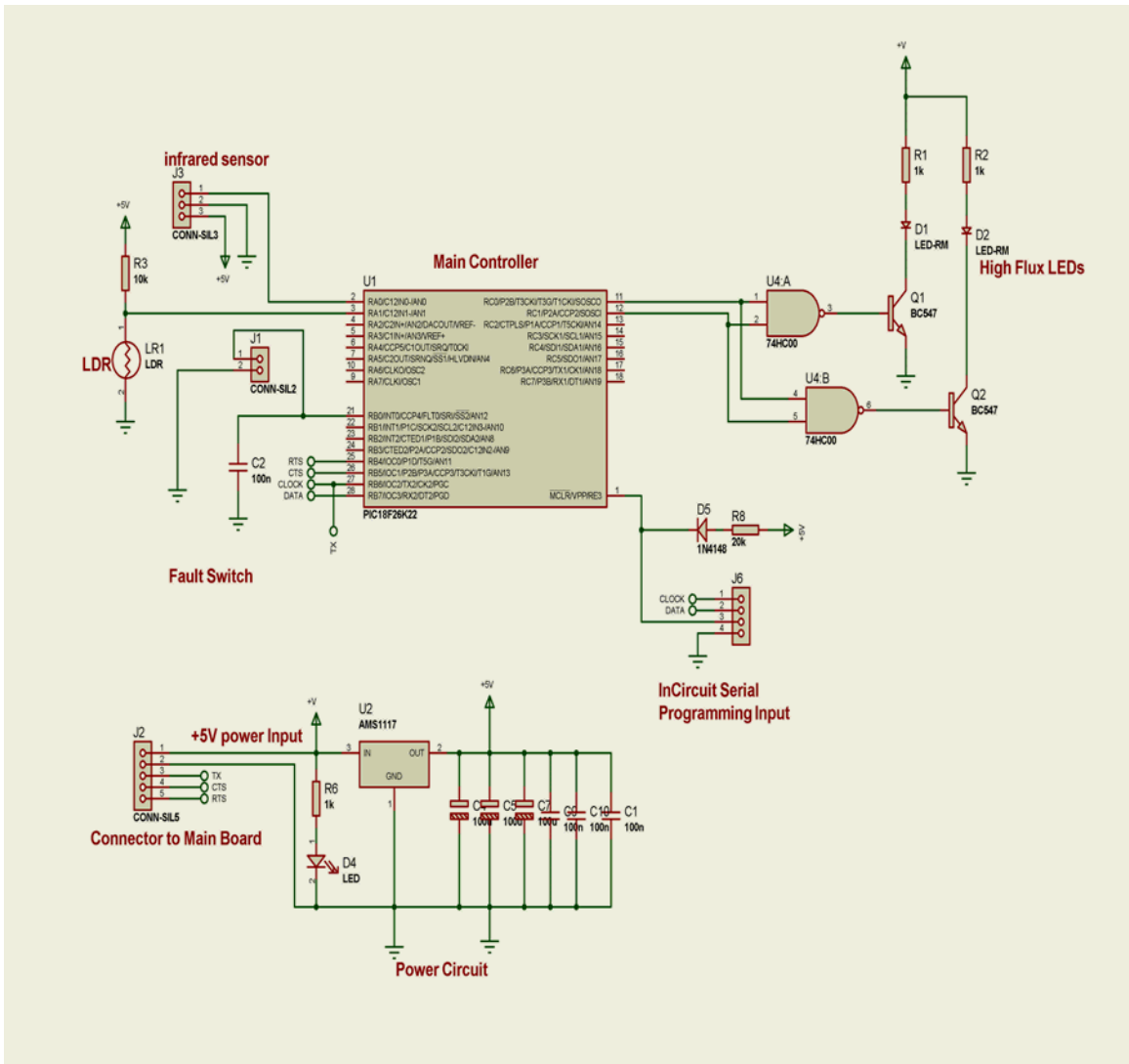Power Circuit

Figure 3.5b Circuit diagram of the Street Light Pole

3.6 Summary

This chapter presented the design of the street lighting system, showed the two main circuit boards and components in the circuits. The schematics of the circuits were also shown for the project.

CHAPTER FOUR

SYSTEM IMPLEMENTATION AND TESTING

4.1 Introduction

This chapter shows details of implementation of the designed system in chapter three and the complete system test result.

4.2 Implementation

After the circuit diagrams were thoroughly examined, all the required components were bought. The printed circuit boards were produced and all components were mounted and soldered properly; the PIC microcontroller is a 5volt microcontroller that is mounted and installed on the PCB. The GSM module has a consumption of 4 volts which is also mounted and soldered to it. A multiplexer integrated circuit is installed on the main board circuit which communicates with the circuits for the street light pole.
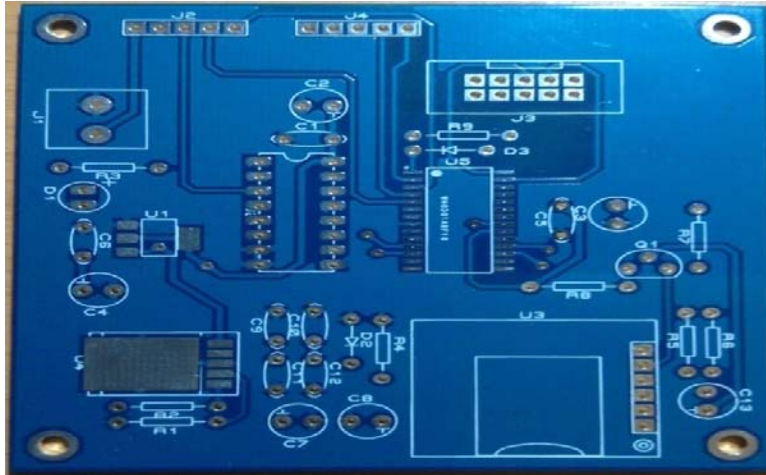
Figure 4.1 Diagram for the Main Board PCB before implementation
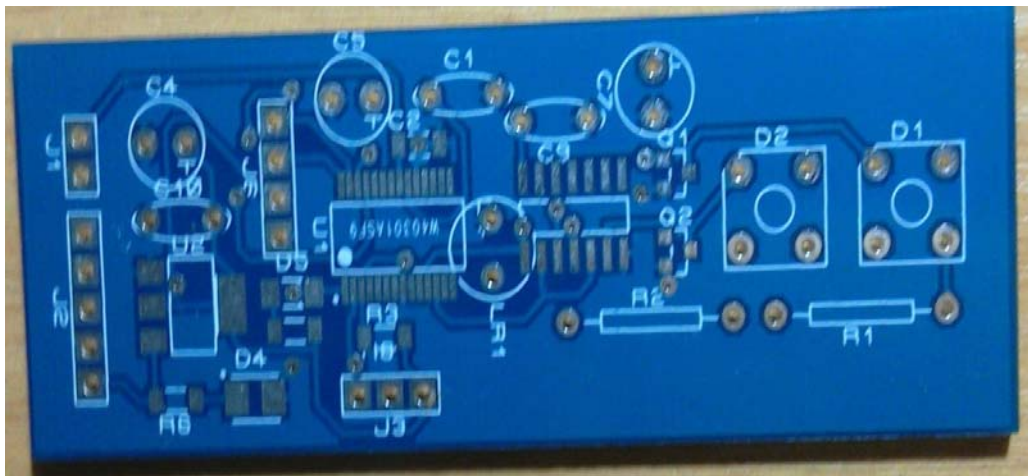
Figure 4.2 Diagram for the Street Light PCB before implementation

4.2.1 Implementation of the PIC18F26K22 Microcontroller

PIC18F22K26 was programmed using assembly language. The compiler used is the Microcontroller Lab. The Microcontroller which serves as the brain of the system is programmed to;

- Power up the Light Dependent Resistor and Infra Red Sensor once there is a considerable degree of darkness

- Dim LED at Startup

- Dim LED when no movement is detected

- Take LED to a Full ON state when movement is detected

- Send fault detection messages to a control centre or a designated GSM number when an LED does not Light up

- Cut OFF power to the sensors at daylight
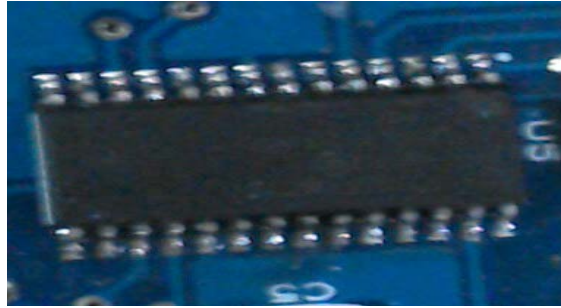
FIGURE 4.3 Diagram of the PIC Microcontroller after soldering on the PCB

4.2.2 Implementation of the Light Dependent Resistor

The LDR has a resistance which varies inversely proportional to light. An example is the more the light, the less the resistance. Two Light Dependent Resistor was used for this prototype; each of the PCB's has an LDR soldered to it. Figure 4.4 shows the LDR soldered to the Street Light PCB.

FIGURE 4.4 Diagram of the LDR after soldering

4.2.3 Implementation of the Infrared Resistor

Four Infrared sensors consisting of two pairs each of Infrared sensors were used for this prototype; each of the PCB has a pair of Infrared sensors soldered to it. Proximity detection for the IR sensor is between 4cm to 26cm. Figure 4.5 shows the Infrared sensor soldered to the Street Light Printed Circuit Board.
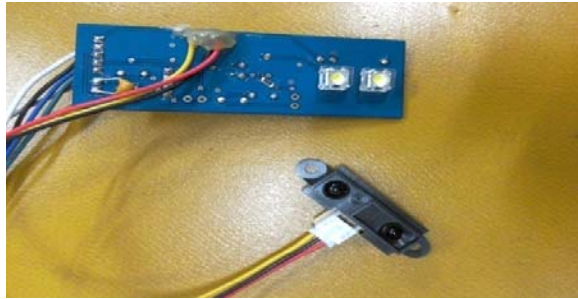
FIGURE 4.5 Diagram of the Infrared Sensor after soldering

4.2.4 Implementation of the GSM Module

The SIM 8OOL GSM Module is used for this Project Prototype. The pins were soldered carefully to avoid damage. Figure 4.6 shows the GSM module after soldering on the Main Board Printed Circuit Board.

FIGURE 4.6 Diagram of the GSM module after soldering

4.2.5 Implementation of LED

Four high flux LED's of two pairs each was used in this prototype LED. Each Printed Circuit Board for the Street Light has a pair of LED soldered to it. The diagram below shows the LED soldered to the Printed Circuit Board for the of the Street Light
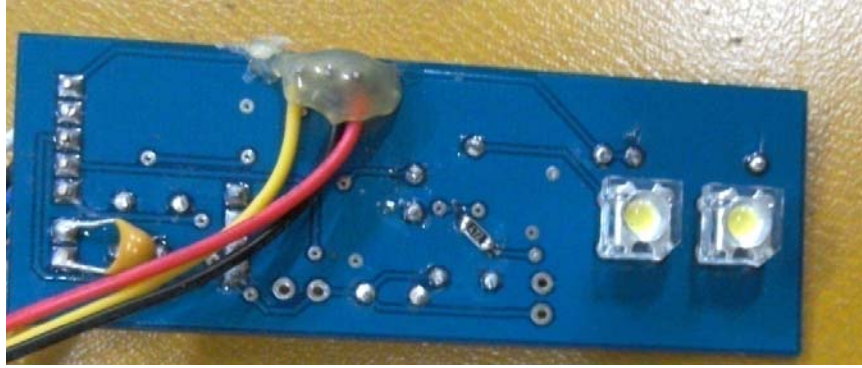
FIGURE 4.7 Diagram of the LED after soldering

4.2.6 Implementation of the Power Supply Unit

Electronics components used of various types used in this project prototype has various voltage levels ranging from 3.5volts to 5volts. A power pack of 5 volts and 10 amps switch mode power supply which is light in weight and generates high voltage was gotten for this project. Below is the diagram for the Unit that supplies power.

Figure 4.8 Diagram for the power supply unit

4.3 Testing

All units of this project prototype were properly packaged after implementation. All units worked properly as stated in the expected result in chapter one.

A fault was deliberately introduced to the system for an LED not to come up, an SMS stating the status and location of the street light was sent to an assigned number. Below are pictures of the circuit for main board and street pole after all components were soldered and working properly.
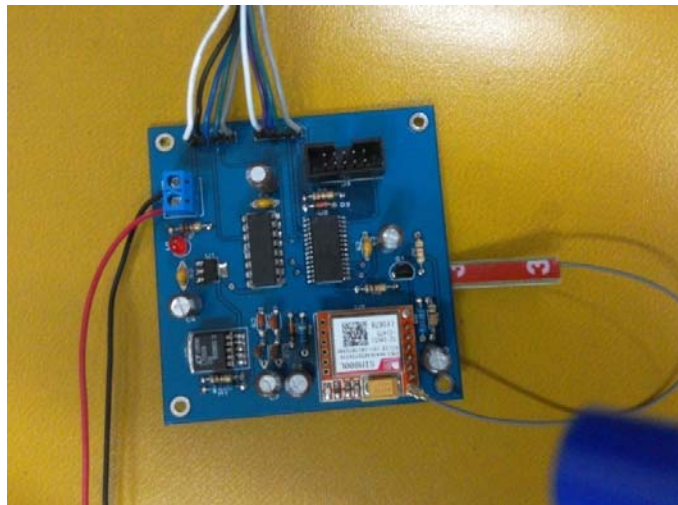
FIGURE 4.9a Street Light Prototype for the Main Board
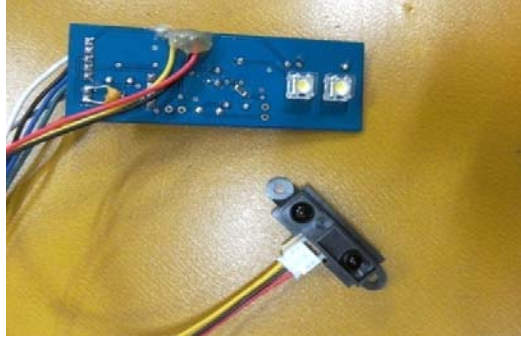
FIGURE 4.9b Street Light Prototype for the Street Light Pole

FIGURE 4.9bi Street Light Prototype for Streetlight Pole
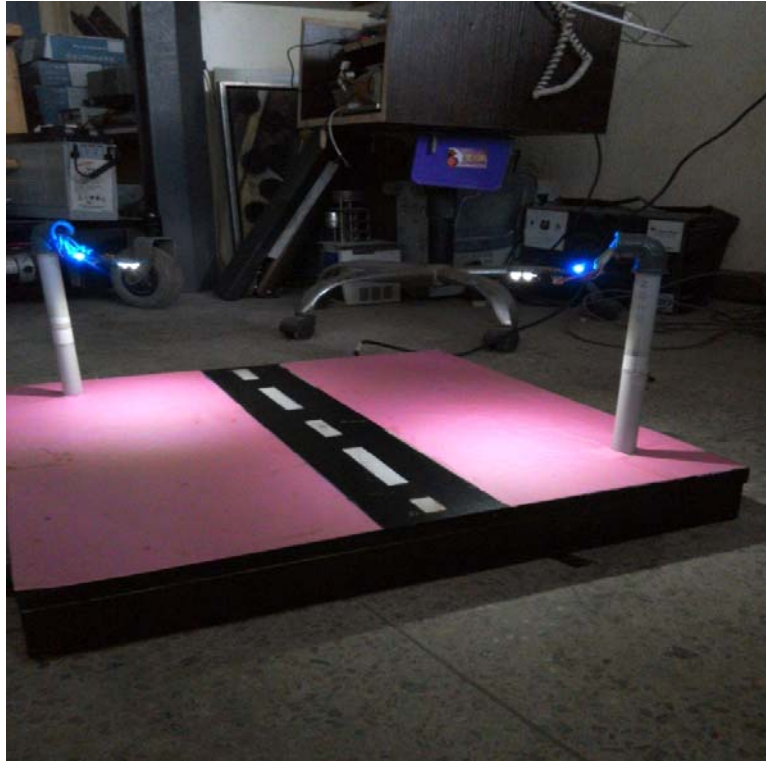
Figure 4.10 Complete Street Light Prototype in its Framework

4.4 Materials Purchased

ITEM	QUANTITY	PRICE
Short Range Special Infrared Sensor	4	12,500

LDR Sensors	2	1,000
0.005ohm Sensor Resistors		3,000
SIM 800L GSM Module	1	10,000
PIC Microcontroller Components		15,000
PCB Fabrication	3	30,000
Auxiliary Board Components	4	5,000
5 volts Power Pack		9500
Shipping		15,000
Miscellaneous and Logistics		20,000

TABLE 4.14

4.5 Summary

This chapter described how the designed system discussed in chapter 3 was implemented. The circuits were tested before their packaging and after their packing and each module working as proposed

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The major aim this project aimed at achieving was the design and construct a microcontroller based automated intelligent street lighting system.

Without a street lighting system in place, crime would be on the rise on our various roads. Whereas there is no proper street lighting system, cost of manpower and maintenance would be on the increase; this is due to the fact that there is no intelligence introduced to the system and there is no automation. Chapter one gave a general introduction to the project.

In chapter two, Components used for the construction of this project was reviewed, various journal papers on automated street lighting systems were also reviewed. The analysis of the designs, results, and implications obtained in the literature review supported the fact that LED lighting with automation and fault detection is more efficient than the traditional lighting system in terms of cost, power consumption, and fault detection.

In chapter three, the design of the street lighting system was discussed showing the two main circuit boards and components in the circuits. The schematics of the circuits were also shown for the project.

In chapter 4, the implementation of the system was described. This chapter also described how circuits were tested before their packaging and after their packing and how each module worked as intended.

And finally, the aim and objectives of this project was achieved as each unit worked properly

5.2 CONCLUSION

The Design and Implementation of a Microcontroller Based Automated Intelligent Street Lighting System were successfully carried out. The LED lighting with automation and fault detection proved more efficient than the traditional lighting system in terms of cost, power consumption and fault detection. PIC Main Board PCB programme is in the Appendix I and also STREET LIGHT BOARD PCB Programme is in the appendix II.

5.3 ACHIEVEMENT

The following objectives were achieved during the duration of the design and construction of the project;

- Successful design, construction, and implementation of the main PCB and street light PCB

- Successful Automated Operation

- Successful real-time fault detection and instant maintenance.

- The intelligence of the system; Dimming of the street light.

5.4 RECOMMENDATION

Recommendations for this Project are outlined below.;

- A database should be created where information on power consumed, fault detecting, time of fault should be stored for analysis

- Embedding surveillance camera to the street light PCB for security monitoring

within the street lighting area.

- A Wifi interface for wirelessly controlling the LED's/ Street light on a computer should be included

- Mobile phones should not just receive fault messages but should be used to switch ON/OFF the street light remotely.

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APPENDIX I: PIC MAIN BOARD PCB PROGRAM

;!!

;The streetlighting ******************

;Processor PIC18F26K22************************

;clock frequency = 64MHz**********************

;!!!

```
            list        p=pic18f26k22


        #include     <p18f26k22.inc>


        config   FOSC=INTIO67, FCMEN=OFF, IESO=OFF, PRICLKEN = ON,
PLLCFG = ON

        config   PWRTEN=ON, BOREN=OFF   ;CCP2MX=PORTBE

        config   WDTEN=SWON, WDTPS = 16384        ;4096

        config   MCLRE = INTMCLR, PBADEN=OFF, HFOFST = OFF

        config   STVREN=OFF, LVP=OFF, XINST=OFF, DEBUG=OFF

        config   CP0 = ON, CP1 = ON, CP2 = ON, CP3 = ON
```

;***
;
;WARNING!!!!!!!!!!!!!!!!!!!!!!!! DON'T USE THE n-BIT OF THE STATUS
REGISTER....... IT DOESN'T WORK


```
        cblock  0x0000 ; bank1 for the gpr's
```

```
d1

d2

d3

myFlags

hold


        movlw  low printfTable

        movwf  tblptrl

        call      StringOut

        goto     printfDone

printfTable:

        da        str,0     ; Packed ASCII. 16bits per 2 chars.

printfDone

        endm

;*********************************************

printfRegAscii  macro   par1

        movf   par1,w

        addlw   0x30

        movwf  arg1

        call      FontOut10

        endm
```

```
printfReg        macro   par1

        movf    par1,w

        movwf arg1

        call        FontOut10

        endm


Dprintf macro   par1

        movlw par1

        movwf arg1

        call        FontOut10

        endm


        movwf transmit

        btfss     txsta,trmt

        goto      $-2


;now check for the echo

        clrwdt

        watchdog_on                  ;turn on the watchdog timer
```

```
gsmOut2:

        btfss   pir1,rc1if

        goto    $-2

        movf    rcreg1,w

        xorwf   transmit,w

        btfss   status,z

        goto    gsmOut2
```

```
*************************************

;*********************************************

;*********************************************
```

```
eeread  bcf     eecon1,eepgd    ;point to the eeprom memory

        bcf     eecon1,cfgs     ;access the eeprom memory

        bsf     eecon1,rd

        return
```

```
eewrite:

        bcf     eecon1,eepgd    ;point to the eeprom memory

        bcf     eecon1,cfgs     ;access the eeprom memory
```

```
                bsf      eecon1,wren
```

;setting up for 8-bit asynchronous transmission & reception @ 9600 baud, @64MHz,
SPBRGH:SPBRG value=1666 with BRGH=1 & BRG16=1

```
bsf     rcsta1,cren      ;enable 8-bit continous reception

                bsf      rcsta1,spen      ;enable the eusart1 module


                #1s

                movlw  high .1666

                movwf  spbrgh1


                movlw  low .1666

                movwf  spbrg1
```

;MSSP1 intialization (SPI mode)**********************

;SPI clock for MSSP1 module is by default at Fosc/4

;the ports must have been properly confugured: SCKx,SDOx = output, SDIx = input

;configure the SSP1STAT register*********************

```
;        bcf      ssp1stat,smp     ;*input data sampled at the middle of data output time

;        bsf      ssp1stat,cke     ;transmission occur from ctive to idle clock state
```

;;configure the SSP1CON1 register*********************

```
;       bcf     ssp1con1,ckp    ;clock polarity, idle state of clock is low

;       movlw  0xf0     ;configure the synchronous serial port mode

;       andwf  ssp1con1,f

;       movlw  0x00     ;in this case it is SPI master mode with clock = Fosc/4

;       iorwf  ssp1con1,f

;       bsf     ssp1con1,sspen ;enable the MSSP1 (synchronous serial port1) module
```

;**

;MSSP1 intialization (I2C mode)**********************

;**

```
;       movlw  0x00     ;slew rate control (SMP) set for 400KHz

;       movwf ssp1stat;and mode and input levels are 12c spec loaded in sspstat

;       movlw  (i2cfosc/(4*.400))-1      ;calculates sspadd setting for the

;       movwf ssp1add;desired baud rate and sets up sspadd

;       movlw  0x08     ; PORTD pins for I2C mode on SSP module (SSPEN is set)
AND

;       movwf ssp1con1          ; Enables I2C Master Mode (SSPMx bits)

;       bsf     ssp1con1,sspen ;enable the MSSP1 (synchronous serial) module
```

;enabe/disable some peripheral registers**********************************

```
        banksel porta
```

PORTB weak pull up*************************************

```
        movlw  b'00000110'       ;b'00000001'

        call    format
```

;

****

***


```
        End
```

APPENDIX II: STREET LIGHT BOARD PCB PROGRAM

;Default Radix = Hex ***************************

;************ StreetLight bulkhead Control *************

```
        list      p=pic18f26k22



        #include     <p18f26k22.inc>



        config  FOSC=INTIO67, FCMEN=OFF, IESO=OFF, PRICLKEN = ON,
PLLCFG = ON

        config  PWRTEN=ON, BOREN=OFF   ;CCP2MX=PORTBE

        config  WDTEN=SWON, WDTPS = 16384      ;4096

        config  MCLRE = INTMCLR, PBADEN=OFF, HFOFST = OFF

        config  STVREN=OFF, LVP=OFF, XINST=OFF, DEBUG=OFF

        config  CP0 = ON, CP1 = ON, CP2 = ON, CP3 = ON
```

;**

```
            cblock  0x0000

        endm


switch  macro   par

        movff   par,switchcaseReg

        endm


case    macro   par

        movf    switchcaseReg,w

        xorlw   par

        btfss   status,z

        endm


clrw    macro

        movlw 0

        endm


sprintf macro   str

        local   printfStart, printfTable, printfDone
```

```
printfStart

        movlw  upper printfTable

        movwf  tblptru

        movlw  high printfTable

        movwf  tblptrh

        movlw  low printfTable

        movwf  tblptrl

        call       sOut0


        movf     tablat,w

        movwf  arg1

        xorlw    0

        btfsc     status,z

        return


        movlw  0x55

        movwf  eecon2

        movlw  0xaa

        movwf  eecon2

        bsf       eecon1,wr          ;start the write sequence

;       bsf       intcon,gie
```

```
        bcf     eecon1,wren

        btfss   pir2,eeif

        goto    $-2

        bcf     pir2,eeif       ;wriet is complete.


        return



        fsr0l,w

        xorlw   0x60

        btfss   status,z

        goto    cycle0

        return
switchDetect:

        btfsc   portb,0

        bcf     latb,4


        ;wait for the streetlight to be restored...

        btfss   portb,0

        goto    $-2


        call    debounce
```

;this means street light is ok so restore:

return

movff   adresl,value0

movf   adresh,w

andlw   0x03

;resolution of ADC is 10bits, +Vref = 4.47V (measured the supply voltage of the application circuit)

; formula is (+Vref/Resolution) * ADC value = Measured Voltage

;rearranging: (Resolution/+Vref) * Measured Voltage = ADC Value

; for a 10bit ADC, the resolution is (2^10)-1 = 1024 - 1 = 1023

; for a value of 3V, the ADC value is approx 687

; for a value of 2.1V, the ADC value is approx 481

;the digital value of the measured quantity

retlw   2

btfss   myFlags,negative

Significant bits)

```
        call    switchDetect

        call    LDRadc

        movwf   temp1

        switch  temp1   ;test register

        case    0

        goto    st0a

        case    1       ;outside valid range

        goto    st2a

        ;case 0 statement

        movlw   BRIGHT_MIN

        movwf   bright

        call    offsets  ;

        movwf   ccpr2l

        goto    state0


st2a:

        case    0       ;within valid range

        goto    state0
```

```
                ;case 1 statement


call      offsets  ;

          movwf  ccpr2l


          goto      state0



          end
```

DESIGN AND CONSTRUCTION OF AN AUTOMATED
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MAY, 2018

DESIGN AND CONSTRUCTION OF AN AUTOMATED STREET LIGHTING SYSTEM

By

AWODEYI, AFOLABI IFEDAYO

HND (Computer Engineering) (Owo)

15PCJ01023

A PROJECT SUBMITTED TO THE SCHOOL OF POST GRADUATE STUDIES OF COVENANT UNIVERSITY, OTA, OGUN STATE NIGERIA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF POST GRADUATE DIPLOMA (PGD) DEGREE IN COMPUTER ENGINEERING, IN THE DEPARTMENT OF ELECTRICAL AND INFORMATION ENGINEERING, COLLEGE OF ENGINEERING, COVENANT UNIVERSITY, OTA, NIGERIA.

SUPERVISOR
DR. ISAAC SAMUEL

MAY, 2018

ACCEPTANCE

This is to attest that this Project is accepted in partial fulfilment of the requirement for the award of the degree of **Post Graduate Diploma (PGD) Degree in Computer**

Engineering in the Department of **Electrical and Information Engineering**, College of Engineering, Covenant University, Ota, Nigeria.

Philip John Ainwkhai   ..………………

Secretary, School of Postgraduate Studies **Signature & Date**

Prof. Samuel Wara   ..…………..……

Dean, School of Postgraduate Studies   **Signature & Date**

DECLARATION

I hereby declare that I carried out the work reported in this Project in the Department of

Electrical & Information Engineering, Covenant University, under the supervision of Dr. Isaac Samuel. I also solemnly declare that to the best of my knowledge, no part of this Thesis has been submitted here or elsewhere in a previous application for the award of a degree. All sources of knowledge used have been duly acknowledged.

AWODEYI, AFOLABI IFEDAYO
(15PCJ01023)

CERTIFICATION

This is to certify that this Project titled "Design and Construction of an Automated Street Lighting System" is an original work carried out by AWODEYI, Afolabi Ifedayo (15PCJ01023), in the Department of Electrical and Information Engineering, College of Engineering, Covenant University, Ota, Ogun State, Nigeria, under the supervision of Dr. Isaac Samuel

Dr. Isaac Samuel   **...………………**

   Supervisor   **Signature & Date**

Dr. Victor Matthews   **...…………..……**

Head of Department   **Signature & Date**

DEDICATION

This project is dedicated to God Almighty for his faithfulness, love, and Grace towards me and to my parents Mrs Veronica Ebunoluwa Awodeyi and Professor Amos Fola Awodeyi for making sure I get the best Education.

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ABSTRACT

This Project report presents details of the design and construction of a microcontroller-based automated intelligent street lighting system. The circuits are designed specifically for self-intelligence and fault detection of the system.

The street light system consists of two circuit boards; the main printed circuit boards and the street light pole printed circuit board.

The major components of the main printed circuit board are PIC microcontroller, GSM module, voltage translator, multiplexer integrated circuit, resistors, and capacitors, while the major components of the street light pole circuits are the light dependent resistor circuit sensors, infrared sensors, PIC microcontroller, capacitor and resistors.

The Light Dependent Resistor is used for Automation, the Infrared sensor is used for Intelligence; sensing movement and taking the LEDs to a full ON state and the GSM module for fault detection.

The Printed Circuit Board circuits and their components are housed in its physical framework. The circuit for the main board and the circuit for the street light pole were tested and worked properly as intended.