DESIGN AND IMPLEMENTATION OF A GSM BASED STREET LIGHT CONTROL SYSTEM

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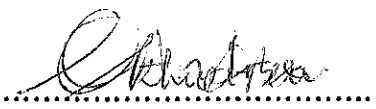
EKITI STATE

SEPTEMBER, 2016.

DECLARATION

I, Okhueigbe, Andrew Ayemere, hereby declare that this is my work and it has not been submitted anywhere for the purpose of the awarding of a degree to the best of my Knowledge. All sources of information are duly acknowledged by means of references.



26/10/16

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CERTIFICATION

This is to certify that this project work has been approved and meets the requirement for the award of Bachelor of Engineering (B.Eng.) degree in the Department of Electrical/Electronics Engineering, Federal University, Oye-Ekiti, Ekiti State.

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DEDICATION

This work is dedicated to Almighty God, the Giver of life, my Heavenly Father, for His blessings, mercies, opportunities, love and support now and forever.

I also dedicate this work to my parents Mr. And Mrs. David Okhueigbe and my siblings for having sacrificed a lot to give me the best in life and for their encouragement, prayers and love during my academic pursuit.

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After this tireless and fruitful journey, which came to a reality with the support, I received from a number of people. My acknowledgment first goes to God Almighty for his love and favour during my research. My warm appreciation and gratitude also goes to my supervisor, Engr. G. K. Ijemaru, for his support, ingenuity, patience and direction towards the success of this work. My gratitude also goes to all the lecturers in the Department of Electrical and Electronics Engineering both past and present.

I also wish to acknowledge my parents Mr. And Mrs. David Okhueigbe, my parish priest Fr. Patrick Agbodi, my siblings Faith, Clement, Rita, Charity and Monica, my Uncles Mr. Kayode, Mr. Author and my Aunties Mrs. Rose and Mrs. Uwa and Mr. And Mrs. Fred Iyogun for their moral, material and financial support.

Thank you all may God continue to bless you more abundantly.

ABSTRACT

This report presents the design and implementation of a GSM based Street light control system. This system enables the user to switch ON/OFF street lights automatically at the required time (switched off, during the day and switched on, at night) and also control the street lights through Global System for Mobile communication (GSM). The project is designed with a microcontroller which uses a transistor as a switch to put ON and OFF the street lights automatically when a command is received from the GSM module which was initially sent from a mobile phone with both circuits (GSM and microcontroller circuits) connected through serial ports (RS232 communication). The SMS shows the mobile number of the sender and the time respectively. The pulse width signal was established at the output of the system. Major applications of a GSM based street light control system include prevention of accidents on roads, highway, pedestrians and increase in safety in these vital areas for the benefit of mankind.

TABLE OF CONTENTS

CHAPTER THREE: RESEARCH METHODOLOGY AND DESIGN

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

A Street light, light pole, street lamp, light standard or lamp standard is a raised source of light on the edge of a road or walkway. Modern lamps may also have light sensitive photocells that activate automatically when light is needed or not during dusk, dawn or the onset of dark weather. Studies have shown that darkness results in a large number of crashes and fatalities, especially those involving pedestrians; pedestrian fatalities are 3 to 6.75 times more likely in the dark than in daylight. Street lighting has been found to reduce pedestrian crashes by approximately 50% in the modern world.

Basically, street lighting is one of the important parts of a city's infrastructure where the main function is to illuminate the city streets during dark hours of the day. Previously, the numbers of street lamps are relatively simple but with the development of urbanization, the number of streets increases rapidly with high traffic density. There are several factors needed to be considered in order to design a good street lighting system such as; night time safety for community members and road users, also provide public lighting at cost effective and the reduction of crime.

GSM based street light monitoring and control system is an automated system designed to increase the efficiency and accuracy by automatically timed controlled switching of street lights. GSM based street light monitoring and control system consists of a designed microcontroller which on setting of time, switches ON/OFF the street lights and dims at 12 midnight for reducing power consumption and when any movement is detected, it becomes bright. This is smart way of managing street

lighting systems. There are basically two modules which include the client side and the server side. The client side consists of the GSM modem which is further connected to the microcontroller, the server side consists of the cell phone.

The latest trend in the technologies related to wireless communication has led to the emergence of several engineering designs for human requirements. The creeping interests in the wireless and GSM based projects, brought up the idea of developing a simpler, multipurpose, cost-effective design to control the on-off street lights via short message service (SMS). Commands are sent to street light for night lighting Applications system through user mobile as data through SMS (Short Service Messages) providing a cost effective, reliable far reaching access to the user. The coded SMS is sent to the light relay system to base station controller that receives the messages, decodes the messages, initiates required automation operations and responds to the successful initiations by a reply to the user.

In recent years there has been an increased amount of attention paid to the condition of electrical distribution systems, including those supplying street lights. The consequences of these incidents range from pedestrians reporting a "tingling" sensation to cases which have resulted in fatality. The application is designed in such a way that we place light sensors in all the street lights circuit and which are responsible to switch on and off automatically. Once the lights are switched on, current sensors placed at every light pole are responsible to report problem status to the centralized system with the help of GSM module attached with the circuit. With the status available in the centralized system, the workman now can easily locate the faulty light for repair hence reducing the time to search it and repair.

In addition, providing street lighting is one of the most important and expensive responsibilities of a city. Street lighting is particularly a critical concern for public authorities in developing countries

- To design a lighting system which targets the energy saving and autonomous operation that is affordable for the streets.
- To use wireless sensor Networks; using GSM for streetlight monitoring and control.

1.5 SCOPE OF THIS PROJECT

This project focuses on a development of an intelligent street lighting system controlled by a Global System for Mobile Communication Network for urbanization. The concept of the street lighting system is to switch on and off automatically using the GSM network during climatic changes (day and night) and also sensible to street light fault detection.

GSM based street light control system consists of a designed microcontroller which on setting of time, switches ON/OFF the street lights and dims at 12 midnight for reducing power consumption. This is smart way of managing street lighting systems. There are basically two modules which include the client side and the server side. The client side consists of the GSM modem which is further connected to the microcontroller, the server side consists of the cell phone.

1.6 SIGNIFICANCE

The need of automatic streetlight system is felt because, very few town corporations and cities in the country have metering facilities for streetlight consumption. Most of the cities pay the bill to respective electricity board based on the number of fittings in the rural and urban area. And there is no proper and efficient control system for the streetlight according to the needs.

The concept of this project would play a vital role in the development of various cities in the world which can be considered to be one of the important parts of a city's infrastructure where the main function is to illuminate the city's streets during dark hours of the day. Previously, the

because of its strategic importance for economic and social stability. The proposed plan for street light monitoring and control system can provide automated street lighting maintenance. This maintenance can also enable municipalities to expand street lighting to additional areas, increasing the availability of street light for all the streets and also other underserved areas. In addition, improvements in lighting quality and expansion in services can improve safety conditions for both vehicle traffic and pedestrians.

1.2 STATEMENT OF THE PROBLEM

Street lighting systems, particularly within the public sector, are still designed according to the old standards of reliability and they don't exploit the most recent technology. In early days, there was no technique for controlling the streetlights remotely which increased the demand for human labour to maintain the street light. Through manual working system, street lights cannot be monitored dynamically and therefore, results to improper management of power.

1.3 AIM

The aim of this project is to design and construct a simple model of a GSM based street light control system that efficiently defines the control of street lightning system and thereby saving electricity which is a major concern worldwide.

1.4 OBJECTIVES

The objectives of this project are;

- To provide automatic control of street light.

CHAPTER TWO

THEORETICAL BACKGROUND

2.1 AN OVERVIEW OF A STREET LIGHTING SYSTEM

A Street light is a raised well-spring of light on the edge of a road or walkway, which is used to give light when it is required. Street light assumes a critical part in the safety and security of boulevards and open spots. Nowadays, street lighting must be smarter to act in accordance with new enactment, ecological difficulties and use of energy. Energy (power) is an imperative item for developing countries, therefore, essential is its proficient use. Currently, developing nations are noticeable among other energy squandering nations for the absence of any energy products such as street lighting, home lighting and industrial lighting. The most noticeable wastage of energy (power) occurs in street lighting [1]. The primary extent of street lighting is the expansion of human life quality of the dark period of the day. Street light can be controlled by two methods, namely manual method and automated method. In manual method, the street lights are controlled by the humans and the control switch will be available in each of the street lights [2]. In automated method, automation is intended to reduce the manpower. Automated street light system considers some factors to provide the safety of road walkers such as lighting.

Street lighting systems, particularly within the public sector, are still designed according to the old standards of reliability and they do not exploit the most recent technology. Electricity is the major requirement in the developing countries all over the world, so majority of the power is consumed by the street lights [3].

Furthermore, wastage of power occurs when controlling the street lights manually. In early days there was no special controlling technique to control the street lights remotely, so

numbers of street lamps are relatively simple but with the development of urbanization, the number of streets increases rapidly with high traffic density. There are several factors needed to be considered in order to design a good street lighting system such as; night time safety for community members and road users, also providing public lighting at cost effective to help in the reduction of crime and equally helps balance improper management of power, thereby increasing the efficiency and accuracy of street lights when working under normal conditions.

1.7 ORGANIZATION OF THE PROJECT

The structure of this work titled "GSM based street light control system" consists of five chapters. Chapter two concentrates on the literature review in which extensive survey work has been accounted with respect to the street light control system and explains the merits and demerits of all the street light control systems, which was taken through research papers published during the period of 2008-2014. Chapter three shows the step by step procedure used for the hardware implementation of the streetlight control system of the project. Chapter four focuses on the installation and testing of this GSM based street light control system unit anywhere applicable most especially in the rural and urban areas. Finally, chapter five gives the conclusion, limitations and future recommendations of this project work.

power wastage was more. Through manual working system, the street lights cannot be monitored dynamically and maintenance expenses will be high.

In the present world, most street lighting system is to fulfil their primary purpose of casting light onto dark roadways, parking areas and public spaces. Street lighting system is increasingly evaluated for how well it reduces power consumption; improve safety for both drivers and pedestrians.

2.1.1. MANUAL STREET LIGHT CONTROL SYSTEM

In the early days, the street lights were operated manually because each street lamp consisted of a control unit. Following that, another method has been used such as optical control method and time control method. In optical control method, light sensitive device-control is used to switch OFF light automatically in the morning and switch ON automatically after the sunset. Time control method used time control to switch ON/OFF light based on timing [4]. The above method has disadvantages such as power loss and high cost.

2.1.2. AUTOMATED STREET LIGHT CONTROL SYSTEM

Automated street lighting system avoids power loss and maintenance cost by using latest technologies such as LED Light technology and GSM (Global System for Mobile Communication). It is cost effective, energy efficient, and also convenient for maintenance [5].

2.2 GSM TECHNOLOGY

GSM stands for Global System for Mobile Communication. It is a digital cellular technology used for transmitting mobile voice and data services. The concept of GSM emerged from a cell-

based mobile radio system at Bell Laboratories in the early 1970s. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard. GSM is the most widely accepted standard in telecommunications and it is implemented globally.

Global System for Mobile Communication is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz time-slots. GSM operates on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world. In the US, GSM operates in the bands 850 MHz and 1900 MHz; it owns a market share of more than 70 percent of the world's digital cellular subscribers. GSM makes use of narrowband Time Division Multiple Access (TDMA) technique for transmitting signals [6]. GSM was developed using digital technology. It has an ability to carry 64 kbps to 120 Mbps of data rates.

Presently GSM supports more than one billion mobile subscribers in more than 210 countries throughout the world. GSM provides basic advanced voice and data services including roaming services. Roaming is the ability to use your GSM phone number in another GSM network. GSM digitizes and compresses data, then sends it down through a channel with two other streams of user data, each in its own timeslot [7].

2.2.1. GSM MODEM

A GSM modem is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. A GSM modem requires a SIM card to be operated and operates over a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connection.

A GSM modem can also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on your computer. The GSM modem has wide range of applications in transaction terminals, supply chain management, security applications, weather stations and GPRS mode remote data logging [8].

2.2.2 OPERATION OF GSM MODULE

A GSM module is designed for communicating with standard communication interfaces like RS-232 (Serial Port); USB etc. so that it can be easily interfaced with a computer or a microprocessor / microcontroller based system. It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Also they have IMEI (International Mobile Equipment Identity) number similar to mobile phones for their identification. A GSM module can perform the operation of Receiving, sending or deleting SMS messages in a SIM. The module needs AT commands for interacting with processor or microcontroller, which are communicated through serial communication. These commands are sent by the controller/processor. The module sends back a result after it receives a command [9]. From the circuit diagram below, a GSM modem duly interfaced to the Microcontroller through the level shifter IC Max232. The SIM card mounted GSM modem upon receiving digit command by SMS from any cell phone sends data to the Microcontroller through serial communication. While the program is executed, the GSM modem receives command 'STOP' to develop an output at the Microcontroller; the contact point is used to disable the ignition switch. The command sent by the user is based on an intimation received by him through the GSM modem to'ALERT'a programmed message only if the input is driven low. The complete operation is displayed over 16×2 LCD display. The figure 2.1 shows the GSM module circuit [10].

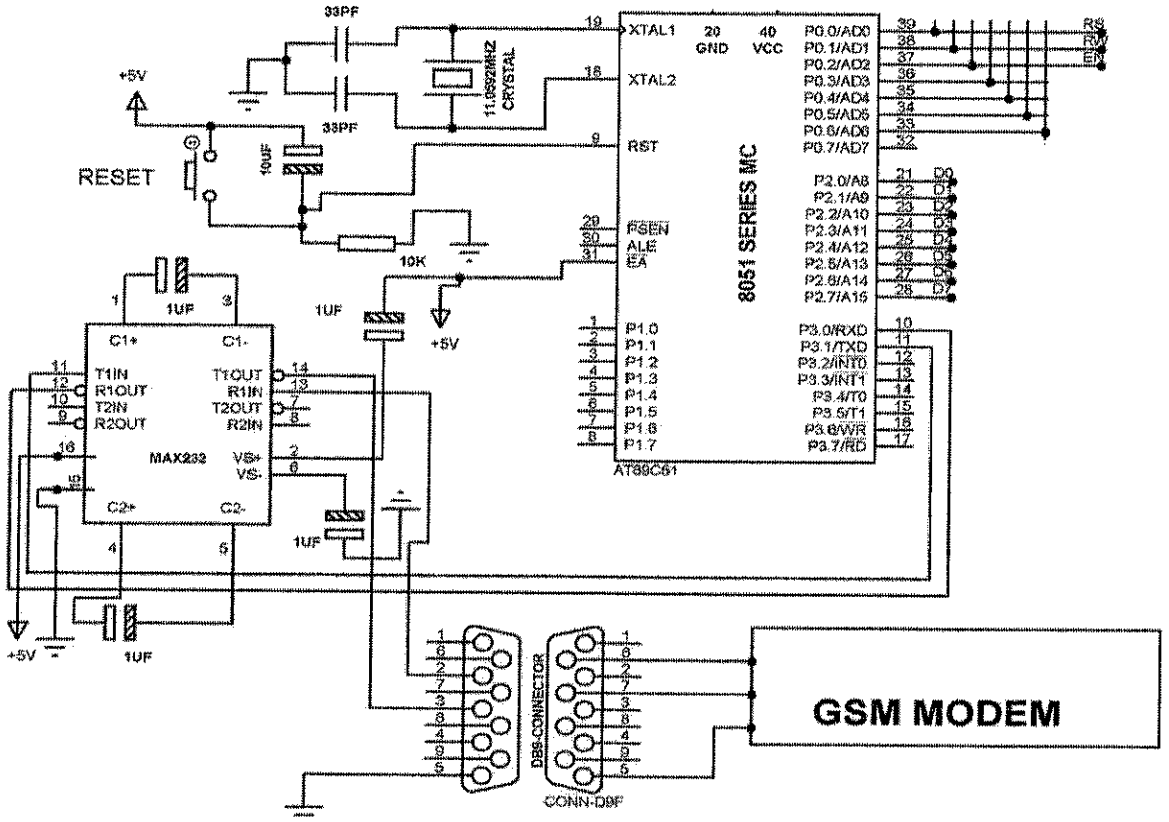

Figure 2.1: GSM Module Circuit

Features of GSM Module:

There are some basic features of a GSM module for various operations which are listed below;

- Improved spectrum efficiency
- International roaming
- Compatibility with integrated services digital network (ISDN)
- Support for new services.
- SIM phonebook management
- Fixed dialling number (FDN)

- ❖ Real time clock with alarm management
- ❖ Uses encryption to make phone calls more secure
- ❖ Short message service (SMS)

2.3 METHODS FOR ACTIVATION

This Monitoring and Control system having three different modules;

- ❖ Controller for RF and Machine
- ❖ GSM
- ❖ PC -Data Base Storage System

➢ **Controller for RF and Relays**; this is divided into two different modules,

a) Serial Communication

b) Driver for four Relay control

c) RF Communication

➢ **PC**; This is divided into three modules,

a) RS232 communication (Serial Communication)

b) Display module

c) Data Base Storage System

➢ **GSM** (Global system for mobile communication)

a) GSM communication technique is used for long range communication by SMS.

b) The long range communication is utilized between main-server and sub-server.

Some of the Features of this system are as follows;

1) To automate Street Light error testing and debugging through mobile via SMS Communication.

2) Secure this system through GSM technologies.

By sending a SMS to microcontroller circuit by the help of GSM circuit through mobile, the unit of street light automatically switches ON/OFF. LED should indicate whether the street light is on or off and it should be controlled by using fix timer. Therefore wastage of time and requirement of a skilled worker is reduced to a great extent and more parameters and devices can also be monitored and controlled [11].

2.4 REVIEW OF PREVIOUS WORK

The issue of the street light control system has been considered broadly in the background of power consumption, maintenances, cost, etc. Extensive survey work has been accounted with respect to the street light control system. Some vital overview work identified with this topic includes;

The author in [12] depicts a remote control system for managing and checking status of street light. It is developed by ALBATROS device, master board and slave board. Master board is situated inside electrical panels and slave board is situated every street light. The communication achieved between master and slave board by using GPRS-GSM and power line. ALBATOROS device fused inside the slave board. This system allows turn ON/OFF the street light, monitoring

the street light, checking current status on the street light and reducing power consumption by utilizing a device ALBATROS. Also, the author in [13] proposed an advanced energy efficient street lighting driving system based on various performance metrics like power consumption, street light automatically modifies their working condition according to the environments by utilizing LED lamps, Ether-based communication interfaces, a digitally-controlled multi-phase driving system for LED light. The author in [14] equally presented an automated reliable and efficient street light remote control system. The system is planned by AT89C2051 and (SC1128) microchip. The system is used to monitor the street lamp, reduce the human power, power consumption. On that note, the author in [15] examined a solar panel based LED street lighting system. Here the lighting system comprises a solar panel as a primary source, battery as a secondary source and LED consider as a lighting source. Using (DC) converter, batteries are charged during day time through solar panel. DC converter is controlled by Maximum Power Point Tracker (MPPT) algorithm; through this the system can attain reducing power consumption.

In view of this, the author in [16] presented a wireless street light control system, the system focused around (SCM MSP430F149), electric power carrier communication and wireless communication technology (nRF401 chip). In this system the lamp will shut down when communication network failure. Controlling the street light wirelessly, so maintenances cost and power consumption is reduced. Another author in [17] analyzed a new application on a remote monitoring system for the street lamp, based on ZIGBEE technology. This system provides a solution about node deployment. The maximum distance between the street lamps is 40M for transmitting information about lamp to the controller. Moreover, the author in [18] discussed controlling solar LED street lights utilizing programmed control circuit. This system consists of

three working modes such as light control delay, delay quenching and delay plus low power. Light control delay is used to turn OFF lights in daytime and turn ON light after sunset. Delay quenching mode is used to turn ON/OFF lights automatically based on setting time. Delay plus low power is used to changing the pulsed lighting power based on setting time. The above three working modes can be used in different situations flexibly and conveniently. This system can be used for the place such as streets, shops and so on. In line with this, the author in [19] presented intelligent street light control system based on timing control and photo electric control. It allows street lights automatically turn ON/OFF. If there are no vehicles passage or pedestrians the street light will turn OFF automatically. The LED Street light turns ON automatically, when the human passed within the distance 10M, through this the system can reduce power consumption. Similarly, the author in [20] proposed a street light control system which utilizes PIC microcontroller and GSM technology. The street lights turn ON/OFF automatically based on the RTC (Real Time Clock). Information about the street lights and street light maintenances are informed through GSM. Another author in [21] discussed about controlling street light remotely using ZIGBEE and sensors. The system uses various sensors like motion sensors, light sensor to ensure reduction of power consumption, maintenance cost and human power. The author in [22] reviewed energy conservation in lighting system based on various lighting technologies such as incandescent light, compact fluorescent lamp and Light Emitting Diode (LED). Based on this, the author in [23] proposed an energy efficient street lighting system based on ZIGBEE wireless technology, GSM modem, and LDR sensor interface with (ATMEGA16) microcontroller. The street lights can be controlled by using mobile phones, the option in the mobile phones is ON/OFF/DIMMING. Utilizing ZIGBEE technology the power consumption is reduced. On the contrary, the author in [24] developed a wireless street light control system based on wireless

sensor network interfaced with (JN5139) microcontroller. Street lights should be switched ON/OFF remotely by an admin. The system provides an optimal cost saving for maintaining the street lights with (ATME189C51) microcontroller which Controls and monitors street lights using GSM via short message service. The system provides 70% power and manual operator is saved. Another author in [25] introduced a way of monitoring and controlling the street lights using GSM with (89C51) microcontroller. It is an android and IOS based application that can be developed for mobile phones for controlling the street lights. This system reduces power consumption up to 50% whereas the author in [26] suggested a new method for monitoring and remotely sensing the street lights by using computer vision and image processing technique. Utilizing the image processing technique; the system gives a clear picture of damaged street light to the controller and the system implementation cost is high. The authors in [27] worked on intelligent wireless street light control and monitoring system, which integrates new technologies, offering ease of maintenance and energy savings. Using solar panel at the lamp post by using LDR it is possible to save some more power and energy, and also we can monitor and control the street lights using GUI application, which shows the status of the lights in street or highway lighting systems. The authors in [28] worked on a GSM Based Remote Control System of High Efficiency Intelligent Street Lighting System using a Zigbee Network of Devices and Sensor. New intelligent and smart street light system is designed with wireless technology for maintenance and network of sensors for controlling. In which, they used high efficiency LED lamp which consumes less energy with high life time and which are supplied with renewable energy of solar panels. Nevertheless, the authors in [29] introduced the design of a Wireless Framework for Energy Efficient Street Light Automation suggested an intelligent management of the lamp posts by sending data to a central station by ZigBee wireless communication. With

the suggested system, maintenance can be easily and efficiently planned from the central station, allowing additional savings. In line with this, the authors in [30] worked on ZigBee Based Remote Control Automatic Street Light System, This streetlight control system helps in energy savings, detection of faulty lights and maintenance time and increase in life span of system.

CHAPTER THREE

RESEARCH METHODOLOGY AND DESIGN

3.1 METHODOLOGY

For the hardware implementation of a streetlight control system, a GSM module will be used. It is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. A GSM module requires a SIM card to be operated over a network range subscribed by the network operator. GSM based street light control system is basically used to control the street lights automatically by the help of GSM module (global system for mobile communication). It is designed to perform and increase the efficiency of street light even more at night.

3.2 SYSTEM ARCHITECTURE

The overall system architecture consists of two major modules which are the GSM module and the microcontroller. The system architecture also consists of the street lighting units and the buffer as the functional block diagram of the GSM based streetlight control system is shown in Figure 3.1.

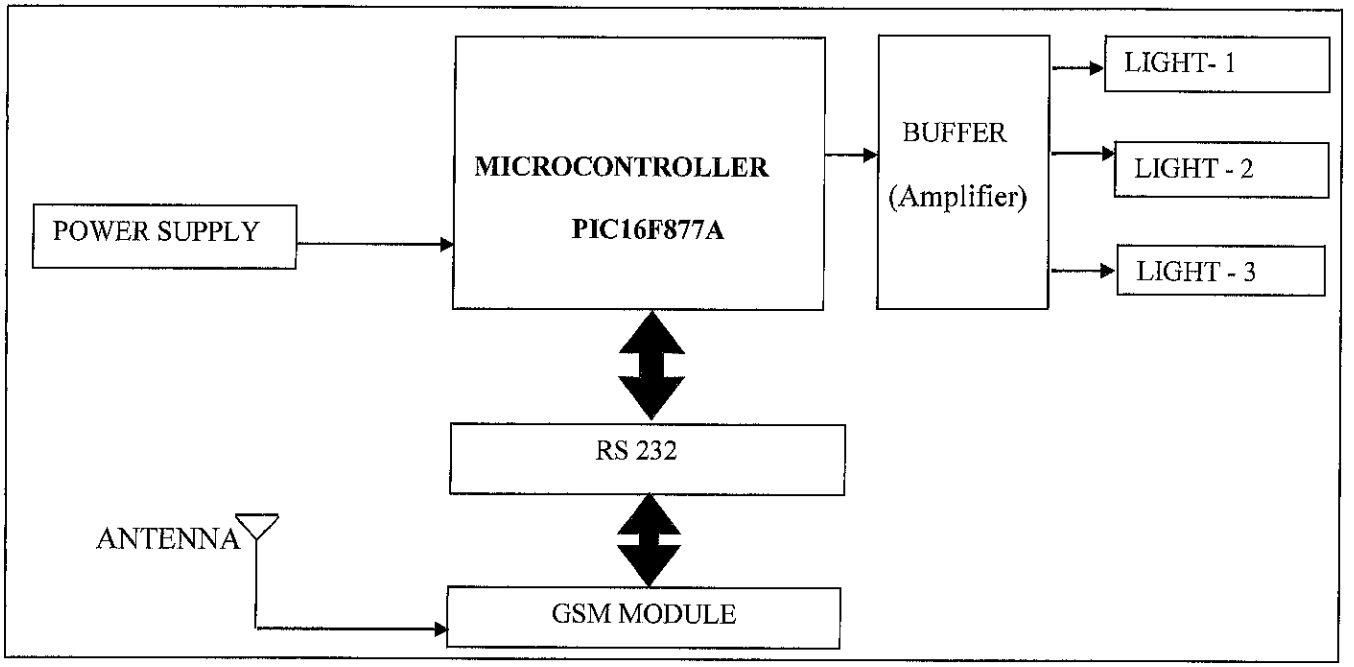

Figure 3.1: Block diagram representation of the GSM based streetlight control system.

3.2.1 POWER SUPPLY

For the design of this system, a 5V power supply which consists of some important components like the step down transformer, voltage regulator, capacitors and so on is used, which is needed for converting mains AC voltage to a regulated DC voltage. The output of the power supply is a dc source and is used to bias all the active components of the system including the microcontroller.

3.2.2 GSM MODULE

A GSM module is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. The GSM module

requires a SIM card to be operated and operates over a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connection.

3.2.3 STREETLIGHT SYSTEM

Automated street lighting system avoids power loss and maintenance cost by using latest technologies such as LED Light technology and GSM (Global System for Mobile Communication). It provides cost effective, energy efficient, and it is convenient for maintenance. In the present world, most street lighting systems are constructed to fulfil their primary purpose of casting light onto dark roadways, parking areas and public spaces. Street lighting system is increasingly evaluated for how well it reduces power consumption; improve safety for both drivers and pedestrians.

3.2.4 ANTENNA

The frequency of the GSM antenna ranges between 800MHz and 1,990MHz. The GSM antennas have been used by major GSM equipment manufacturers worldwide. The antenna in the GSM module is majorly used to increase the strength of weak signals of the network during communication.

3.2.5 RS-232C NETWORK INTERFACE

RS-232 stands for Recommend Standard number 232 and C is the latest revision of the standard. The serial port on the GSM and microcontroller circuit is a full-duplex device meaning that it can send and receive data at the same time. In order to be able to do this, it uses separate lines for transmitting and receiving data. Although some types of serial devices support only one-way

communications and therefore use only two wires in the cable; the transmit line and the signal ground.

3.2.6 BUFFER AMPLIFIER

In this design, a buffer amplifier is used. It (sometimes simply called a buffer) is one that provides electrical impedance transformation from one circuit to another. It is connected to the microcontroller to help increase the power of the signal to switch all three streetlights ON/OFF respectively as the signal from the microcontroller does not have the capability to put ON/OFF the lights at the same time.

3.2.7 THE MAIN SYSTEM CHIP-MICROCONTROLLER

The PIC 16F877A microcontroller is used for the design of this project. The microcontroller is a computer control system on a single chip. PIC 16F877A is a 40-pin 8-Bit microcontroller. It is a family of Harvard architecture and manufactured by Microchip technology. PIC stands for Peripheral Interface Controller, used by industrial developers due to wide availability space and serial programming for flash memory. It has many electronic circuits built into it, which can decode written instructions and convert them to electrical signals. The microcontroller will then step through these instructions and execute them one by one.

Therefore, the microcontroller in this design as shown in the figure 3.2 can be used to control the street lights by using the exact procedures. Microcontrollers are now changing electronic designs. Instead of hard wiring a number of logic gates together to perform some function we now use instructions to wire the gates electronically. The list of these instructions given to the microcontroller is called a program.

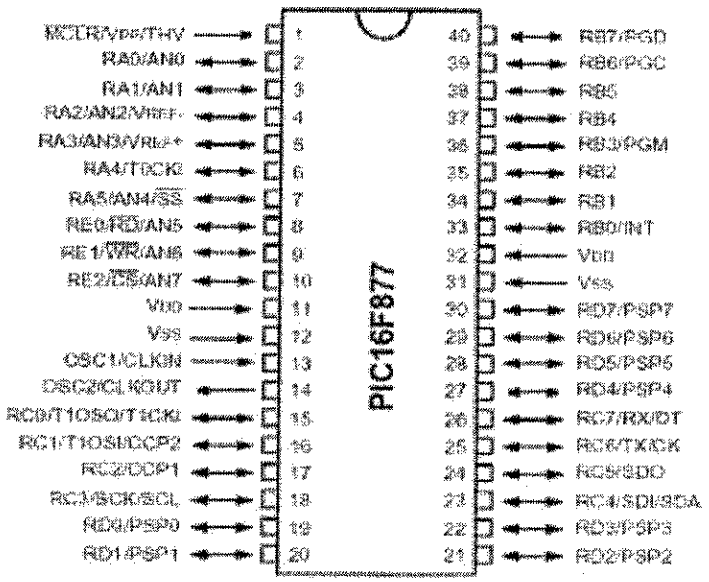

Figure 3.2: Pin diagram of Microcontroller PIC16F77A.

3.3 COMPLETE CIRCUIT DIAGRAM

This comprehensive schematic of the GSM based Street light Control System as shown in the figure 3.3 was designed with ISIS Proteus Software.

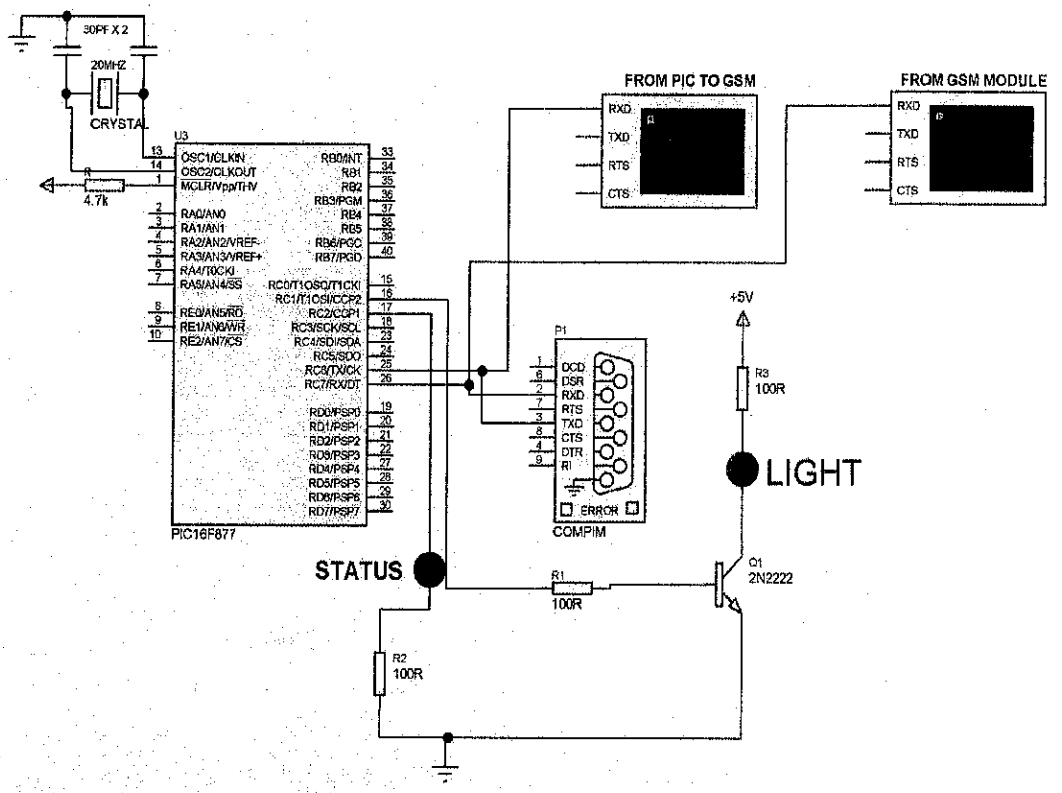

Figure 3.3: Comprehensive Schematic of the project

3.4 PRINCIPLE OF OPERATION

The project is designed with a PIC16F877A microcontroller which uses a transistor as a switch to put ON and OFF the street lights automatically when a command is received from the GSM module which was initially sent from a mobile phone with both circuits (GSM and microcontroller circuits) connected through serial ports (RS232 communication). The SMS shows the mobile number of the sender, the time and much more information. Therefore, by applying the proposed monitoring and control system, streets can be illuminated with lower power consumption lamps, low operating cost, and environmentally friendly. It is best used without any disadvantage as compared to others and would be the best way of managing a street light system.

Step 1: Connecting the system to power supply

When the system is connected to a regulated power supply for operation, the 'STATUS' light connected to the microcontroller is activated which indicates that the microcontroller is ready to interface with the GSM module to transmit and receive command as shown in the figure 3.4

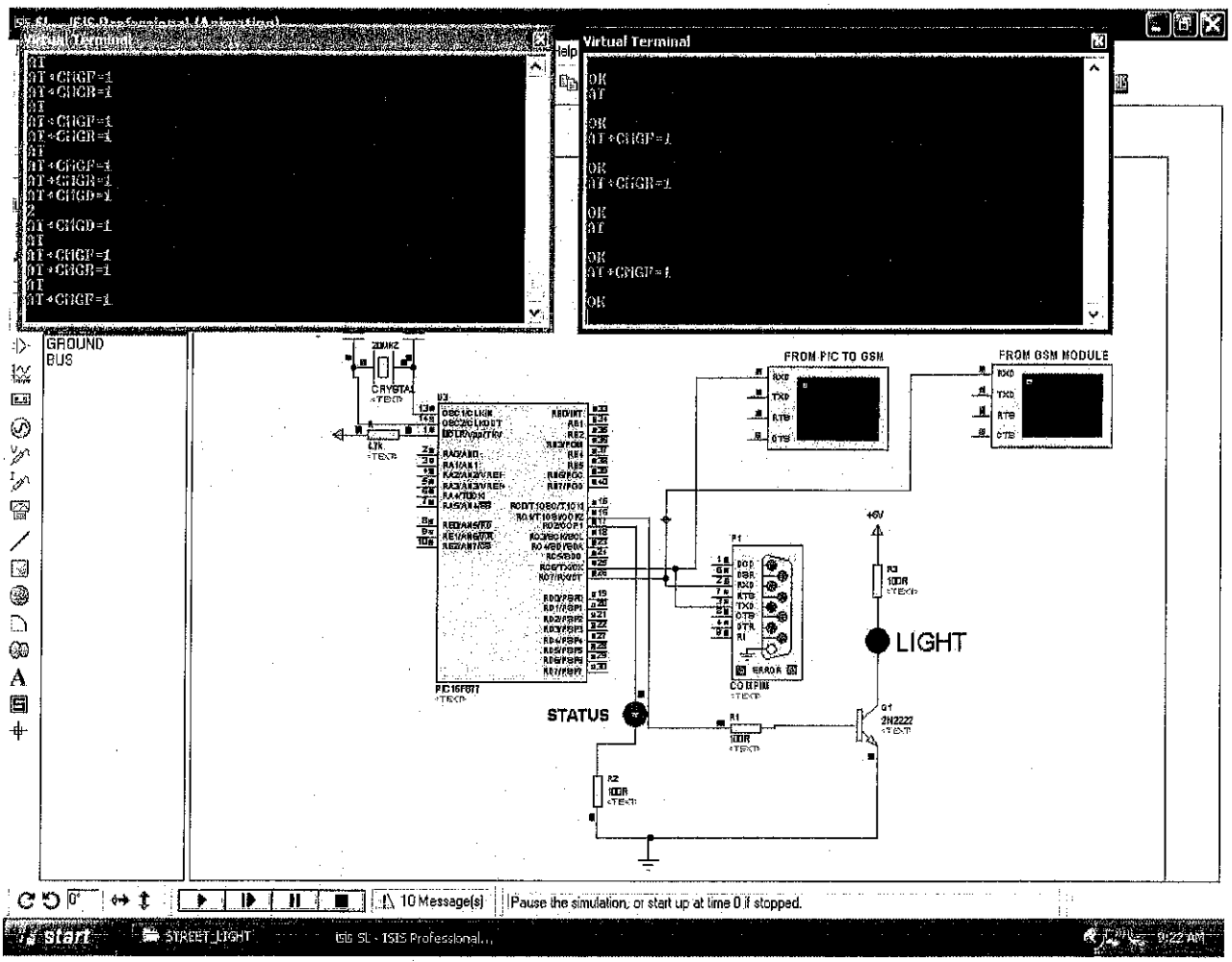

Figure 3.4: connecting the system to mains.

Step 2: AT command

For this design, the AT commands are used to control modems; GSM module which is communicating through RS232 serial communication interface with a microcontroller as shown in the figure 3.5

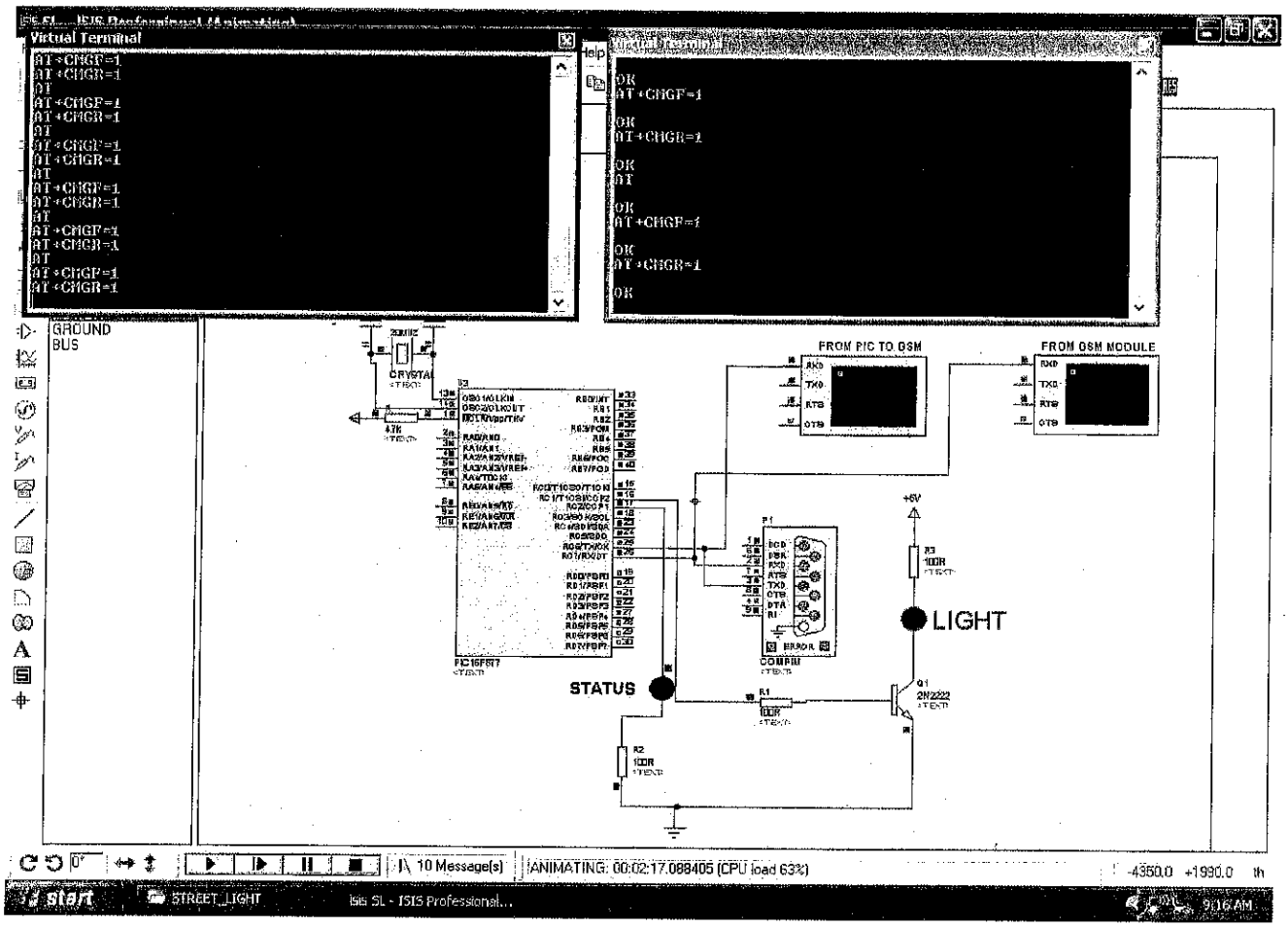

Figure 3.5: sending AT command.

Therefore, to set the module in a text mode in order to receive a text message from the user, an AT command is sent from the microcontroller through the RS232 network interface. The AT command used is: AT+CMGF=1

Step 3: Activating the street light

A text message is sent from the user to the GSM module and immediately, a command is sent to the microcontroller through the serial communication between them as shown in the figure 3.6. Then, the microcontroller performs the operation as instructed by the command to switch ON the street lights.

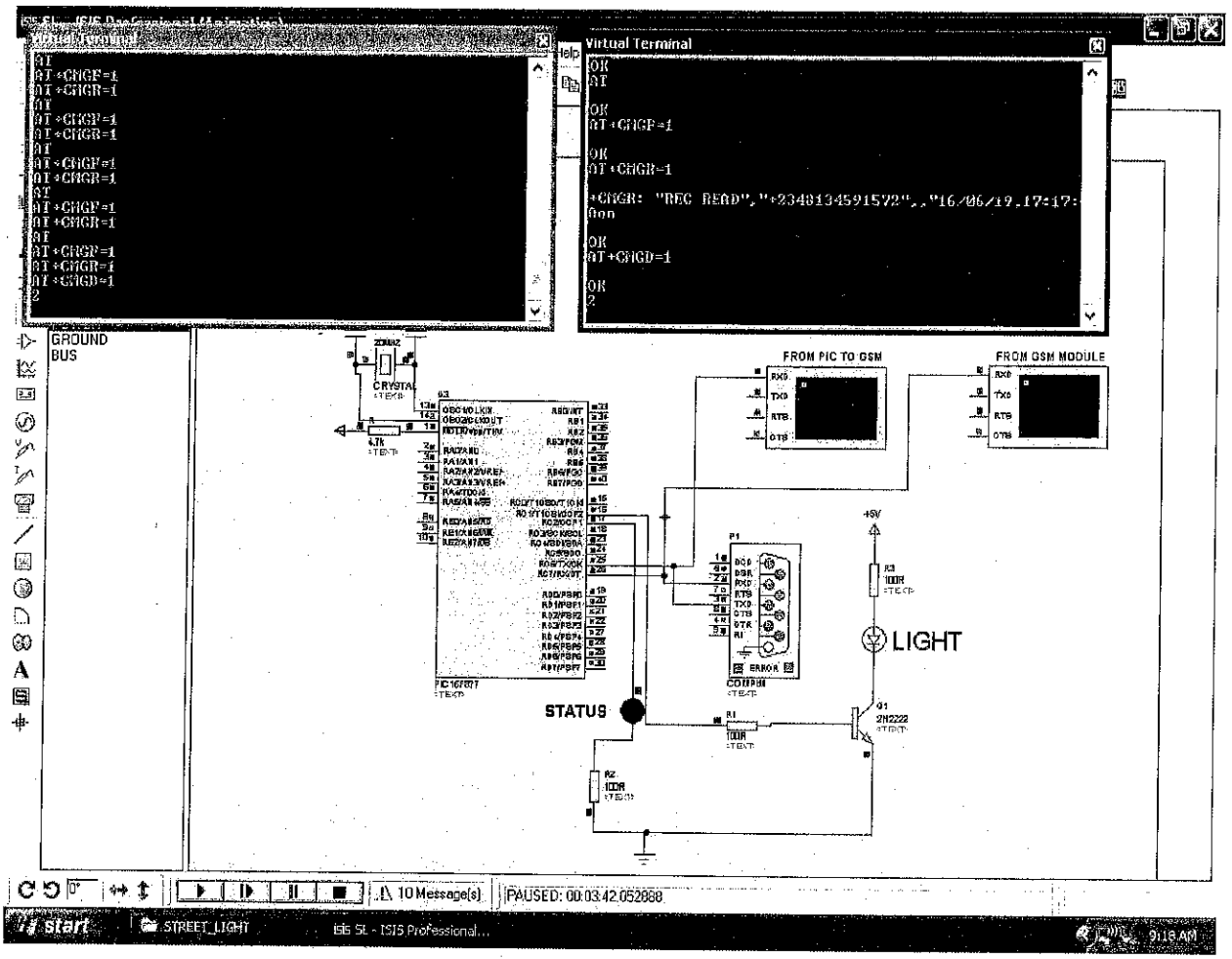

Figure 3.6: activating the street light.

Step 4: Deactivating the street light

The same procedure is repeated for this operation whereby a text message is also sent from the user to the GSM module and immediately, a command is sent to the microcontroller through the same serial communication between them as shown in the figure 3.7. Then, the microcontroller performs the operation as instructed by the command to switch OFF the street lights.

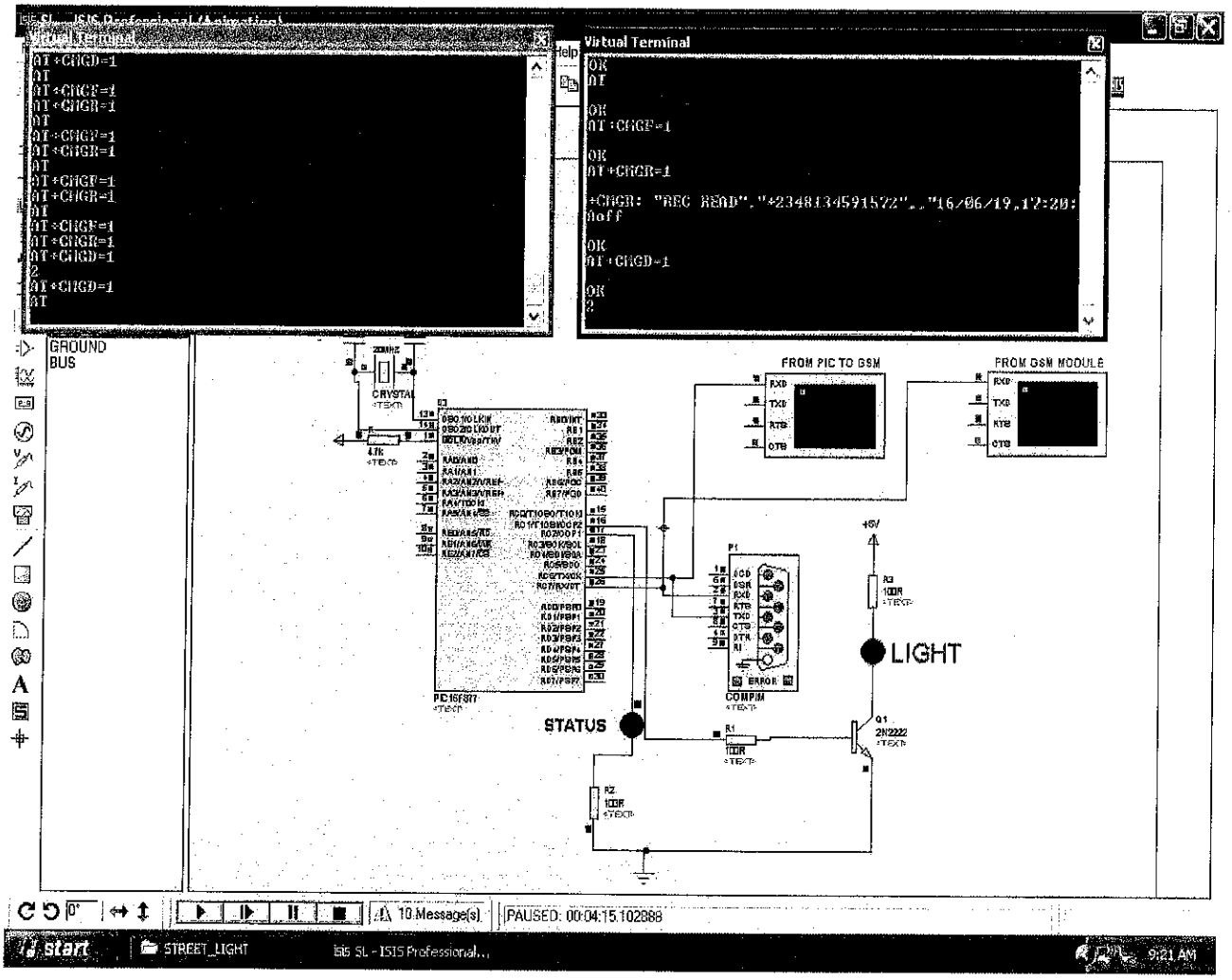

Figure 3.7: deactivating the street light.

3.5 DESIGN CALCULATION

3.5.1 OVERALL SPECIFICATIONS

- INPUT VOLTAGE → 240VAC
- SUPPLY VOLTAGE → 5VDC
- CURRENT→ 100mA
- FREQUENCY → 50Hz

However, a host of resistors were used to oppose the flow of current, thereby protecting the circuit from getting damaged. Also, some capacitors were used to filter out the noise caused in the circuit by passing voltage over some components.

3.5.2 CHOICE OF RESISTOR FOR THE LEDs.

Resistors as we know are electrical components that oppose the flow of current, employed to protect the circuit. Resistors attached between the LEDs and other components in this project are meant to limit the current flowing into the LEDs to prevent any damage to the LEDs.

FOR THE WHITE LEDs

Given that;

Current rating for the LED, Iled= 20mA

Voltage rating for the LED, Vled = 3.2V

Source voltage used, Vs =5V

Therefore, to find the resistance Rr of the resistor to be used, we make use of ohm's law.

$$Rr = \frac{(Vs - Vled)}{Iled} = \frac{5-3.2}{0.02} = 90\Omega$$

$Rr = 90\Omega$

Also, the lower the resistance of the resistor used, the dimmer the LEDs will become. So therefore, to have brighter LEDs, a uniform resistance of $Rr = 100\Omega$ was chosen and used for the LEDs. The light output (brightness) of the each LED is 5990mcd (milli-candela) according to the specifications.

3.6 INTERFACING GSM MODULE WITH PIC MICROCONTROLLER

In the design of this GSM based streetlight control system, the GSM module and pic microcontroller were interfaced together through the serial ports to link both components for communication. It is therefore very easy to interface a GSM modem to a pic microcontroller as most GSM modems have serial interface. The USART (universal synchronous/asynchronous receiver/transmitter) serial input pin RX and TX of the microcontroller are connected to the TXD and RXD of the GSM module. The figure 3.8 shows a block diagram of a GSM module connected to USART module of a pic microcontroller.

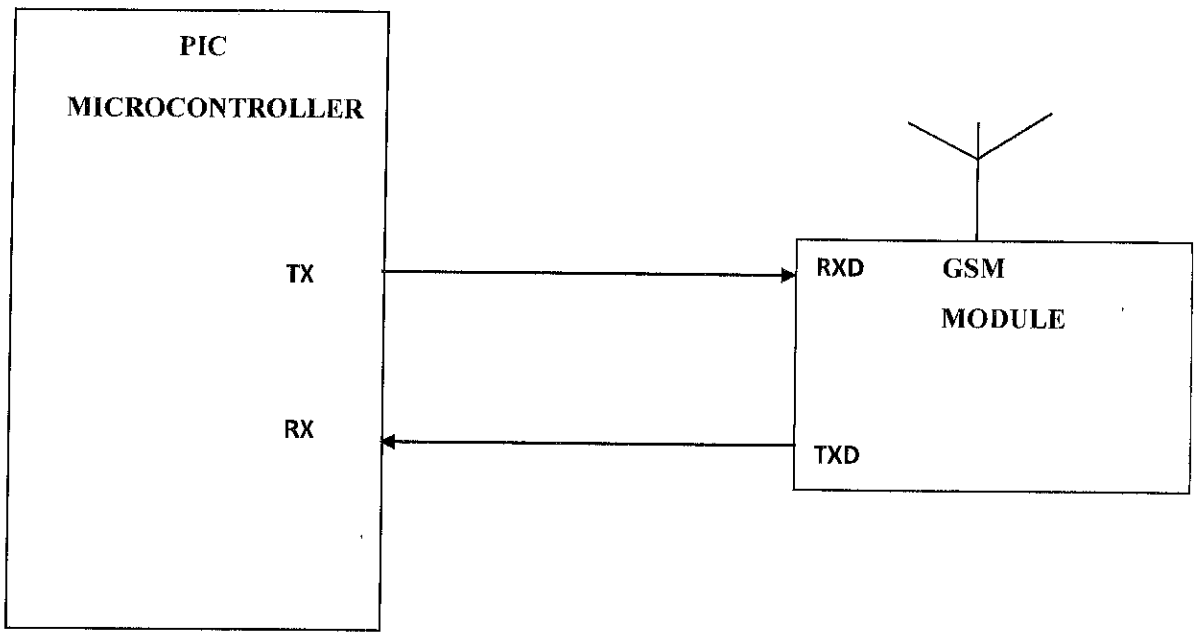

Figure 3.8: GSM module connected to PIC microcontroller.

CHAPTER FOUR

PERFORMANCE ANALYSIS AND TESTING

4.1 DESIGN ANALYSIS

Having designed the GSM based street light control system as presented in the preceding section, the main focus will be on the installation and testing of this GSM based street light control system unit anywhere applicable in the world most especially in the rural and urban areas. This new development will bring about the need for low power consumption in the lighting system.

Moreover, the GSM (Global system for mobile communication) has made the automatic control of street lighting systems more easier and reliable whereby the system operator can control a set of street lights of a city, organization or institution, take for instance, In Federal University, Oye Ekiti. Ekiti state with the use of short message service (SMS) sent from his/her mobile phone to a specified number in the GSM module. This will play a vital role in the reduction of human effort most especially in developing cities where it is implemented.

4.2 TESTING

The hardware design of this project is very important. In other words, it is where the fantasy of the whole idea meets reality. The research carried out on this work is not just on the article gathered but also as a finished hardware. The testing of the project was first done on a printed circuit board whereby the entire component used for the project was fixed properly. Usually it is not expected to work at the first attempt and so each connection terminal was checked carefully to make sure that they are all fitted perfectly on the printed circuit board.

Also, another testing was done when the components have all been soldered on the printed circuit board, before the final work was cased. At this point, the working principle of the project

was tested to make sure it was working perfectly before the circuit was coupled and cased afterwards. An SMS was sent and the outcome is displayed in the figure 4.1 on the GSM based street light control system.

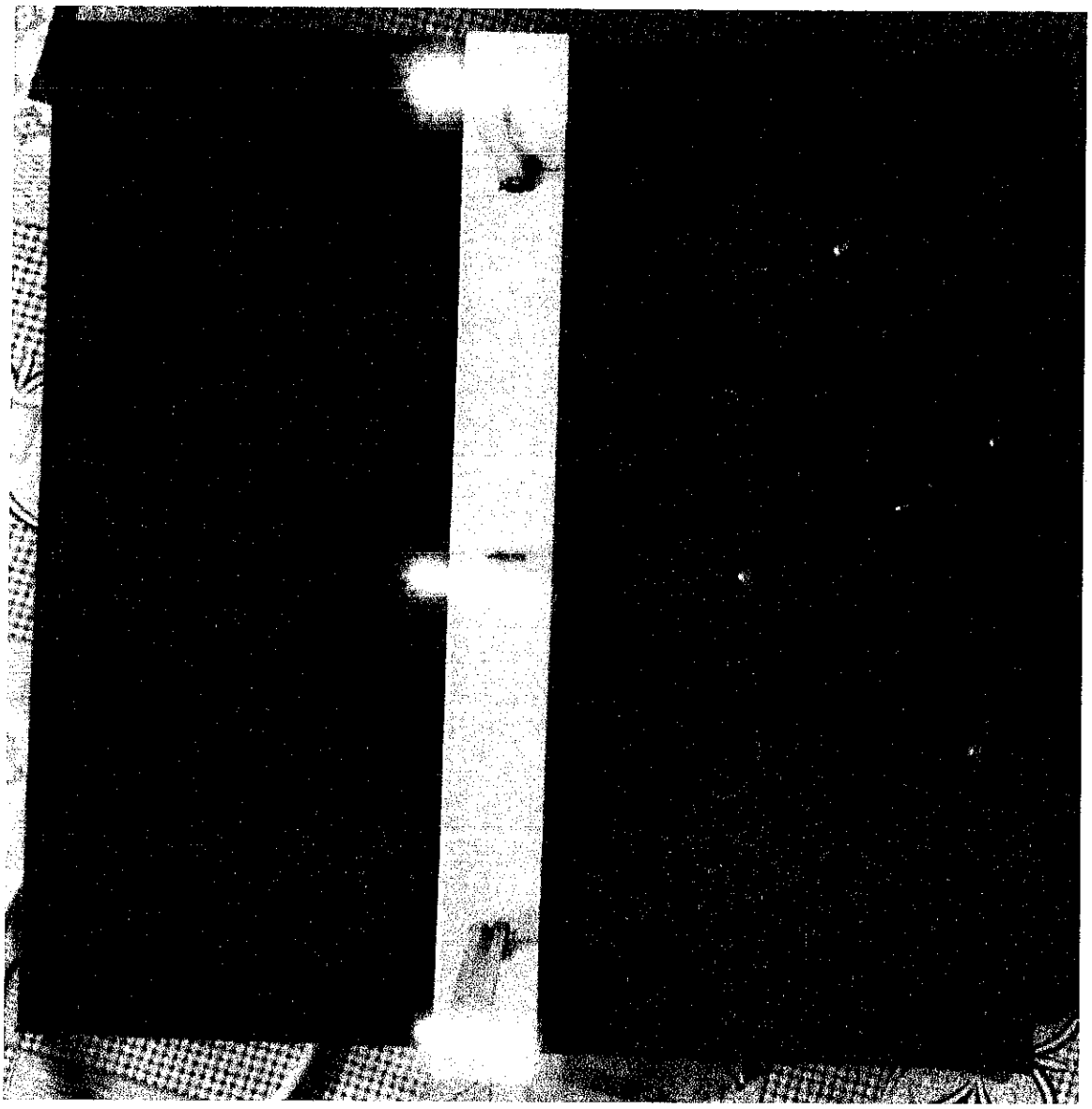

Figure 4.1: Street lights activated with an SMS protocol.

4.3 CONSTRUCTION

The construction of this control system shown in the figures 4.2 and 4.3 commenced with the soldering of the components to the board and was tested respectively.

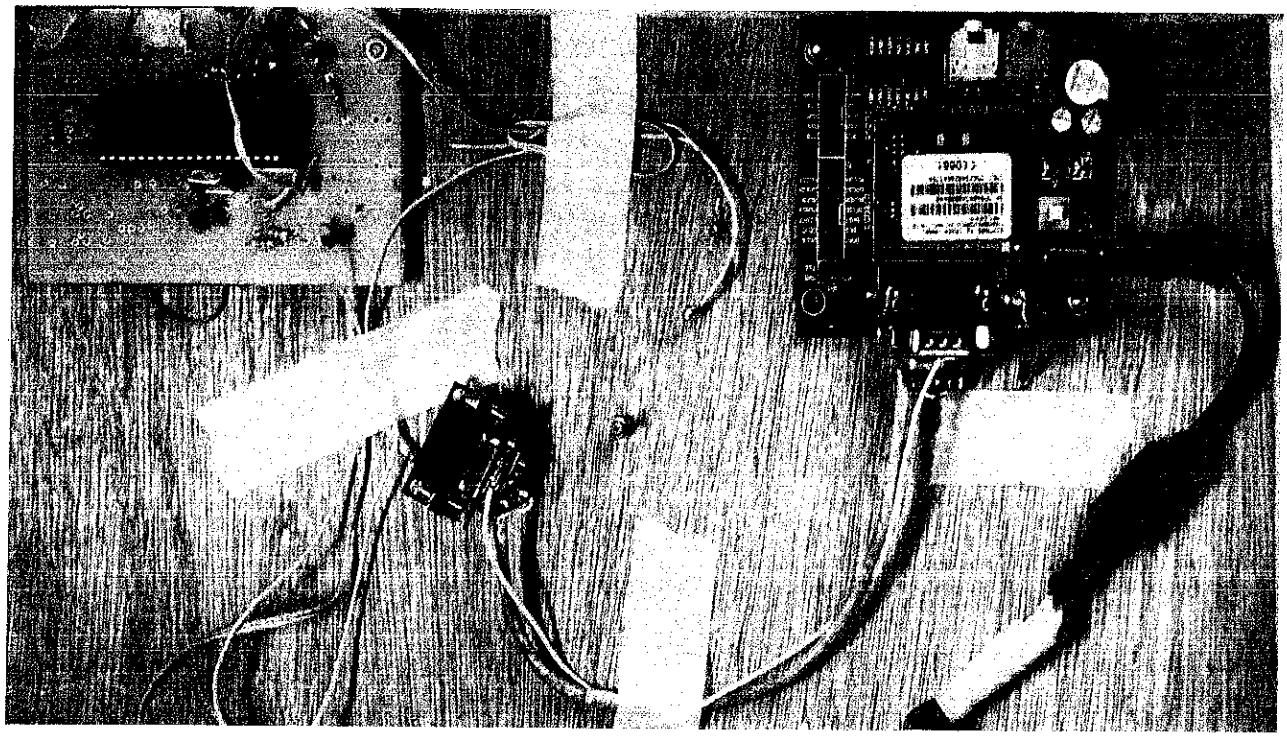

Figure 4.2: Both circuits interfaced together with RS232 serial communication.

During the soldering, some steps were taken;

- The tip of the soldering iron was tinned to avoid dry solder joints.
- Each stage on the board was tested as soldering progressed.
- The shielded cable was connected and terminated properly at each end of the serial ports on the module and microcontroller circuit.
- The wires were rated to match necessary power required, like the mains, jumper wires etc.

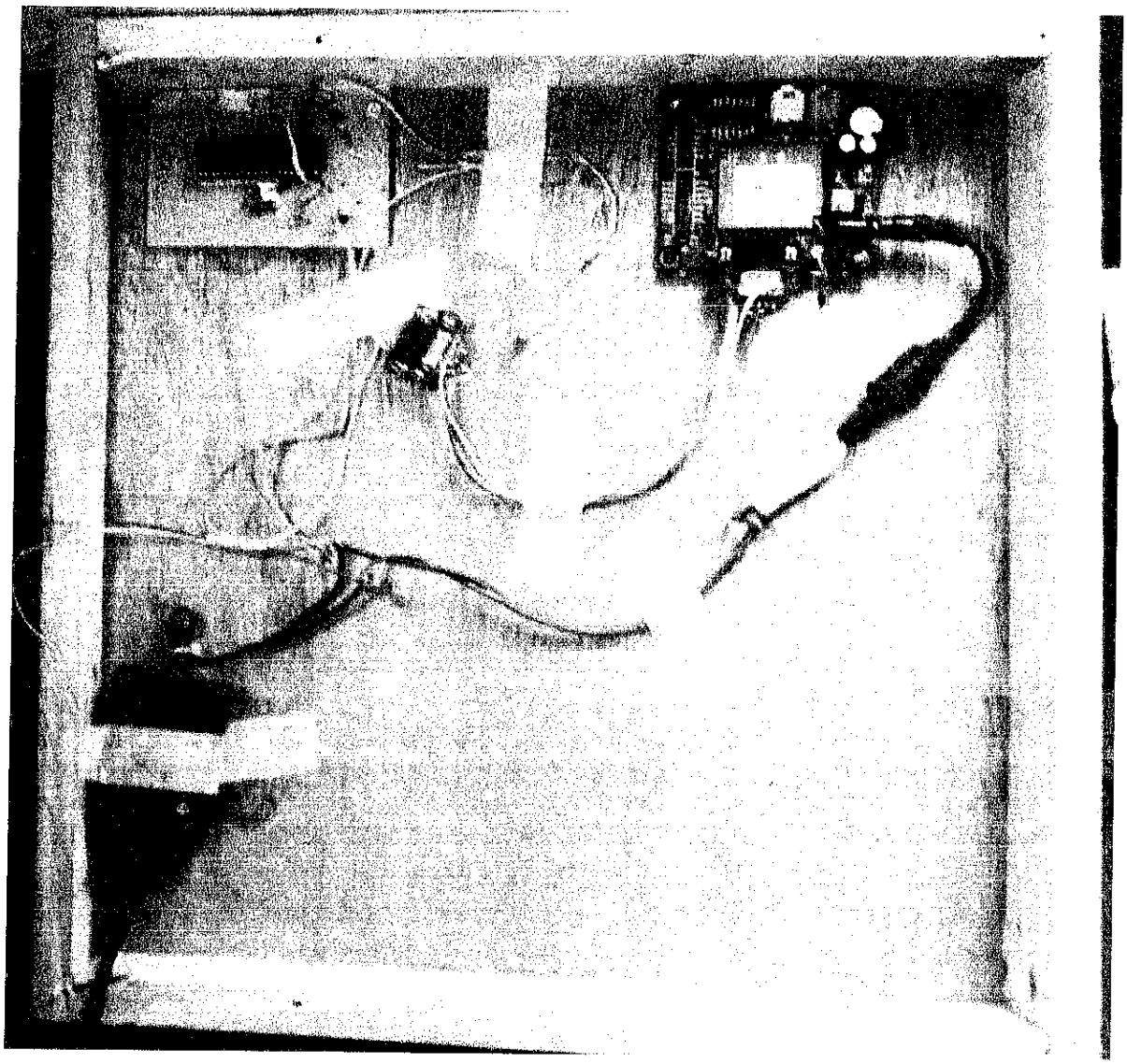

Figure 4.3: Construction of the project.

4.4 PROBLEMS ENCOUNTERED

During the project construction to implementation process, some problems were encountered;

1. During implementation, as the project was plugged to mains, there was increase in the temperature of some components; which was soldered on the microcontroller circuit

which resulted to frequent malfunction of the system. The components were replaced immediately for better efficiency and reliability.

2. During the process of interfacing the GSM module with the microcontroller circuit, it was noticed that the module was not responding to command from the microcontroller due to improper connection within the serial ports. It was necessary to check that either the transmit (TXD) and receive (RXD) pins of GSM module and microcontroller are compatible with each other.
3. During the process of testing the system, it was noticed that any random message sent by the user to the GSM module to switch on or off the lights was accepted. This occurred due to some certain errors in the programming language written and installed into the microcontroller.

4.5 CASING AND IMPLEMENTATION OF THE BASED STREET LIGHT CONTROL SYSTEM.

This system being a prototype was wholly enclosed in a wooden, cuboid-like case with dimensions shown in the table 1.

Table 1: Dimension of the Casing

PARAMETERS	VALUES
Length	40cm
Width	5cm

Also, the street light model shown in the figure 4.4 was designed with a thermoplastic shaped casing with the bulbs hung on each casing.

The implementation of this project was done on a printed circuit board after several simulations were performed. Step by step testing was done before soldering of the circuit commenced on the board. There was a lot of modification in the process of construction which led to the modification of the circuit diagram.

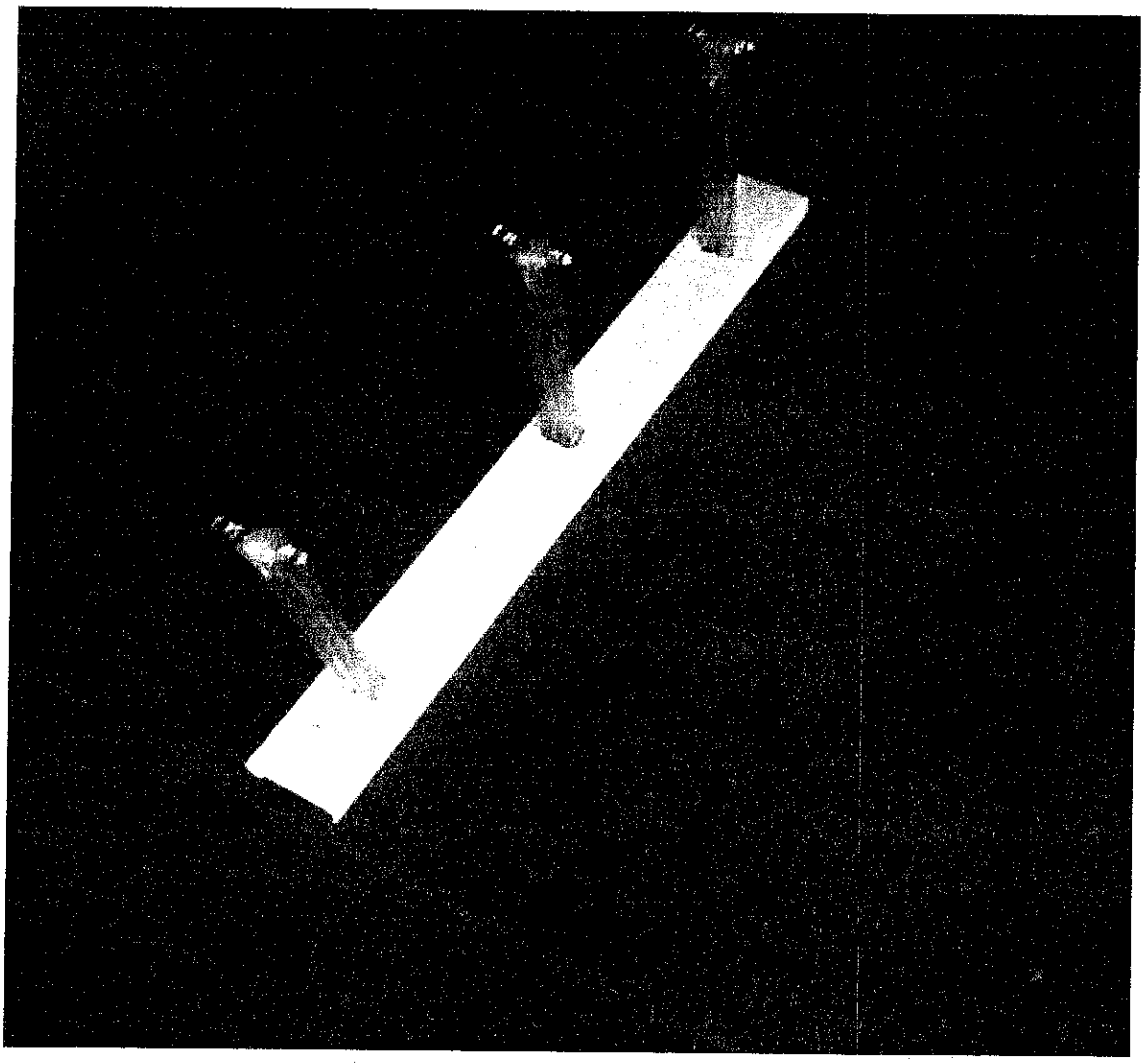

Figure 4.4: Cased project

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

In this project, the design and implementation of the GSM based streetlight control system was successfully achieved. This streetlight control system proposes a new way of reducing power consumption and designing a lighting system which targets the energy saving and autonomous operation on economical affordable for the streets as all the Street Lights can be switched ON/OFF through GSM (Global system for mobile communication) in which the operator sends a text message indicating the command from a mobile phone to the GSM module and thereafter, received by the microcontroller circuit through the RS232 serial communication that links the GSM and microcontroller circuit together and no labour is required for switching ON/OFF the street lights respectively. Doing all these in turn increases the performance and life of the lamps.

In a nutshell, the GSM based Street light control system could be very feasible in today's up growing countries and will be more effective in case of cost, man power and security as compared with today's running complicated and complex light controlling systems. GSM based street light control system puts up a very user friendly approach and could be efficient and accurate when working under normal conditions.

5.2 LIMITATIONS

This GSM based street light control system project has some limitations. Therefore, the limitations of this project include;

1. This GSM based street light control system uses the short message service protocol to switch ON/OFF the bulbs when necessary and any message sent by the user to the GSM module attracts a service charge by the network provider.
2. The use of GSM technology in some geographical area may not be reliable and efficient for this system. This is due to bad or poor network coverage in that area, and any text message sent may not be delivered in order to carry out its operation.
3. This GSM based street light control system does not send a text message back to the operator based on the status of the system (to indicate whether the street light is ON/OFF anytime a message is sent to the system).
4. The system is prone to receive any random message sent by the operator to switch on or off the lights. This is because the program written for the microcontroller to specifically accept a command for the activation and deactivation of the street lights was not assigned. Therefore the security features of this system are not guaranteed as it can be hacked by other users.

5.3 RECOMMENDATION

After the completion of this project work, the following recommendations are necessary so as to achieve a higher efficiency in terms of performance.

1. Future research should be directed towards designing an automated street lighting system that can control the lamps based on environmental conditions with the use of various sensors for instance; light sensors that can detect daylight or darkness.
2. Research should also be done on designing integrating latest technologies like LED Light and using Renewable Source of Energy (Solar Panel) with low cost microcontroller, to efficiently make it an automated street lighting system also with the use of GSM technology.
3. Furthermore, research should be directed towards designing an automated street lighting system that would be switched ON/OFF by the help of a GSM and microcontroller circuit and regulate their communication strategies dynamically when changing network environment.
4. Research should equally be done on designing a GSM based streetlight monitoring and control system in order to reduce time wastage, human effort and manual control of street lights from one control station to another and provide better working efficiency of the system.
5. Research should be directed towards writing a detailed program for the microcontroller for controlling the system accurately. In other words, the microcontroller should only accept the command for switching on or off the street lights and discard any random command to also perform the same function which would reduce security threats to the system.

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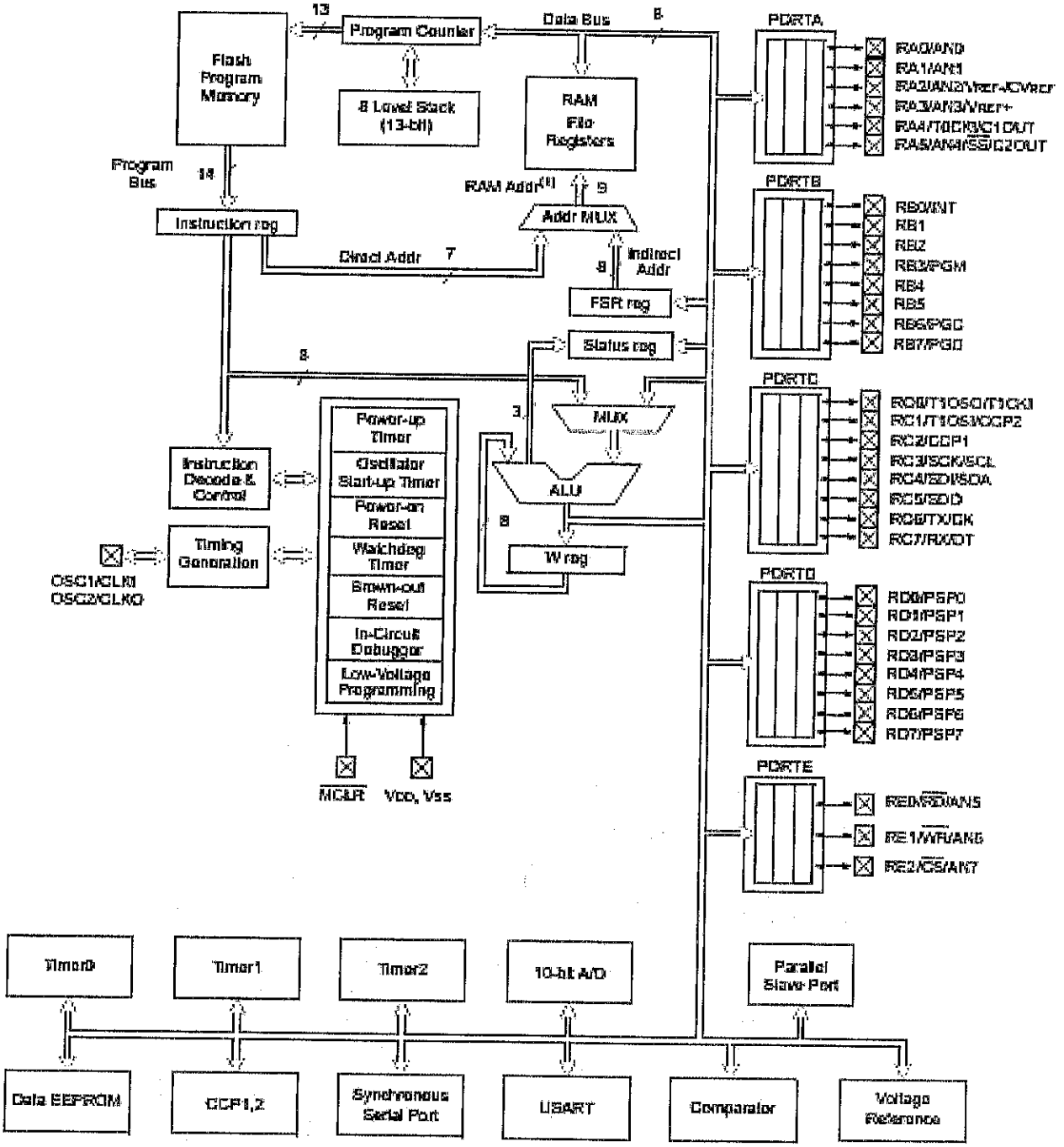
APPENDIX A

PIC16F877A BLOCK DIAGRAM



APPENDIX B

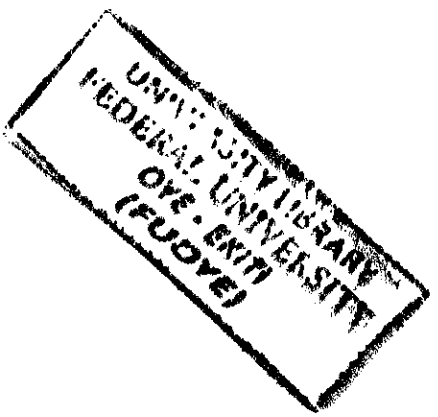
PIC16F877A ASSEMBLER CODE

```
DEFINE OSC 20

@ DEVICE pic16F877A

TRISA=0

TRISB= %00000010

TRISC= %10000000

DEFINE OSC 20

Flash  VAR PORTC.2

Tx     VAR PORTC.6

Rx     VAR PORTC.7

LED    VAR PORTC.1

X VAR BYTE

DATO VAR BYTE


HIGH Flash

PAUSE 200

LOW Flash

PAUSE 200

HIGH Flash

PAUSE 200
```

```
LOW Flash

PAUSE 200

SEROUT Tx, T9600,["AT+CMGD=1",13,10]

PAUSE 500


LOW PORTC.1

PORTB=0


START:

HIGH Flash

PAUSE 20

LOW Flash

PAUSE 20

;SEROUT Tx,N1200,["AT",13]

SEROUT Tx,T9600,["AT",13,10]

SERIN Rx,T9600,5000,INICIO,["OK"]

FOR X=1 TO 1

GOSUB BUZZ

NEXT X

PAUSE 500
```

```
SEROUT  Tx,T9600,["AT+CMGF=1",13,10]

SERIN Rx,T9600,5000,INICIO,["ON"]

FOR X=1 TO 2

GOSUB BUZZ

NEXT X

PAUSE 500


SEROUT  Tx,T9600,["AT+CMGR=1",13,10]

SERIN  Rx,T9600,5000,INICIO,["OFF"]


FOR X=1 TO 5

SERIN  Rx,T9600,5000,INICIO,DATO

IF DATO = "A" THEN ZZ

NEXT X


ZZ:

SEROUT  Tx,T9600,["AT+CMGD=1",13,10]

PAUSE 500

SEROUT  Tx,T9600,[DATO,13,10]


TOGGLE LED
```

```
PAUSE 1000


SEROUT  Tx,T9600,["AT+CMGD=1",13,10]
PAUSE 500
GOTO START


JMP30:
FOR X=1 TO 3
GOSUB BUZZ
NEXT X
GOTO INICIO


BUZZ:
HIGH Flash
PAUSE 200
LOW Flash
PAUSE 200
RETURN
END
```



APPENDIX C

BILL OF QUANTITY

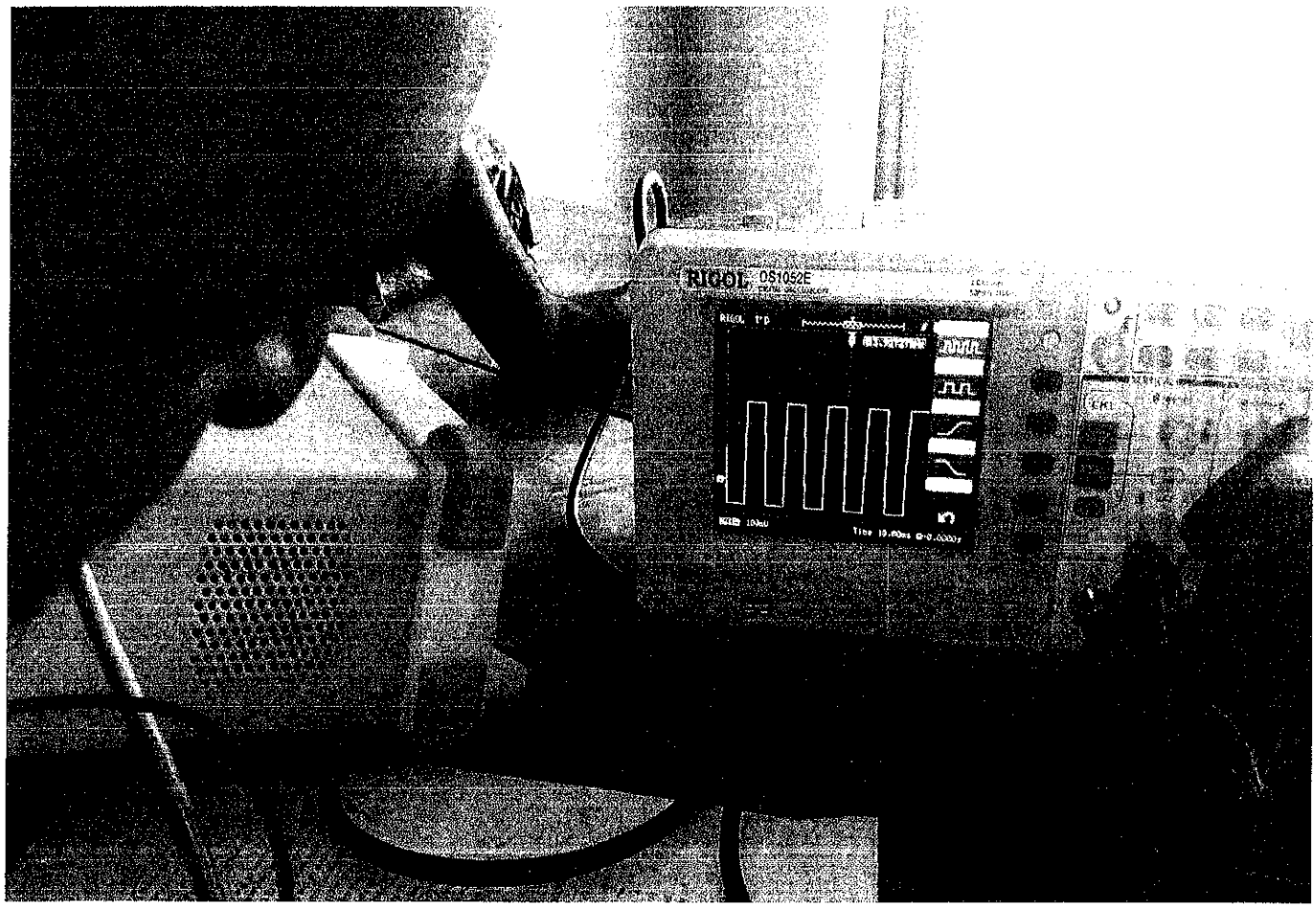
Table 2: Project cost and Expenditure.

COMPONENT	QUANTITY	COST	TOTAL
PIC 16F877A	1	1,000	1,000
CASING		1,000	1,000
PRINTED CIRCUIT BOARD	1	100	100
RESISTORS 100R	10	30	300
SIM300 GSM MODULE	1	10,000	10,000
20MHZ CRYSTAL OSCILLATOR	1	300	300
2N2222	1	100	100
CAPACITORS 30Pf	2	30	60
LEDS	7	30	210
VGA CONNECTOR	1	300	300
TRANSPORT			5000
TOTAL			18,370

The design and implementation of a GSM based street light control system is economical and cost effective most especially in the remote and rural areas.

APPENDIX D

OUTPUT WAVEFORM OF THE PROJECT



The output of the GSM based street light control system produced a pulse width waveform, using a digital oscilloscope for the measurement.