DESIGN AND CONSTRUCTION OF TEMPERATURE MONITORING DEVICE WITH SECURITY FEATURES

BY

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EEE/13/1091

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DEDICATION

I dedicate this report to God, the Almighty; the All-knowing, the All sufficient, the Giver of wisdom, knowledge and understanding, to my dearest parents MR and MRS ADENIJI who made my academic succession a reality through their financial and moral support.

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A DESIGN AND CONSTRUCTION OF TEMPERATURE MONITORING DEVICE WITH SECURITY FEATURES

Submitted by

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Has satisfied the regulations governing the award of degree of

BACHELOR OF ENGINEERING (B. Eng)

Federal University Oye-Ekiti, Ekiti State.

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ABSTRACT

Safety and security are important considerations in modern buildings, especially in research laboratories and other restricted areas. In this work, a temperature monitoring device with intruder-detection security features was designed and constructed using a microcontroller-based control mechanism. It was discovered that the device functioned well with SMS alerts for both intruder and high temperature. Based on these findings, it can be deduced that this project is very useful for monitoring access to buildings and also for protection against fire disasters with a view to improve safety and security systems' performance in buildings. This is aimed at sensing ambient temperatures in the steps of 25°C, 30°C, 35°C, 40°C and 45°C, light indicators and both buzzer alarm and SMS alert.

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LIST OF ACRONYMS

NTC	Negative Temperature Co-efficient
PTC	Positive Temperature Co-efficient
GSM	Global System on mobile
SIM	System Identification Module
LED	Light Emitting Diode
LCD	Liquid Crystal Display
SMS	Short Message Service
RTD	Resistive Temperature Detector
AC	Alternating Current
DC	Direct Current
PIR	Pyro-electric infrared sensor
VLSI	Very Large Scale Integration
CPU	Central processing unit
ROM	Read only memory
RAM	Random Access Memory
I/O	Input and Output
DAC	Digital to Analog converter
ADC	Analog to Digital Converter
PC	Personal Computer
PCB	Printed Circuit Board
GUI	Graphical User Interface
USB	Universal Serial bus
IC	Integrated Circuit

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First of all, I would like to thank God almighty, the most merciful, the creator of heaven and earth for his guidance and protection over me throughout the course of the project. As my individual project, this project would not have been possible without considerable guidance and support from almighty God.

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CHAPTER ONE

INTRODUCTION

1.1 PREAMBLE

Security is the degree of protection against danger, damage, loss or any criminal activity. Security can also be seen as a condition so that one can develop and progress freely. An important aspect of security includes Home Security. It is very important, because crime rate is increasing day by day. The advancement of technology has increased the safety and security of people along with their belongings. One of the reasons for the rise of the smart home is the increasing risk of burglary and robbery and the busy lifestyle (Girod, E., & Pottie, S. 2012).

The busy lifestyle of people is leading to the necessity of keeping surveillance over their homes. Mobile phones today are not just used to make calls. The use of mobile phones is changing with the development of technology and they can be used for different purposes. They can be used as clocks, calendars or controllers instead of being used just as phones. Today smart phones are available in the market with different applications and hardware which can be implemented without any further development or enhancement.

SIM800l-GPRS module and microcontroller (ATMEGA8) are used to communicate between the mobile phone and the devices and sensors installed at home. The mobile phone can be used as a controller from anywhere in the world if the GSM network is available. In addition, it requires three sensor, such as, heat/temperature detector (Negative temperature co-efficient), motion detector and intrusion detector which trigger the alarm upon reaching the critical limit. The system is limited to the area with the GSM network available and the whole system does not work without the network

Conventional security systems which are the commonest form of protection to lives and properties, have certain limitations such as lack of real time monitoring and control of activities such as intruders in the form of human beings, fire, smoke, etc.(Rundel et al . 2009). These limitations in most cases result in high financial loss to properties and lives. This work involves design and construction of GSM temperature monitoring device with home security system for real time monitoring of intruders and room temperature. It consist of intrusion detection sensors, (Smoke/Fire and PIR motion), wireless sensors, programmable microcontroller in embedded C language, regulated power supply unit, proteus (circuit simulator), relays, GSM modem, mobile phone, data acquisition node and an interface program development). The design calculation and analysis was carried out before it was modeled, simulated in proteus electronic simulator environment. When the PIR finds intruders the relevant sensing device(s) respond and the microcontroller sends encoded alarm signal to the wireless sensor network established in home. The moment the alarm signal is received, it will send an alarm short message to the users (owners of the building) through GSM network immediately. Home security system is adopted for reasons of ease, security and energy efficiency. The controller devices are properly interconnected such that there is obvious communication between the home appliance/device and the controller. For example, an alert message is sent through telephone line in case of any intrusion taking place. The automated device then makes the home intelligent and will call neighbour(s), or any other emergency line dedicated to intrusion(s) cases/attempt. It does the monitoring via GSM handset. The system could also make a loud alarm which will alert the neighbour(s).

This work is capable of monitoring the room temperature and sending SMS alert to a predefined user when the room temperature is far beyond the reference level(normal room temperature 25°C) . Temperature rise in a room might be due to weather condition or due to fire in a room which lead to an increase in temperature, As temperature increases, the LED(light emitting diode) also indicate that the temperature is increasing, but when the increase in temperature is higher than 45°C,then the buzzer sound a loud alarm which in return send a signal to the GSM module. After this signal has been received by the GSM module it in return send a short message to a predefined user in the program. It measures temperature in the following step $25°C, 30°C, 35°C, 40°C$ *and* $45°C$.

1.2 STATEMENT OF PROBLEM

Over the last few years, and even up-to date there have been several cases of fire incident in the building such as laboratory, residential areas, offices and others. This always bring a big loss of and life. This happens due to lack of sign or warning, for example, of room temperature given to the people regarding fire.

Similarly, there have been several cases of robbery and insecurity in the society, In fact, security problem has become hydra headed monster all around

Therefore, there is a need to monitor building when no one is around. But Conventional security systems are the commonest form of protection to lives and properties, but they have certain limitations such as lack of real time monitoring and control of activities such as intruders in the form of human beings, fire, smoke, etc. These limitations in most cases result in high financial loss to properties and lives. In a quest to limit these insecurities and fire hazard in the societies this project "design and construction of a temperature monitoring device with security system" was developed to alert the user when the room temperature is above the threshold level and also send SMS alert to a predefined mobile number in case of any intrusion being detected within the house.

1.3 AIM AND OBJECTIVES

The aim of this project is to design and construct a temperature monitoring device with security features. The specific objectives of this project are:

- To monitor changes/rises in temperature using the negative temperature co-efficient (NTC) thermistor.
- Detect an intruder using the pyro-electric Infrared sensor(PIR)
- Activate the buzzer alarm when intrusion is detected
- Activate an indicator to indicate changes/rises in temperature
- Send SMS to a predefined mobile number set inside the program

1.4 SCOPE OF STUDY

This project developed a design and implementation of temperature monitoring device with security features using Negative temperature co-efficient(NTC) sensor and the Pyro-electric infrared(PIR) sensor. The NTC and the PIR sensor served as control device to the microcontroller, that is to say the temperature sensor sends signal when there is persistent rise in room temperature, as well as the PIR also sends signal to microcontroller when it notices an intrusion which then send SMS alert via mobile phone with the help of GSM technology, For this project, ATMEGA8 microcontroller (a member of the Atmel family of microcontrollers) was used, even though there are other microcontroller families that could have been used, such as PIC microcontrollers, 8051 microcontrollers, etc.

1.5 SIGNIFICANCE OF STUDY

The use of temperature monitoring device with security functions at homes, laboratories, industry and offices will be beneficial to its users in many ways, some of which are:

1. **Better Security:** The designed system will ensure the availability of security at all time, and reduce robbery crime in homes.

2. **Reduced Cost of Providing Security:** The system will reduce the number of physical security officers at door posts, as it has always been the custom at almost every place where security is needed. There is also no need for regular maintenance of the system.

3. **Convenience:** The designed system eliminates conventional securities system with there limitations.

4. **Easy Usage and Maintenance:** The system is designed to ensure minimal maintenance which makes it easy to use and also eliminates the need for regular maintenance.

1.6 METHOD OF STUDY

The first stage of this project was to carry out extensive feasibility study and adequate literature review. This is also included studying background information about the project concepts, and familiarization with the tools needed for the implementation of the project.

The second stage of the project was for circuit design development, code writing embedded in C language and verifying the temperature level with medical thermometer. Also at this stage, the software simulation (proteus) was carried out.

The third stage was for the procurement of the tools needed for the project, as well as for the project implementation.

The final stage was for the performance evaluation of the construction of temperature monitoring device.

CHAPTER TWO

LITERATURE REVIEW

2.1 SECURITY SYSTEM

Securing a home is an indispensable task because of the burglary incidents. The conventional design of home security systems typically monitors only the property and lacks physical control aspects of the house itself. In today's context, it is common to leave the house unattended as people are busy catching up with their tight daily schedule. Therefore, most people have chosen the home security system as the most reliable way to protect their home. All the body generates some heat energy in the form of infrared which is invisible to human eyes. But, it can be detected by electronic sensors (John,W. 2007).

Home security system has been a feature of science fiction writing for many years, but has become practical since the early 20th century following the widespread introduction of electricity into the home, and rapid advancement of information technology. Early remote control devices began to emerge in the late 1800s, Nikola Tesla, patented an idea for remote control of vessels and vehicles (Tesla, 1898) in a research work titled "*Method for Controlling Mechanisms of Moving Vessels and Vehicles*". The emergence of electrical home appliances began between 1915 and 1920. More so, the decline in domestic servants meant for the household needed cheap, mechanical replacement. Domestic electricity supply however was still in its infant stage-meaning this luxury was afforded only by the more affluent households as investigated and published by Harper in 2003. Ideas similar to intelligent home security systems originated during the world fairs of the 1930s (Mann, 2005) as reported in the work titled "Smart Technology for Aging, Disability and Independence Depicted Electrified and Automated Homes". In 1966, Jim Sutherland, an engineer working for Westinghouse Electric developed home security system called "ECHO IV". This was however, a private project and never commercialized. The first "wired home" were built by American hobbyist during the 1960's using the available technology of the times. The term "Smart Home" was first coined by the American Association of House builders in 1984 with the invention of microcontrollers. The cost of electronic control fell rapidly as time progresses thus making it more affordable. Remote and intelligent control technologies were adopted by the building services industry and appliance manufacturers worldwide, as they offer end users easy accessibility and/or greater control in their products (Hecht, porszasz, & Casaburi, 2003). During the 1990's, home security systems rose to prominence by the end of the decade, domotics was commonly used to describe any system in which informatics and telematics were combined to support activities in the home. The phrase appears to be a portmanteau word formed from domus (Latin meaning house) and informatics referring specifically to the application of computer technology to domestic appliances (Shahram, 2003). As described by the author in the work titled "*Home Automation and Wiring*". Despite interest in home security systems, by the end of 1990's, there was still no widespread uptake with such systems as it was still considered as the domain of hobbyist or the rich. The major challenge was however traced to lack of a single, simplified, protocol and high cost of the device, thus resulting in not making customers to be able to afford it. While there is still much room for growth, according to researchers, one million, five hundred thousand home security systems were installed in the US in 2012 and sharp uptake could see shipments topping over eight million in 2017 (Weiss, Herman, Plotnik, Brozgol, Maidan, Giladi, Gurevich, & Hausdorff, 2012).

Intelligent home security system involves automation of homes or household activities such as security locks of gates and doors. The overall idea is to provide improved efficiency and security in their place /areas of applications. In recent years, the popularity of home automation has been increasingly great because of its affordability and simplified design through smartphones, internet connectivity/facilities and cable connectivity. Devices may be connected through a computer network to allow control by a personal computer, and may allow remote access from the internet. Through the integration of information technologies with the home security, systems are able to communicate in an integrated manner which results in convenience, energy efficiency and safety benefit. GSM based intelligent home security system refers to the use of device and information technology to control home features/systems (such as windows, doors, etc. Home security system is adopted for reasons of ease, security and energy efficiency. The controller devices are properly interconnected such that there is obvious communication between the home appliance/device and the controller. For example, an alert message is sent through telephone line in case of any intrusion taking place. The automated device then makes the home intelligent and will call neighbour(s), or any other emergency line dedicated to intrusion(s) cases/attempt. It does the monitoring via GSM handset or web browser. One of the areas of application of intelligent home automation system is in smoke detection. An example of remote monitoring in intelligent home security system could be triggered when a smoke detector detect a fire or smoke condition. The system could also call the home owner on their mobile phone to alert them, or alert the neighbour(s).

2.2 THE EVOLUTION OF SECURITY SYSTEM

Nikhil, A., & Subramanya, N.B. (2012) uses password protected door system methodology in home automation system. The door lock is password protected with an LED based resistive screen input panel which operates by detecting difference in light intensity captured by the photo diode which is emitted by surrounding red LEDs and reflected by the finger. The display is a 16X2 LCD panel. PIR sensors are used to detect any obstacle while monitoring the windows and doors at night or when away. Fire alarm system uses temperature sensor LM35 which senses sudden considerable increase in temperature and raises alarm. They uses the following components in those automation system i.e .PIR sensors, LCD Display,Temperature Sensor, Microcontroller, Relay, Power Supply, GSM Modem.

Visa, M., Asogwa, A., & Victor, S.Y. (2004) constructs security system for car protection. In that concept if thief tries to rob a car it automatically demobilizes the car by disconnecting the ignition key supply from the car battery. This now makes it impossible for anybody so start the car, let alone moving with it. In an attempt of theft through the car doors or boot, the system sends the message to the car owner and at the same time starts the alarm. This design popped out due to the increasing rate at which packed cars are stolen especially in our country, but with this design this packed car is being monitored irrespective of where it is packed, provided there is GSM network coverage.

Jayashri, B., & Arvind, S.A.(2003) says that Automated home or intelligent home which indicates the automation of daily tasks with electrical appliances used in homes and security is an important aspect or feature in smart home applications. The new and emerging concept of smart homes offers a comfortable, convenient, and safe environment for occupants. Conventional security systems keep homeowners, and their property, safe from intruders by giving the indication in terms of alarm. However, a smart home security system offers many more benefits. They proposed Two system in this project i.e. one is based on GSM technology and other uses web camera to detect the intruder. First security system uses a web camera, installed in house premises, which is operated by software installed on the PC and it uses Internet for communication. It detect motion of any intruder in front of the camera dimension and camera range. The second security system is SMS based and uses GSM technology to send the SMS to the owner. The proposed system is aimed at the security of Home against Intruders and Fire. In any of the above cases happens while the owners are out of their home then the device sends SMS to the emergency number which is provided to the system. Mahmud S. Parab et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 6 (3) ,2015, 2950-2953

Syam Krishna, I., & Ravindra, S.Y. (2004). Designed WSN and GSM based Remote Home Security System by combining the advantages of Wireless Sensor Networks and GSM technology is presented. It can detect intrusion, fire etc. and inform the user remotely about the incidence with distance playing no barrier. In those security system intruder has detect if they comes under the dimension of WSN.

2.3 EMBEDDED SYSTEM

An embedded system can be thought of as a computer hardware system having software embedded in it. In a general sense, it is a microcontroller or microprocessor based system which is designed to perform a specific task. Implementation of the embedded system could be done as an independent system or as a part of a system.

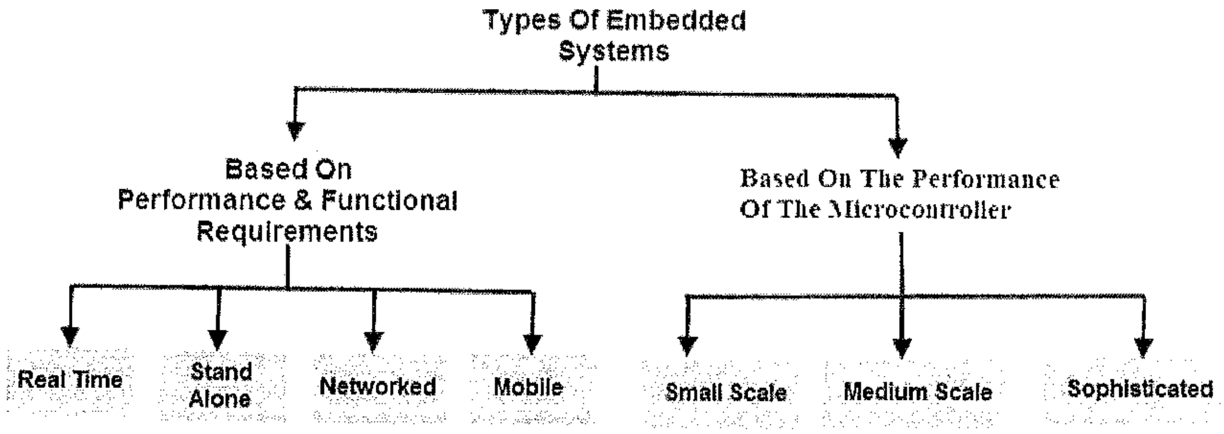


Figure 2.1: Classification of embedded systems

Embedded systems are primarily classified into different types based on the performance of the microcontroller or based on the performance and functional requirements of the system embedded system as shown in Figure 2.1. Real time embedded systems are by far the most critical category in terms of functionality and reliability. Embedded systems find numerous applications in various fields such as digital electronics, telecommunications, computing network, smart cards, satellite systems, military defense system equipment, research system equipment, and so on.

2.4 TEMPERATURE SENSORS

Temperature sensors possess an essential role in industries such as petrochemical, medical, automotive, aerospace and defense, consumer electronics and further on. Temperature monitoring and control in such industries is critical for proper functionality, for example maintaining a specific temperature is essential for equipment used to fabricate medical drugs or in an incubator used for intensive care of newborns. There are many different types of temperature sensors available and all have different characteristics depending upon their actual application. A temperature sensor consists of two basic physical types:

- **Contact Temperature Sensor:** These types of temperature sensors are required to be in physical contact with the object being sensed and use conduction to monitor changes in temperature.
- **Non-contact Temperature Sensor**: These types of temperature sensors use convection and radiation to monitor changes in temperature and do not have to be in direct contact with the object being sensed.

2.4.1 Types of Temperature Sensors

1. *Thermistors:-*

A thermistor is a special type of resistor which changes its physical resistance when exposed to changes in temperature. Thermistors can either have a Negative Temperature Coefficient of resistance (NTC), that is their resistance value decreases with an increase in temperature, or have a Positive Temperature Coefficient (PTC), in which their resistance value increases with an increase in temperature (Yang et al., 2002).

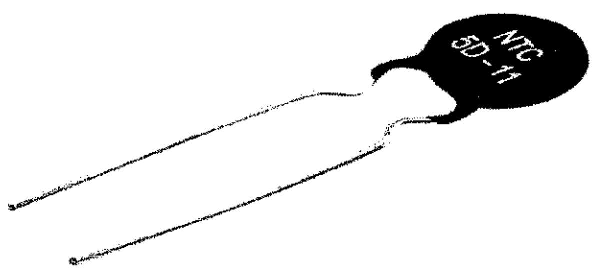


Figure 2.2: NTC Temperature sensor (Chun-Liang et al ., 2009)

2. *Resistive Temperature Detectors* (RTD):

An RTD, also known as a resistance thermometer, measures temperature by correlating the resistance of the RTD element with temperature. An RTD element consists of a film or, for greater accuracy, a wire wrapped around a ceramic or glass core. The most accurate RTDs are made using platinum but lower cost RTDs can be made from nickel or copper.

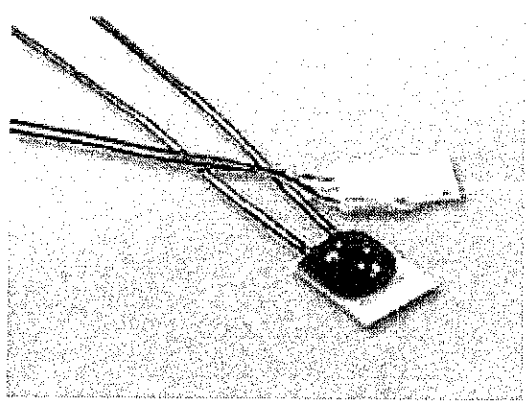


Figure 2.3: A RTD

3. *Thermocouple*:-

Thermocouples are thermoelectric sensors that basically consists of two junctions of dissimilar metals that are welded or crimped together. One junction is kept at a constant temperature called the reference (Cold) junction, while the other the measuring (Hot) junction. When the two junctions are at different temperatures, a voltage is developed across the junction which is used to measure the sensed temperature.

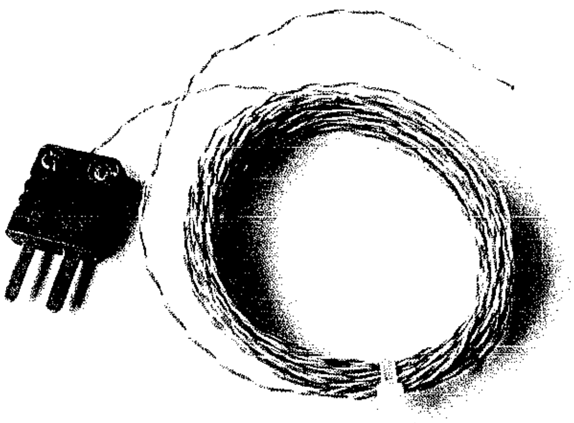


Figure 2.4: K Type Thermocouple

2.5 PIR SENSOR

PIR sensors are used to detect living being movement. PIR is a Passive Infrared sensor, which detect infrared rays. All living being with a temperature above absolute zero emits heat energy in the form of radiation (Campbell et al 2002). These radiations are infrared ray. Human eye cannot see these rays because these rays are radiated at infrared wavelength. When any living being comes in range of PIR sensor, it detects heat of that living being and generates an output. PIR sensor module does not send any rays for detection; its only detects heat (Infrared). Passive elements are those elements that don't generate their own voltages or energy. They just only measures things. So we can say that this sensor is a passive infrared sensor and it doesn't generate anything by itself. It is only capable to measure the radiations emitted by other objects around it. It measures those radiations and do some desired calculations.

Most PIR modules have a 3-pin connection at the side or bottom. The pinout may vary between modules so triple check the pinout! It's often silkscreened on right next to the connection. One pin will be ground, another will be signal and the final one will be power. Power is usually 3-5VDC input but may be as high as 12V. Sometimes larger modules don't have direct output and instead just operate a relay in which case there is ground, power and the two switch connections. The output of some relays may be 'open collector' - that means it requires a pull up resistor. If you're not getting a variable output be sure to try attaching a 10K pull up between the signal and power pins. PIR sensor has total 3 pins:

Pin#1 is of supply pin and it is used 1. to connect +5 DC voltages

2. Pin#2 is of output pin and this pin is used to collect the output signal which is collected by PIR sensor.

3. Pin#3 is marked as GND pin. This pin is used to provide ground to internal circuit of PIR sensor.

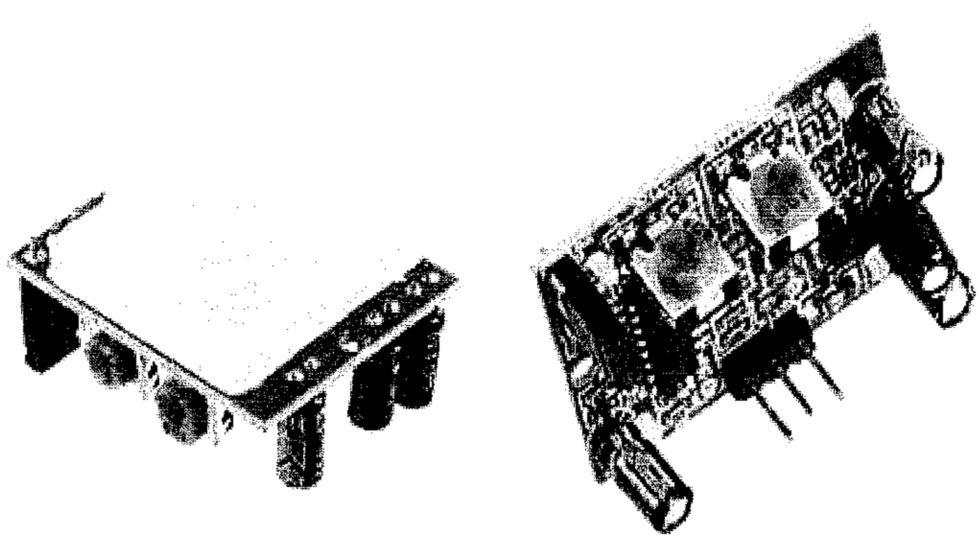
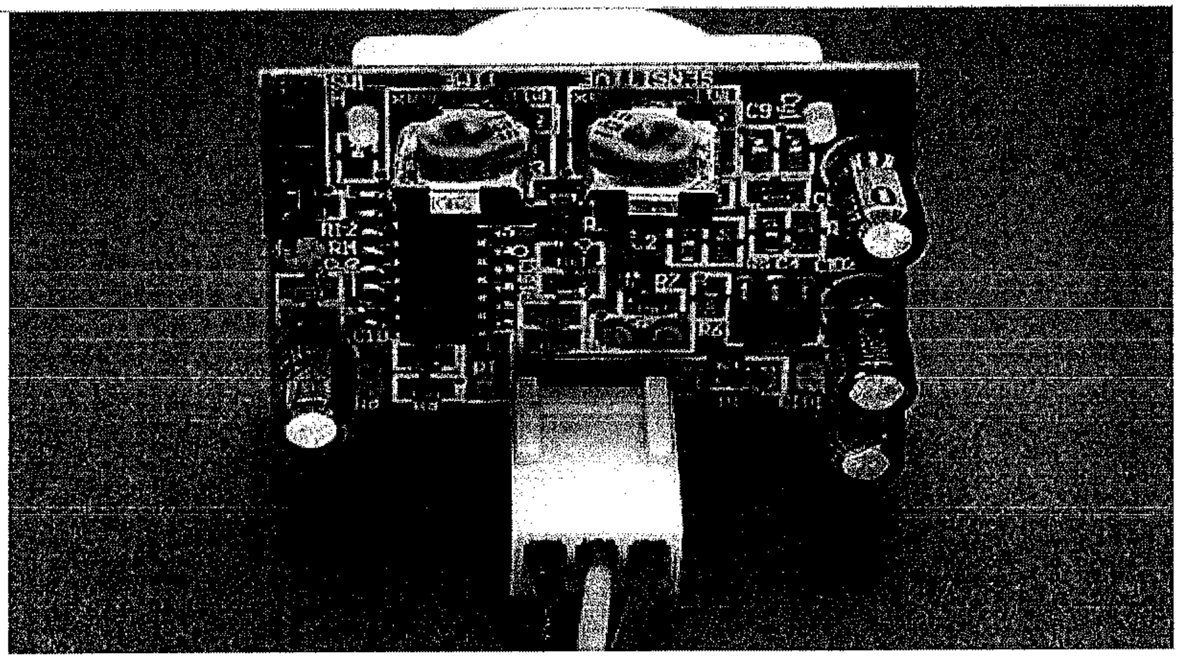


Figure 2.5: PIR Sensor (Jerdaman et al., 2006)



Changing Pulse Time and Timeout Length

There are two 'timeouts' associated with the PIR sensor. One is the "Tx" timeout: how long the LED is lit after it detects movement - this is easy to adjust on Adafruit PIR's because there's a potentiometer. The second is the "Ti" timeout which is how long the LED is guaranteed to be off when there is no movement. This one is not easily changed

2.6 MICROCONTROLLERS

A microcontroller can be considered as a self-contained system with a processor, memory and peripherals. Along with a variety of uses in electronic systems microcontrollers are particularly used in embedded systems for real-time control applications with on-chip program memory and devices.

A microcontroller is a solitary chip microcomputer fabricated from VLSI fabrication. A micro controller is also known as embedded controller. Today various types of microcontrollers are available in market with different word lengths such as 4 bits, 8 bits, 64 bits and 128 bits microcontrollers (Garfinkel, and Juels, 2005). Microcontroller is a compressed micro-computer manufactured to control the functions of embedded systems in office machines, robots, home appliances, motor vehicles, and a number of other gadgets. A microcontroller is comprises components like – memory, peripherals and most importantly a processor. Microcontrollers are basically employed in devices that need a degree of control to be applied by the user of the device (Graylogix, 2017).

2.6.1 Features of a Microcontroller

Any electric appliance that stores, measures, displays information or calculates comprise of a microcontroller chip inside it. The basic structure of a microcontroller comprise of:

1. **CPU** – Microcontrollers brain is named as CPU. CPU is the device which is employed to fetch data, decode it and at the end complete the assigned task successfully. With the help of CPU all the components of microcontroller is connected into a single system. Instruction fetched by the programmable memory is decoded by the CPU.

2. **Memory** – In a microcontroller memory chip works same as microprocessor. Memory chip stores all programs & data. Microcontrollers are built with certain amount of ROM or RAM (EPROM, EEPROM, etc.) or flash memory for the storage of program source codes.

Input/output ports – I/O ports are basically employed to interface or drive different appliances such as- printers, LCD's, LED's, etc.

4. **Serial Ports** – These ports give serial interfaces amid microcontroller & various other peripherals such as parallel port.

5. **Timers** – A microcontroller may be in-built with one or more timer or counters. The timers & counters control all counting & timing operations within a microcontroller. Timers are employed to count external pulses. The main operations performed by timers' are- pulse generations, clock functions, frequency measuring, modulations, making oscillations, etc.

6. **ADC (Analog to digital converter)** – ADC is employed to convert analog signals to digital ones. The input signals need to be analog for ADC. The digital signal production can be employed for different digital applications (such as- measurement gadgets).

7. **DAC (digital to analog converter)** – this converter executes opposite functions that ADC perform. This device is generally employed to supervise analog appliances like- DC motors, etc.

8. **Interpret Control** - This controller is employed for giving delayed control for a working program. The interpret controller can be internal or external.

9. **Special Functioning Block** – Some special microcontrollers manufactured for special appliances like- space systems, robots, etc., comprise of this special function block. This special block has additional ports so as to carry out some special operations.

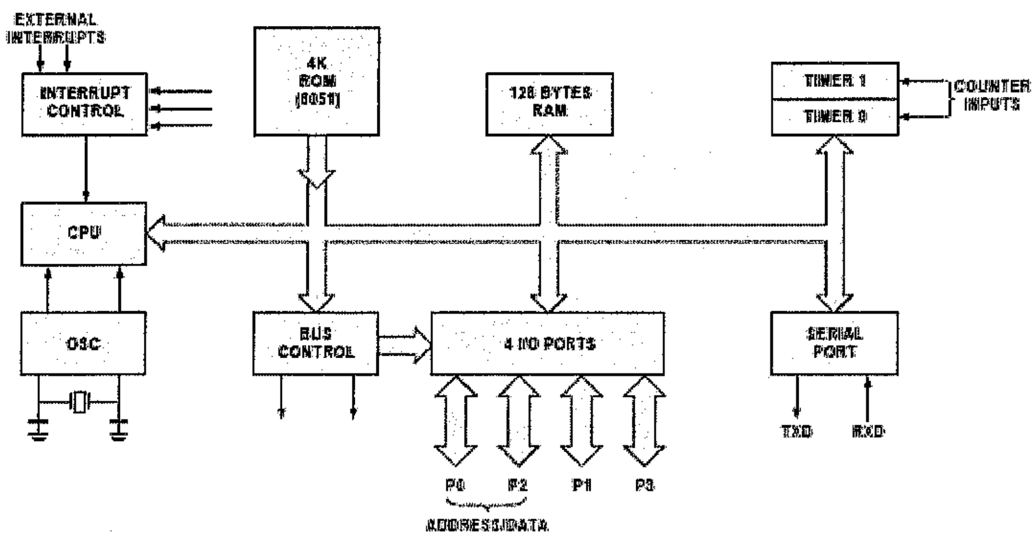


Figure 2.6: Block Diagram of a microcontroller (Domdouzis et al., 2007).

2.6.2 Categories of Microcontrollers

Microcontrollers are divided into categories according to their bits, memory, instruction sets, and memory architecture.

1. Bits:

- 8 bits microcontroller executes logic & arithmetic operations. Examples of 8 bits micro controller is Intel 8031/8051.
- 16 bits microcontroller executes with greater accuracy and performance in contrast to 8-bit. Example of 16 bit microcontroller is Intel 8096.
- 32 bits microcontroller is employed mainly in automatically controlled appliances such as office machines, implantable medical appliances, etc. It requires 32-bit instructions to carry out any logical or arithmetic function.

2. Memory:

- External Memory Microcontroller – When an embedded structure is built with a microcontroller which does not comprise of all the functioning blocks existing on a chip it is named as external memory microcontroller. For illustration- 8031 microcontroller does not have program memory on the chip.

- Embedded Memory Microcontroller – When an embedded structure is built with a microcontroller which comprise of all the functioning blocks existing on a chip it is named as embedded memory microcontroller. For illustration- 8051 microcontroller has all program & data memory, counters & timers, interrupts, I/O ports and therefore its embedded memory microcontroller (Harmon and Adams, 1989).

3. Instruction Set:

- CISC- CISC means complex instruction set computer, it allows the user to apply one instruction as an alternative to many simple instructions.
- RISC- RISC means Reduced Instruction Set Computers. RISC reduces the operation time by shortening the clock cycle per instruction.

4. Memory Architecture:

- Harvard Memory Architecture Microcontroller
- Princeton Memory Architecture Microcontroller

2.6.3 ATMEGA8 Microcontroller

ATMEGA8 provided by Micro-chip Technology to categorize its solitary chip microcontrollers. These appliances have been extremely successful in 8 bit micro-controllers. The foremost cause behind it is that Micro-chip Technology has been constantly upgrading the appliance architecture and included much required peripherals to the micro-controller to go well with clientele necessities. The ATmega8 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1 MIPS per MHz, allowing the system designer to optimize power consumption versus processing speed. ATMEGA8 microcontrollers are very popular amid hobbyists and industrialists; this is only cause of wide availability, low cost, large user base & serial programming capability (Sheikal & Bibya, 2012).

The architecture of the 8 bit PIC microcontrollers can be categorized as below :

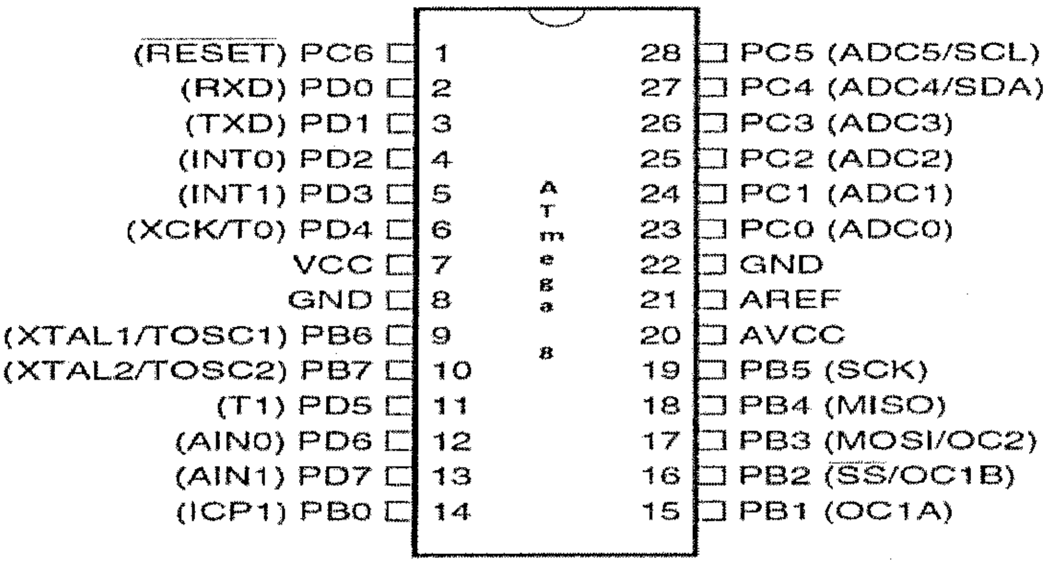


Figure 2.7: ATMEGA8 pin out

2.6.4 Microcontroller Applications

Microcontrollers are intended for embedded devices, in comparison to the micro-processors which are used in PCs or other all-purpose devices. Microcontrollers are employed in automatically managed inventions and appliances like- power tools, implantable medical devices, automobile engine control systems, , office machines, remote controls appliances, toys and many more embedded systems. By dipping the size and expenditure in comparison to a design that make use of a different micro-processor, I/O devices and memory, micro-controllers formulate it inexpensive to digitally control more & more appliances and operations. Mixed signal micro-controllers are general; putting together analog constituents required controlling non-digital electronic structures (Domdouzis et al., 2007).

Microcontrollers can be applied in our day to day life devices. Some of the devices which they can be used are: Light sensing & controlling devices, temperature sensing and controlling devices, fire detection & safety devices, industrial instrumentation devices, process control devices and access control devices. Microcontrollers can also be used in making industrial control devices such as industrial instrumentation devices, Process control devices and also, access control devices (Lakshminaryan, Belza, Steele,Hunziker, Holt, & Buchner 2001).

2.7 BUZZER

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. Buzzer is an integrated structure of electronic transducers, DC power supply, widely used in computers, printers, copiers, alarms, electronic toys, automotive electronic equipment, telephones, timers and other electronic products for sound devices. Active buzzer 5V Rated power can be directly connected to a continuous sound.

Figure 2.8: buzzer

2.8 GSM MODULE

System for Mobile Communication is an open, digital cellular technology used for transmitting mobile voice and data services. A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator. A GSM modem connected to a computer, allows the computer to use the GSM modem to communicate over the mobile network. GSM modems can also be used for sending and receiving SMS and MMS messages. Global System for Mobile (GSM) is a wireless telephone technology that is used globally in phones. GSM is developed by the European Telecommunications Standards Institute (ETSI) for mobile communications. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band. Since many GSM network operators have roaming agreements with foreign operators, users can often continue to use their mobile phones when they travel to other countries. Subscriber Identity Module (SIM) cards holding home network access configurations may be switched to those will metered local access, significantly reducing roaming costs while experiencing no reductions in service .AT commands are used to control GSM module. ATD are commands are used for calling. Sheikhlzzal, A., & Bibya, S. (2012)

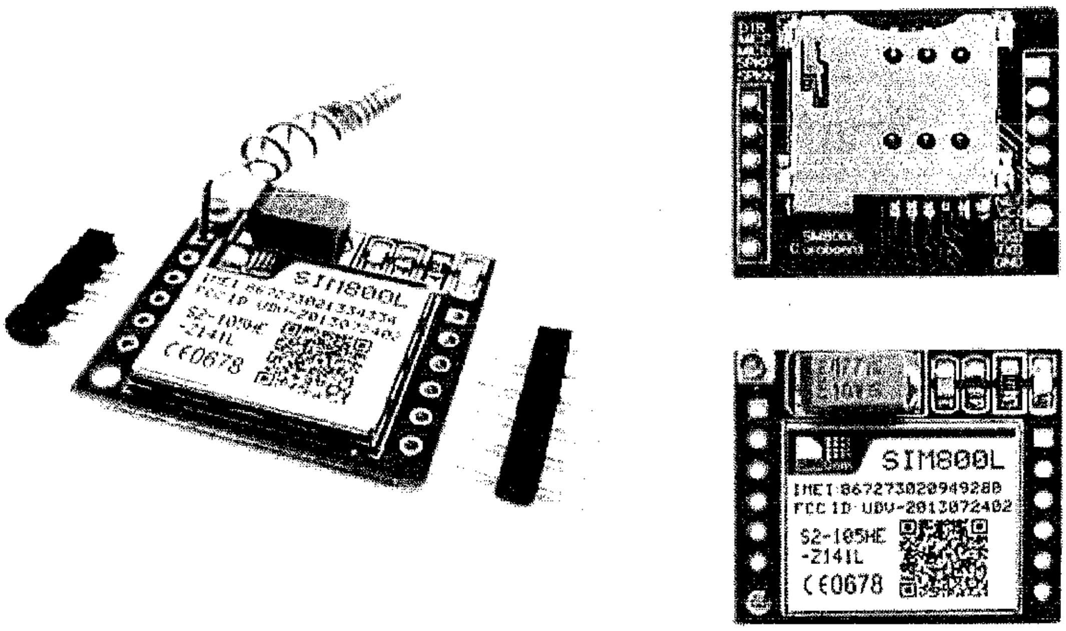


Figure 2.9: **SIM800L** (Sheikhlzzal et al., 2012)

2.8.1 SIM800L

SIM800L is a quad-band GSM/GPRS module that works on frequencies GSM850/900/1800/1900MHz, it can transmit Voice, SMS and data information with low power consumption. Featuring Bluetooth, module control via AT commands and a UART port for serial transmission.

2.8.2 AT COMMANDS

AT commands are instructions used to control a modem. AT is the abbreviation of attention. Every command line starts with "AT" or "at". Many of the commands that are used to control wired dial-up modems, such as ATD (Dial), ATA (Answer), ATH (Hook control) and ATO (Return to online data state), are also supported by GSM/GPRS modems and mobile phones. Besides this common AT command set, GSM/GPRS modems and mobile phones support an AT command set that is specific to the GSM technology, which includes SMS-related commands like AT+CMGS (Send SMS message), AT+CMSS (Send SMS message from storage), AT+CMGL (List SMS messages) and AT+CMGR (Read SMS messages).(Karri, V., & Daniel lim, J.S. (2005).

2.9 PRINTED CIRCUIT BOARD

A printed circuit board (PCB) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. The non-conductive substrate is a thin board made of fiberglass, composite epoxy, or other laminate material. Components (e.g. capacitors, resistors or active devices) are generally soldered on the PCB using their footprint or land pattern which is the arrangement of pads (in surface-mount technology) or through-holes (in through-hole technology) used to physically attach and electrically connect a component to a printed circuit board. PCBs can be single sided (one copper layer), double sided (two copper layers) or multi-layer (outer and inner layers). Conductors on different layers are connected with vias. Multi-layer PCBs allow for much higher component density. The manufacturing and assembly of PCB can be automated. Manufacturing circuits with PCBs is cheaper and faster than with other wiring methods as components are mounted and wired with one single part. PCBs are used in both desktop and laptop computers, TVs, radios, digital cameras, cellphones .e.t.c

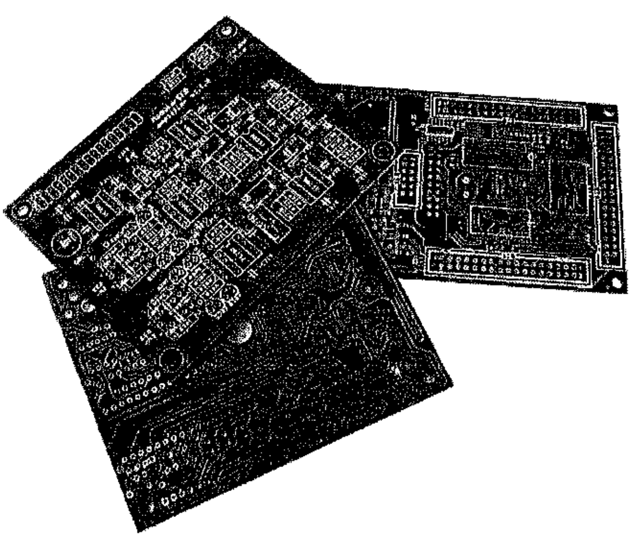


Figure 2.10: A sample of PCBs (Zenon, C., & Fady, A. 2000).

2.10 RELATED WORKS

It is becoming increasingly difficult to ignore the importance of security in homes, offices and industry (Wan et al, 2002) . Meystres' survey (Meystre, 2005) gives a good introduction and overview on some of the central topics in security system and temperature monitoring. Sadeque et al (2012) limited the scope of their examination to product authentication and a discussion of the trade-off between complexity and security authentication methods. Moreover, there are publications on state-of-the art in temperature monitoring system (Belza et al, 2005), as well as numerous reviews on security and privacy concerning health care, ecommerce and data mining.

Renjith, M., Prasanna , R., & Manikandan, K. (May 2008) developed a low cost GSM/GPRS based wireless home security system which includes wireless security sensor nodes and a GSM/GPRS gateway. It has the following features:

(a) Low cost,

(b) Low power consumption,

(c) Simple installation,

(d) Fast response

(e) Simple user interface.

In general, GSM modem acts as the interface between the users and the sensors nodes. There are 3 types of sensor nodes applied in the system which include the door security nodes, PIR sensor nodes, and Temperature sensor nodes. This architecture includes components such as filters, amplifiers, analog to digital converters and communication interfaces. The system used a wireless transceiver module to transfer data between gateway and sensor nodes. Every sensor node comprises a microprocessor and a wireless transceiver module. The function of the microprocessor is to receive and analyze the signal from the sensors' node as well as the current status of the nodes.

Goswami, A., Bezboruah, T., & Sarma, K.C. (2004) developed a wireless security system where an alarm system is programmed in a graphical user interface (GUI). The system is used to detect an intruder incase the owner of the house is not around. The pyro-electric infrared sensor send signal to the microcontroller. If an intruder is noticed within the building, the buzzer alarm system will start to draw attention. Meanwhile, the owner will be notified by an alert message. In addition, the alarm system will not be stopped until the owner press a reset button. The owner will be notified with short messaging service (SMS) from the server via GSM module system in a few seconds. Alternatively, it can be improved with audio-visual camera technology which is embedded in most of mobile phone today. The GSM terminal is used as the SMS interface to send messages. Usually GSM terminal comes with a RS232 connector to external terminal equipment, and the Subscriber Identity Module (SIM) cardholder and the external connector.

Salarian, A., Horak, F., Zampieri, C., Carlson-kuhta, P., Nutt, J., & Aminian, K. (May 2010) developed a security system against asset theft by using radio frequency identification technology. The system consists of five main parts:

(a) RFID reader and tag,

(b) GUI,

(c) Database system,

(d) CCTV

(e) Wireless transmitter and receiver.

The RFID reader is installed at the entrance of the campus and the tags are attached on/in student ID cards and their properties. The program of the developed system has the capabilities of investigating the identification process, database management and controlling function of the hardware. GUI is used in a vehicle security system where the information is controlled via the GUI. The system is activated when the tag is read while the motorcycle is being located within the effective range. The system will automatically record this incident and exhibit the information on the monitor. Any theft occurrence will turn the monitor on automatically with the alarm signal which alerts other systems. When the burglar occurs, the CCTV will also be started for recording is immediately. The motorcycle engine is shut off automatically when the asset theft occurs however this requires a further investigation. This proposed project monitors everything by pyro-electric infrared sensor and temperature sensor (negative temperature co-efficient. The system is based on SMS technology using any GSM modem/mobile. The proposed system works from anywhere in the world.

CHAPTER 3

DESIGN METHODOLOGY

3.1: INTRODUCTION

This project is built around a microcontroller, pyro-electric infrared sensor, buzzer, GSM module, temperature sensor and led indicator. The GSM module send signals to the microcontroller when an intruder is detected, the project is also capable of measuring the room temperature between the range of 25°C, 30°C, 35°C, 40°C, and 45°C respectively, the system will send a warning message or alert the owner of the house via GSM technology when the temperature is greater than 45°C indicating that the room temperature is not conducive and thereby sounding a loud alarm via buzzer.

The hardware components are temperature sensor, GSM module, Buzzer, pyro-electric infrared sensor, LED indicator, connecting cables, ATMEGA8 microcontroller, assorted resistor, 5V regulator (LM 7805), transistor(BC547), switch, circuit board, battery connector power source and capacitors. It is placed at a vantage position in the building or house where an intruder/burglar can easily be noticed and sensed.

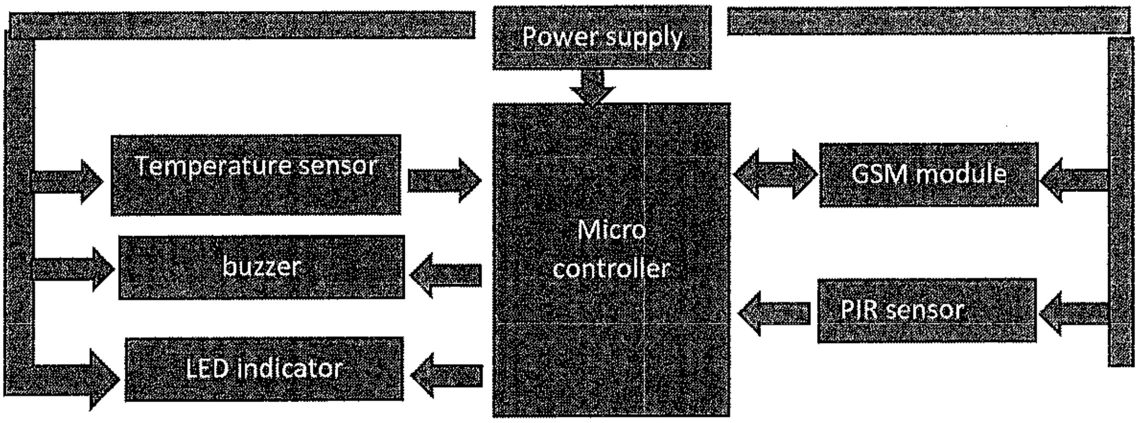


Figure 3.1: Block diagram of the designed hardware

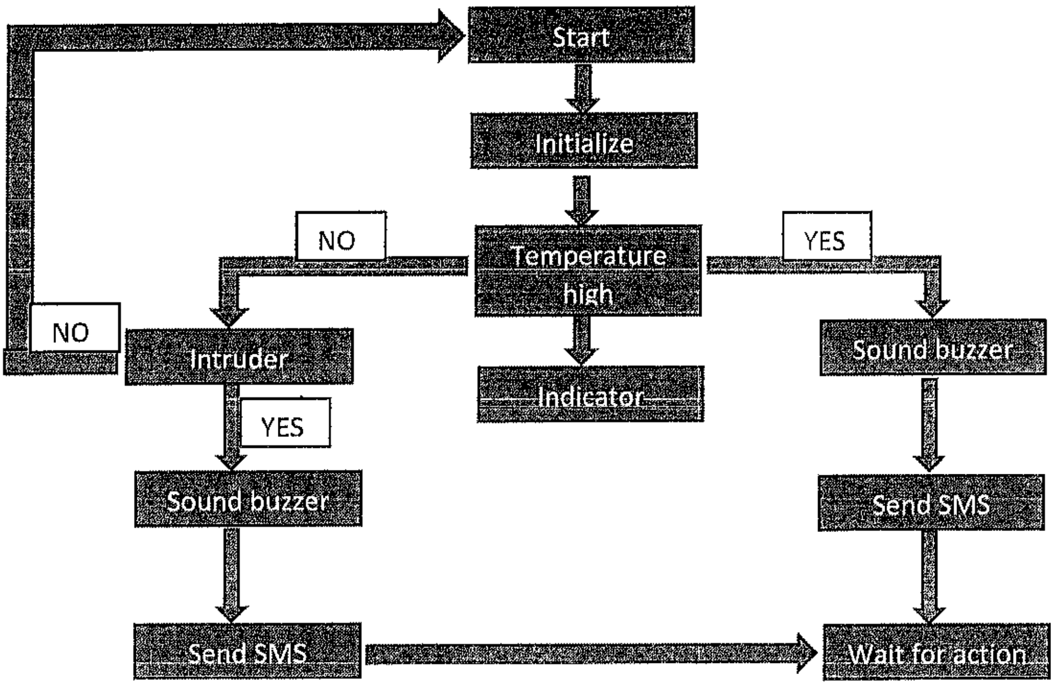


Figure 3.2: Flowchart diagram of the designed harware

3.2: SYSTEM REQUIREMENTS

The system should provide a continuous monitoring of temperature and intruder within the stipulated area. If one or both of the temperature and intruder is noticed then the system must send a message to a predefined number in the program. The values of the temperature are stated in the predefined program and also when intruder from 10metres away is noticed within the area .After the message as being sent, then the user can take necessary actions

3.3: COMPLETE SYSTEM DESIGN

Proteus simulation application was used for the circuit design (see Figure below). As seen in Figure below, the circuit consist of PIR sensor, microcontroller, voltage regulator, temperature sensor, push button, reset button, 5 led indicators for temperature less than $25°C, 30°C, 35°C, 40°C$ *and greater than* $45°C$ respectively. Buzzer is also connected to the port 2 of the microcontroller; the function of the buzzer is to make a loud sound to alert the people around whenever an intruder or high temperature is detected.

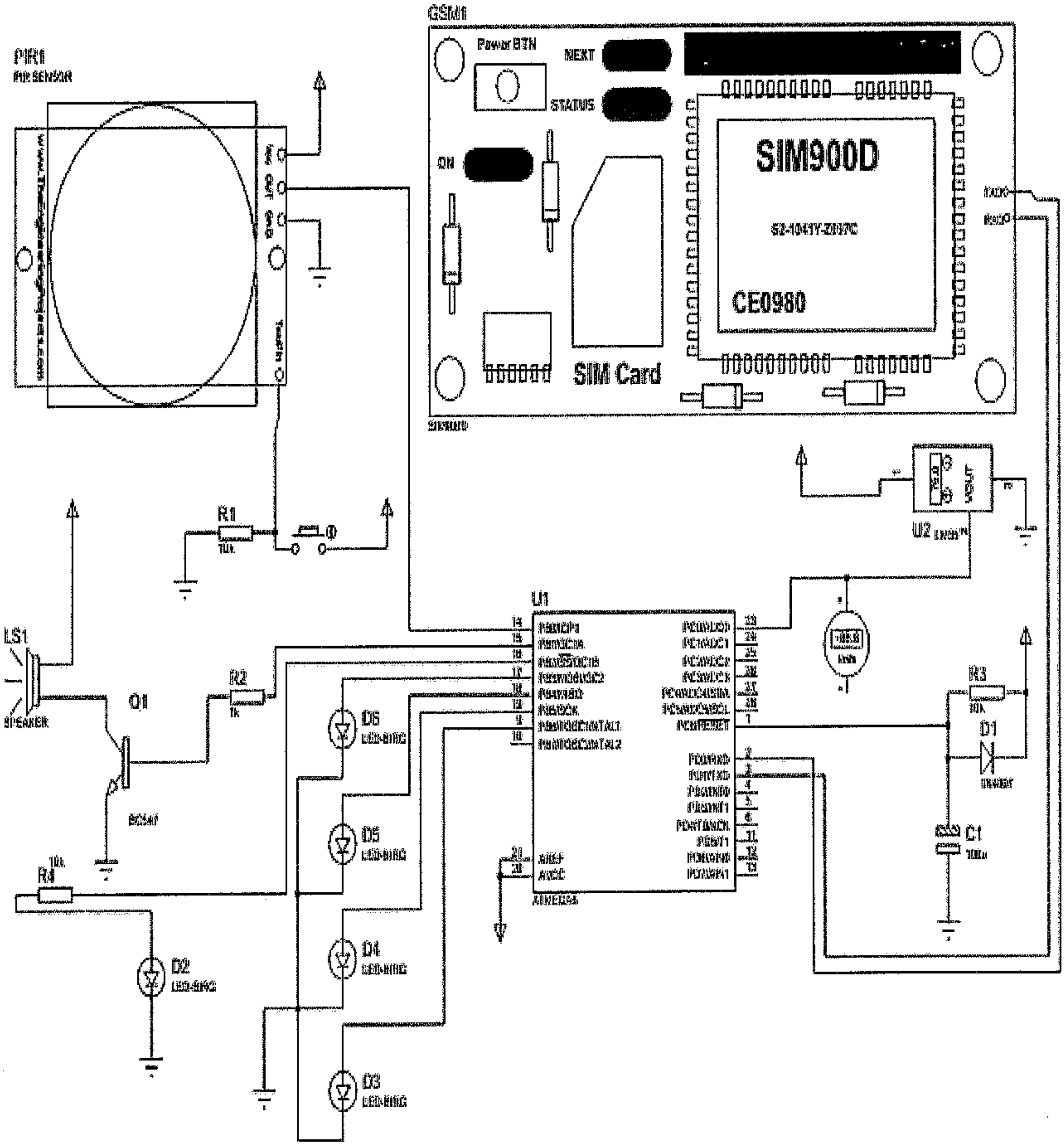


Figure 3.3: CIRCUIT DIAGRAM

3.4: POWER SOURCE

A power source is a device which delivers an exact voltage to another device as per its needs. Power sources, which are sometimes called power adapters, are available in various voltages, and they have varying current capacities, which is the maximum capacity of a power supply to deliver current to a load. For this project, a 9V DC power source will be required to power the circuit, Here, the power supply employs the use of voltage regulator IC 7805 needed by the PIR sensor, ATMEGA8 to regulate the voltage from 9V to 5-volt supply. For this system (as seen in Figure below), a converter is needed to step down the 5-volt supply to 4.2V needed by the GSM module. The power supply employs the use of voltage regulator (LM 7805).

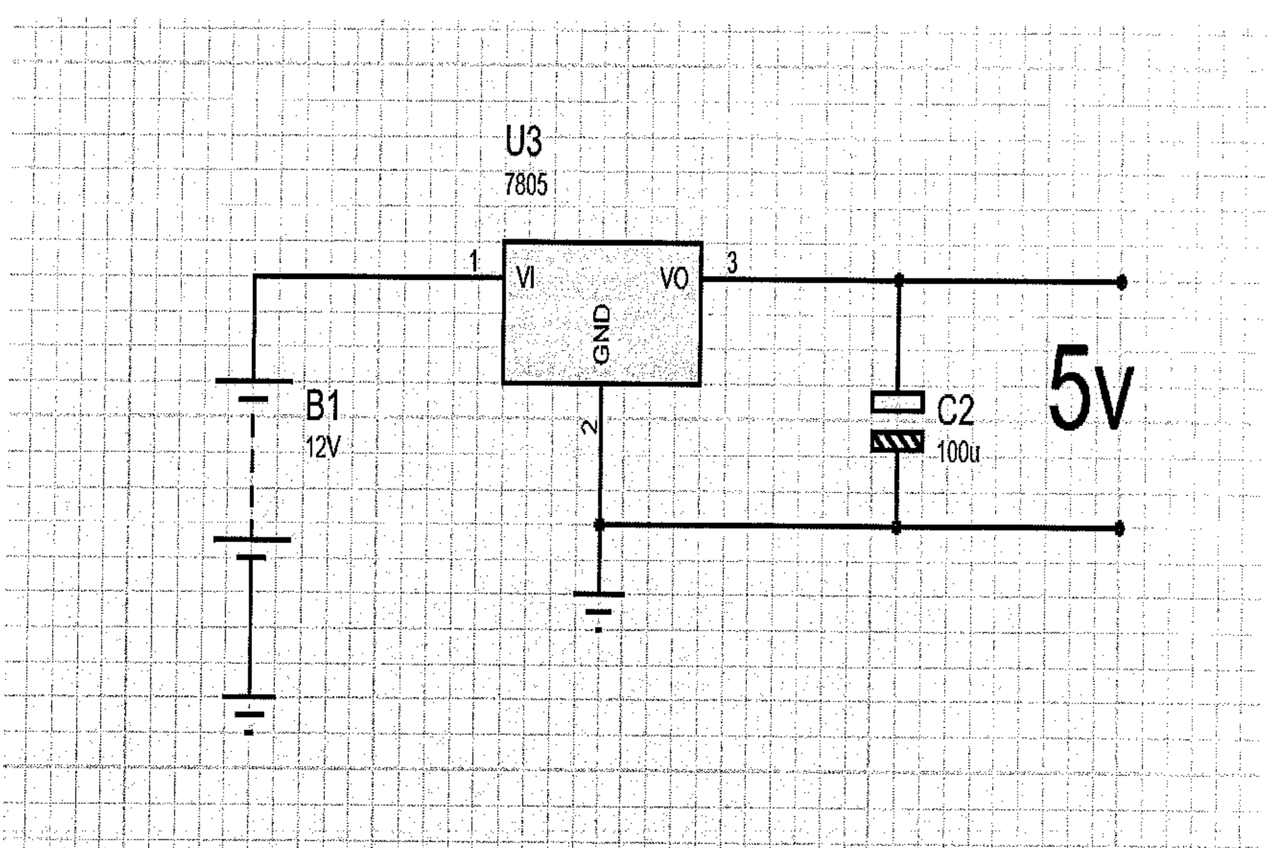


Figure 3.4: power source

3.5: ATMEGA8

The following comparison was done in Table below before choosing the ATMEGA8.

Table 3.1 : Comparison of ATMEGA8, ATMEGA8 and ATMEGA8L microcontrollers

Device Features	ATMEGA8A	ATMEGA8	ATMEGA8L
FLASH (bytes)	24K	32K	14.3K
EEPROM (bytes)	256	256	256
USART	Yes	Yes	Yes
PORTS	5 ports	5 ports	3 ports
USB	No	Yes	Yes

The system requires no USB interface for the Configuration Graphical User Interface (GUI) block and a considerable amount of flash memory, the most suitable choice is the ATMEGA8.

3.5.1: ATMEGA8 Programming

To program the microcontroller, the universal Programmer was used. The programmer has 28 pins ZIF sockets that are used for holding the pins of the microcontroller, and programming of a 45 microcontroller is done using USB cables. The programmer supports only 5V devices and it has current protection that effectively protects the programmer and the devices (Graylogix, 2017). The microcontroller was programmed with a code written in mikro C language and translated to assembly language (hex file) using Keil uVision software, before it was inserted into the development board. The loading of the hex file into the microcontroller was done using the Universal Programmer. AVR programmer software can also be used as an alternative for MikroProg software.

3.5.2: THERMISTOR (NTC) Sensor

The following comparison was done in Table before choosing the negative temperature co-efficient sensor.

Table 3.2 : Comparison of thermocouple, resistive temperature and thermistor

characteristics	Thermocouples	Resistive Temperature Detector	Thermistors(NTC)
Temperature range	-100°C to +2500°C	-200°C to +800°C	-80°C to +150°C
Overall	• Very broad range • Moderate accuracy	• High accuracy and repeatability	• Higher accuracy • High resolution
Type of output signal	Very low voltage	Slight resistance change	Wide resistance change
Accuracy	±0.5°C	±0.01°C	±0.1°C
Output	Digital	Analog	Digital

The comparison between Thermocouples and Thermistors shows that Thermistors (NTC) temperature sensor is more accurate and has a wider range. Digital sensors are better than analog sensor and more reliable.

3.5.3: BUZZER

Buzzer has the following specifications

• On-board passive buzzer

• Can control with single-chip microcontroller IO directly

• Working voltage: 5V

• Board size: 22 (mm) x12 (mm)

3.5.4: PYRO-ELECTRIC INFRARED SENSOR

PIR sensor has the following specifications:

- low cost
- small, inexpensive, low-power, easy to use and don't wear out
- it requires a Supply Voltage(V) of 5V (Maximum rating : 5V)
- Maximum Warm-up Time is 30 sec
- Maximum range(V) is -0.3 to 5V
- Operating Temperature is between -20 to +70 deg. C
- Storage Temperature is between -30 to +80 deg. C
- Transmission is ≧ 70 % average 8 to 13 micron
- 3 to 5V power and I/O
- Field of view between X,Y-axis : 132 deg.
  Z-axis : 146 deg.
- Good for 0-50° C temperature readings ±2° C accuracy
- No more than 1 Hz sampling rate (once every second)
- Body size 1 5.5mm x 1 2mm x 5.5mm
- 3 pins with 0.1 " spacing

3.5.5: SIM800L GSM Shield

For the ease of simulation, SIM900D was used instead of the actual SIM800l on the proteus simulation circuit. it has the following specifications:

❖ It require 3.5-4.2V power supply for it to work effectively.

❖ Micro-SIM card holder.

❖ LED indicator light to show if the module is operating or not.

❖ SMA connector and antenna.

Table 3.3: UNVSIM800l Board Pinout

PIN	Description
DCIN	5-18 V DC power input, used to supply power to the development board.
GND	Ground of the system
3V8	Input or output, when DCIN is connected to the power supply, the output of this pin 3V8 DC voltage. When used as an input , this pin is used to supply power to the development board : 3.5 — 4.2 V.
VDD	Used to match the high voltage output of the TTL serial port
RXD	SIM800l data receiving end, need to connect the sending end of the external system.
TXD	SIM800l data sending end, need to connect the receiving end of the external system.
GND	Ground of the system.
RST	SIM800l reset, active low effective duration 600MS

3.5.6: DESIGN CALCULATIONS

Selecting switch resistor for buzzer and for led

Buzzer parameters: Voltage = 5v, current I = 70mA

BC547 transistor has been chosen to drive the buzzer

$where\ I_C = hFE * I_b$ ..(from BC547 datasheet)

$$I_b = \frac{70mA}{120} = 583uA$$

Note: 120 is the value chosen as hFE(ohms law)

From Ohms law $R = \frac{V}{I}$

$$R_b = \frac{V_s - V_b}{I_b} = \frac{5-0.7}{583*10^{-6}} = 7375.6\Omega = R_b = 7.5k\Omega$$

LED series Resistance (R_s) calculations

LED specification: forward voltage(V_f) =3.3v, current I_f = 30mA.

$R_s = \frac{V_s - V_f}{I_f}$, Where V_s is the supply voltage

$$R_s = \frac{5-3.3}{30*10^{-6}} = 56.6\Omega$$

Note:

R_b(Base resistor)

H_{FE}(Current amplification)

V_b(Base voltage)

V_f(LED forward voltage)

I_f(LED forward current)

V_s(Supply voltage)

I_b(Base current)

Table 3.4 : List of components

Components	Functions
Dc supply	Provide 9V for the circuit
LM7805 5V voltage regulator IC	To provide regulated 5V from the 9V of supply
BC547	Is used for driving the buzzer
1K ohm variable resistor	Restricting current to the base of the transistor
100µF capacitor	Ac filter that filter noise
10K ohm variable resistor	Pull down resistor to configure the push button
60 ohm resistor	Resisting current to the LED, it prevent overcurrent
Led (light emitting diode)	To indicate different level of temperature
10K ohm resistor	Pull up resistor(to pull logic 1)
Converter	Regulate the 5V DC supply to 4.2V needed by the module
ATMEGA8	Downloading and uploading of C programming code

3.6: PCB CONSTRUCTION

In order to achieve a fully functioning system, the modules must be combined into a full complex system. This procedure was done using Express card Designer by constructing a PCB that will include the modules and other required components. In order to construct a PCB, a circuit schematic is needed, Further comes the construction of the components footprints and importing the footprints into the PCB file. Tracks are used to connect the components together, the fully routed board is shown below

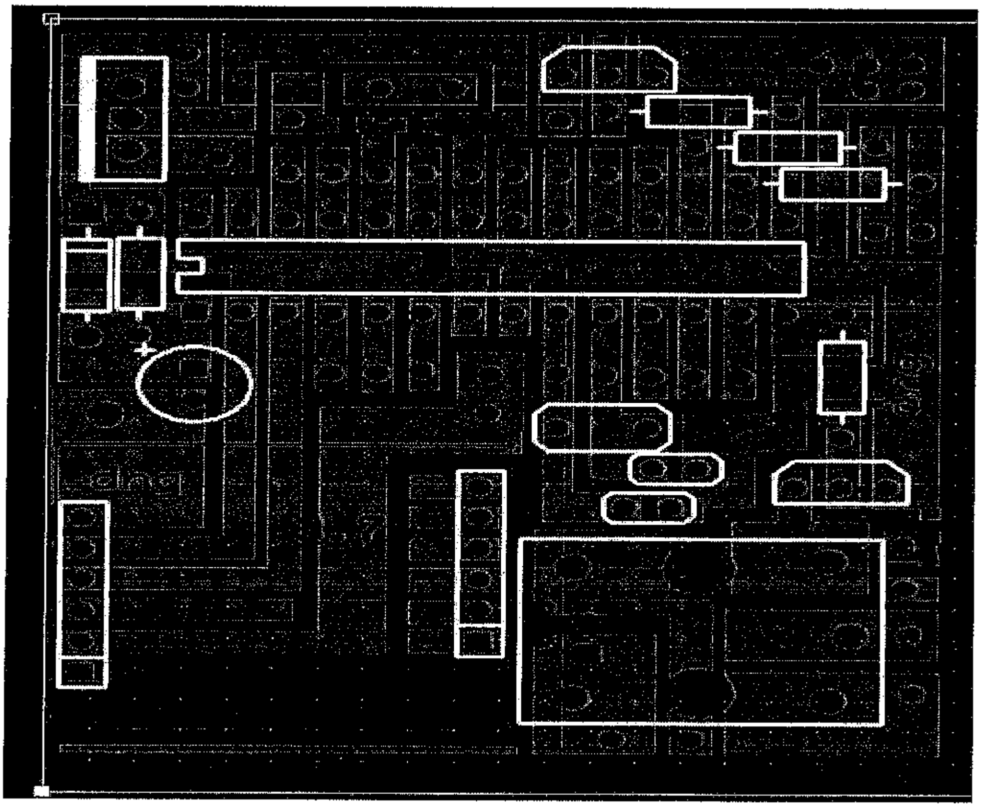


Figure 3.5:PCB simulation

The bottom layer represents what should be on the bottom side of the board, which means anything depicted as green should be implemented on the bottom side. While red represents the top layer indicating what should be done on top. This PCB is single sided as can be seen in the PCB layout, no tracks are visible on the top side and all the connections are made on the bottom side. The yellow represents the silk screen or the overlay layer which is used for the naming of components or any other writings, finally the black represents the mechanical layer which indicates where cutting of the board should occur. Afterwards, the board must be fabricated. The fabrication process starts with the drilling of the holes, pads and vias required on the board, then a mechanical outline is performed to determine the size of the board. After that the drilling of the tracks begins, once finished the board is cut off the sheet.

The next step would be fabricating the solder mask layer, and it is done by using a chemicals called etchant .Thus, the final step was to solder the components onto the printed circuit board (PCB)

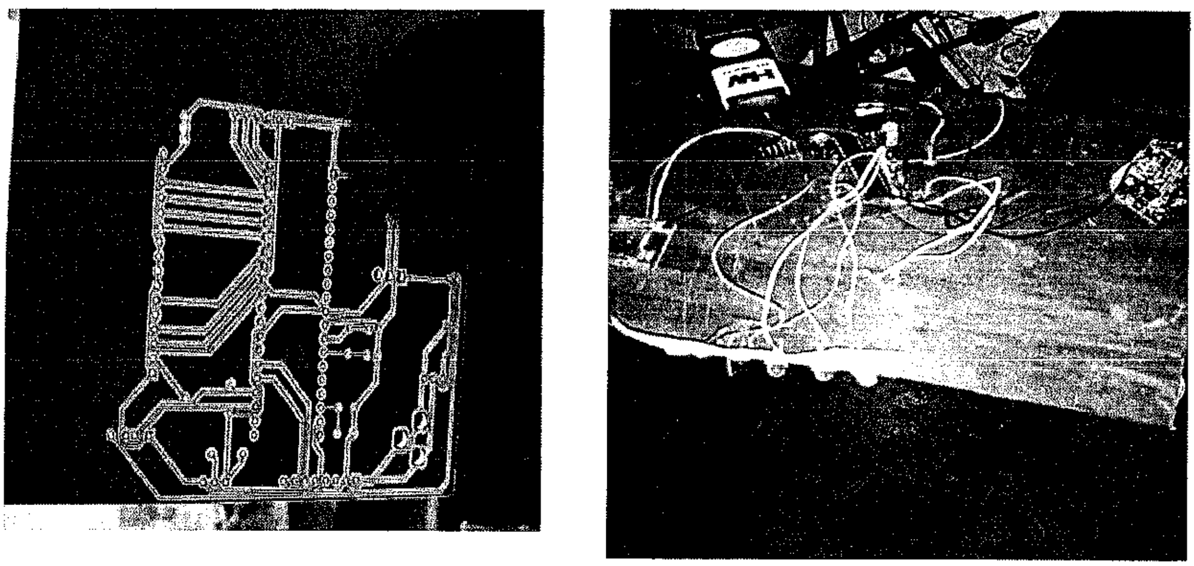


Figure 3.6:PCB layout

3.7: PERFORMANCE EVALUATION

In order to ensure that all the necessary specifications and requirements are met, the performance of the system was evaluated in real life situations. Both the software and hardware will be tested by several users. The three major metrics used for the performance evaluation are Simulation parameters, Hardware testing and functional requirements.

3.7.1: Simulation Parameters

In order to ensure that the written program will be compatible with the system design, it is necessary that the system design should be simulated. To carry out the simulation, Proteus simulation tool was used to test the system design. The hex file of the written program is to be loaded onto the microcontroller in the system design and then the "play" button of Proteus is tapped. When the "play" button is tapped, if the written program is compatible with the system design, it will sense intruder via the pyro-electric sensor

3.7.2: Hardware Testing

Under this section, the system hardware components were tested independently to ensure that every component was in good working condition. For example, the voltage of the power source must be 12V, as any voltage that is less than or greater than 12V will have an effect on the system. Also, the AC current to be used to power the power source must be within the range of 110-240V; any voltage greater than 240V will damage the power source.

3.7.3: Functional Requirements

The system was evaluated by different users (using both registered tags and unregistered tags), based on its response to registered and unregistered tags, whether or not it saves tag information after reading the tag, whether or not it grants access to registered tags, whether or not it reads more than one tag information at a time, data management, theft tolerance, etc.

3.8: PROBLEMS FACED DURING DESIGN AND IMPLEMENTATION PROCESS

3.8.1: DC supply mismatch

The introduction of a 12V DC supply as an alternative to 9v in the proteus simulation software due to the fact that the proteus simulation software does not have a 9v dc supply, furthermore, the introduction of 5V voltage regulator IC to regulate the DC supply source which is needed to power the microcontroller, temperature sensor and the PIR sensor was taken into consideration. Other alternatives were taken but didn't give results.

3.8.2: Unavailability of Solder Mask

The lack of solder mask on top of the copper in the PCB caused delays in the process of making the PCB , as the solder will stick to as much copper as it can which if left unhandled will definitely create a short circuit and possibly ruin the entire board. Soldering required meticulous work and high precision.

3.8.3: Track Width Consideration

Tracks are made on the PCB to connect components together where it allows electricity to flow through them. If a certain amount of voltage crosses a think track, it might possibly burn the track or the pad from all the resistance. Therefore having wider tracks or pads when connected to high voltages will not be damaged.

CHAPTER FOUR

ANALYSIS OF RESULT AND DISCUSSION

4.1 SIMULATION RESULTS

This system is easy to use and very simple. The model can be installed with a economical cost. The GSM technology gives a good response after received a message of particular action from microcontroller. SMS received time to house owner is basically depend on the signal strength range that you have got through mobile tower. I have developed and tested the model using C language further the same model can be enhanced with the help of some high end language and which would be more portable. The simulation of the design of the Temperature monitoring system with security features was carried out using Proteus simulation tool.

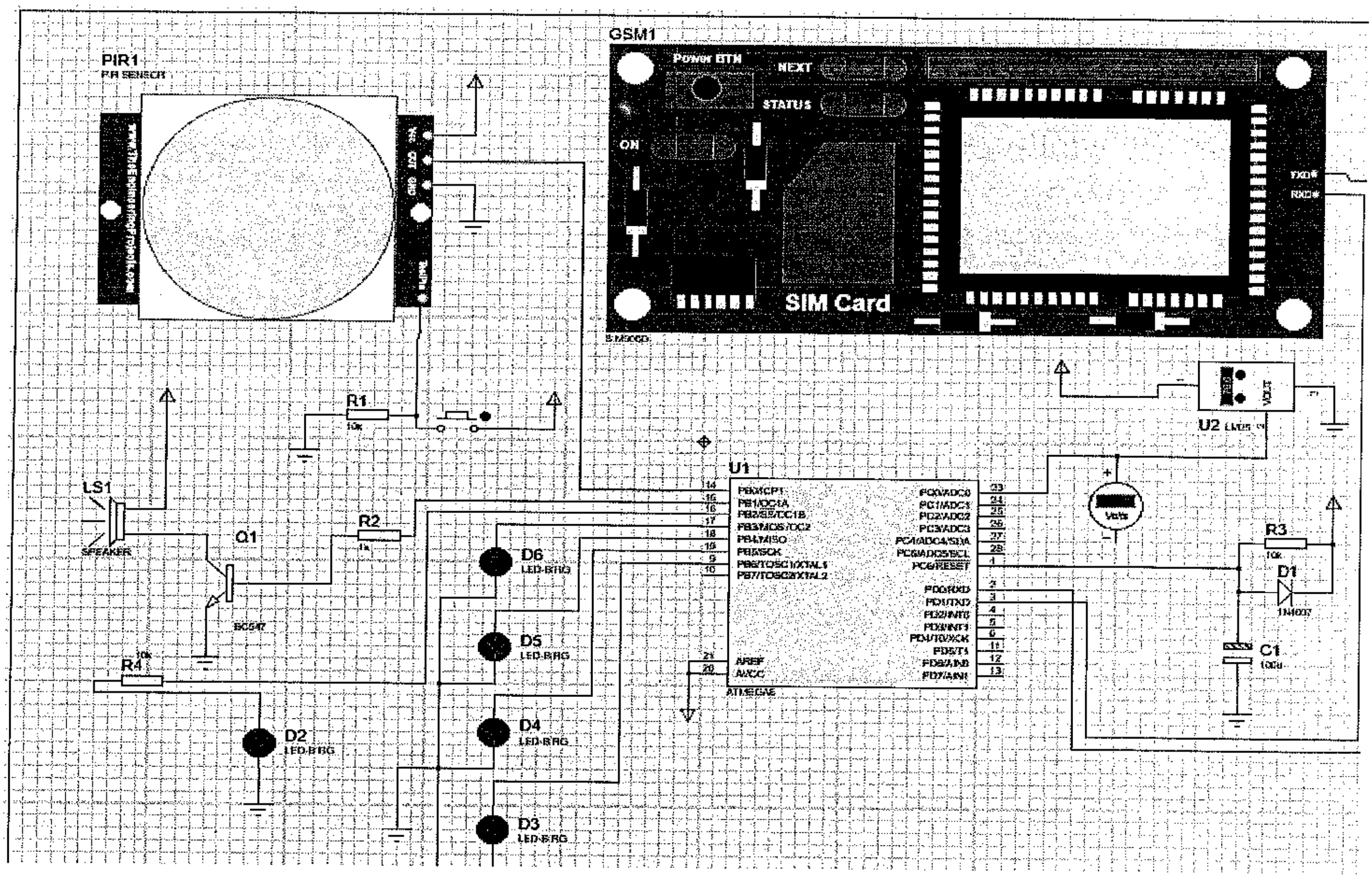


Figure 4.1: Simulation diagram

4.2 SYSTEM IMPLEMENTATION

The construction of this project was done in four different stages: Firstly, the implementation of the components in the system design onto a solderless experiment board (breadboard). Next is the transfer of components from the solderless experiment board to the printed circuit board, and then soldering the components permanently on the printed circuit board. Thirdly, the printed circuit board was connected to both the power source and and the GSM module. Finally, the entire project was coupled together into a 3 by 3 casing. The Bill of Engineering Measurement and Evaluation (BEME) which highlights all the components used for the system implementation are listed in the Appendix section of this report.

4.3 COMPONENTS IMPLEMENTATION ON SOLDERLESS EXPERIMENT BOARD (BREADBOARD)

Firstly, the microcontroller (after it has been programmed using the universal programmer), the buzzer, the PIR sensor was, and GSM module were all setup on a breadboard and interconnected with each other as seen in the circuit diagram below of this report. Interconnections were done using jumper wires and a Multimeter was used to test every component to verify whether or not they are in good conditions. The Multimeter was also used to measure the voltage and current that gets to every component present in the connection.

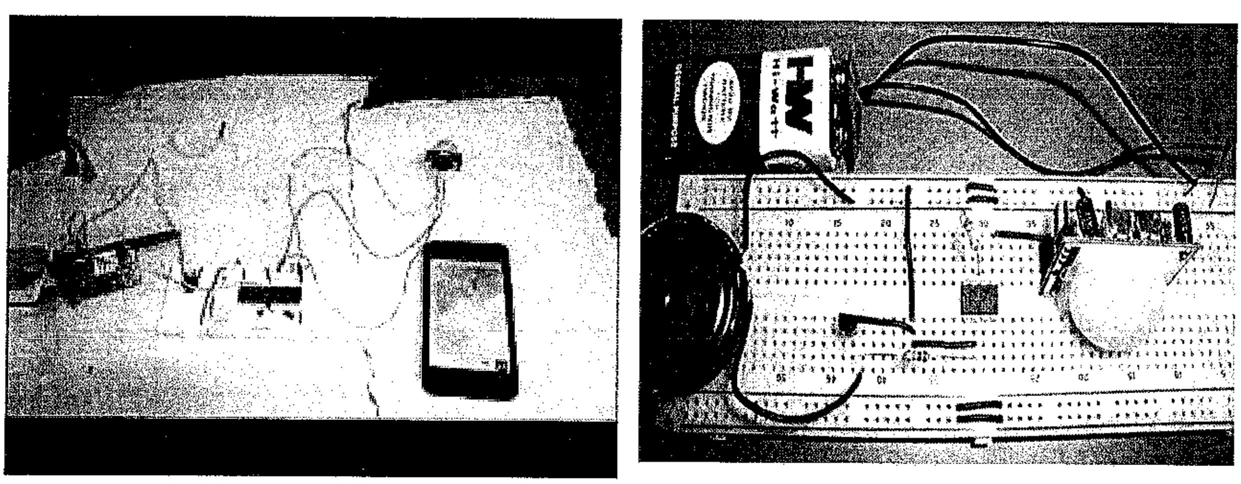


Figure 4.2: Breadboard simulation

4.4 COMPONENTS IMPLEMENTATION ON PRINTED CIRCUITBOARD

After a successful components layout and testing on the breadboard, the components were then transferred to the development board and were permanently soldered to the printed circuit board as seen in Figure below. The microcontroller was placed on an IC socket before soldering it to the printed circuit board.

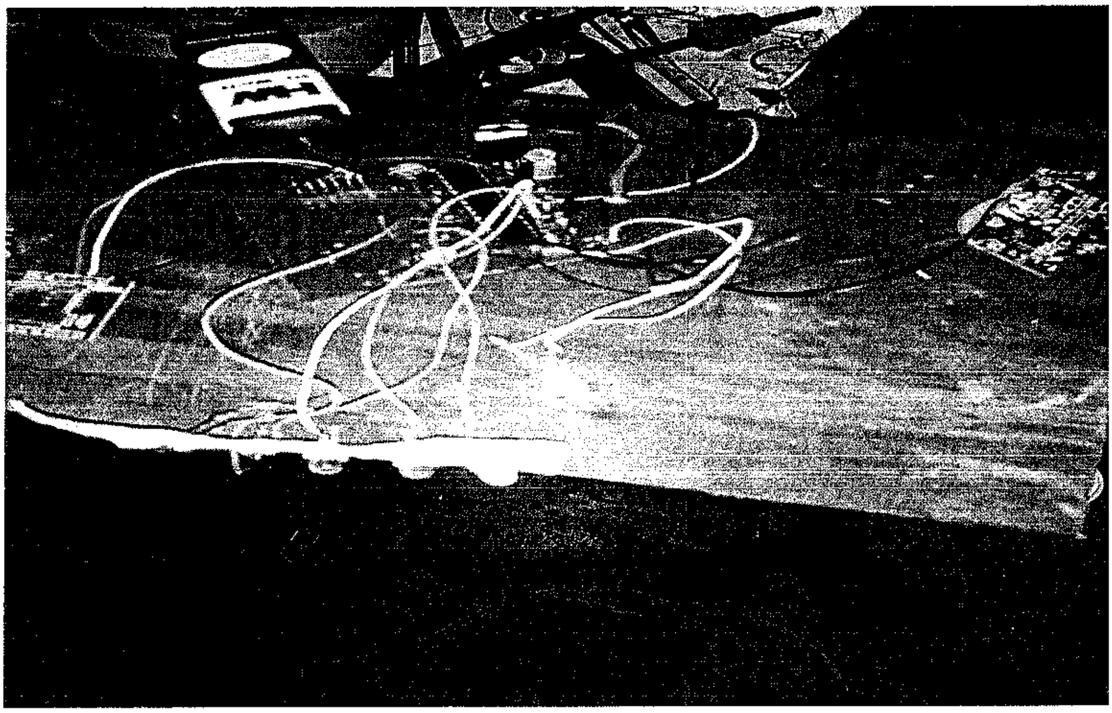


Figure 4.3: PCB implementation

4.5 COMPONENTS INTERCONNECTION

After a successful layout of components on the printed circuit board, there is need to interconnect the development board with the PIR sensor, Thermistor (NTC), GSM and the power source using connecting cables. The interconnection of the components is shown in the Figures 4.4 and 4.5 below. The PIR sensor, microcontroller and Temperature sensor require a 5V power supply, and this power is supplied by using voltage regulator IC 7805 to regulate the voltage from 9V to 5V DC. The live cable of the door lock is connected to the positive terminal of the power source and the ground cable is connected to the negative terminal of the power source. The development board is also connected to the power source through its ports 12V and GND.

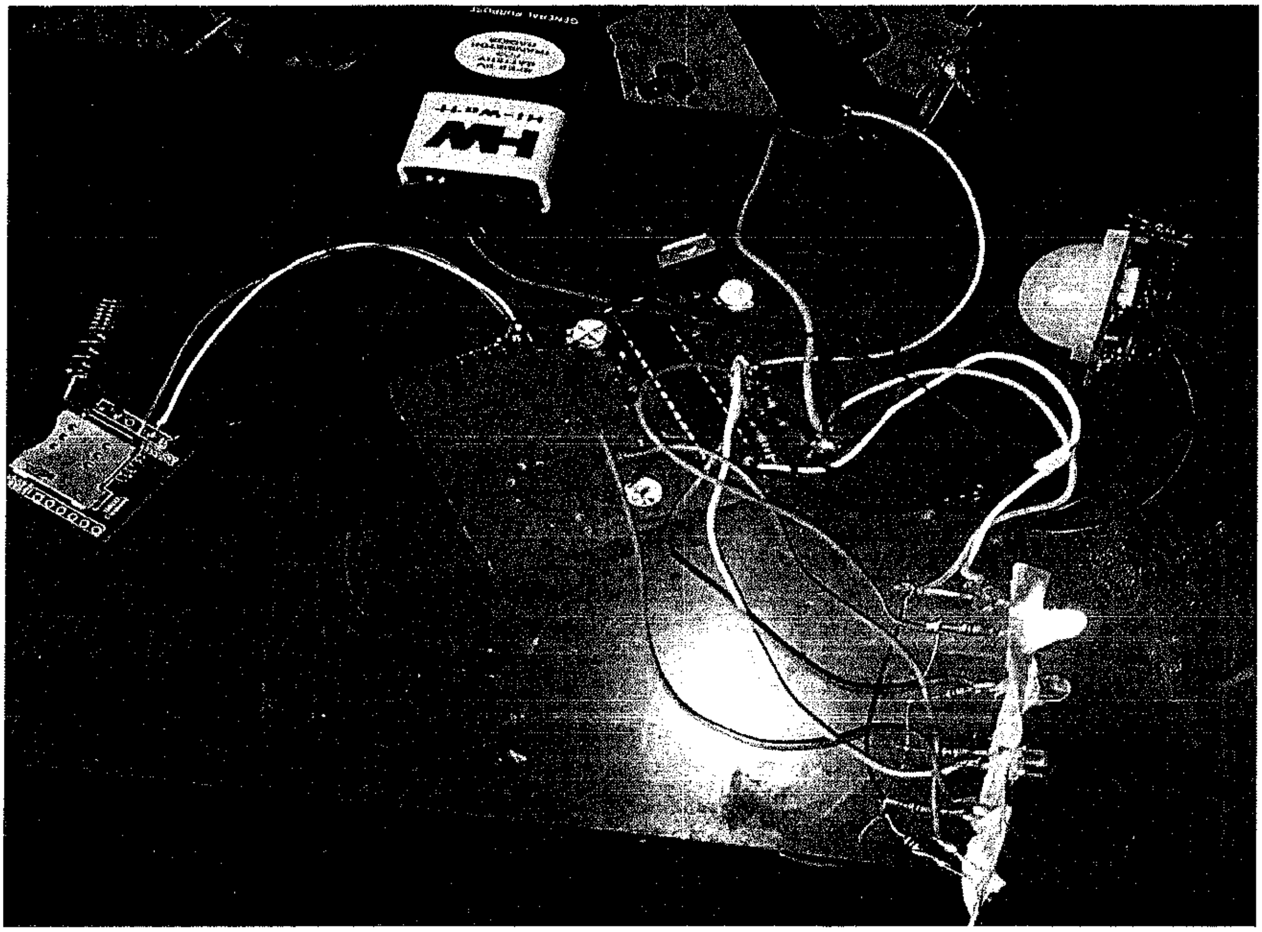


Figure 4.4: Components interconnections

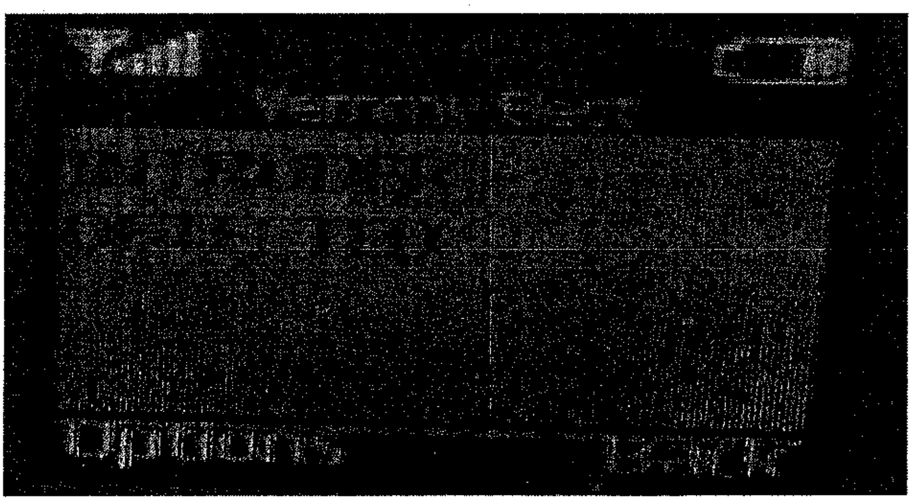


Figure 4.5: Intruder alert message

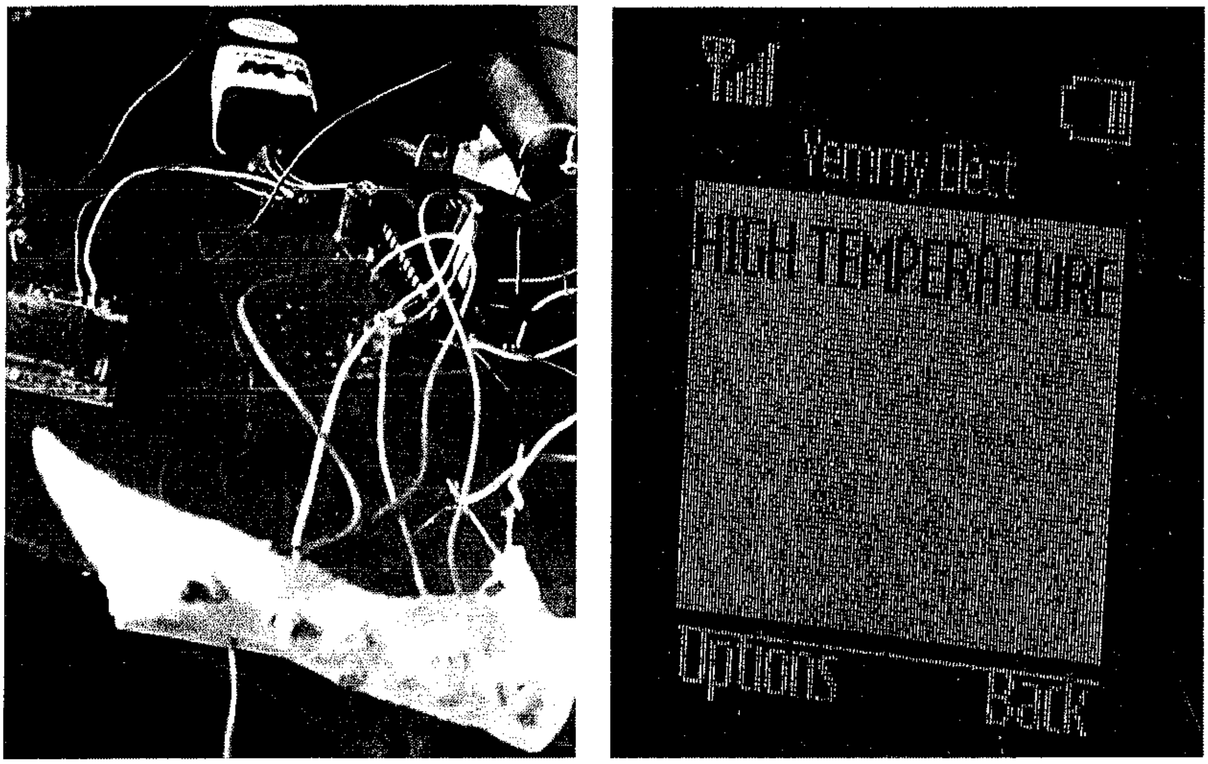


Figure 4.6: High temperature message notification

4.6 COUPLING OF PROTOTYPE COMPONENTS

After a successful components interconnection, the whole connection is tested to check whether or not it is in good working condition. If the connections perform the desired operation, then there is need to couple the components together into a casing. For this project, the casing used is a 3 by 3 plastic box, and the components are well laid and screwed to the box. The PIR sensor and Thermistor Temperature sensor is placed on the top and side view of the box. This is done for easy detection of intruder within the range and it is done for the test of temperature, the power source is well housed inside the box as well as the reset button. The Figure below shows the developed prototype of the access control system.

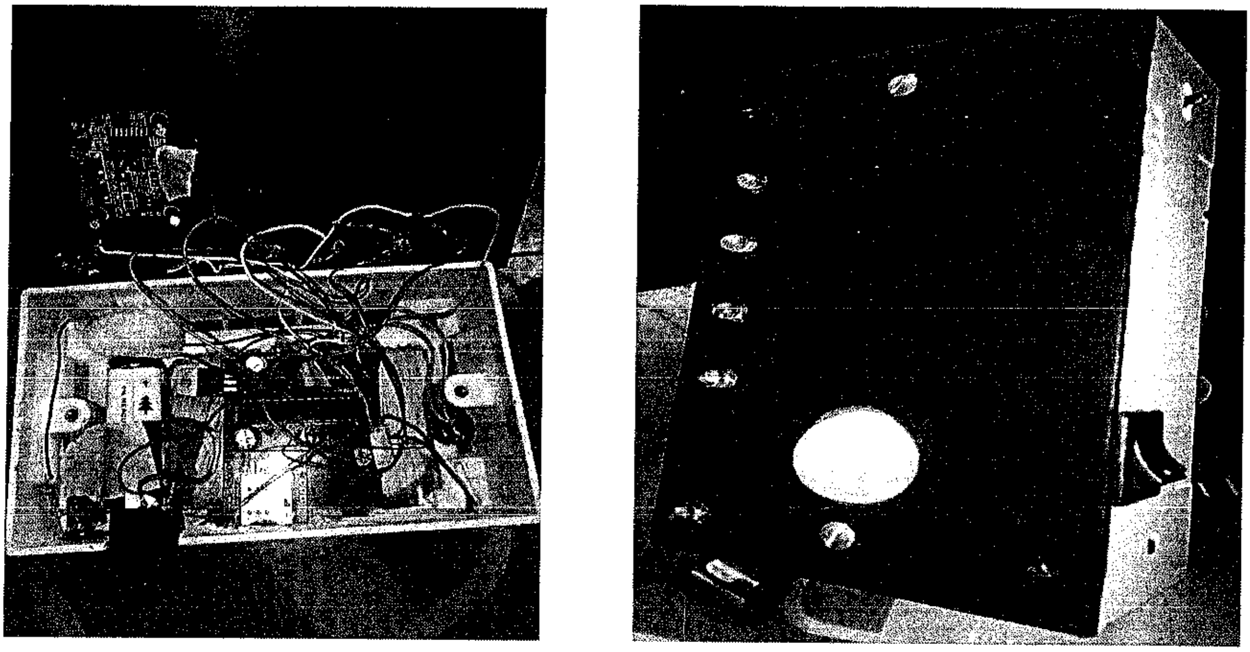


Figure 4.7: **Prototype of temperature monitoring device with security features**

4.7 SYSTEM EVALUATION

In order to ensure that all the necessary specifications and requirements are met, the performance of the system has been evaluated according to real life situations. Both the simulation program and the hardware have been tested in real scenarios by many users. The two major metrics that have been used are Hardware testing and functional requirements.

4.8 HARDWARE TESTING

Under this section, all system hardware were tested independently using a Multimeter to ensure that every component is in good working condition. The system hardware components that were tested are the PIR sensor, Thermistor (negative temperature co-efficient) and the power source.

1. Testing the Power Source

It is important that the power source must be tested since it provides power to the entire system. Any damage that results from the power source may damage the entire system. The result of testing the power source shows us that, the voltage of the power source must be 9V, as any voltage that is less than or greater than 9V will not make the system work or will damage the system respectively.

2. Testing the pyro-electric infrared sensor and temperature sensor

The PIR sensor and temperature sensor requires a 5V DC power supply and a current of 800mA. This is achieved by a voltage regulator 7805, it regulate the voltage needed by both the PIR sensor and the NTC temperature sensor (9V to 5V) . Temperature sensor was tested with hot soldering iron while the PIR sensor was tested with movement of human body.

3. Testing of the GSM module

The module requires an input of 5V DC supply to produce an output of 4.2V with the aid of a converter. The module was further tested with a working sim card in order to send a short message to the predefined number in the program.

4.9 FUNCTIONAL REQUIREMENTS

The system has been evaluated by different users (using the PIR sensor and temperature sensor), based on its response to intruder and high temperature, it send message to a predefined user in the program, it also send message when there is higher temperature.

Table 4.1 Performance evaluation

Functional requirement	**Send SMS**	**No SMS**
Intruder	Yes, send SMS	
No intruder		No SMS
Temperature above 45degree.c	Yes, send SMS	
Temperature below 45degree.c		No SMS, but just indicate via the LED indicator

4.10 GANTT CHART FOR THE DESIGN AND CONSTRUCTION OF TEMPERATURE MONITORING DEVICE WITH SECURITY FEATURES

WORK DESCRIPTION	MONTH	SEPTEMBER				OCTOBER			
	Weeks	1	2	3	4	1	2	3	4
	Days	7	14	21	28	35	42	49	56
TASK SCHEDULE									
PROGRAMMING SECTION									
Programming and debugging of control commands	7 days								
Compiling using micro C compiler	1 day								
ELECTRICAL SECTION									
Design and Simulation of circuit connections and process flow using proteus software	3 days								
Printed circuit board design(PCB)	2 days								
Etching of the PCB using the etchant	1 day								
Implementation of GSM module	2 days								
Soldering of ATMEGA8 microcontroller, pyro-electric sensor ,temperature sensor, voltage regulator, BC 547 transistor, BC 546 transistor, capacitors, current limiting resistors and light emitting diodes	7 days								
Downloading and uploading of C programming code On ATMEGA8 microcontroller	1day								
HARDWARE SECTION									
Testing	1day								
TOTAL DURATION	4 WEEKS								

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The aim of the project was to design a temperature and security monitoring embedded system for monitoring of temperature and detecting an intruder. The objectives were achieved and the system functions as desired in the specifications, the system will provide continuous monitoring of temperature and intruder in the environment and alert the user whenever the temperature are not desired.

This work has presented the design and construction of a GSM based temperature monitoring device with security features, after the construction and component assembly, it was tested and they were responding to the GSM modem as detected by the infra-red sensors, and temperature sensor. But misuse of the system by end users may probably lead to lapses in the system performance. The system was designed and constructed in such a way that maintenance and repairs are easily done, it monitors house with the aid of sensors that are integrated within the microcontroller and a GSM module while SMS is used to alert users via mobile phone when a possible intrusion occurs, the system is design using modularity, to become a flexible system that can add more sensors to increase systems functionality without changing the whole system.

5.2 CONTRIBUTIONS TO KNOWLEDGE

- Implementation of components on printed circuit board rather than vero board implementation.
- Negative temperature co-efficient has been the best temperature sensor.
- Detection of intruder using the pyro-electric infrared sensor has been the best so ever.

5.3 RECOMMENDATION

- Better microcontrollers are being produced all the time, I recommend the use of the latest microcontrollers and embedded microcontroller technology.
- An alternative source of power (such as a UPS) should be provided as a backup so as to ensure that the power supply to the entire system doesn't go off at any time.

5.4 LIMITATIONS

- It require a power source for it to work effectively.
- Pyro-electric infrared sensor won't tell you how many people are around or how close they are to the sensor.
- This system provides information to users using SMS via mobile phone carried by the user wherever the user is located only while in the coverage area.
- Since the the system is still in prototype form (pilot), then infrared sensor used is an infrared sensor at close range (8-10 m).

5.5 FUTURE WORKS

5.5.1 Implementing an audio-visual camera

Future suggestions of this project are very great considering the amount of time and resources it saves. This system can be used as reference or as a base for realizing a scheme to be implemented in other project of greater including the audio-visual camera by sending the captured images to an email instantly. The project itself can be modified to achieve a complete home automation system which will then create a motion system which will then create a platform for user to interface between himself and his households.

5.5.2 Implementing a Graphical LCD

If we implement a graphical LCD we would be able to add more icons such as battery percentage, date and time in order to improve the interaction with the user and make it easier.

5.5.3 Improving the Configuration Graphical User Interface

- To increase the number of phones that the alert message will be sent to, in order to ensure other user receiving the messages in case failure to deliver to the main intended user .

- Support of Arabic language.

5.6 Critical Appraisal

During the course of the project, I have been expose to different simulation software like the printed circuit simulation software and the multism simulation software, of which the PCB software has been the best among them.

Finally, the project has really exposed me to different microcontrollers, and of which ATMEGA8 has been the best, due to its reliabilty.

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APPENDIX

APPENDIX A: Bill of Engineering Measurement and Evaluation (BEME)

For the complete design and construction of temperature monitoring device with security features, the items used are highlighted in the Table A below:

Table A: BEME for the entire system

S/N	ITEM	QUANTITY	RATE (IN NAIRA)	AMOUNT (IN NAIRA)
1	GSM module	1	4,000.00	4,000.00
2	PCB	1	2000.00	2000.00
3	PIR sensor	1	1,500.00	1,500.00
4	Jumper wires	20	20.00	400.00
5	Buzzer	1	100.00	100.00
6	LED	6	15.00	90.00
7	Microcontroller	1	500.00	500.00
8	Thermistor	1	500.00	550.00
9	Power Source	1	200.00	200.00
10	Bread Board	1	1,200.00	1,200.00
11	Enchanter	1	500.00	500.00
12	3 by 3 box	1	200.00	200.00
13	BC 547	1	50.00	50.00
14	Voltage regulator	1	100.00	100.00
15	Assorted resistor	10	100.00	100.00
16	Capacitors	1	20.00	20.00
17	Converter	1	150.00	150.00
TOTAL				11,660.00

APPENDIX B: Program code

```
;
; Temperature and intruder.asm
;
; Created: 8/2/2018 4:54:20 AM
; Author : ADENIJI
;
.EQU    ADRES1= 0X60
.EQU    ADRES2= 0X61
.EQU    ADRES3 = 0X62
.EQU    ADCCOUNT = 0X63
.EQU    ADRES1B         = 0X64
.EQU    ADRES2B         = 0X65
.EQU    ADRES3B = 0X66
.EQU    ADCCOUNT2 = 0X67
.ORG    0X00
START:
        LDI     R17,0X5F
        OUT     SPL,R1
        LDI     R17,0X04
        OUT     SPH,R17
        CLR     R17
        OUT     PORTD,R17
        LDI     R17,0XFC
        OUT     DDRD,R17
        LDI     R17,0X00
        OUT     PORTC,R17
        OUT     DDRC,R17
        LDI     R17,0X00
```

```
        OUT     PORTB,R17
        LDI     R17,0XFE
        OUT     DDRB,R17
        LDI     R17,0X40
        OUT     ADMUX,R17
        LDI     R17,0X86
        OUT     ADCSRA,R17
        LDI     R17,0X04
        OUT     SFIOR,R17
REDO:
   CBI          PORTB, 1
        SBI   PORTB, 2    ;POWER ON INDICATOR
        RCALL  TEMP
        SBIC    PINB, 0
        RCALL   SENDMBUTTON1
        RJMP    REDO
SERIAL5BUTTON1:
                        ; PHONE NO  I.E 08166744293 = 2348166744293
                ;       add F to make even no  = 2348166744293F
                ; THEN INTERCHANGE EACH 2 CHARACTERS = 328461764492F3
                  ; THE FIRST 2 DIGITS HAS BEEN USED IN SERIAL4
                  ;USE THE REST IN THIS ROUTINE = 8461764492f3
        RCALL   SERIAL4GEN8
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN6
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN7
        RCALL   SERIAL4GEN6
        RCALL   SERIAL4GEN4
```

```
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN9
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GENF
        RJMP    SERIAL4GEN3
MESSAGE1: ;INTRUDER DETECTED  IN PDU FORMAT with SMSC
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN9
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GEN7
        RCALL   SERIAL4GEN5
        RCALL   SERIAL4GEN5
        RCALL   SERIAL4GEN5
        RCALL   SERIAL4GENA
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GEN5
        RCALL   SERIAL4GEN1
        RCALL   SERIAL4GEN6
        RCALL   SERIAL4GENA
        RCALL   SERIAL4GEN5
        RCALL   SERIAL4GEN2
        RCALL   SERIAL4GEN0
        RCALL   SERIAL4GEN6
MESSAGE2: ;HIGH TEMPERATURE IN PDU FORMAT
        RCALL   SERIAL4GENC
        RCALL   SERIAL4GEN8
        RCALL   SERIAL4GENE
        RCALL   SERIAL4GEN4
        RCALL   SERIAL4GEN1
```

```
RCALL   SERIAL4GEN1
RCALL   SERIAL4GEN0
RCALL   SERIAL4GEN9
RCALL   SERIAL4GENA
RCALL   SERIAL4GEN2
RCALL   SERIAL4GEN1
RCALL   SERIAL4GEN6
RCALL   SERIAL4GEN9
RCALL   SERIAL4GENB
RCALL   SERIAL4GEND
RCALL   SERIAL4GEN0
RCALL   SERIAL4GENA
RCALL   SERIAL4GEN2
RCALL   SERIAL4GEN3
RCALL   SERIAL4GEN4
RCALL   SERIAL4GEN4
RCALL   SERIAL4GEN8
RCALL   SERIAL4GENA
RCALL   SERIAL4GEND
RCALL   SERIAL4GEN4
RCALL   SERIAL4GENA
RCALL   SERIAL4GEN8
RCALL   SERIAL4GENB
RCALL   SERIAL4GEN2
RCALL   SERIAL4GEN0
;THESE DELAY DOES NOT USE TIMERS AND INTERRUPT
;ADJUST AS NEEDED FOR OTHER CRYSTALS
; FOR 16MHZ ADD 8 NOPS TO EACH INCIDENT OF 1 NOP  OR CREATE A SUB AND PUT 1 NOP
;FOR 20MHZ  ADD 12 NOPS TO EACH INCIDENT OF 1 NOP OR CREATE A SUB AND PUT 5 NOP
```

```
SUB16:
        NOP
        RET
SUB20:
        NOP
        NOP
        NOP
        NOP
        NOP
        RET
;THERE ARE 8 INCIDENCE OF RCALL SUB16/20 IF THE NEED ARISES FOR ADJUSTMENT
DELAY1US:  ; IF 8MHZ THEN EACH NOP IS 0.125US REQUIRES 8 NOPS TO MAKE 1US
        NOP    ; RET = 4 , RCALL = 3 HENCE ONLY ONE NOP NEEDED
        ;RCALL SUB16
        ;RCALL SUB20
        RET
RCALL   DELAY10MS
        RCALL   DELAY10MS
        RCALL   DELAY10MS
        RCALL   DELAY10MS
        RCALL   DELAY10MS
DELAY100MS:
DELAYM3:  ; UPDATED TO 100MS
        RCALL   DELAY10MS
        RCALL   DELAY10MS
RCALL   DELAY10MS  ;90MS
        RCALL   DELAY1MS
        RCALL   DELAY1MS
        RCALL   DELAY1MS
```

```
RCALL   DELAY1MS  ; 99MS
        RCALL   DELAY100US
        RCALL   DELAY100US
        RCALL   DELAY100US
SEC1:
DELAY1SEC:  ; 1.000 000 875 SEC
        RCALL   DELAYM4
        RCALL   DELAYM4
        RET
SEC5:  ; 5.000 000 875 SEC
DELAY5SEC:
        RCALL   DELAYM4
        RCALL   DELAYM4
        RCALL   DELAYM4
        RCALL   DELAYM4
SEC10: ; 10.000 000 875 SEC
DELAY10SEC:
        RCALL   DELAYM4
        RCALL   DELAYM4
        RCALL   DELAYM4
        RCALL   DELAYM4
SEC20:
DELAY20SEC: ; 20.000 000 875 SEC
        RCALL   DELAYM4
        RCALL   DELAYM4
        RCALL   DELAYM4
        RCALL   DELAYM4
```