DESIGN AND CONSTRUCTION OF A TEMPERATURE MONITORING AND ALARM SYSTEM

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DEDICATION

This work is dedicated to God Almighty who saw me through the course of my undergraduate days, and has given me wisdom to execute this project. without whose help it would have been impossible.

DECLARATION OF ORIGINALITY

I OJO BUKUNMI EMMANUEL (EEE/13/1112) hereby declare that this project report is all my own work and has not been copied in part or in whole from any other source except where duly acknowledged.

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CERTIFICATION

This project work titled "Design and construction of a temperature monitoring and alarm system" by Ojo, Bukunmi Emmanuel, meets the minimum requirements governing the award of Bachelor degree in Electrical/Electronic Engineering Department, Federal University Oye-Ekiti, Ekiti.

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EXTERNAL EXAMINER DATE

ABSTRACT

The temperature monitoring system is designed with microcontroller and is quite useful for conference halls, auditoriums, cinema halls, medical facilities and other commercial organizations where many people gather together, and lot of fans and air conditioning systems are required at these places to maintain required temperature. Digital Temperature monitor and alarm using arduino, here we use arduino as main controller, this temperature monitor measures the temperature of any environment or device, and compares it with given set points, and afterwards blows an alarm if any difference is observed. It also displays state of the device either on or off and current temperature.As the name implies, a **temperature monitor** is an instrument used to monitor and display temperature. The temperature controller takes an input from a temperature sensor and has an output that is connected to a LED and an alarm.Chapter one gives introduction to the topic, reasons for the project, aim and objectives of the project. Chapter two contains literature review of the project, previous activities on the topic, critical evaluation of all processes and stages of the project. Chapter three exposes us to how the project was got done, materials used, methodology deployed, and how operation was achieved. Chapter four talks about the test, result, and construction procedure, Chapter five has the conclusion.

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CHAPTER ONE

INTRODUCTION

The main purpose of temperature monitoring and alarm system is to check on the temperature of any electronic device or environment whose temperature keeps fluctuating and thus requires a constant watch. The use of this system eliminates constant manual watching of the ambient temperature by self-checking and displaying the temperature of the environment.

Our proposed project consists of a temperature sensor for more accurate temperature measurement and control in various industries. Our system overcomes the disadvantages of thermostat/analog systems in terms of accuracy. This system can be used in any firm or organization where it is very important to maintain precise temperatures. LCD is used to display the temperature and when the temperature exceeds the set limit, the alarm will blow in order to inform the user.

The system uses a digital temperature sensor in order to detect temperature and pass on the data to the Arduino microcontroller. The Arduino microcontroller processes data and sends the temperature to be displayed on LCD screen. The display is 16 *2 LCD. After that the system detects temperature and switches the load when it goes beyond set limits.

Process monitoring and control is a very important way of improving the operation of a process, the productivity of a plant, and the quality of products, the quality of health service delivery. Nowadays, the demand for accurate temperature monitoring, control and air ventilation control has conquered many of industrial domains such as process heat, alimentary industry, automotive, industrial spaces or office buildings where the air is cooled in order to maintain a comfortable environment for its occupants. One of the most important concerns involved in heat area consists of the desired temperature fruition and consumption optimization. To fulfill such a challenge one should promote suitable control strategies. In the last decade extensive research has been made with respect to temperature control for different types. Monitoring and maintaining temperatures is important in many control applications, for instance, industrial domains such as process heat, automotive, industrial places, storage or office buildings and the desired temperature achievement and consumption optimization are the most important concerns [1].

The goal of this project is to implement the temperature system that will perform the observation and monitoring of the rooms or devices it is attached to, as well as sending alert messages over a buzzer when the temperature exceeds certain values that might affect and damage the patients, equipment or devices in question. Another objective is to design a graphical user interface to give a user the control and accessibility to change the settings of the temperature sensor by changing the values that might damage the sensor.

1.1 BACKGROUND OF THE PROJECT

Temperature sensing and precise control forms an integral part of any industrial monitoring and control system. It is becoming more prevalent in the food industry, medicines, catering and supermarkets. It is a widely used parameter in any given process controlled environment. Earlier, many attempts were made to develop a temperature monitoring system based on analog temperature sensors, thermocouples, resistance temperature detectors (RTD), thermistors, but the timing, response time and accuracy were insufficient. In case of industrial applications where very high sensitivity sensing and control of temperature is required we require a precise temperature monitoring system which can detect a small change in temperature and can maintain the same within the set-point with least variation with reasonably short response time. In the proposed temperature monitoring and alarm system a digital temperature sensor DS18B20 of Dallas Instruments is used to sense the ambient temperature that gives out the digital value of the temperature [2].

Information technology has been the enabling domain in reshaping conventional healthcare systems. Emerging technologies such as m-health, ubiquitous health monitoring as well as telemedicine have recently become widespread and attracted the attention of many researchers. The Continuous and real-time monitoring systems, as the key elements of modern caregiving systems, can effectively revolutionize the conventional

healthcare systems. Wireless body sensor networks (WBSNs) have received a considerable attention as the viable alternative in achieving continuous health monitoring systems. Currently, WBSNs support a wide range of applications including fall prevention, wireless electrocardiography (ECG) (i.e., wireless ECG), and also remote respiration and temperature monitoring. As it can be deduced, different types of vital sign sensors (e.g, blood pressure, glucose, ECG and temperature) which are wirelessly networked together can incorporate in WBSNs for specific health monitoring purposes.

However, currently in hospitals, patients' vital signs are recorded and supervised several times during the course of a day by clinical staff. Human errors, lack of adequate skills, tiredness and inefficient staff in additional to shortcoming of sufficient accuracy due to wrong measurement and personal interpretation of the results can deteriorate patients' life, especially when the number of hospitalized patients exceeds [3].

Nowadays, air conditioning systems are widely used especially in warm countries including Nigeria. Usually the conventional air conditioning is always cooling the room depending on the fixed temperature setting and is not automatically adjusted for the comfort of the users. In the central air conditioning control field, excellent real-time, high reliability, and good intelligence are proposed by many researchers. The traditional PID algorithm is, in fact, still playing a main role in the control process. The air conditioning system has become a field to be researched to improve the user convenience by applying intelligent system such as THERMOCOUPLE.

While the enhanced air conditioning system is being designed, the consideration of the type of control system must be included in a modeling design. In particular the controller must be able to avoid the inefficiency of having the air conditioner operate all the time. The whole system works, and operates based on the data input from the sensor. This project is geared towards improving healthcare by means of electrical/electronics engineering. In certain places at hospitals such as intensive care units, and blood bank where certain temperature level is supposed to be maintained, it will help a lot, to keep tabs on the temperature and display it for easy administration.

1.2 PROBLEM STATEMENT

Temperature monitoring and control has been a major issue over the years, it gets a bit tasking and cumbersome in public places to keep tabs on and maintain a particular temperature value or range. People and authority in some areas such as hospital do not realize the change in temperature of the environment, which can be detrimental to the health status and recovery of the patient in question.

In cases of varying temperature, there is relatively slow alert and action of emergency response personnel in the area.

It is also quite difficult to determine ambient temperature

1.3 MOTIVATION

The motivation for this work is to improve health care delivery and general human existence with the use of electrical/electronics engineering, and also to provide a cost effective way of achieving this using locally obtainable products.

1.4 AIM AND OBJECTIVES OF THE PROJECT

The aim of the project is to design and construct a TEMPERATURE MONITORING AND ALARM SYSTEM.

The objectives of the project are:

- To monitor the temperature of a device or environment.
- To design an alarm system using temperature sensor.
- To analyze the performance of the controller.
- To display Real-time temperature on its LCD screen.

1.5 SIGNIFICANCE OF THE PROJECT

With this system, one can remotely monitor system temperature and get the idea of whether temperature is constant / increasing / decreasing. Another and most important advantage is when temperature exceeds specified limit the alarm signal is available on output terminal. This can help in taking any immediate or automatic action.

It solves the problem of having to manually check out temperature level of an environment, this project is needed because it eliminates the possibility of human error in temperature monitoring.

1.6 SCOPE OF THE PROJECT

In this work, the device was built to display and monitor the temperature of the surrounding or any other material to which the DS18B20 temperature sensor is connected for its temperature measurement in degree centigrade in a 16*2 Alphanumeric LCD. Also, we will compare the temperature of the surrounding or material to which the DS18B20 temperature sensor is attached with a threshold value continuously and when the temperature of the surrounding or material to which the DS18B20 temperature sensor is attached is greater or lesser than the threshold value, the buzzer will start beeping.

Below are some highlights of the project:

i. In this work, used was a DS18b20 thermocouple for direct measurements **of up to 1000°C** temperature. It is a low-cost and one of the most popular and accurate **general-purpose** thermocouples. Output is digital

ii. Inside and outside room temperature are used in the controller design.

This device can be used for temperature monitoring of appliances such as:

i. Air conditioner

ii. Refrigerator

iii. Fan,

iv. furnace etc.

It can equally be used to monitor ambient temperature of buildings, rooms, etc

CHAPTER TWO

LITERATURE REVIEW

According to The writing Centre, the University of Wisconsin- Madison; "A review may be a self-contained unit – an end in itself – or a preference to a rationale for engaging in primary research. A review is a required part of grant and research proposals and often a chapter in thesis and dissertations. Generally, the purpose of a review is to analyze critically a segment of a published body of knowledge through summary, classification, and comparison of prior research studies, reviews of literature, and theoretical articles." From this statement, the literature review is like a way to gain the ideas on how the developed system is going to be. The discussion in this section extensively exhausts that

2.1 REVIEW OF RELATED WORKS

The authors in [1] present a temperature monitoring system based on 1-wire protocol communication and PIC microcontroller. The proposed system uses a digital temperature sensor DS18B20, which has a unique 64-bit serial code identifier which allows multiple DS18B20s to function on the same 1-Wire bus thereby making it possible for one PIC microcontroller to control many DS18B20s distributed over a large area. The results were compared with that of a mercury and a digital thermometer and showed the system was accurate. However, the system could not save the temperature data.

In [2], the authors present a system that uses a microcontroller and a digital IC temperature sensor TMP275 to measure ambient temperature. They implemented a PID controller in the firmware and then the microcontroller generates PWM signals with appropriate duty cycle that is used to maintain and control the temperature in a ventilated chamber. The results show the system can measure temperatures as low as -18°C to temperatures as high as +70°C with a resolution of 0.0625°C and accuracy of 0.5°C and that the system can maintain and control the temperature within the required set temperature with least variation.

The paper in [3] addresses the design and implementation of a real-time temperature monitoring system with applications in telemedicine. The developed system consists of some wireless thermometers with each thermometer incorporating a wireless transceiver unit operating at 2.4GHz, an accurate digital temperature sensor and a microcontroller.

The thermometers were provided with unique identification codes to enable the system to distinguish relevant measurements. The system evaluation results show a good stability condition with a fluctuation level (averaged) less than 0.25°C. The mean square error of the system when compared with mercury thermometer was 0.357°C. The results also reveal that the wireless thermometers can be connected with a central node from a distance of nearly 30 meters without encountering disruption to communication. The author in [4] proposes a PC based temperature monitoring and alarm system. It uses a linear and highly sensitive temperature transducer whose analog output is converted to digital form using an 8-bit analog to digital converter. The digital signals are then fed to the personal computer (PC) through the parallel port for display on the monitor. The result shows the temperature of the PC compares well with that of the thermometer (± 0.2°C) and that the alarm triggered at ± 0.1°C of the threshold temperature. However, due to the temperature transducer used, the device range is limited to -55°C to +150°C.

The author in [5] proposes a temperature monitoring and logging system suitable for use in hospitals, incorporating GSM text messaging. The features include ability to monitor the temperature of a patient on a continuous basis while displaying the result instantly on a liquid crystal display device. The results obtained when compared with a digital thermometer showed a small deviation from the two temperatures. The possible reason that was given was that the resolution of the ADC is 1 and that would mean the temperatures are rounded up to the nearest whole number during the ADC conversion process. In [6], the authors describe a simple, low cost microcontroller based design that can regulate the temperature changes in equipment for industries. The system is designed using DS1621 temperature sensor, AT89C52 microcontroller and LCD. The output of temperature sensor is fed to the microcontroller which converts it to an appropriate digital value according to the set of pre-defined values stored in its memory and displays it in the LCD. This system is designed to monitor temperature from -55°C to 125°C.

In [7], the authors presented two different experiments on the developed system. The first experiment is conducted in order to analyze the differences between the output signal produced by IR sensor and visible greenlight for heart rate reading.

Second experiment is done to evaluate the temperature response of the sensor by using the monitoring system that has been designed and the differentiation of the heart rate reading between manual calculation and developed system monitoring.

In the study, the monitoring system uses Bluno board for heart rate and temperature measurement. The system gives an allowance to be further developed in future where the environmental effect on the output signal need to be reduced and more sensors can be added into the system for more functionality. [8] is a smart phone based system for measuring and monitoring the body parameters (which include but not limited to temperature, pulse, heart rate, etc) by creating a unique application. By sitting at home one can know his/her body parameters. Facility is also provided to transmit the information to the family doctor in the case of an abnormal condition, so that family doctor is informed with the patient's condition. If required or in emergency situation, doctor can also suggest remedies to the patient before visiting him/her. For all the parameters, If the measured value is within the range then the processor displays value on the screen. If the measured value is outside the range, then the processor provides suggestions to the user along with displaying the measured value of screen. Finally, the same information is transmitted to the cell phone or computer of family doctor using GSM module.

In [9], the authors proposed a healthcare monitoring system which allows a continuous remote patient monitoring and diagnostics by doctors. The wireless nature of the network and use of sensors is a new approach to healthcare system. There is no manual operation required, all operations automated by the use of wireless sensor nodes. By staying at remote place, doctors can operate patient easily with the help of technology used in wireless network. The study presents an idea for better improvement in healthcare system with the help of information technology by using wearable (on) body sensor and (in) body sensors for patient continuous monitoring. It discusses various techniques and innovation in wireless sensor network for continuous health monitoring. The main aim of the system is so that critical patients can be operated upon by doctors as soon as possible based on the information that has been gathered earlier over the system. To save the life of critical patients, wireless sensor network plays an important role. [10] presents a simple low cost microcontroller based temperature monitoring system using GSM technique. The temperature sensor (LM 35) is connected to PIC microcontroller and varying temperatures is sent to GSM modem which is simultaneously displayed in LCD and also sent as a message to the connected telephone number. The project can be extended and control can be incorporated in case of future varying conditions. [11] talks about the importance of climate and environmental monitoring, for effective agricultural production. It exploits the use of wireless sensor networks (WSN) in precision agriculture.

It entails the Integration of a variety of components with an internal distributed clustering mechanism for these sensor nodes craft. A sensor node is functionally composed of: sensing unit that is intended and programmed to sense pollutants in air, light, temperature, humidity, pressure, etc., a converter that converts the sensed signal from analog to digital signal, a processing unit processes the signals sensed form sensor with aid of embedded memory, operating system and few related transceiver circuits. A radio unit facilitates communication from the node level to the sink level. Powering these components is classically one or two tiny sized batteries.

In [12] it is expressed that Internet of things serves as a catalyst for healthcare and plays prominent role in wide range of healthcare applications. In this project the PIC16F877A microcontroller is used as a gateway to communicate to the various sensors such as temperature sensor, Respiration sensor, Blood Oxygen level and heart beat sensor. The microcontroller picks up the sensor data and sends it to the network through IOT and hence provides real time monitoring of the health care parameters for doctors. The data can be accessed anytime by the doctor. In addition, the controller is connected with buzzer to alert the caretaker about variation in sensor output. The data is securely transmitted to the destination end and provision is made to allow only authorized user to access the data. The security problem is addressed by transmitting the data through the password protected internet which will be encrypted by standard AES128 and the Doctors can access the records by logging to the html webpage. Next to the instance of extremity situation, alert message is sent to the doctor through IOT connected to the controller. For this reason, quick provisional medication can be easily done by this system. This system is capable of operation with low power consumption, easy setup, high performance and time to time response.

[13] stipulates that there is need to continuously monitor temperature and humidity. These have been done through analog devices which can't fulfil current requirements in terms of accuracy, and time duration. The study therefore proposes a microcontroller based temperature monitoring and logging system. The microcontroller will acquire digital temperature values from a precision temperature sensor, whose value is then processed and sent to computer software through the USB port for logging and future analysis of the measured data. The authors in [14] presents an embedded wireless sensor network prototype for remote room temperature monitoring. This network will be used for management of fire rescue operations. It will give the Android registered user freedom to continuously monitor the remote room temperature and in this way it provides better fire controlling technique.

The proposed system provides an android user interface for registered user to access the current temperature and a flash/beep message in case of fire. LM35 sensor senses the remote room temperature and temperature status is transmitted to the smart phone via GPRS. Transfer of room temperature data between the smart phone and application server that is done using Google's C2DM service. The application server which analyzes the temperature data, then informs a registered user to take proper action in case of fire. This work aims at monitoring of remote room temperature. Thus providing opportunity to quickly respond to fire emergencies. [15] presents the design of a remote-controlled microcontroller-based system. A multi-sensor/ multi-actuator system is also proposed. The PIC18F450 with 40 pins is used as the main control unit. The system displays the temperature using 7 segments LEDs because they offer better readability with respect to LCD. Thermistors are used as temperature sensors due to their suitable characteristics. An IR remote control with 38 kHz carrier frequency subsystem is integrated with the temperature control system to perform temperature settings replacing the use of a keypad. [16] proposes a project based on monitoring of patients. It designs and develops a reliable, energy efficient patient monitoring system. It is able to send parameters of patient in real time. It enables the doctors to monitor patient's health parameters (Temperature, Heartbeat, and ECG) in real time. Here the parameters of patient (temperature, heartbeat, ECG) are measured continuously and wirelessly transmitted using Bluetooth. It provides a solution for enhancing the reliability and flexibility by improving the performance and power management of the patient monitoring system. In the system, the patient's health is continuously monitored and the acquired data is analyzed at a centralized AtMega16 microcontroller. This data is continuously transmitted to the doctor using Bluetooth. The Doctor can get a record of a particular patient's information by just accessing the database of the patient in the developed Android application in his mobile phone which is continuously updated through Bluetooth receiver module. The authors in [17] proposed a "Remote Patient Tracking and Monitoring System" due to the increasing number of patients in need of continuous care, which has become an encumbrance for medical personnel. The system monitors patient's vital signs via wireless medical sensors. The medical sensor sends the data to an Android based mobile device, which, in turn, periodically sends the patient health data to the server.

The proposed system allows the patients to change their position freely; it tracks them using the collected GPS data from the mobile device and directs them to medical care team at any health emergency case. Also, the server informs the patient's doctor about his patient's status and position.

The proposed system components communicate with each other through a third party and there is no direct access between them. The transmitted data is encrypted by P2P key using AES. The doctors can do query about their patients using a dedicated Android based application. Also, they can query using an established web server. In [18], proposes a system based on IoT, the aim of the study is to develop an architecture based on an ontology capable of monitoring the health and workout routine recommendations to patients with chronic diseases. This study aims to improve the quality of life of patients, not just monitoring them, but also to direct them to improve their eating habits and workout routines.

The authors in [19] presents a 13.56 MHz/402 MHz autonomous wireless sensor node with asynchronous ECG monitoring for near field communication which basically monitors electronic gadgets that are connected to a patient and transmits the operational situation of such gadgets.

[20] derives several requirements of patient monitoring and shows how infrastructure-oriented wireless LANs, such as versions of IEEE 802.11, can be used to support patient monitoring in diverse environments. It allows monitoring for mobile and stationary patients in indoor and outdoor environments, and gives room for future research to address how to improve the reliability of patient monitoring under varying coverage of WLANs, wireless link variations and access point failures. It intends the eliminate the risk of a patient having an attack in the bathroom when alone.

The authors in [21] presents a web-based database management system developed for collecting, managing and analyzing information of diabetes patients. It is a searchable, client-server, relational database application, developed on the Windows platform using Oracle, Active Server Pages (ASP), Visual Basic Script (VB Script) and Java Script. The software is menu-driven and allows only authorized healthcare providers to access, enter, update and analyze patient information. Graphical representation of data can be generated by the system using bar charts and pie charts. It also has an interactive web interface which allows users to query the database and generate reports. In addition to providing patient data on a continuous basis in a simple format, the system is used in population and comparative analysis.

The author in [22] is of the opinion that Patient monitoring is becoming a requirement for offering a better healthcare to an increasing number of patients in nursing homes and hospitals, hence developed a system that alerts professionals during the monitoring of vital signs of patients in case of any significant fluctuation and/or matching certain undesirable patterns.

It overcomes the limitation of infrastructure-oriented wireless networks for transmission of emergency messages by introducing an ad hoc network that can be formed among patients' devices for improved transmission of emergency messages. The authors in [23], proposes the all-IP WSNs (wireless sensor networks) for real-time patient monitoring. In this paper, the all-IP WSN architecture based on gateway trees is proposed and the hierarchical address structure is presented. Based on this architecture, the all-IP WSN can perform routing without route discovery. Moreover, a mobile node is always identified by a home address and it does not need to be configured with a care-of address during the mobility process, so the communication disruption caused by the address change is avoided. Through the proposed scheme, a physician can monitor the vital signs of a patient at any time and at any place, and according to the IPv6 address he can also obtain the location information of the patient in order to perform effective and timely treatment. Finally, the proposed scheme is evaluated based on the simulation, and the simulation data indicate that the proposed scheme might effectively reduce the communication delay and control cost, and lower the packet loss rate.

In [24], the authors present a study on the problem of how to design a medical-grade wireless LAN for healthcare facilities. Unlike IEEE 802.11e MAC, which categorizes traffic primarily by delay constraint, medical applications are prioritized into access categories according to medical criticality. It has fully distributed contention control mechanism that can efficiently utilize wireless channel for improving medical-grade QoS. It further derives a sufficient condition for the convergence of the proposed algorithm, simulation result shows that medical access categorization and the contention control mechanism significantly improves the performance of a medical network over the conventional IEEE 802.11e MAC. The authors in [25] present a system which provides patient localization, tracking and monitoring services within nursing institutions through a wireless sensor network. The system is comprised of three functional blocks: a localization and tracking engine which performs localization out of samples of the received signal strength and tracking through a particle filter; a personal monitoring module based on bi-axial accelerometers which classifies the movements of the patients eventually detecting hazardous situations, and a wireless communication infrastructure to deliver the information remotely to concerned personnel. The paper comments on the design and dimensioning of the building blocks.

Two approaches are proposed to the implementation of the localization and tracking engine: a centralized implementation where localization is executed centrally out of information collected locally, and a distributed solution where the localization is performed at the mobile nodes and the outcome is delivered to the central controller. Strengths and weaknesses of the two solutions are highlighted from a system's perspective in terms of localization accuracy, energy efficiency and traffic loads during testing, it offers an average localization error lower than 2m in 80% of the cases and a movements classification accuracy as high as 90%.

In [26], the authors propose a bio signal acquisition and classification system with wireless telemetry for BSN. Three chips, namely, a body-end chip, a receiving-end chip, and a classification chip, are implemented in TSMC 0.18-µm standard CMOS process. The accuracy in terms of beat detection and classification are 99.44% and 97.25%, respectively. These results indicate that the proposed system can correctly diagnose heart disease based on the MIT-BIH arrhythmia database. In [27], the authors present a system with advancement over the wireless medical telemetry service (WMTS) systems, which had a data loss of about 25min/day. It seeks to operate outside of the WMTS. Standards-based 802.11 networks with published reliability tenfold higher than conventional telemetry it is advanced and matured to meet the needs for life-critical applications on an enterprise-wide shared network. To achieve peak performance, proper installation and validation is required. [28] presents a modification and an adaptive tuning scheme of IEEE 802.11 WLAN for healthcare applications. This method can significantly improve medical-grade quality of service (QoS) and network performance at the same time. Though the conventional IEEE 802.11e protocol supports a certain level of QoS, it does not provide medical-grade QoS due to its relative priority among different traffic classes. This scheme adaptively tunes the arbitrary inter frame space number (AIFSN) of the IEEE 802.11e protocol for enhancing the overall network performance while providing the required medical-grade QoS. In healthcare scenario, the following three medical traffic categories are considered: medical alarm, real-time electrocardiogram (ECG) transmission, and TCP connection. Simulation results show that the scheme improves the performance of low-priority TCP traffic while protecting high-priority medical alarms from lower priority traffic. The authors in [29] made provision for a ubiquitous healthcare solution which provides healthcare services at any time anywhere due to the emphasis on healthcare awareness and also the growth of mobile wireless technologies.

Attendant to this development, an Android smart phone device is proposed as a mobile monitoring terminal to observe and analyze ECG (electrocardiography) waveforms from wearable ECG devices in real time under the coverage of a wireless sensor network (WSN). It is able to substitute the complicated wired technology, eliminating the limitation of a fixed location setting. Authors in [30] state that Computer-aided bedside patient monitoring is applied in areas where real-time vital function analysis takes place. Modern bedside monitoring requires not only the networking of bedside monitors with a central monitor but also other standard communication interfaces. Hence, the paper presents a novel approach to patient monitoring. A patient monitoring system was developed and implemented based on an existing industry standard communication network, using standard hardware components and software technologies. The open architecture system design offers scalability, standard interfaces, and flexible signal interpretation possibilities. The main benefit of the system from the signal interpretation point of view is in the design of the central monitor which allows the real-time access of bedside data via standard software interfaces.

[31] proposes a mobile-care system integrated with a variety of vital-sign monitoring devices, where all the front-end vital-sign measuring devices are portable and have the ability of short-range wireless communication. In order to make the system suitable for home applications, wireless sensor network is introduced to transmit the captured vital signs to the residential gateway by means of multi-hop relay. Then the residential gateway uploads data to the care server via internet to carry out patient's condition monitoring and the management of pathological data. Additionally, the system is equipped with the alarm mechanism, where the portable care device is able to immediately perceive the critical condition of the patient and send a warning message to medical and nursing personnel in charge to achieve the goal of prompt rescue. A simple and fast GPS data compression method is used in [32] to ensure that the GPS data takes as minimum as possible and guarantee the location accuracy. The doctor can query about his latest patient health status using a dedicated application. If the doctor wants the historical information about his patient he can access the web server, use his password for authentication, then he will be able to do the required queries about his patient's historical health data. The web server is established using Apache web server. PHP is used as server-side HTML embedded scripting. There are many published researches to help in controlling the patient status in wireless area; the wireless medical device in [33] receives information from sensors that are put on the patient's body wirelessly, this information also can be read wirelessly by medical staff.

These systems do not require the patient to be limited to his bed and allows him to move [illegible] but requires being within a specific distance from the bedside monitor. Out of this range, it is [illegible] possible to collect data. [34] states that Body sensor network systems can help people by providing healthcare services such as medical monitoring, memory enhancement, medical data access, and communication with the healthcare provider in emergency situations through the SMS or GPRS. In [35], the authors propose a Continuous health monitoring with wearable or clothing-embedded transducers which keeps tabs on patient's health vitals always. Although present systems allow continuous monitoring of patient vital signs, these systems require the sensors to be placed as bedside monitors or PCs, and limit the patient to his bed.

But now, there is no relation between the sensors and the bedside equipment due to the wireless devices and wireless networks studied in [36]. [37] presented a system for reliable and real-time transmission. In most systems the health data from multiple patients can be relayed wirelessly using multi-hop routing scheme to a base-station. In [38], the patient's physiological signals are acquired by the sensors attached on the patient body, and are then transmitted to the remote base-station and also a PC for storing and analyzing.

AMON [39] is an advanced care and alert portable tele-medical monitor (AMON), targeting at healthcare for high-risk cardiac/respiratory patients. The functions of AMON include continuous collection and evaluation of multiple vital signals, intelligent medical emergency detection, and a cellular connection to a medical centre. AMON integrates all parts into an unobtrusive, wrist-worn enclosure and applies aggressive low-power design techniques. Thus, the patients can wear AMON without the restrictions to daily activities and mobility. However, AMON needs to integrate the GSM module into it, which has not well used the commercial products of mobile phone and caused high cost.

In [40], the authors developed a system which can monitor personal health status in a real-time manner and automatically issue the alert for medical aids in case of emergency. It is a novel wearable personal healthcare and emergency aid system, which does not require specific caregiver aid. It employs the tiny wearable sensors to continuously collect user's vital signals and Bluetooth device to transmit the sensory data to a mobile phone, which can perform on-site vital data storage and process.

CHAPTER THREE
METHODOLOGY

Digital temperature monitor and alarm is an essential instrument in the field of electronics, instrumentation and control automation for measuring and controlling temperatures. It can be used as much at homes as in industrial applications. Presented here is a low-cost Arduino-based temperature monitor that can read and control temperatures in the range of zero to 1000°C. Real-time temperature is displayed on its LCD screen, and you can use it to control the temperature within the preset minimum and maximum range.

Circuit is constructed using Arduino Uno and DS18B20 temperature sensor and other components. We are using 16×2 LCD to display current temperature and system condition. DS18B20 gives direct digital output proportional to the temperature which is given to Arduino digital input 2. Which is then compared with set points. If it is more than set point, it means the temperature is more so turn ON the alarm and the LED which are connected to Arduino pin 3 and 6 respectively.

3.1 REQUIREMENTS SPECIFICATION

Circuit is constructed using Arduino Uno and DS18B20 temperature sensor and other components. We use 16×2 LCD to display current temperature and system condition. DS18B20 gives direct digital output proportional to the temperature which is given to Arduino digital input 2. Which is then compared with set points. If it is more than set point, it means the temperature is more so turn ON the alarm and the LED which are connected to Arduino pin 3 and 6 respectively.

Circuit diagram is shown below:

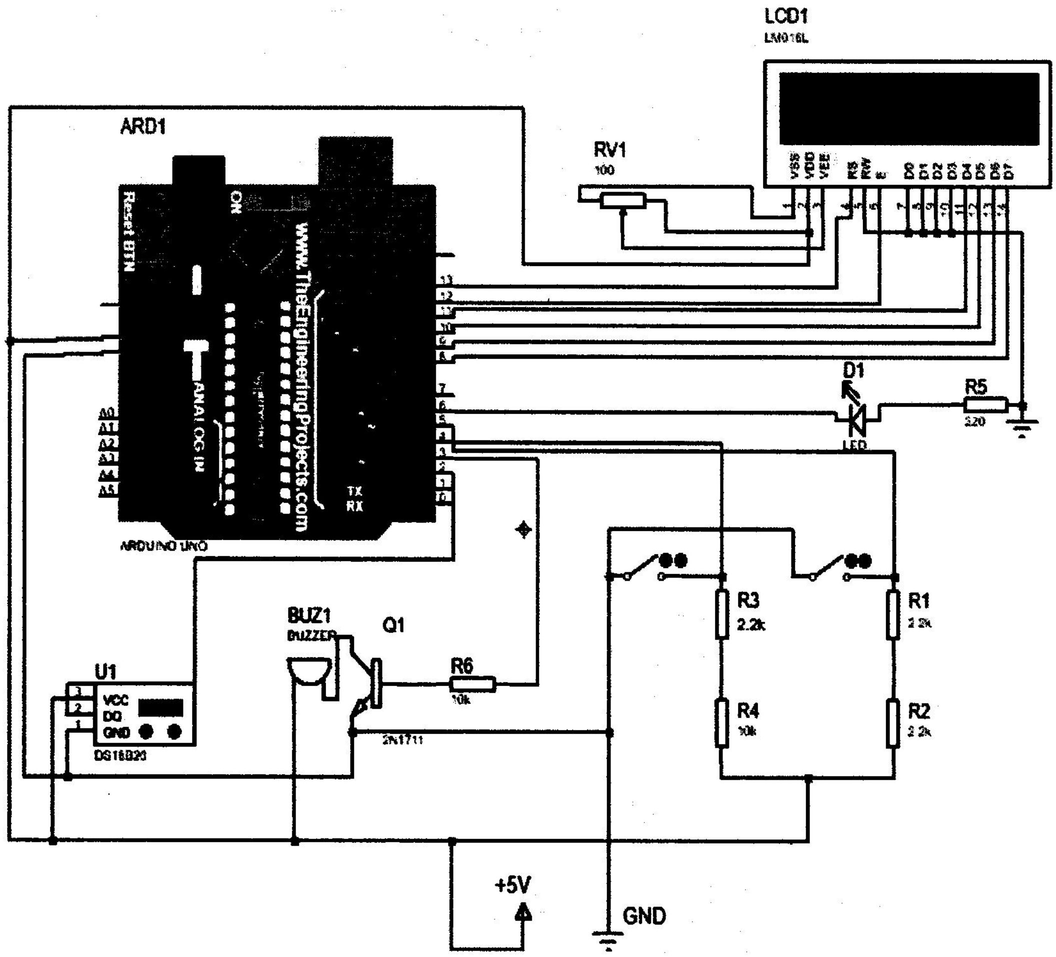

Fig 3.1: Circuit Diagram

SENSOR SELECTION

There are basically two types of temperature-measurement systems—direct temperature-measurement systems for up to 1000°C and indirect temperature-measurement systems for higher temperature range, where temperature sensors may get physically damaged due to the high temperatures. The selection of temperature sensor is dependent on the range of temperature you wish to check. There are different types of direct-measurement sensors, for different ranges of temperature (refer Table I).

TABLE I
Different Types of Direct Measurement Sensors

	Thermocouple	RTD	Thermistor
Range (°C)	-200 to 2000	-250 to 850	-100 to 300
Accuracy (°C)	>1	0.03	0.1
Thermal response	Fast	Slow	Medium
Cost	Low	High	Low to moderate
Long-term stability	Low	High	Medium

Table 3.1: classification of measurement sensors

Here we have used a thermistor for direct measurements of up to 125°C temperature. A thermistor is a low-cost device and is not complex to use since it's not too distinct from a resistor, and it is one of the most popular general-purpose temperature sensors. Its operating range is around -55 to +125°C.

COMPONENTS REQUIRED

Components used in this work are listed below:

ARDUINO UNO

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.

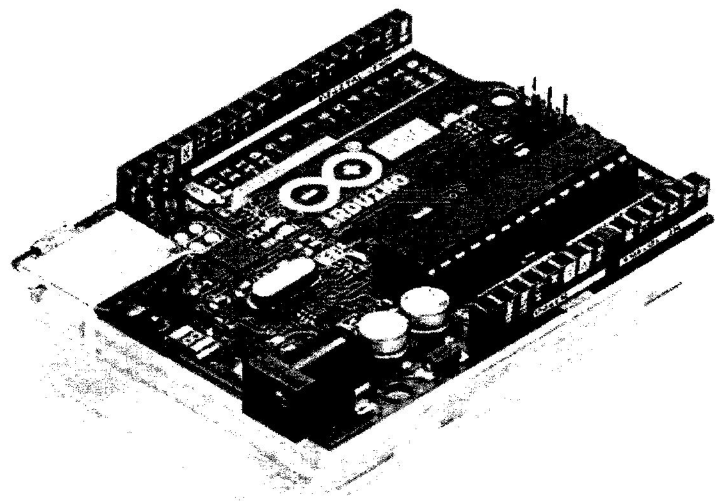

Fig 3.2: Adrduino UNO

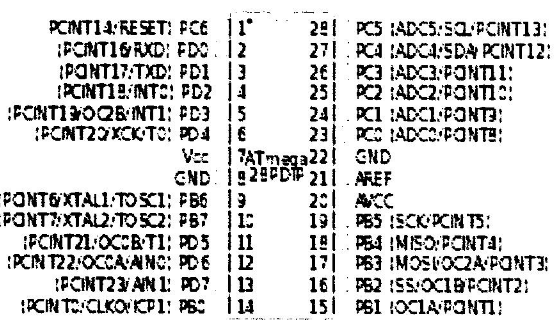

Fig 3.3: Architecture of ATmega 328

BUZZER

A buzzer or is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (*piezo* for short). Typical uses of buzzers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

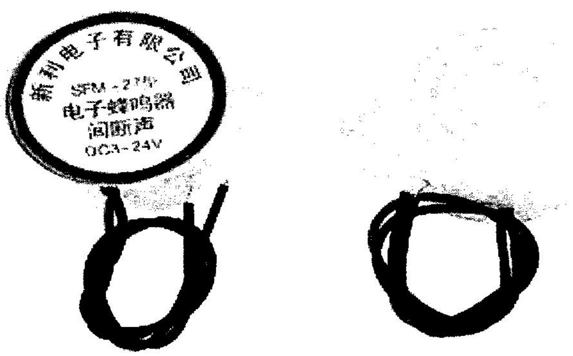

Fig 3.4: Buzzer

DS18B20 TEMPERATURE SENSOR

The **DS18B20** is a 1-wire programmable Temperature sensor from maxim integrated[1]. It is widely used to measure temperature in hard environments like in chemical solutions, mines or soil etc. The constriction of the sensor is rugged and also offers a waterproof option making the mounting process easy. It can measure a wide range of temperature from **-55°C to +125°** with an accuracy of **±5°C**. Each sensor has a unique address and requires only one pin of the MCU to transfer data so it a very good choice for measuring temperature at multiple points without compromising much of your digital pins on the microcontroller.

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply. Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1-Wire bus.

Thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area [1]. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems [1].

Pin Configuration

No:	Pin Name	Description
1	Ground	Connect to the ground of the circuit
2	Vcc	Powers the Sensor, can be 3.3V or 5V
3	Data	This pin gives output the temperature value which can be read using 1-wire method

Table 3.2: DS18B20 pin configuration

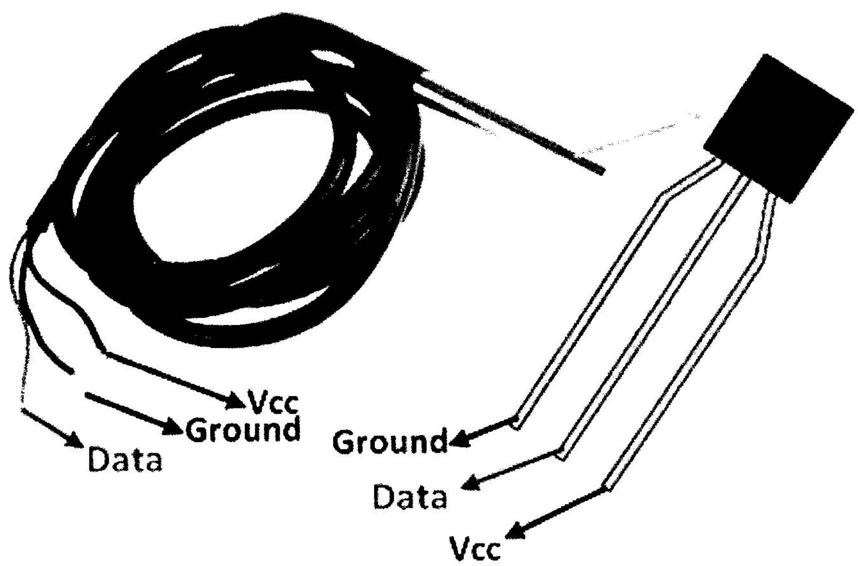

Fig 3.5: DS18B20

LCD MODULE

LCD (Liquid Crystal Display) screen is an electronic display module and finds a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

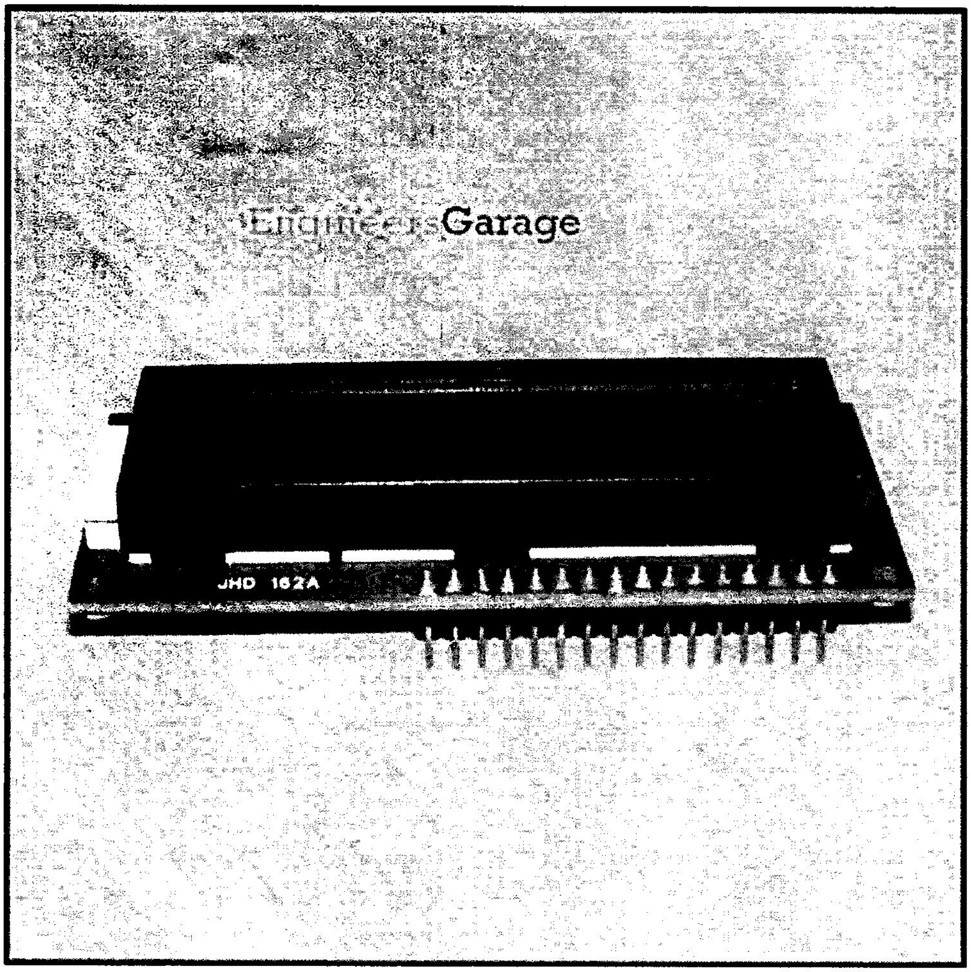

Fig 3.6: LCD

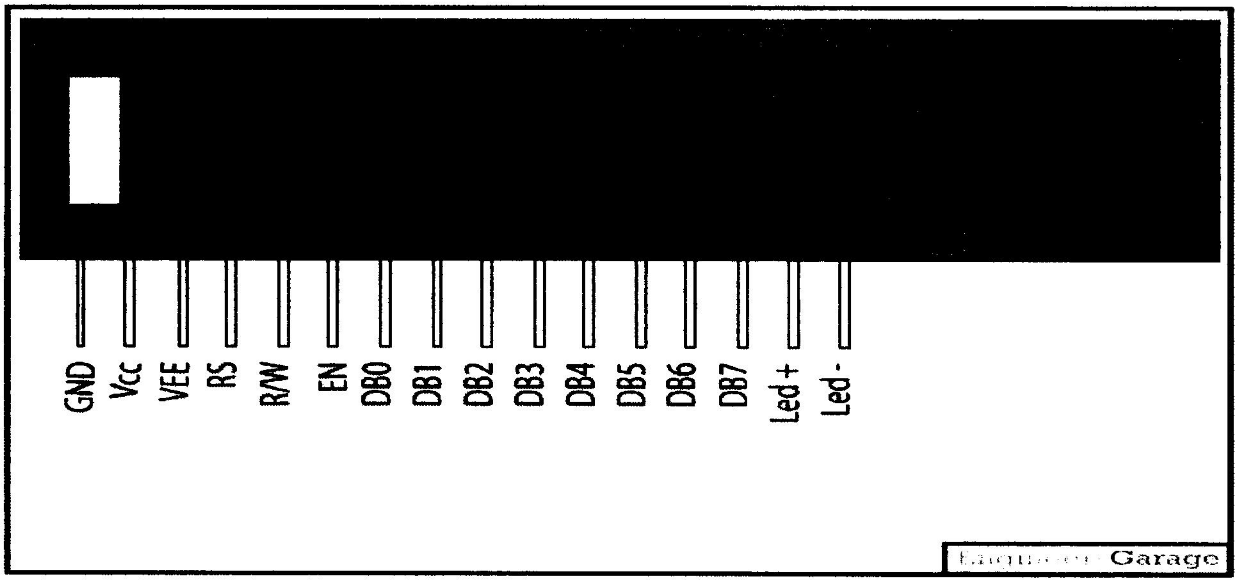

Fig 3.7: LCD architecture

Pin Description:

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7		DB0
8	8-bit data pins	DB1
9		DB2

10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Table 3.3: LCD pin description

RESISTOR

It is a component that opposes the flow of current through it. A pure resistor possesses only resistance, no capacitor or inductance, but all practical resistors possess some small amount of capacitance or inductance. Usually these are sufficiently small to be negligible.

They are constructed from a mixture of carbon of the materials in proportions that give the required amount of resistance. They can be connected in series, parallel or the combination of the both.

They can also be connected to protect devices such as transistor and diode against excess current.

Resistor can be fixed or variable. It is measured in ohms.

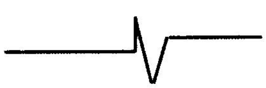

Fig.3.8: showing the circuit symbol of a resistor

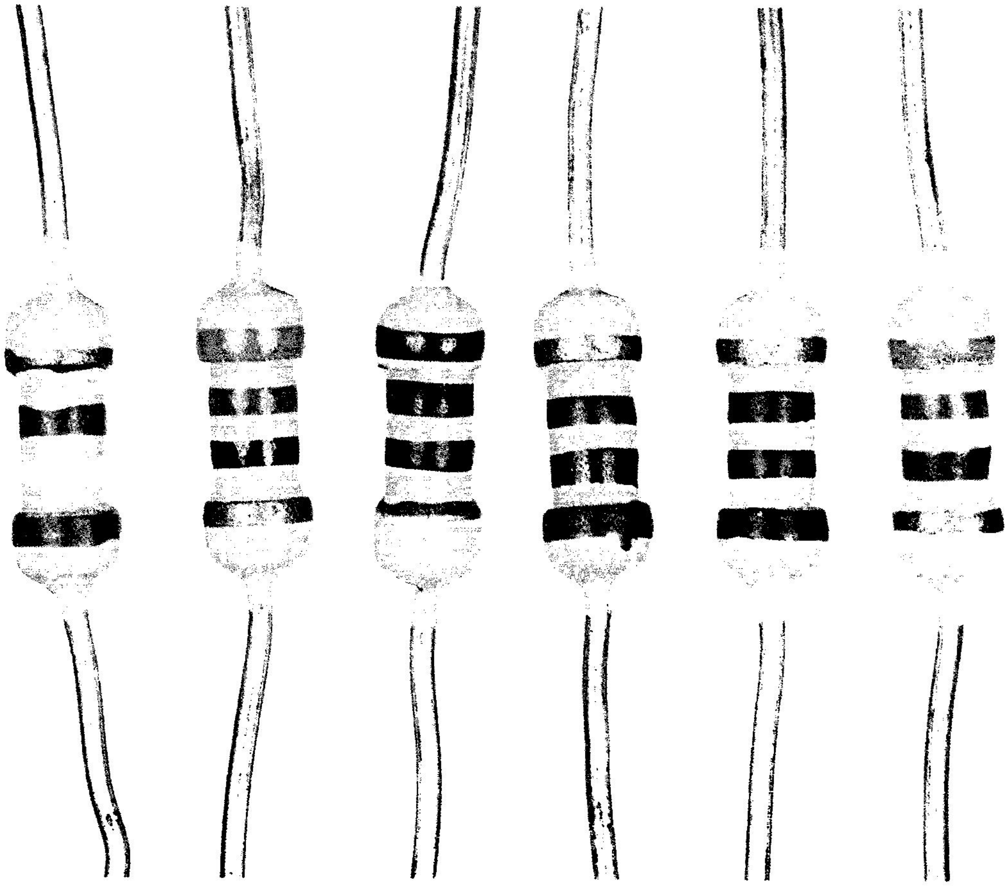

Fig 3.9: Resistor

Types of Resistor

- variable resistor
- rheostat resistor
- potentiometer resistor
- fixed resistor

COLOUR	FIRST BAND	SECOND BAND	THIRD BAND	TOLERANCE
BLACK	_	0	X10	
BROWN	1	0	$x10^1$	±1%
RED	2	00	$x10^2$	±2%
ORANGE	3	000	$x10^3$	

YELLOW	4	0000	$x10^{4}$	
GREEN	5	00000	$x10^{5}$	
BLUE	6	000000	$x10^{6}$	
VIOLET	7	0000000	$x10^{7}$	
GREY	8	00000000	$x10^{8}$	
WHITE	9	000000000	$x10^{9}$	
GOLD	–	–	X0.1	±5%
SILIVER	–	–	X0.01	±10%

Table 3.4: A table showing the resistor colour code

LED (LIGHT EMITTING DIODE)

LEDs emit light when an electric current passes through them.

LEDs must be connected the correct way round, the diagram may be labelled "**a**" or "+" for anode and "**k**" or "-" for cathode (yes, it really is k, not c, for cathode!). The cathode is the short lead and there may be a slight flat on the body of round LEDs. If you can see inside the LED, the cathode is the larger electrode (but this is not an official identification method). LEDs can be damaged by heat when soldering, but the risk is small unless you are very slow. No special precautions are needed for soldering most LED

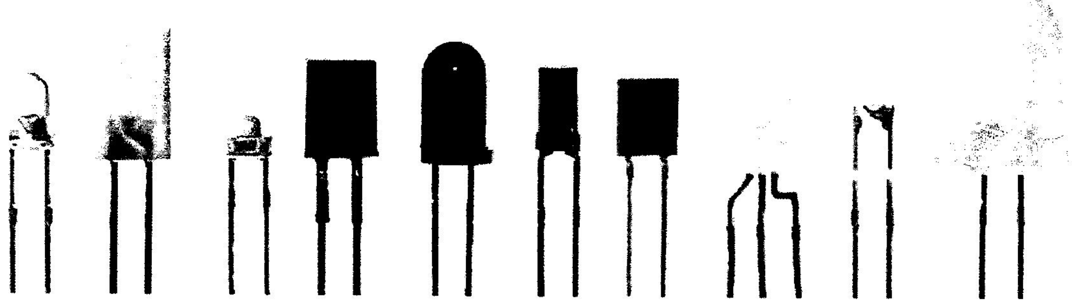

Fig3.10: LED

3.2 DESIGN

The system is designed using DS18B20 temperature sensor, ATMEGA328 microcontroller and LCD. The output of temperature sensor is fed to the microcontroller which converts it to an appropriate digital value according to the set of pre-defined values stored in its memory and displays it in the LCD. This system is designed to monitor temperature from -55°C to 125°C [6].

Before carrying out any project, the block diagram must be drawn and fully understood. Block diagram gives a pictorial understanding of any work. The block diagram of the system is as below:

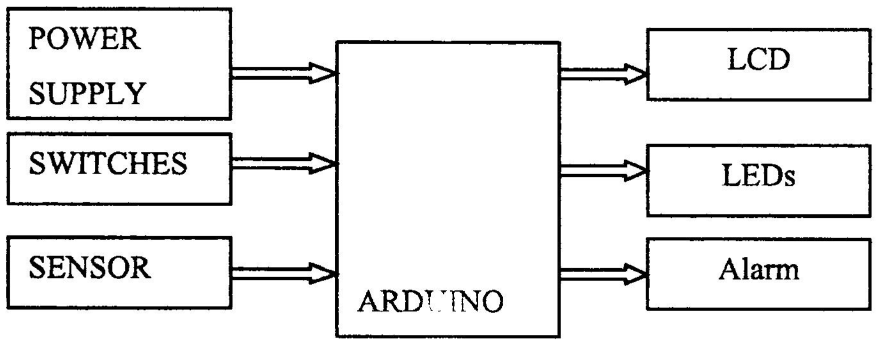

Fig 3.11: system block diagram

The basic step in the designing of any system is to design the power supply required for that system, and thereafter the main functional system.

Power Supply Unit

The power supply unit consists of a 9V/500mA step down transformer, a bridge rectifier (made of diode 1N4007), 470µf/25V capacitor, voltage regulator, 103 ceramic capacitor. The 220-240V/50Hz input supply into the transformer, passes through the rectifier which converts it to a d.c. voltage. Smoothening the d.c. is carried out by the capacitor. The voltage regulator regulates voltage to give a voltage of 6Vdc required as charging voltage for the cell. VCC is gotten from the cell. This Vcc is delivered to various loads that needs the supply. The characteristics of the power supply unit and distribution of the d.c.voltage to various parts of the system have some effects on the performance of the circuit. The essential features of the power supply unit include;

- Isolation of the a.c. mains supply
- regulation of output voltage.

- stability

D.C. voltage is isolated from the mains by the transformer. From the rating, it steps down **240v input** to 12v before delivering to the input of the bridge rectifier. The rectifier circuit **consists of four diodes** configured into a full-wave bridge rectifier mode. The regulator used in this design provides regulated and stable d.c .voltage (6v+/_0.1%) And this output drives all chips and components used for this design. The capacitor is designed to filter and remove surges that appear on either the input or output of the supply.

Component List for power unit

1. Step down transformer
2. Voltage regulator
3. Capacitors
4. Diodes (Rectifying circuit)

Step Down Transformer:

Selecting a suitable transformer is of great importance. The current rating and the secondary voltage of the transformer is a crucial factor.

- The current rating of the transformer depends upon the current required for the load to be driven.
- The input voltage to the 7806 IC should be at least 2V greater than the required 2V output, therefore it requires an input voltage at least close to 8V.
- So I chose a 6-0-6 transformer with current rating 500mA (Since $6*\sqrt{2} = 8.4V$).

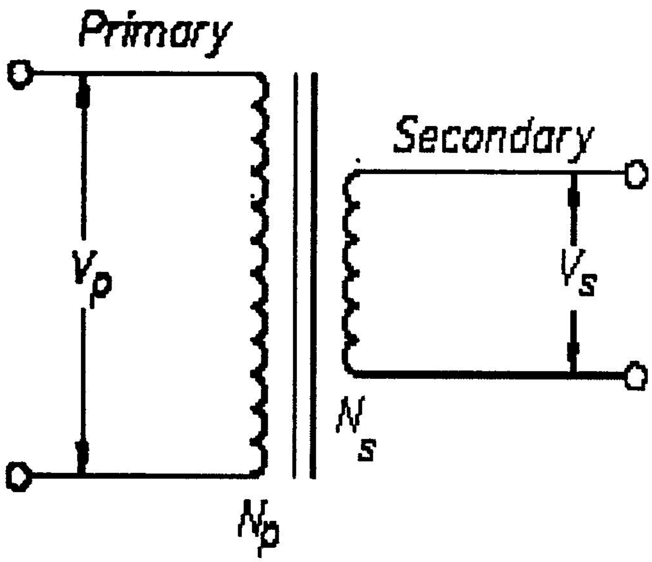

Fig 3.12: typical step-down transformer

NOTE: Any transformer which supplies secondary peak voltage up to 35V can be used but as the **voltage** increases size of the transformer and power dissipation across regulator increases.

Voltage regulator:

Since we require a 6V output, we need LM7806 Voltage Regulator IC.

7806 IC Rating:

- Input voltage range 7V- 35V
- Current rating $I_c = 1A$
- Output voltage range V_{Max}=6.2V, V_{Min}=5.8V
- A voltage regulator is a 3-terminal device.

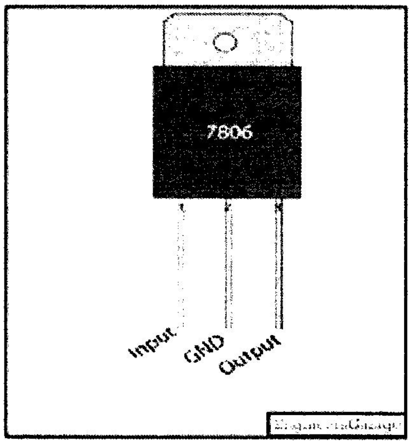

Fig 3.13: LM7806 – Pin Diagram

- Pin 1 is the Input Pin. The output voltage of whatever voltage source you want to regulate down (whether it's a transformer, battery, etc.) is fed into this pin. So for instance, if you have 10 volts coming from a transformer that you want regulated down to 6 volts, the output of the transformer (the 10 volts) is fed into the regulator input (pin 1) so that the regulator can regulate it down to your wanted voltage (6 volts). The voltage regulator should always be fed as smooth of a DC signal as possible (which gives the best regulated output) so it can regulate it down to its specified voltage. Remember, the input voltage has to be larger than the voltage that the regulator regulates out. In this case, we are using a LM7806, which outputs 6 volts. In order for the regulator to output 6 volts, the voltage entering has to be at least 2 volts higher, so it has to be at least 8 volts. 8 volts would work perfect. However, for experimental purposes and ease of getting parts, we will use a 9-volt battery as our input voltage.
- Pin 2 is Ground. It hooks up to the ground in our circuit. Without ground, the circuit couldn't be complete because the voltage wouldn't have electric potential and the circuit wouldn't have a return path. Ground is essential.
- Pin 3 is the Output Pin. This is the pin that gives out the regulated voltage, which, in this case, is 6 volts. At the end of this experiment, when our circuit is hooked up, we're going to read out the voltage with a multimeter and it should give out close to 6 volts.

Capacitors:

The capacitor is supposed to be a filtering capacitor, to remove surges and variations from the 9V output of the stepdown transformer. A 470µf/25V capacitor is selected to suit this purpose.

Datasheet of 7806 prescribes to use a 0.01µF capacitor at the output side to avoid transient changes in the voltages due to changes in load also, a 0.01µF capacitor is used at the input side of regulator to avoid ripples in case the filtering is far away from regulator.

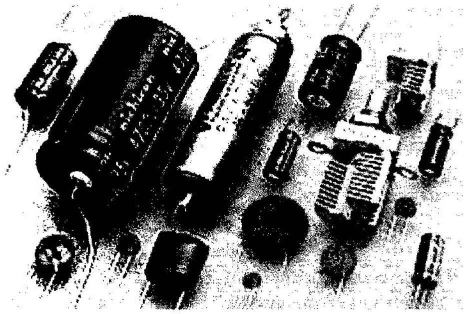

Fig 3.14: Capacitor

Rectifying Circuit

The best used in this work is a full wave rectifier

- Its advantage is DC saturation is less (as in both cycle diodes conduct).
- Higher Transformer Utilization Factor (TUF).
- 1N4007 diodes are used generally as its is capable of withstanding a higher reverse voltage of 1000v whereas 1N4001 is 50V

- For purpose of simplicity, a single full wave rectifier is used in this project.

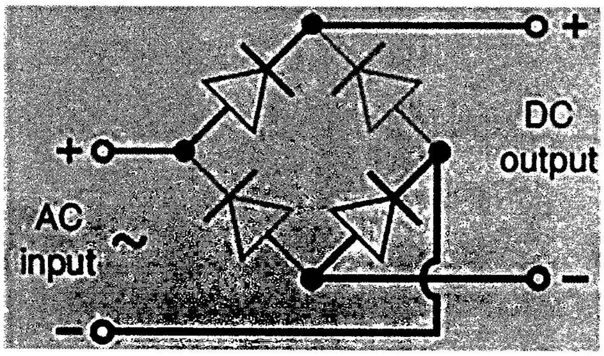

Fig 3.15: rectifying circuit

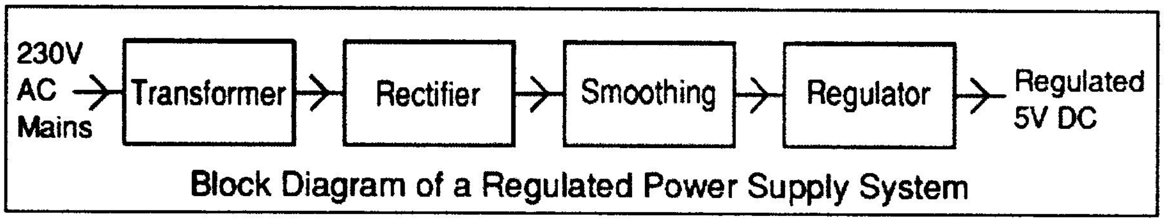

Fig 3.16: Basic Block Diagram of Power Supply

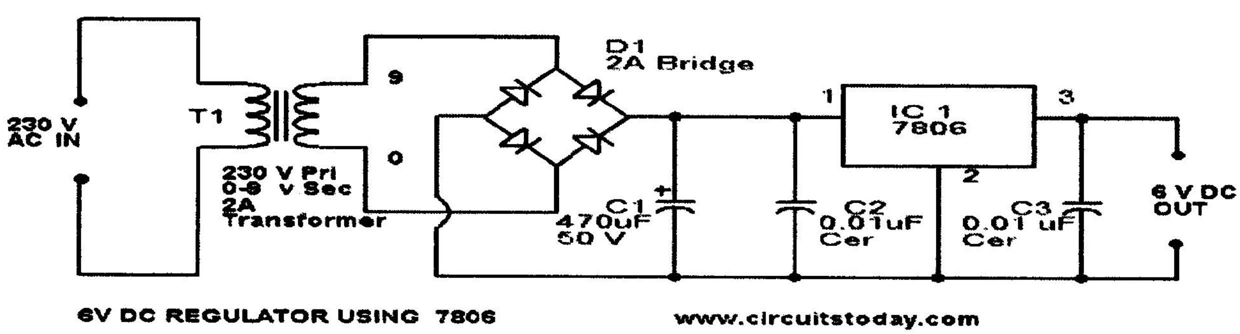

Fig 3.17: Power Supply Circuit Diagram

Operations of The Power Supply

This unit is the power source for the entire system. The power cable is the connector for the primary of the step down transformer to the main socket (240Vac) via power switch. This transformer which is a 220/240V AC steps the main voltage to 9V AC. The Bridge diode (BDI) further rectifies the step down voltage to a dc voltage which is subsequently smoothened by the filter capacitor C1.

The resulting voltage is an unregulated voltage in the range of 14 to 16 Vdc. This voltage is regular to 10V to provide the exaltation voltage. Since most of our digital devices required standard 12v to operate, we supply a voltage regulator (Vreg) of that order to regulate the voltage to + 5v. This further filtered by the ceramics capacitor in the order of 0.1 μF.

CHAPTER FOUR

TESTING, ANALYSIS AND DISCUSSION

Testing, Processes, procedures of this project are succinctly described in this chapter.

4.1 TESTING

In this stage, the system was due for testing and operation. The system operation was tested in the following steps where all its required performance was maintained:

i. Getting cold and hot water in respective containers
ii. The system was connected to mains supply
iii. The required set-point was selected using the tact switches.
iv. The sensor was put in each container one after the other.

4.1.1 DISCUSSION

CONSTRUCTION PROCEDURE

In building this project, the following procedures were properly considered,

I. Purposing of the entire materials / Components needed

ii. Resistance check of the components bought with the help of ohmmeter before making the necessary connection with the components

iii. Drafting out a schematic diagram or how to arrange the materials / components.

iv. Testing the completed system to see if the design works and

v. Finally, implementation of design of the project.

Having procured all the materials, I progressed into the testing of the components when arranged on a prototype(bread) board and thereafter arrangement of the components into the Vero board, proper soldering of the components then followed. The components were all soldered into the board after which it was correctly confirmed done.

CASING AND PACKAGING

The casing of this project comprises of plastic housing, with the major boards attached with glue. The entire circuit followed by other external components such as indicators, rectifying circuit. Arduino Uno, buzzer, LCD and sensor connector were all included in the casing.

ASSEMBLING OF SECTIONS

Having provided the casing and having finished the construction of the sections of this system, the assembling into the casing followed. The sections were properly laid out and assembled into the casing where the general coupling and linkages into the peripheral devices took place.

Finally; the mains lead, switch, screen, indicator LED and sensor were carefully brought out from the internal part of the casing through the holes made on the body of the casing, the input cable will be connected directly to a 13 amps plug outlet

INSTALLATION OF THE COMPLETED DESIGN

This project could be used effectively to keep tab on the temperature condition of a system. In situations where the system is to be manually controlled, it could be switched off from the mains outlet.

The system could be placed anywhere provided there is a power outlet to power it.

4.2 ANALYSIS

4.2.1 OPERATIONAL ANALYSIS

Below is a table showing temperature of a room at different times of the day using different temperature measuring devices:

TIME (HOURS)	MERCURY (°C) THERMOMETER	INFRARED (°C) THERMOMETER	DIGITAL (°C) THERMOMETER	PROPOSED (°C) SYSTEM
8.00	23.4	24.2	24.0	24
10.00	24.0	24.4	23.8	24
12.00	27.0	27.1	27.0	27
14.00	30.0	30.1	29.6	30
17.00	28.1	27.8	28.0	28

19.00	26.0	25.9	26.1	**26**

Table 4.1: Temperature Comparison

Relational graph of time against temperature for each respective measuring device is represented below

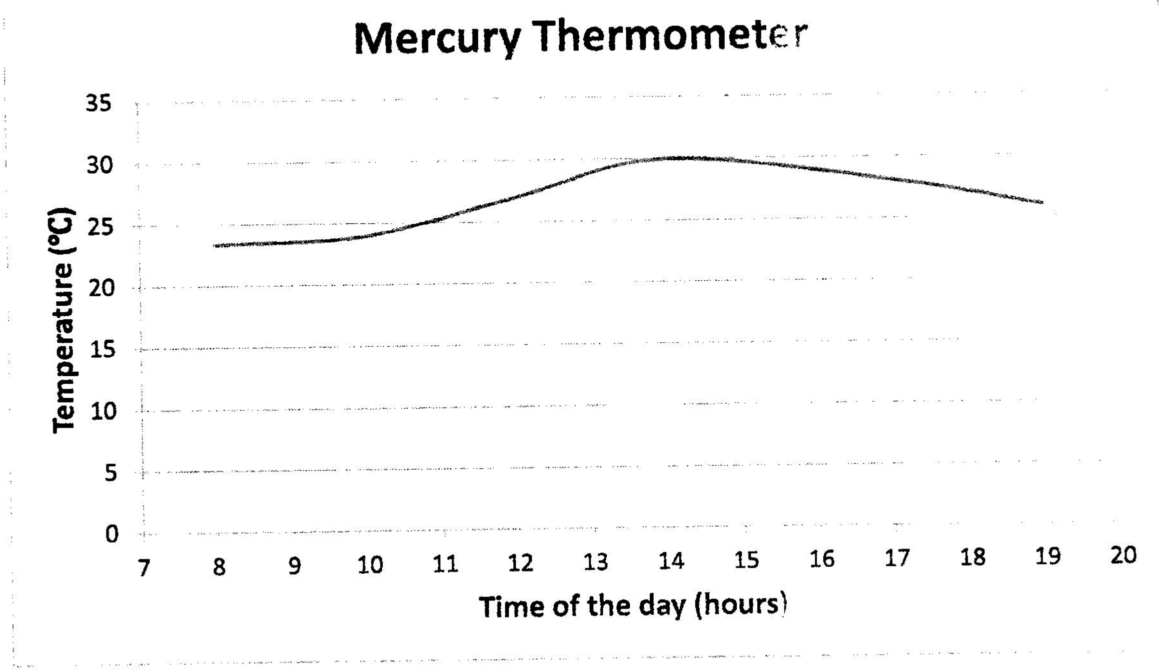

Fig 4.1: Mercury Thermometer graph

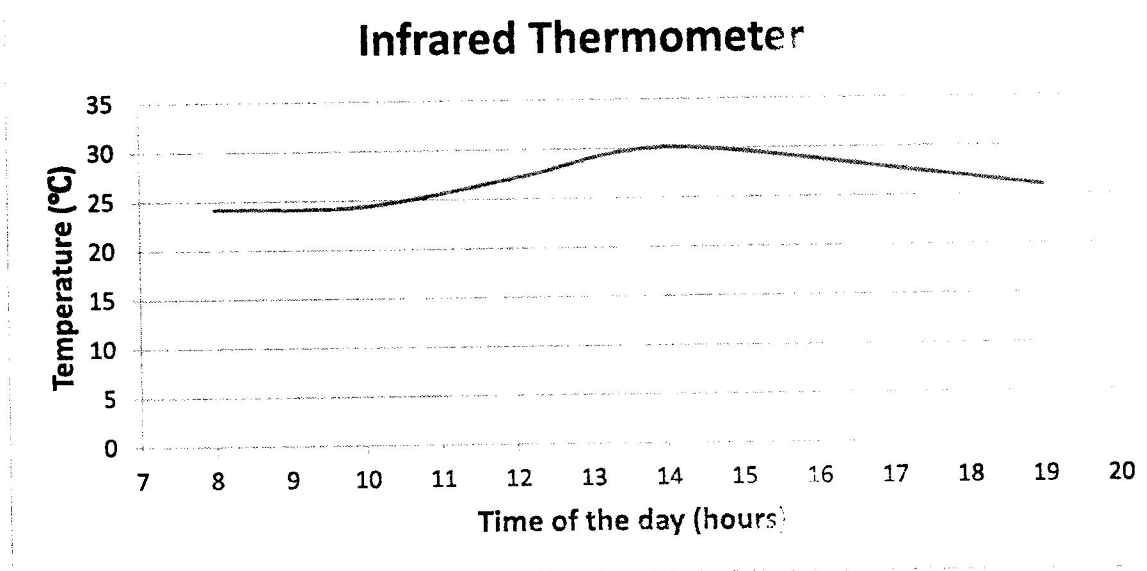

Fig 4.2: Infrared Thermometer graph

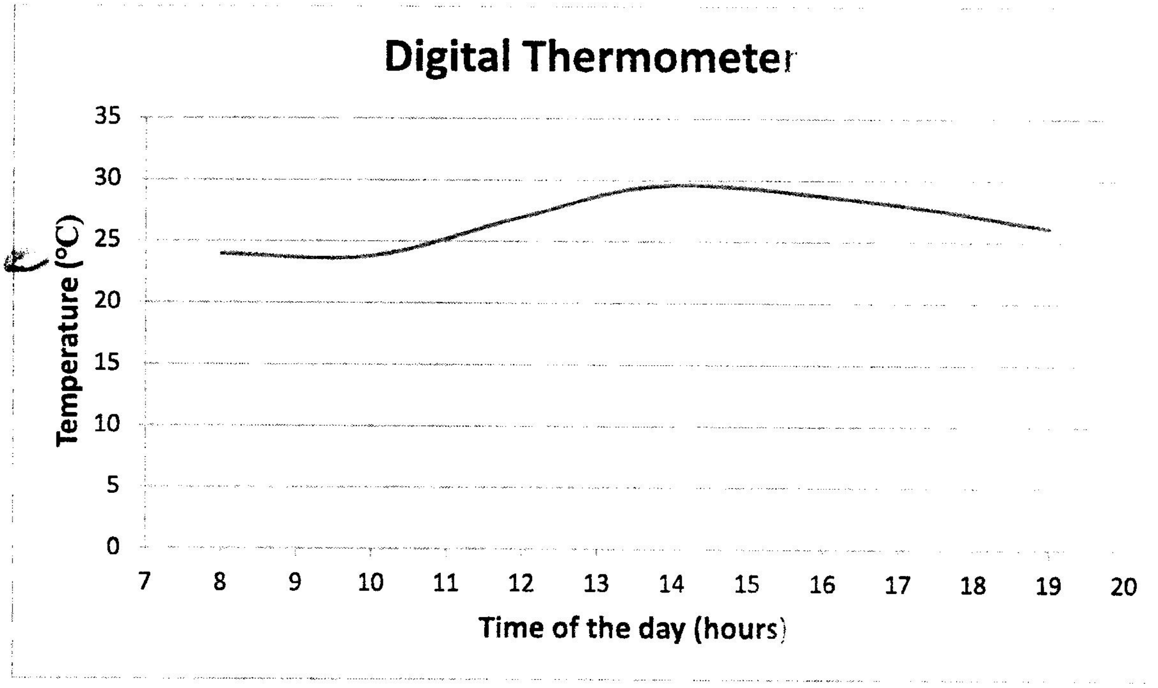

Fig 4.3: Digital Thermometer graph

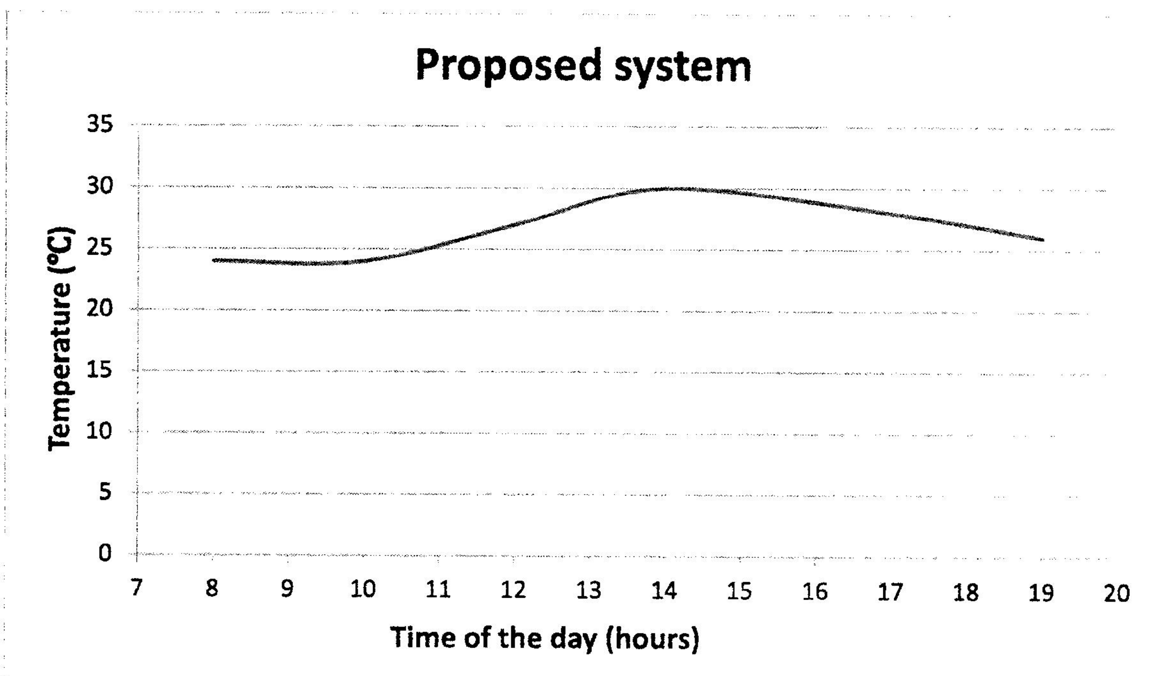

Fig 4.4: Proposed System graph

The above analysis shows that the operation of this system is not too different from other conventional temperature monitoring devices as the graph follows the same trend.

4.2.2 COST ANALYSIS

The expenditure made in purchasing all the components / materials and quantity used in building this project is tabulated as show below

MATERIAL COMPONENTS	DESCRIPTION	QTY	UNITY PRICE (N)	TOTAL PRICE (N)
Transformer/ Rectifying circuit	9v – 220v, 500mA	1	600	600
Mains plug		1	100	100
Resistors		10	10	100
Sensor	DS18B20	1	900	900
Capacitors		2	20, 50	70
Light emitting	red and green	2	20	40
LCD		1	1500	1500
Integrated circuit	ARDUINO	1	3500	3500
Connecting leads	-	-	-	150
Connecting wires	Male to male, male to female	2	350	700
Cable	1.5mm^2	1 yard	200	200
switch		1	50	50
Digital multimeter			1500	1500
Vero board	Dotted	1	200	200
Bread Board		1	500	500
Casing		1	1000	1000
Screws		12	5	60
Soldering iron	60 Watt	1	1500	1500

Transport and logistics			3000	3000
Total				15670

Table 4.2 Cost Analysis

4.3 PROJECT MANAGEMENT

The following were entailed in management of the project

4.3.1 PROJECT SCHEDULE

This section shows each task that was carried out in the course of execution of this project and the time respective ones took. This is aptly represented in a chart below.

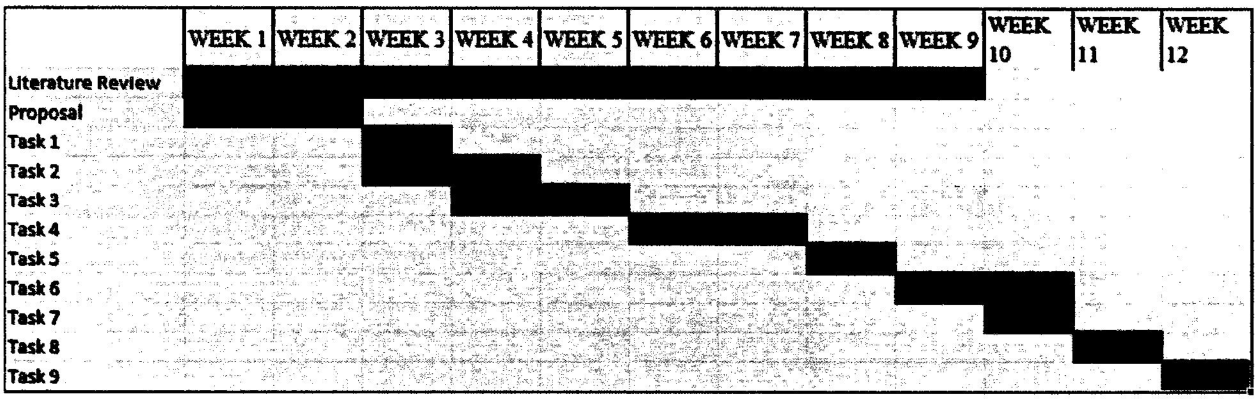

Table 4.3: Task Schedule

Tasks Description

Task 1: Determination of required components

Task 2: Design of circuit diagram

Task 3: Compiling of required program code

Task 4: Acquisition of components

Task 5: Hardware prototyping

Task 6: Hardware implementation

Task 7: Soldering of components

Task 8: Testing of completed hardware

Task 9: Casing of project

4.3.2 RISK MANAGEMENT

Due to the flexibility of electronic circuit components, there was a high risk of burning out components. This was checkmated by ordering for redundant components.

There was also risk of electric shock this was mitigated by the use of protective gloves and careful operations.

4.3.3 SOCIAL, LEGAL, ETHICAL AND PROFESSIONAL CONSIDERATIONS

The system as much as possible was made to be user interactive to make for easy mounting and operation. No laws were contravened as all components were all locally obtained.

No hazard to health as it has no emissions.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.0 CONCLUSION

The course of undergoing this project has disclosed numerous important things about **temperature** monitoring. Ranging from its economic importance and recommendation based on the use of this temperature monitor and alarm system. Hence with the successful design and construction of this project, a more efficient way of ensuring continuous availability of temperature monitoring is provided.

From the work, we have used combination of LCD and Temperature sensor DS18B20 to make simple temperature monitor using Arduino. Apply temperature to DS18B20 sensor more than set point it will turn on the alarm. if it is less it will also turn on the alarm.

This project is designed to be used in our homes and industries, majorly hospitals where the need for accurate temperature and safety is needed. And should be used and maintained by a qualified personnel.

5.1 CONTRIBUTION TO KNOWLEDGE

By successfully undergoing this project, I now fully understand the operations of a DS18B20 temperature sensor, gained an insight into Arduino programming, how to mount programmes unto a microcontroller via Arduino, a better knowledge of circuit layout and design.

5.2 LIMITATIONS

Every engineering work goes with one or more problem, which enhances research and probably technological advancement to engineers while endeavoring to resolve such problem. Therefore, the project on discussion suffers some noticeable drawback, which includes:

i. Mechanical problem: we found it quite difficult to compact the circuit and other components and accessories into a space effective and efficient casing. But after the effort was made, our aim was later achieved.

ii. Microcontroller selection: we found it a bit challenging to select the right microcontroller that will be used to control the operations of the system, due to the simplicity we wanted to achieve. This led us to the choice of ATMEGA328.

iii. Inadequate knowledge of components: lack of proper understanding of circuit components and sensors posed a little challenge which was thereafter subdued after dedicated study.

5.3 FUTURE WORKS

The following are possible future advancements and development on this project

i. A control mechanism could be included to control the room's air conditioner or fan on the detection of abnormal temperature

ii. A loud speaker could be incorporated into the system and voice inclusion too, to make room for announcement over public address, what the current temperature is per time

iii. More sensors could be added to the system for a more holistic performance.

5.4 CRITICAL APRAISAL

With the importance of temperature in the wellbeing of humans, and smooth running of operations, this project becomes very useful to make the whole system "semi-automated" which in turn eliminates the need to manually run periodic checks on temperature.

The system is reasonably user friendly which allows for setting of required temperature ranges, it is easy to mount, operate and maintain.

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APPENDIX

Arduino code

- Device PIN Jumper_Color
- ------------ ----- -------------
- temperature sensor 2 Yellow
- Buzzer 3 Blue
- lowerbtn 4 white
- upperbtn 5 Green
- ledPin 6 Yellow

-

-

-

```
lcd.setCursor(12,1);
    conversion(uppertemp);
    lcd.write(b);;
    lcd.setCursor(2,1);
    conversion(lowertemp);
    delay(2000);
    lcd.clear();

}
```