CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Heart beat rate means the number of heartbeats per unit time, usually expressed as beats per minute (bpm). The human heart pounds to pump oxygen rich blood to the muscles and carry cell waste products away from the tissues. Heartbeat rate can vary according to the demand of the muscles to absorb oxygen and excrete carbon dioxide changes such as during exercise or sleep. It also varies significantly between individuals based on age, fitness and genetics. This means that the heart must beat faster to deliver more oxygen rich blood. During exercise routines, the heartbeat rate gives a strong indication of how effective the exercise is to the body.

The patient monitoring systems is one of the major improvements in the global health care program because of its advanced technology. A patient monitoring system measures the heartbeat and body temperature by using embedded technology. This advancement in technology is highly needed because many sick patients at the hospitals die because of high fever and heart attacks. The trend of cardiovascular disease has shown that heart beat rate plays a key role in determining the possibility of a heart attack while an increase in the body temperature can induce fever on a patient. Heart diseases such as heart attack, coronary heart disease, congestive heart failure, and congenital heart disease are the leading causes of death for men and women in many countries. Most of the time, the aged people of the society are more prone to heart disease problems than the younger ones. For people who live alone with no one to monitor their health condition, this device offers an opportunity to them for a constant monitoring of their health status, it is developed to monitor and alert the doctors about the heartbeat and temperature condition of a patient. It is developed to give patients a timely and proper heath care.

These days it is not easy for doctors and the nurses to remain close to a patients bed side to monitor their heath condition. In the past, a huge and fixed monitoring device was used (only in the hospitals) to know the health status of a patient when on a bed. These monitoring devices are only available in the hospitals and are constantly on the patient’s body. Many of them are not user friendly so it is important that the doctors and family members will have a handy device that can always monitor their patients when they are not around. One of the vital things to monitor on a patient is the body temperature. This has to do with the measurement of the body's ability to generate and get rid of heat. Temperature monitoring is one of chief indicators of the normal functioning of health. The nature of the human body is to keep its temperature within a narrow, safe range in spite of large variations in temperatures outside the body. Normal human body temperature depends upon the place in the body, from which the measurement is made, and the time and level of activity of the person. The typical body temperature is 37.0 °C ± 0.4°C (98.6 ° F ± 0.7°F). When the body temperature is high, the blood vessels within the skin expand (dilate) to carry the excess heat to the patients skin surface. One may begin to sweat, and as the sweat evaporates, it helps to cool his/her body. When one is too cold, the blood vessels narrows (contracts) so that blood flow to the skin is reduced to conserve body heat. This may cause an involuntary shivering in some people due to cold which is a rapid contraction of the muscles. This extra muscle activity helps to generate more heat. Under normal condition, thus keeping one's body temperature within a narrow, safe range. Body temperature is regulated by neural feedback mechanism which operate primarily through the hypothalamus. The hypothalamus contains not only the control mechanisms, but also the key temperature sensors. Under control of these mechanisms, sweating begins almost precisely at a skin temperature of 37°C and increases rapidly as the skin temperature rises above this value. The heat production of the body under these conditions remains almost constant as the skin temperature rises. If the skin temperature drops below 37°C a variety of responses are initiated to conserve the heat in the body and to increase heat production. These includes: Vasoconstriction to decrease the flow of heat to the skin, Cessation of sweating, shivering to increase heat production in the muscles, Secretion of nor epinephrine, epinephrine, and thyroxin to increase heat production.

Another vital thing to monitor in a patient is the heartbeat rate. It is very important that the heartbeat is to be normal. That is 72 BPM. If there is any abnormality, then the patient is in distress. Heartbeat rate means the number of heartbeats per unit of time. The normal heartbeat rate of a resting person is about 70 bpm for adult males and 75 bpm for adult females. The average heartbeat per minute for 25-year old ranges between 140-170 beats per minute while for a 60-year old it is typically between 115-140 beats per minute and body temperature is 37 degree Celsius or 98.6 Fahrenheit. . Normally it is difficult to keep track of the abnormalities in the heartbeat count of by manual means. Patients are not well versed with the manual treatments, which the doctors normally use for tracking the count of the heartbeat. Thus, there must be some kind of device which would help patients and their family member to keep track of their health by themselves. This sole reason is why this project presents a heartbeat and temperature monitoring device using radio frequency (RF.). The concept of developing an RF. based patient monitoring device is to have a simple home and hospital based pulse and body temperature monitoring device for sick person's that are in critical condition and needs to be constantly or periodically monitored by clinician or family.

1.2 WHAT IS A PATIENT HEARTBEAT AND TEMPERATURE MONITOR USING RF.?

A patient heartbeat and temperature monitor using RF. is a radio frequency based pulse wave and body temperature monitoring system, which allows the control of a sick person's condition in real time. The system monitors the heart beat and temperature of a patient simultaneously and if the patients heartbeat rate or body temperature is abnormal, the system alerts sends an alert to the doctor or patient's family members to quickly examine or diagnose the patient's condition and take early precaution to save the patient's life. The alerts sound can be triggered at any time as long as there is a deviation in the health condition of the patient from the normal, such that the status of the patient can be known on time. The system consists of a sensor, which monitors the patient and sends a signal to a microcontroller, which processes it to determine the temperature and heartbeat rate of the patient before sending an alert to a receiver using radio frequency. The receiver has to be in the possession of the patient's doctor or family members. This project can also be used by athletes who engage in physical exercise and by medical professionals. Individuals, such as athletes, cyclists or those who are interested in monitoring their heartbeat rate and body temperature to gain maximum efficiency from their training can also use this project. It can be used during physical exercise and healthcare.

1.3 PROBLEM DEFINITION

The human health is one of the most important concerns in the world today. Anything/everything becomes meaningless when one becomes sick and dies due to improper Medicare. For health reasons, people, governments and several voluntary bodies spend a lot of money to ensure a better health condition for themselves and the entire populace. Scientists and Engineers are always at work to device a means of supporting/sustaining a sound health condition for all through the invention of numerous technologies both Electrical/Mechanical gadgets that are in use for health care delivery today. The heart is a very delicate organ in the human body (once it stops beating, nothing else matters). Thus, If early actions are taken (and on time) the heart condition can be managed effectively and many patients can be cured and saved. The problem of patients slumping and dying is associated with cardiovascular arrests and can be checkmated this sensitive and highly effective device (the patient heartbeat and temperature monitor). This device has an outstanding advantage that it is easy to handle and access. Heartbeat rate and body temperature monitors are part of the most vital tools needed in first aid kit for saving lives. Unlike the x-ray, the heartbeat and temperature monitor does not impose any hazard to the human health. There devices in the market which can provide raw measurement data of the patients to the doctors, but the patients may not be able to interpret the medical measurement into a meaningful diagnosis due to their limited medical background. On the other hand, if raw medical data is delivered to the doctor, time is wasted and may pose a problem, but in emergencies waste of time can never be tolerated. It is tough to share data over large area within a short period. Most of the products available in the market have this drawback of limitation in flexibility and portability. If the heat that is produced from metabolism cannot be checkmated on time, it will cause a turbulent body temperature, which could be worse than 40°C and lead to headache, vertigo, low blood pressure, high energy consumption, unconsciousness and crocking up of body temperature regulation function. On the other hand, when the produced heat is less than the dissipating heat, the body temperature cannot hold on and it will result to a decrease in metabolism.

1.4 AIMS AND OBJECTIVES

The major aim and objective of this design [of a patient heartbeat and temperature monitor using RF.] is to help the doctors and family members to keep track of the heartbeat condition of their loved ones [as well as their body temperature] in the case of an abnormality in the health condition (for those with heartbeat defects and those that run excessive high temperature beyond normal). If any varied change takes place, it is notified. This notification through RF. Channel would to take an appropriate action at an instance of time, thereby alerting the appropriate persons..

1.5 SIGNIFICANCE OF THE PROJECT

There are various instruments available in the hospitals to keep track of the internal body changes, but many of them have limitations regarding to maintenance, cost, size of instruments, and mobility. This project is so significant because it is mobile, small in size, cost effective, very easy to use, highly efficient performance, portable and light in weight etc. It uses RF. to help both the patient and the concerned doctor to take an appropriate action.

It is beneficial in terms of cost. It saves time and is very helpful to patients who lives alone. It offers a freedom of movement to patients. It has a low power consumption though the stability of its wireless data communication is still to be enhanced. To some degree, the wireless data communication via RF has anti-jamming ability.

1.6 SCOPE OF THE PROJECT

This project operates at a 30 feet's distance on open space. It is designed to operate with an alkaline battery of a minimum of 9 volts to a maximum of 12v consumes 50mA. It uses a buffer, temperature sensor, AT89c51 Microcontroller and a led display with buzzer for the alert. The hardware and soft ware of the system is oriented towards the AT89c51 single chip microcontroller. Hence, reducing the size of the device. A regulated 3.7v RF. operates in the frequency range of 415 MHZ per second used for data transmission, which can easily penetrate over three floors of a building and go over 30 feet's in open space.

1.7 PROJECT REPORT ORGANIZATION

The organization of the project report is well detailed and vast in its coverage. It covers all the activities encountered during the research work as shown in the block diagram below.

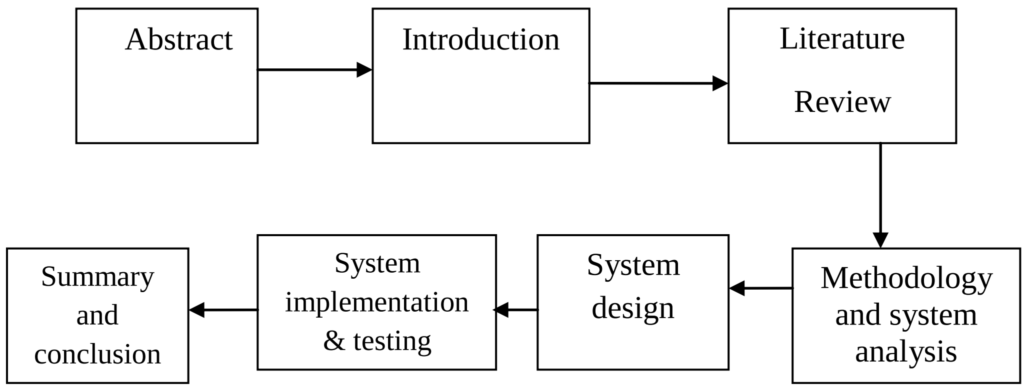


Fig 1.1: PROJECT ORGANIZATION BLOCK DIAGRAM

The first chapter is the introductory chapter, which covers the background, project objectives, scope of the project, constraints and block diagram overview of the states. Chapter 2 presents the literature review. Chapter 3 covers the system analysis and design including the design methodology in block diagram form. Chapter 4 presents the system implementation, which shows the component layout, the wiring schedule, the wiring diagram and the complete schematic diagram. Chapter 5 covers the testing and integration of the project design. The system testing was first carried out in a laboratory. Chapter 6 is the summary and conclusion, which includes the summary of achievements, problems encountered during project design, recommendation and suggestion for further improvement.

BLOCK DIAGRAM OF THE TRANSMISSION BETWEEN THE TRANSMITTER AND THE RECEIVER

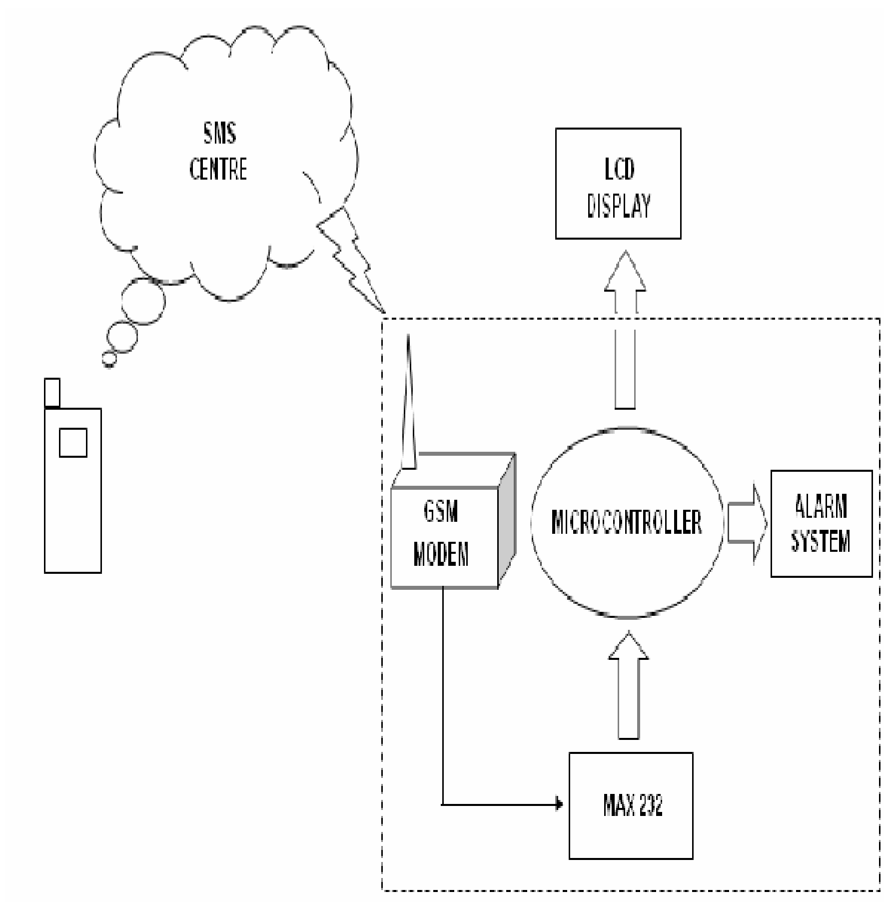


Fig.1.2. Basic idea of a transmitter and receiver transmission using RF.

With the aid of a simple, low cost microcontroller based heartbeat rate and temperature measuring device with LCD output. The heartbeat rate of a patient is measured from the index finger or the wrist or neck using IRD (infrared device) sensors and the rate is then averaged and displayed on a text board LCD.

The device sounds an alarm when the heartbeat and body temperature exceed the safe threshold value. The programmer stipulates this threshold value at the time of programming of the microcontroller. The threshold value given for the device is between 20 to 120 pulses per minute for heart beat indication and 18 degrees Celsius to 38 degrees Celsius for temperature.

CHAPTER TWO

LITERATURE REVIEW

2.1 MEDICAL MONITORING DEVICE

Medical monitor devices are of integrated technology and are found in the area of electronics, computers, material and information Engineering. It plays an important role in the medical/patient simulation system. With the help of the medical monitoring systems, a doctor can get an up to date information of a patient. In any modern society, the physical condition and safety of patients has attracted more and more attention. Patients, who are merely over conscious of their health are easily susceptible to the unexpected situations, such as contraction of diseases/infections as well as some kind of sickness because they take their health issues for granted. Thus, for a good guarantee of the patient's daily life, a monitor designed for this purpose is needed. This monitoring device requires wearable bracelet bangle connected to the device from where the body temperature and heart condition is monitored.

This study aims at the designing of a patient monitoring device with good stability, wearable, low power consumption, low cost and high anti-jamming ability, which enables the doctors to acquaint themselves with the real-time condition of their patients.

2.2 HISTORY OF PATIENTS MONITORING SYSTEM

The invention of a patients monitoring system has been very important even to the fitness industry and as well as an aid to living a healthy lifestyle. Today, many treadmills and elliptical machines often have these monitors built in them to check the rate of the heartbeat at any given time. These monitoring devices are also very important to cyclists and athletes because it prevent them from over training or under training. The very first monitoring device with heartbeat rate (without a body temperature detector) was invented in 1975 by writer, lecturer and inventor Gregory Lekhtman. Lekhtman continues to design fitness electronic devices for his international award winning company, Biosig Instruments Incoporated. He has also collaborated with fitness equipment manufacturers such as Sony, Polar and Nordic Track. By 1977, improvements were made on the original heart rate monitor, and the Polar Electro Company produced the first wireless heart rate monitor. It was specifically used in training the Finnish National Cross Country Ski team. By the late 1970s and early 1980s, heart rate monitors were available in stores abroad for consumers.

2.3 FUNCTIONS OF THE PATIENT HEALTHCARE MONITORS

Patient heart rate monitors can perform many functions beyond tracking of heart rate in real time. One of the features is that when one enters an information and programming of choice within the machine, the monitor can average the person's heartbeat rate and estimate how many calories the person burns per hour. The information obtained can be downloaded into a computer for tracking purposes.

On cardiovascular machines like the treadmill or elliptical trainer, once an information is entered like age and program, the machine can adjust the body resistance until it reaches the desired zone for the heartbeat rate. One of the existing patients monitoring system demonstrated below in this literature review is a technique that measures the heartbeat rate by sensing the change in blood volume in a finger artery (or mostly wrist artery) while the heart is pumping blood. The system consists of an infrared LED that transmits an IR. signal through the fingertip or wrist of the subject, a part of which is reflected by the blood cells. The reflected signal is detected by a photo diode sensor. The changing blood volume with heartbeat results in a train of pulses at the output of the photo diode, the magnitude of which is too small to be detected directly by a microcontroller. A two-stage high gain, active low pass filter is designed for the system using two operational amplifiers (Op-Amps) to filter and amplify the signal to appropriate voltage level so that the pulses can be counted by the microcontroller, (PIC16F628A).

Finally, the detected heart rate was displayed on a three (3)-digit seven-segment display. The schematic circuit diagram of the system is shown in figure 2.1 below.

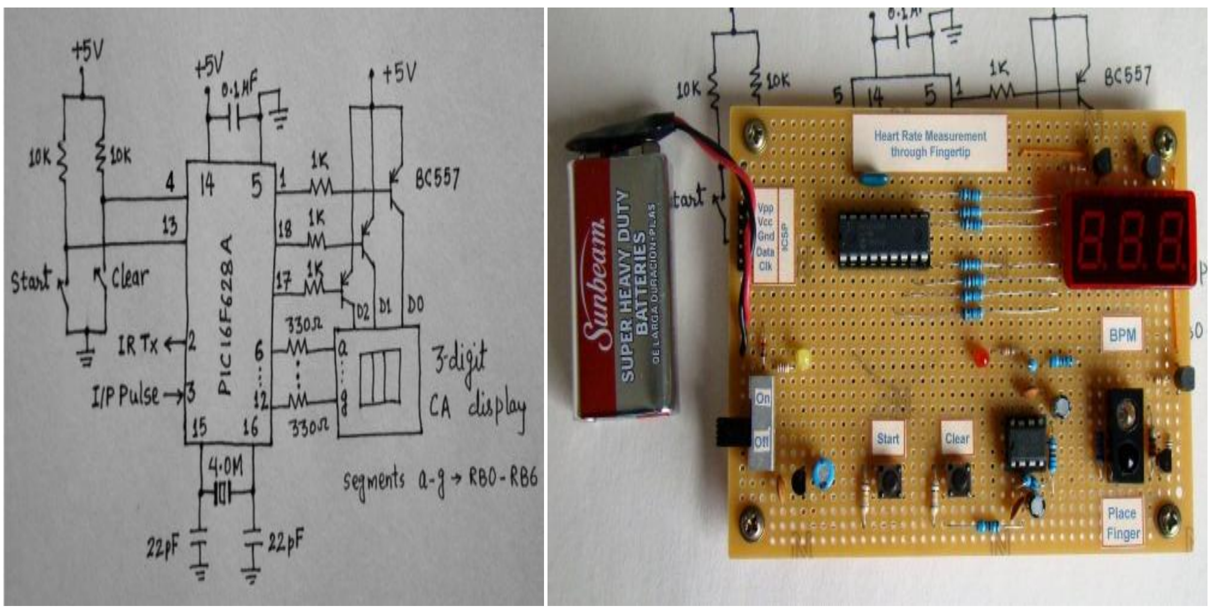


FIG 2.1 PATIENT HEARTBEAT RATE MEASUREMENT USING PIC16F628A

Based on the information gathered on this literature review, the heartbeat rate detected by the machine can be defined as the number of heartbeats per unit of time and is usually expressed in beats per minute (bpm). In adults, a normal heart beats for about 60 to 100 times per minute (occurring during resting condition).

The heartbeat rate during rest condition plays a role in determining the health solution of a patient. The monitoring device can measure the heartbeat rate from any spot on the body from where pulses can felt with the thumb or finger. The most common places are the wrist and neck. You can count the number of pulses within a certain interval (say 15 sec), and easily determine the heartbeat rate in bpm (beats per minute). In the above project design approach, the monitoring system uses an optical sensor to measure the alteration in blood volume at the fingertip with each heart beat. The sensor unit consists of an infrared light-emitting-diode (IR. LED) and a photodiode, placed side by side as shown below.

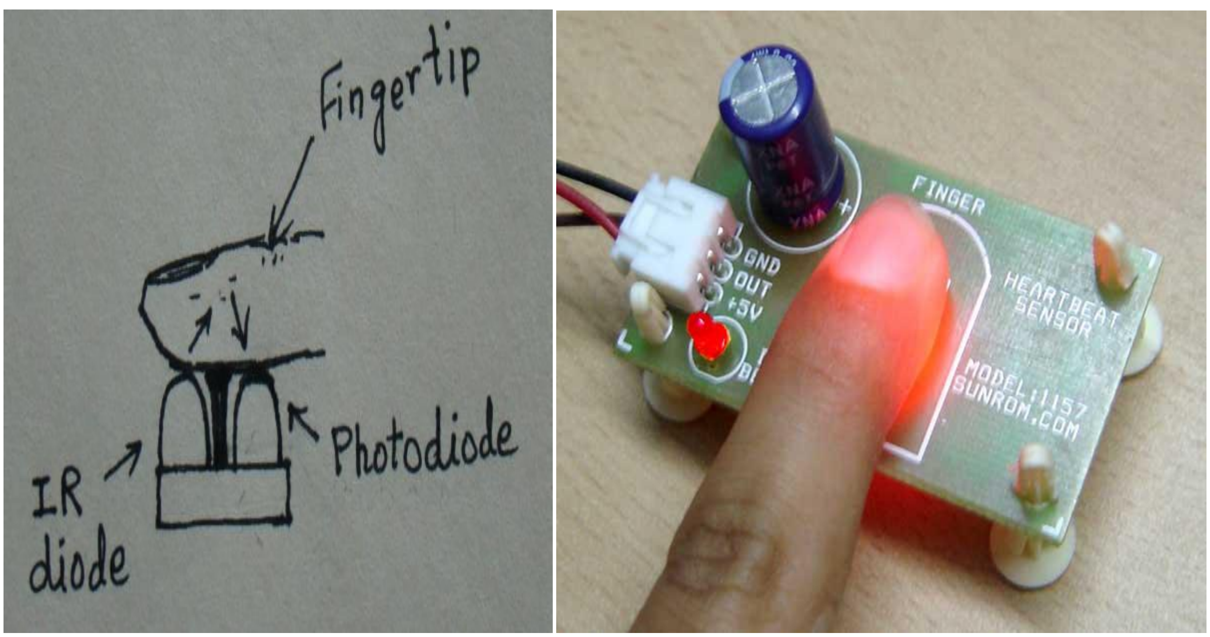


FIG 2.2: FINGERTIP PLACEMENT OVER THE SENSOR UNIT

The IR. Diode transmits an infrared light into the fingertip (placed over the sensor unit), and the photodiode senses the portion of the light that is reflected back. The intensity of reflected light depends upon the blood volume inside the fingertip blood vessel. Thus, each heartbeat slightly alters the amount of reflected infrared light that can be detected by the photodiode. With a proper signal conditioning, this little change in the amplitude of the reflected light can be converted into a pulse. The pulses can later be counted by a microcontroller to determine the heartbeat rate. A circuit diagram of the signal conditioning of the system is as shown below:

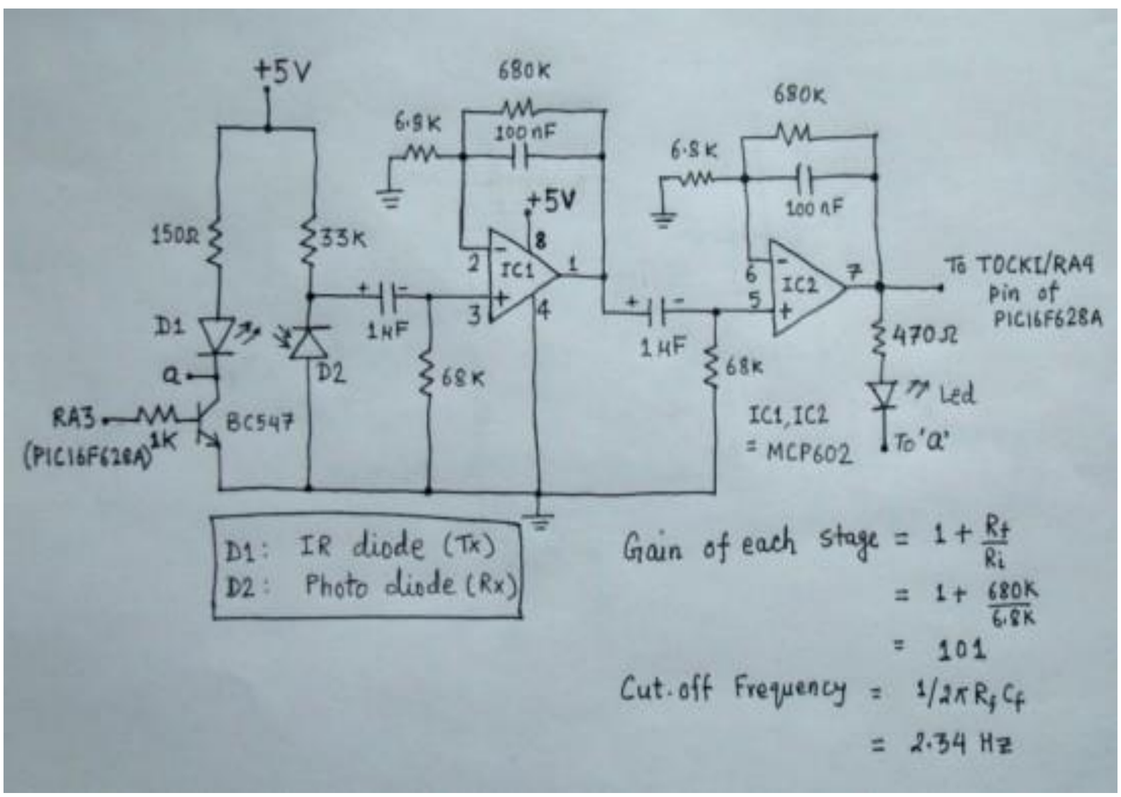


FIG 2.3:IR. SENSOR AND SIGNAL CONDITIONING CIRCUIT

In the above system design, a signal conditioning circuit consists of two identical active low pass filters with a cut-off frequency of about 2.5 Hz. This means the maximum measurable heart rate is about 150 bpm.

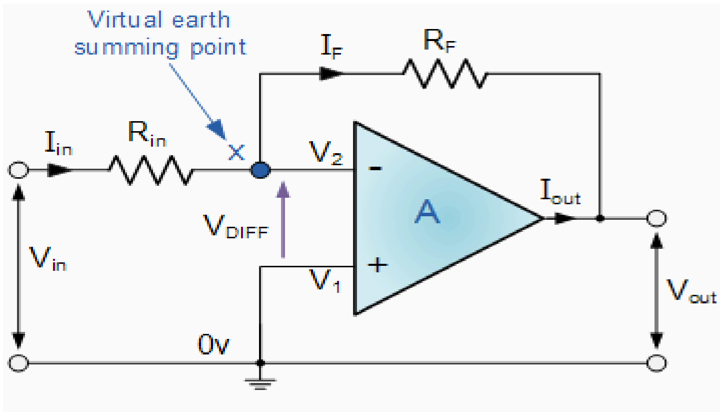
The value of IC 1 and IC 2 in the above diagram is MCP602.

Inverting bias resistor- 680k (Rf.)

Non- inverting resistor – 68k (RI)

The Inverting Amplifier: the **Open Loop Gain**, (Avo) of the operational amplifier can be very high, as much as 1,000,000 (120dB) or more. However, this very high gain is of no real use to us as it makes the amplifier both unstable and hard to control as the smallest of input signals, just a few micro volts, (μV) would be enough to cause the output voltage to saturate and swing towards one or the other of the voltage supply rails loosing complete control. As the open loop DC gain of an operational amplifier is extremely high, we can therefore afford to lose some of this gain by connecting a suitable resistor across the amplifier from the output terminal back to the inverting input terminal to both reduce and control the overall gain of the amplifier. This then produces and effect known commonly as **Negative Feedback**, and thus produces a very stable Operational Amplifier based system. **Negative Feedback** is the process of "feeding back" a fraction of the output signal back to the input, but to make the feedback negative, we must feed it back to the negative or "inverting input" terminal of the op-amp using an external **Feedback Resistor** called Rf. This feedback connection between the output and the inverting input terminal forces the differential input voltage towards zero. This effect produces a closed loop circuit to the amplifier resulting in the gain of the amplifier now being called its **Closed-loop Gain**. A closed-loop amplifier uses negative feedback to accurately control the overall gain but at a cost in the reduction of the amplifiers bandwidth. This negative feedback results in the inverting input terminal having a different signal on it than the actual input voltage as it will be the sum of the input voltage plus the negative feedback voltage giving it the label or term of a *Summing Point*. We must therefore separate the real input signal from the inverting input by using an **Input Resistor**, R-in. As we are not using the positive (non-inverting) input, this is connected to a common ground or zero voltage terminal as shown below, but the effect of this closed loop feedback circuit results in the voltage potential at the inverting input being equal to that at the non-inverting input producing a *Virtual Earth* summing point because it will be at the same potential as the grounded reference input. In other words, the op-amp becomes a "differential amplifier".

Inverting Amplifier Configuration



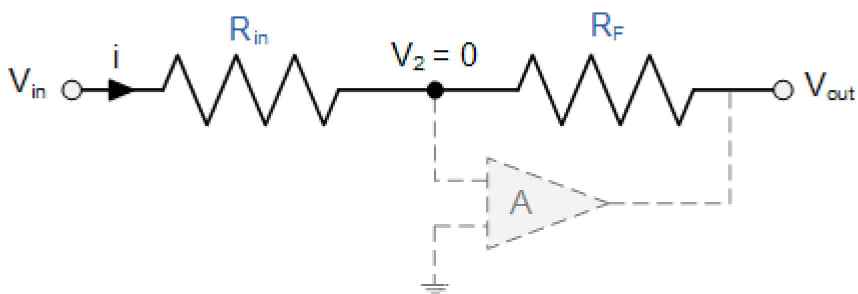
In this **Inverting Amplifier** circuit, the operational amplifier is connected with feedback to produce a closed loop operation. For op-amps there are two very important rules to remember about inverting amplifiers, these are: "no current flows into the input terminal" and that "V1 equals V2", (in real op-amps, these rules are broken). This is because the junction of the input and feedback signal (X) is at the same potential as the positive (+) input, which is at zero volts, or ground then, the junction is a **"Virtual Earth"**. Because of this virtual earth node, the input resistance of the amplifier is equal to the value of the input resistor, R-in and the closed loop gain of the inverting amplifier can be set by the ratio of the two external resistors.

We said above that there are two very important rules to remember about **Inverting Amplifiers** or any operational amplifier for that matter and these are.

- 1. No Current Flows into the Input Terminals
- 2. The Differential Input Voltage is Zero as V1 = V2 = 0 (Virtual Earth)

Then by using these two rules, we can derive the equation for calculating the closed-loop gain of an inverting amplifier, using first principles.

Current (I) flows through the resistor network as shown.



$$i = \frac{Vin - Vout}{Rin + Rf}$$

$$\text{therefore, } i = \frac{Vin - V2}{Rin} = \frac{V2 - Vout}{Rf}$$

$$i = \frac{Vin}{Rin} - \frac{V2}{Rin} = \frac{V2}{Rf} - \frac{Vout}{Rf}$$

$$\text{so, } \frac{Vin}{Rin} = V2\left[\frac{1}{Rin} + \frac{1}{Rf}\right] - \frac{Vout}{Rf}$$

$$\text{and as, } i = \frac{Vin - 0}{Rin} = \frac{0 - Vout}{Rf} \qquad \frac{Rf}{Rin} = \frac{0 - Vout}{Vin - 0}$$

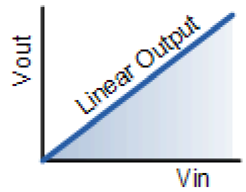
$$\text{the Closed Loop Gain (Av) is given as, } \frac{Vout}{Vin} = -\frac{Rf}{Rin}$$

Then, the **Closed-Loop Voltage Gain** of an Inverting Amplifier is given as.

$$\text{Gain (Av)} = \frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}}$$

In addition, this can be transposed to give V-out as:

$$Vout = -\frac{Rf}{Rin} \times Vin$$



Linear Output

In the above system design, a signal conditioning circuit consists of two identical active low pass filters with a cut-off frequency of about 2.5 Hz. This means that the maximum measurable heart rate is about 150 bpm. The operational amplifier IC used in this circuit is MCP602, a dual op-amp chip from Microchip. It operates at a single power supply and provides rail-to-rail output swing. The filtering is necessary to block any high frequency noise present in the signal. The gain of each filter stage is set to 101, giving the total amplification of about 10000. A 1uF capacitor at the input of each stage is required to block any unwanted DC component in the signal. The equations for calculating gain and cut-off frequency of the active low pass filter are shown in the circuit diagram. The two-stage amplifier/filter provides sufficient gain to boost the weak signal coming from the photo sensor unit and converts it into a pulse. An LED connected at the output blinks every time a heartbeat is detected. The output from the signal conditioner goes to the T0CKI input of PIC16F628A. The display unit of the system comprises of a 3-digit, common anode, seven segment module that is driven using multiplexing technique. The segments a-g are driven through PORT-B pins RB0-RB6, respectively. The unit's, ten's and hundred's digits are multiplexed with RA2, RA1, and RA0 port pins. A tact switch input is connected to RB7 pin. This is to start the heart rate measurement. Once the start button is pressed, the microcontroller activates the IR. transmission in the sensor unit for 15 sec. During this interval, the number of pulses arriving at the T0CKI input is counted. The actual heart rate would be 4 times the count value, and the resolution of measurement would be four. The IR. transmission is controlled through RA3 pin of PIC16F628A microcontroller. The microcontroller runs at 4.0 MHz using an external crystal. A regulated +5V power supply is derived from an external 9V battery using an LM7805 regulator IC.

2.4 PRESENT DESIGN

There are some systems present in the market but all are having some defect. What makes this project different form the past existing products is its wireless communication and method of monitoring of patients. This project can monitor the patient and utilize a radio frequency (RF.) module for a free transmission of data or signal collected by the sensor placed on the patient's body. The radio frequency module makes this project unique and extraordinary. It alerts the doctors or patient family members when the patient's body temperature or heartbeat rate is irregular. The system is very simple and can be used by medical professionals and non-professionals. It is the sensor used that checks the condition of the patient. As soon as the system detects an erroneous signal on the patient's skin, the RF. module will pick up the signals and send it wirelessly to a receiver meant for the project. No wires, no taking of pulse nor involving a multiplication equation, (i.e. the system has two units, the bigger unit "monitor" and the smaller unit "receiver". The bigger unit is placed by the side of the patient. This one is connected with a simple probe to a bracelet on the wrist of the patient but the smaller unit, which is the receiver, has no wire connection of any sort with the monitor). The design concept of using RF. helps to minimize size and functionality in the computerized element of the project. In addition, small size increases the battery's life span and limits the display. The overall design challenge was to minimize the size and weight of the project to be comfortable for the users and easy to understand. For the users comfort reasons, the size and weight will be less obtrusive to everyday, all day usage. The small weight requires careful material selection and product design packaging.

CHAPTER THREE

DESIGN METHODOLOGY AND ANALYSIS

3.1 SYSTEM DESIGN

A patient monitoring system-using RF. is meant to detect abnormal pulses and temperature on a patient's body. The system methodology includes using a radio frequency (RF.) module to transmit a warning signal to a receiver where a specialist (doctor), nurse or anyone can be alerted to attend to the patient. The system repeatedly alerts the concerned persons until the patient recovers. This system has the advantages of high stability, wearable, low power consumption, high anti-jamming ability and seldom region limit because of the RF. This proposed method is designed using top to ground design implementation techniques. The two main parts of the system design is the detection module and the RF. communication module. The detection module must be placed on the patients hand while the RF. communication module will always be with the specialist (doctor) or the patient's family members, so that whenever there is abnormality on the patient's temperature, they can easily be informed to control the situation.

The detection module mainly includes physical signal detection module designed like a wristwatch or bracelet. Due to the wrist type sensor (physical signal detection module), it is convenient for patients to operate and take with them comfortably. The wireless detection module consists of the patients wrist type body sensor, an analog to digital converter (ADC), a clock pulse circuit, a microcontroller (MCU) and a regulated 9 volts battery power supply (PSU) as shown in the system design structural chart shown in figure 3.1 bellow:

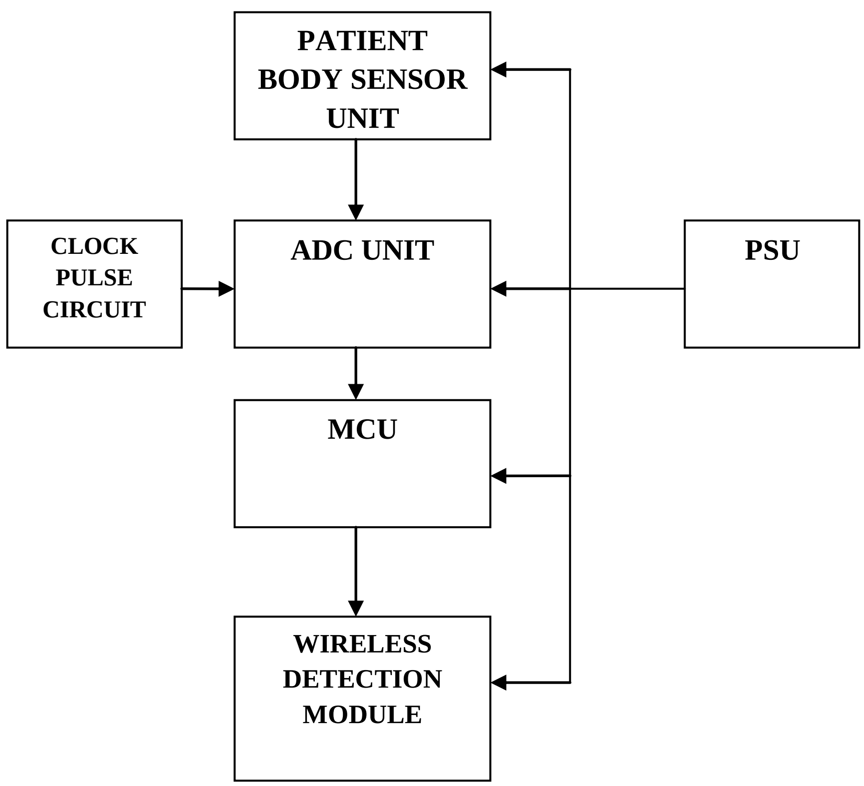


FIG 3.1: SYSTEM DESIGN STRUCTURAL CHART

The first step in the system design procedure was to gather the required information for the quoted system design specifications. The exact system components to be used were calculated and placed on a computer aided design software (Proteus 7) used for the design simulation of the paper design. A code written in assemble language program using MIDE was used to actualize the design program. The program is written based on AT89C2051 specific instructions.

3.2 SYSTEM ANALYSIS

3.2.1 Sensor unit

The patient wrist type body sensor is made of LM35 integrated circuit. The LM35 is used to acquire signal more especially, the body temperature of the patient while a microcontroller processes it. The three common sensors used for this particular task are thermistors, thermocouples and resistance thermometers but here, an LM35 was used because it can measure temperature more accurately than thermistors and generates a higher output voltage than thermocouples. LM35 sensor may not require that the output voltage be amplified and it is placed on an adjustable bracelet to be worn on the patient's wrist to gather/obtain information about the body's pulse rate, heat flow, and skin temperature. The information gathered is interfaced to the

MCU for data transmission. The LM35 is an integrated circuit sensor. Its electrical output signal is proportional to the temperature in **o**C (degree Celsius temperature).

The scale factor is .01V/**o**C. The sensor circuitry is sealed and not subject to oxidation. It does not require any external calibration or trimming and maintains an accuracy of +/-0.4 **o**C at room temperature and +/- 0.8 **o**C over a range of 0 **o**C to +100 **o**C.

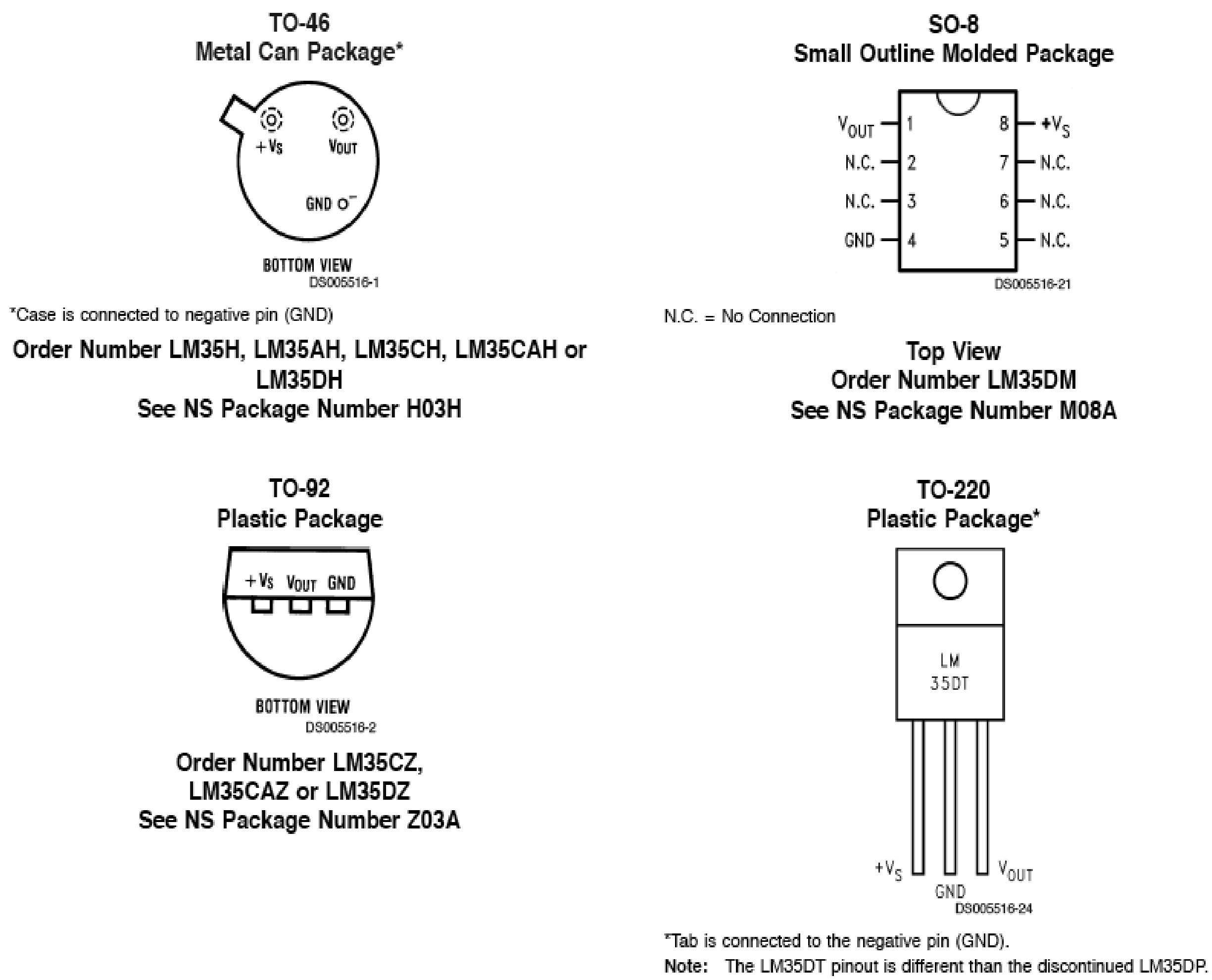


Fig 3.2: THE LM35 SENSOR

3.2.2 Choice of resistor and sensor value

The value of the resistance on the LM35 determines the range of the output voltage. Using a multi-meter, the maximum and minimum values of the sensor resistance (R min*R max) can be determined. In this context:

R min = 1.50KΩ

R max = 780kΩ

R= square root of (R min*R max) = Square root of (1.50kΩ * 780kΩ).

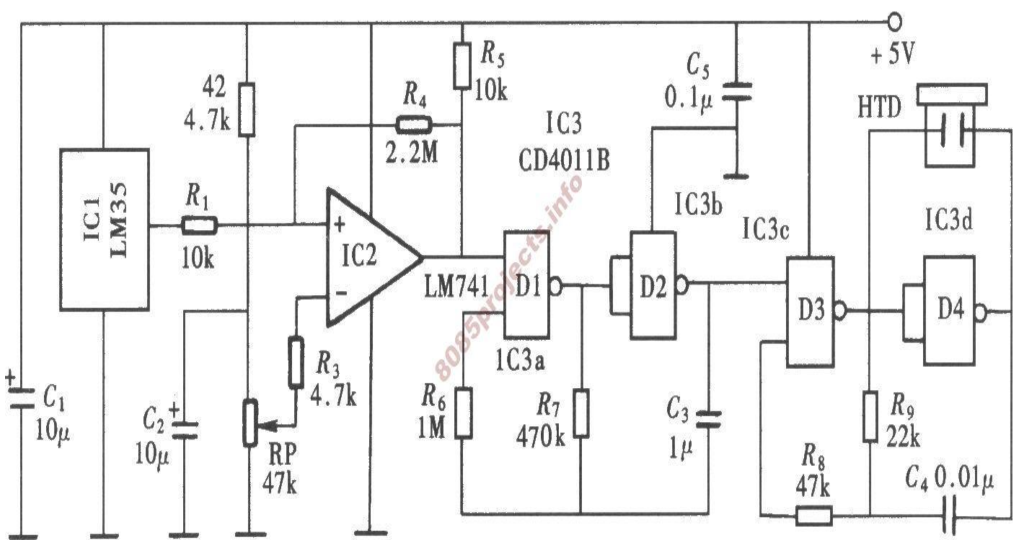


FIG 3.3: THE LM35 SENSOR CIRCUIT

The value of the variable resistor (RP 4.7K) in the sensor unit as shown in the schematic circuit diagram above (Figure 3.3) is used to set a maximum limit of sensor control points. When the body temperature exceeds the limit, a warning sound occurs; the alert sound attracts the user’s attention. The warning sound is also sent to the doctor or the family members of the patient using RF.

3.3 WIRELESS DETECTION MODULE

The wireless detection module is used to transmit the acquired values as detected by the sensor. These physical parameters or value will be converted from analog signal to digital data for further processing. The digital data after been processed by the microcontroller unit is then transmitted into the air by an RF. module. At the receiving end, the job of the RF. communication module (receiver unit) is to detect those incoming digital values from the air and demodulate (transform) the signal into sound. The output sound produced is by an output transducer called buzzer. A buzzer is an electrical component that converts electrical signal into sound. The most fundamental choice to be made in the design of the wireless detection module is the selection of its operating frequency. The RF. signal must comply with government regulations and wireless standards. Currently, frequencies used for wireless systems include 315 MHz, 433 MHz, 868 MHz (for Europe and Nigeria), 915 MHz (North America), and the 2.45-GHz Industrial-Scientific-Medical (ISM) band. The 2.45-GHz band provides implementation flexibility due to the abundance of commercially available RF. devices in that band.

However, the basic concern of using this band is the possibility of intersystem interference. Using lower frequencies would help in extending the communications range due to low path loss attenuation. With low propagation path loss, the antenna gain would not become an important factor in the system link budget. However, low frequencies require larger sized antennas. If the density of deployment allows for few meters spacing between the sensors, the choice of lower frequencies would be a good choice. Very low operating frequencies (70 MHz or even lower) may provide better solutions for some wireless applications.

3.4 MICROCONTROLLER (MCU)

The microcontroller can be adopted for several purposes but in this project, it processes the digital data from the ADC unit. The input pin of the microcontroller is connected to the output terminal of the ADC for the sensor circuitry. When this pin goes to “HIGH”, it means that there is an output from the sensor and vice versa. The microcontroller used is shown below in figure 3.4

Input

Fig 3.4: A MICROCONTROLLER CHIP

The microcontroller determines the number of times the output will sound the buzzer {alarm}. This decision is vital to avoid fake alert from the sensor unit. The output of the microcontroller is connected to a transistor as shown in figure 3.5 as buffer. The transistor is an amplifier known as ransiatorbuffer.

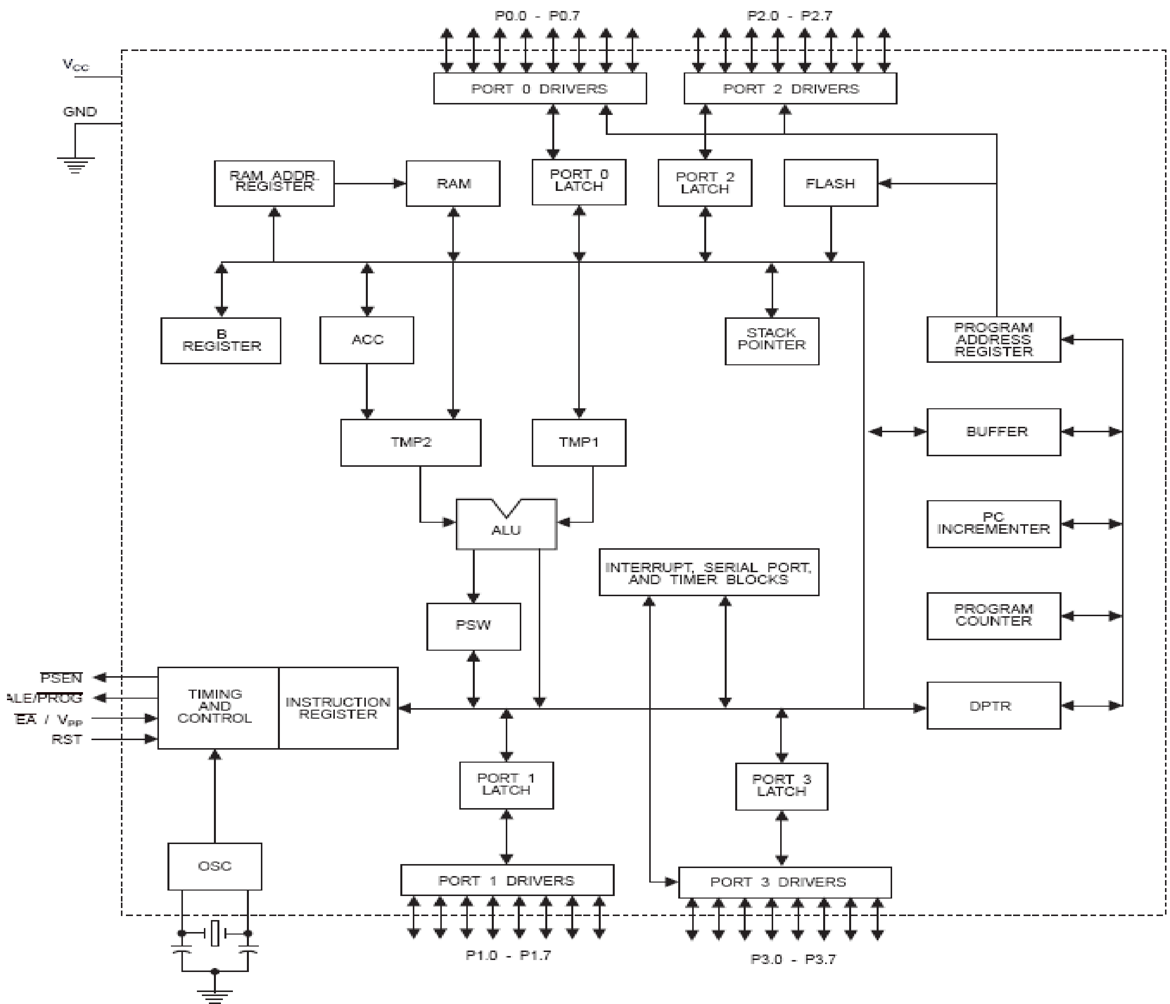


Fig. 3.5 Block diagram of a microcontroller internal circuitry

Pin description

Vcc: Supply voltage.

GND: Ground.

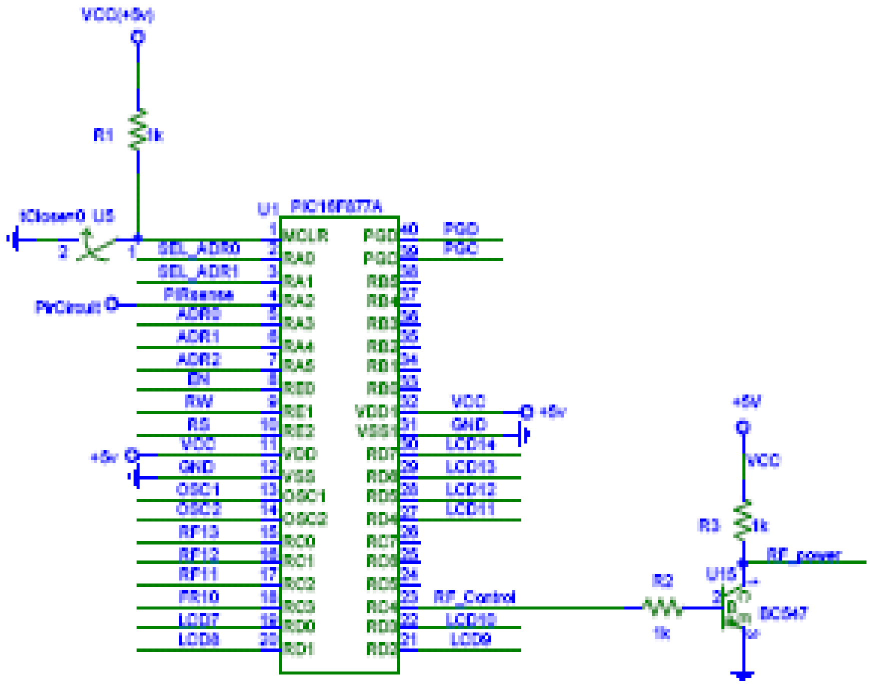


Fig 3.6: TRANSISTOR BUFFER FOR THE RF. TRANSMITTER

The output pin of the microcontroller is connected to the transistor shown in the above circuitry. When this pin goes “high”, the transistor BC547 is switched on and current flow through the transistor. The collector voltage then equals that of the emitter which is connected to ground.

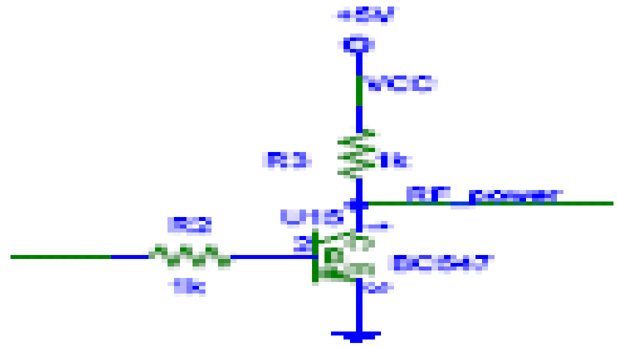


Fig 3.7 TRANSISTOR BUFFER

On the other hand, when this pin goes "low", the transistor BC547 is switched off and no current flow through the transistor. The collector voltage then equals to that of VCC (+5V). Thus, the potential at the point of RF. power connected to the power supply of transmitting module is high and switches on the transmitting module. Therefore, power can be saved for a long running the sensor node activities. The RF. module switches ON only when there is signal at the sensor unit.

3.5 POWER SUPPLY UNIT

The power supply unit is a regulated 5v supply powered from a 9 volts battery. The battery "cycle" is one complete discharge and recharge cycle. It usually discharges from 100% to 20%, and then back to 100%. The battery life is directly related to how deep the battery is cycled each time. If the battery's is discharged to 50% every day, it will last about twice as long as if it is cycled to 80% depth of discharge (DOD). If cycled only 10% DOD, it will last about 5 times as long as one cycled to 50%. The battery powers the project through an LM7805 DC voltage regulator, which keeps the output voltage supply constant. A voltage regulator has only three legs as shown below:

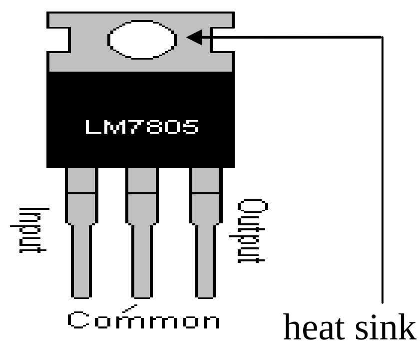


FIG 3.8: LM7805

This device appears to be a comparatively simple device but it is actually a very complex integrated circuit. A regulator converts varying input voltage and produces a constant "Regulated" output voltage. Voltage regulators are available in a variety of output, typically 5 volts, 9 volts and 12 volts. The last two digits in their respective name indicates the output voltage.

Examples of regulator are listed below;

Name	Voltage
Lm 7805	+ 5 volts
Lm 7809	+9 volts
Lm7812	+12 volts
Lm 7905	-5 volts
Lm 7909	-9 volts
Lm 7912	-12 volts

The “LM78xx” series of voltage regulators are designed for positive inputs while “LM79xx series are used for negative input.

3.6 ALARM UNIT

The alarm unit of this device is a buzzer connected to the microcontroller output at the RF. communication module. A transistor amplifier is used to strengthen the signal of the microcontroller before it gets to the buzzer. A 4.7KΩ and 2.2k resistor is used to bias the base of the transistor. The collector of the transistor is connected to the positive supply through the buzzer, while the emitter terminal is connected to the negative terminal. Figure 3.8 shows the connection of the resistors and the buzzer.

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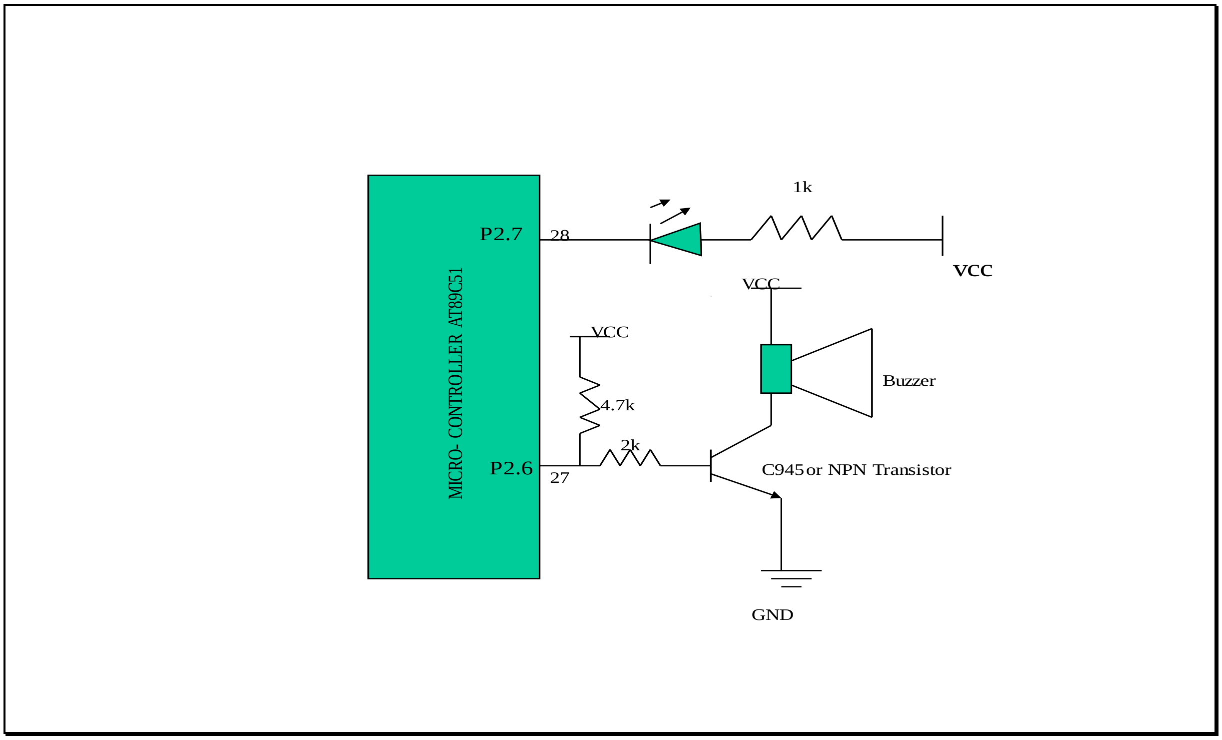

FIG 3.9: TRANSISTOR AMPLIFIER CONNECTED TO THE MICROCONTROLLER

3.7 OTHER COMPONENTS

Some of the passive and active components used in this project are as described below:

3.7.1 Diodes:

A diode plays a very important role in the working/operation of this device to allow an electric current to pass in one direction (referred to the forward characteristics of a diode), while blocking current in the opposite direction (the reverse direction). Diodes can be used for rectification, (to convert alternating current to direct current) and to extract modulation from radio signals in radio receivers. It is a type of two-terminal electronic component with a nonlinear current–voltage characteristic. A semiconductor diode is a crystalline piece of semiconductor material connected to two electrical terminals.

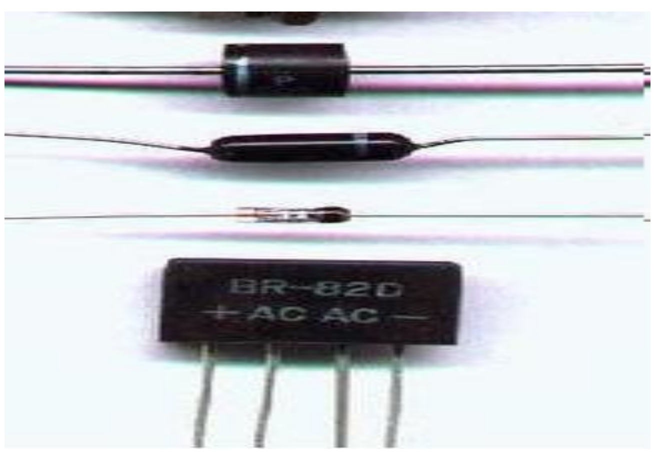

FIG 3.10: TYPES/SHAPES OF DIODES

3.7.2 Capacitor:

Capacitors are two-terminal electrical component separated by a dielectric (insulator) and used for storing electric charges. It consists of metal foils separated by a layer of insulating film. When there is a potential difference (voltage) across the insulated films, a static electric field develops across the dielectric, causing positive charge to attract on one plate and negative charge on the other plate. Energy is stored in the electrostatic field. An ideal capacitor is characterized by a single constant value. Capacitance is measured in farads.

Fig 3.11 STRUCTURE OF THE ELECTROLYTIC CAPACITOR

Capacitors are widely used for blocking direct current while allowing alternating current to pass. In this project, it is used as a filter network, for smoothening the output of the power supply and preventing radio frequency interface.

3.7.3 Resistors:

A resistor is a linear, passive, two-terminal electrical component that implements electrical resistance as a circuit element. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. Thus, the ratio of the voltage applied across a resistor's terminals to the intensity of current through the resistor is called resistance. This relation is represented by Ohm's law: I= V/R.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipments. Practical resistors can be made of various compounds and films, as well as resistance wire (wires made of a high-resistivity alloy, such as nickel-chrome). Resistors are also implemented within integrated circuits, particularly analog devices, and can be integrated into hybrid and printed circuits. The electrical functionality of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. When specifying that resistance in an electronic design, the required precision of the resistance may require attention to the manufacturing tolerance of the chosen resistor, according to its specific application (Wikipedia, 2011).

The temperature coefficient of the resistance may also be of concern in some precision applications. Practical resistors are also specified as having a maximum power rating which must exceed the anticipated power dissipation of that resistor in a particular circuit: this is mainly of concern in power electronic applications. Resistors with higher power ratings are physically larger and may require heat sinks. In a high-voltage circuit, attention must sometimes be paid to the rated maximum working voltage of the resistor.

Fig 3.12: PICTURE OF A FIXED RESISTOR USED IN THE PROJECT

3.7.4 Toggle switch:

The power authentication of this device is a toggle switch. A switch is an electrical component that can open/close an electrical circuit, interrupting the current or diverting it from one conductor to another (free dictionary, 2008). The most familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts. Each set of contacts can be in one of two states: either 'closed' meaning the contacts are touching and electricity can flow between them, or 'open', meaning the contacts are separated and the switch is non-conducting. The mechanism actuating the transition between these two states (open or closed) can be either a "toggle" (flip switch for continuous "on" or "off") or "momentary" (push-for "on" or push-for "off") type.

FIG 3.13. A TOGGLE SWITCH

3.7.5 Transistor:

A transistor is a semiconductor device commonly used to amplify or switch electronic signals. A transistor is made of a solid piece of a semiconductor material, with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current flowing through another pair of terminals. Because the controlled (output) power can be much more than the controlling (input) power, the transistor provides amplification of a signal. The transistor is the fundamental building block of modern electronic devices, and its presence is ubiquitous in modern electronic systems. The bipolar junction transistor (BJT) was the first type of transistor to be mass-produced. Bipolar transistors are so named because they conduct by using both majority and minority carriers. The three terminals of the BJT are named- emitter, base, and collector. The BJT consists of two p-n junctions: the base–emitter junction and the base–collector junction, separated by a thin region of semiconductor known as the base region (two junction diodes wired together without sharing an intervening semiconducting region will not make a transistor). "The [BJT] is useful in amplifiers because the currents at the emitter and collector are controllable by the relatively small base current." In an NPN transistor operating in the active region, the emitter-base junction is forward biased (electrons and holes recombine at the junction), and electrons are injected into the base region. Because the base is narrow, most of these electrons will diffuse into the reverse-biased (electrons and holes are formed at, and move away from the junction) base-collector junction and be swept into the collector; perhaps one-hundredth of the electrons will recombine in the base, which is the dominant mechanism in the base current. By controlling the number of electrons that can leave the base, the number of electrons entering the collector can be controlled. Collector current is approximately β (common-emitter current gain) times the base current. It is typically greater than 100 for small-signal transistors but can be smaller in transistors designed for high-power applications.

Unlike the FET, the BJT is a low–input-impedance device. Also, as the base–emitter voltage (V_{be}) is increased, the base–emitter current and the collector–emitter current (I_{ce}) increase exponentially according to the Shockley diode model and the Ebers-Moll model. Because of this exponential relationship, the BJT has a higher trans-conductance than the FET.

CHAPTER FOUR

SYSTEM IMPLEMENTATION

4.1 HARDWARE IMPLEMENTATION

The final hardware design of this project was implemented on a strip Vero-board. The Vero-board was inspected of wrong linkages in its line, which may be a mistake from the manufactures. The holes of the board were checked to be through for passing the terminals of the components for soldering. An abrasive paper was used on the soldering section of the board for an easy binding of the terminals on the board.

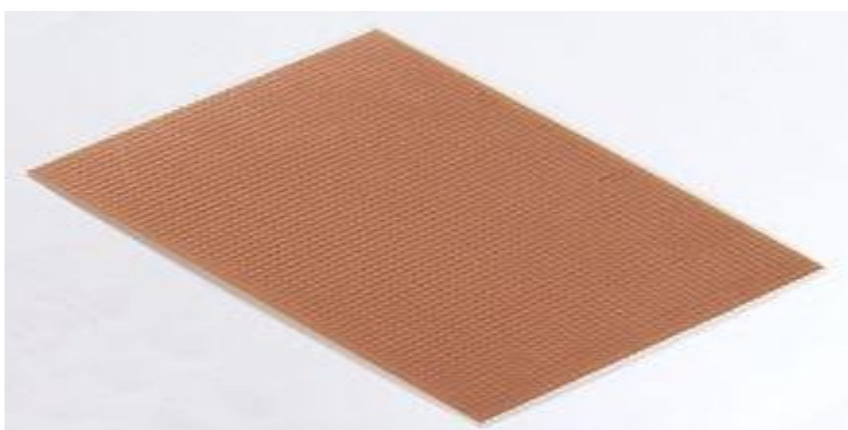

Fig 4.1: The Vero-board used in the project

Components are usually placed on the plain side of the board, with their leads protruding through the holes. The leads are then soldered to the copper tracks on the other side of the board to make the desired connections, and any excess wire is cut off, the continuous tracks is neatly cut as desired to avoid continuity between conductors using a hand cutter made for the purpose or a knife.

The tracks may be linked up on either side of the board using wire. With practice, very neat and reliable assemblies can be created, though such a method is labor-intensive and therefore unsuitable for production.

Vero-board is also called strip board. It is a widely used type of electronic board used mostly for the production of prototypes. It is characterized by features such as: 0.1 inch (2.54 mm) regular (rectangular) grid of holes, with wide parallel strips of copper cladding running in one direction all the way across one side of the board. In using the board, breaks are made in the tracks, usually around holes, to divide the strips into multiple electrical nodes.

4.2 FIXING OF THE COMPONENTS

The sensor was first connected to the input pin of the ADC before the microcontroller unit, then the wireless detection module. During design simulation on the computer, the wireless detection module was removed because the computer software cannot simulate the module. Therefore, a buzzer was connected to the microcontroller to test run the system as shown in figure 4.1 and latter replaced to the RF. wireless module so that it can send an alert to another location where the receiver is.

A 9 volts battery was used to energize the system and the microcontroller chip was programmed using assembly language programming. The code are written in an editor called MIDE and burned in the chip using a programming machine.

4.3 DESIGN PROCESS

A microcontroller based project design is characterized by the following; Definition of task, Requirements, Factor that influence the choice. In defining a task, every design comes from an idea or a problem that requires a solution. Questions can arise on what exactly is required to be achieved and the feasibility of the implementation. If these questions are analyzed critically with tangible solutions to the problem, a development of this idea into reality is the next step.

Requirements for design process have to be considered once an idea has been established. The need to determine whether or not the idea requires a PC or not, depending on the complexity of the circuit, or whether the circuit to be designed needs to make a complex decision or deal with complex data. The microcontroller is the best option for highly sensitive circuits. Thus, to test/know the ability of the microcontroller, a written program designed for the purpose is used.

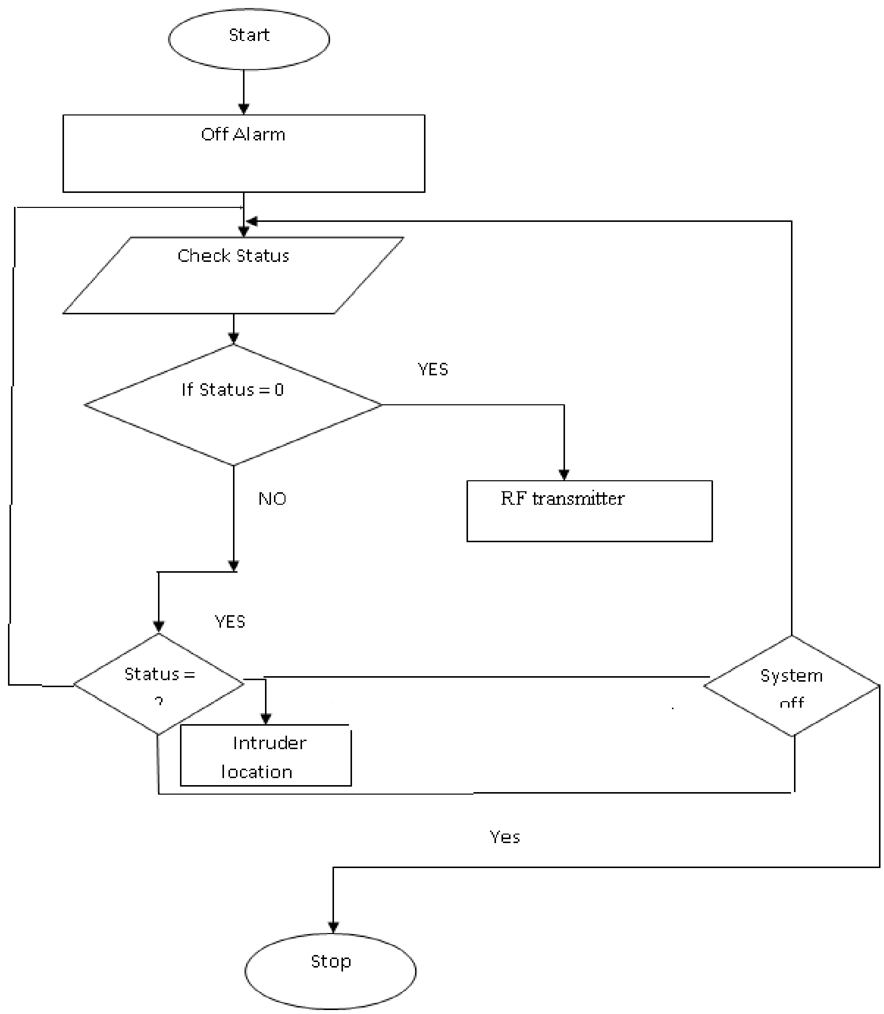

FIG 4.2: PROGRAM FLOWCHART

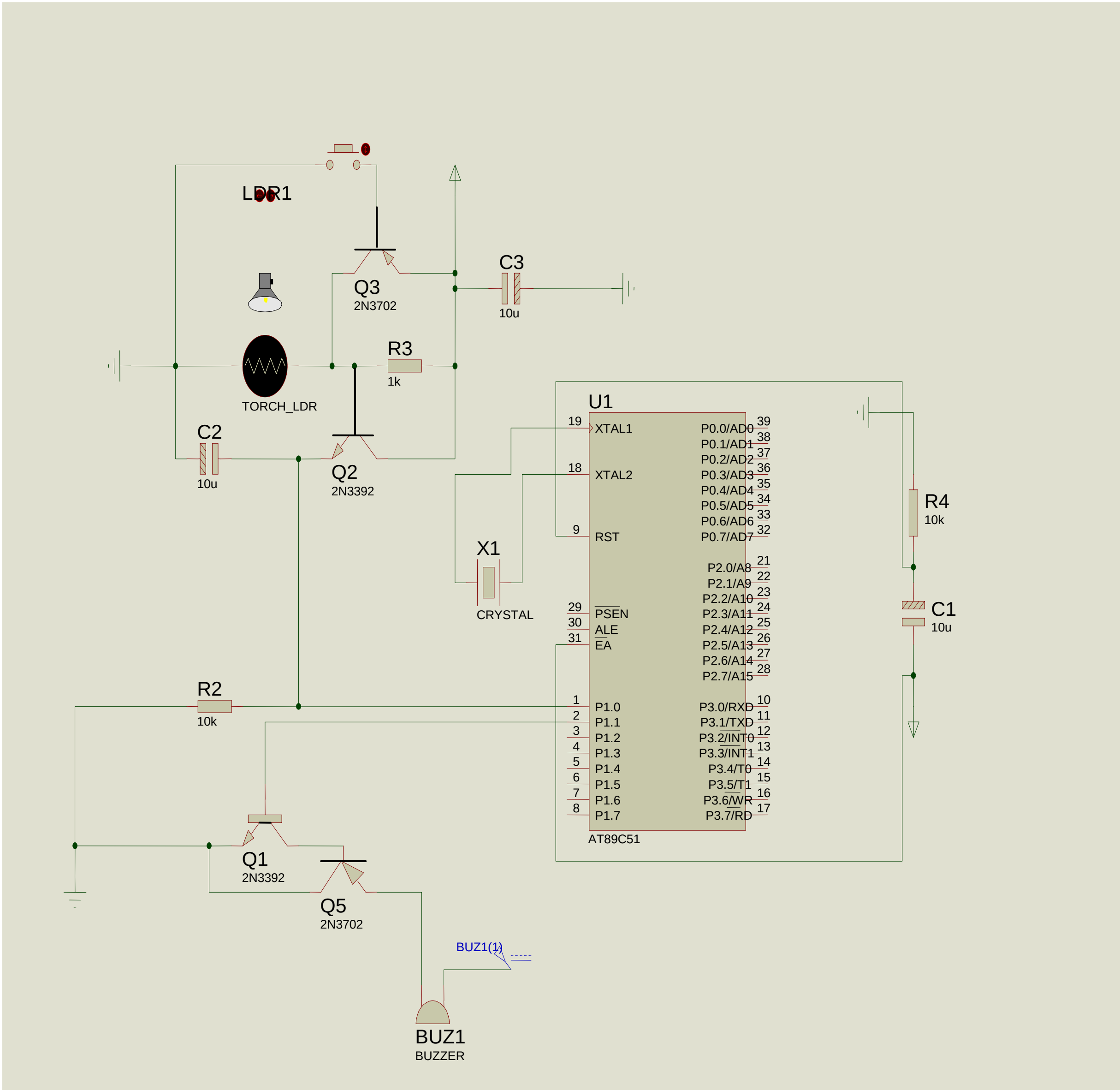

Fig 4.3: CIRCUIT DIAGRAM OF THE PROJECT

The program used in this project is assembling language programming as shown in the source code above in the software design.

4.4 PROGRAM HEX FILE

```
:10000000C290C29120900280FB209000120054D236

:1000100091120054C291120054D291120054C29114

:10002000120054D291120054C291120054D2911273

:100030000054C291120054D291120054C291120085

:1000400054D291120054C291120054D29112005411

:10005000C29180B079037A707BA4DBFEDAFCD9FA16

:01006000227D

:00000001FF
```

CHAPTER FIVE

SYSTEM TESTING AND PACKAGING

5.1 SYSTEM TEST

After the design and implementation phase, the system has to be tested for durability, efficiency, and effectiveness and to ascertain if there is need to modify the design. The system was first assembled using a breadboard. The system was first powered (switched) ON and the patient sensor was placed on a hot iron. As the temperature of the iron increased above 37 o C, an alarm was sounded at the RF. communication module unit, indicating that the system is in good working condition.

Therefore, if a patient's body temperature increases, the sensor can detect it and trigger an alarm at the sensor receiver end.

During the breadboard practical experimentation, all components were properly inserted into the breadboard from where some tests were carried out at various stages. To ensure proper functioning of components, a test was carried out using a digital multi-meter (DMM). Resistors were tested to ensure that they were within the tolerance value. Faulty resistors were discarded .The LM7905 voltage regulator was also tested, the resulting output was 5.02v, which is just a deviation of 0.20v from the expected value of 5.00v.The RF. modules and microcontrollers, were tested to ensure that they were all working properly.

5.2 TEST PLAN AND OVERALL TEST DATA

This section entails an overall system testing of the integrated design. The testing and integration is done to ensure that the design is functioning properly as expected thereby enabling users for which the project was designed to appreciate its implementation and the approach used in the design and integration of the various modules of the project. This involves the checks/tests carried out to ensure that all units and subsystems functions adequately. In addition, there has to be a good interface existing between the input/output unit subsystems.

5.3 OTHER TESTS

Though components like resistors were packed together, reference was made to the resistor color code data sheet to ascertain the expected values of resistors to be used. For each resistor, the value was read and recorded after each test. For the transistor test, the DMM was switched to the diode range. The collector, base and emitter junctions were tested in the following order. The collector, emitter and base pins were obtained from the data analysis on power transistor.

Table 5.1 Test for Transistor

	Black probe	**Red probe**
1st test on pins	Collector	Base
2nd test on pins	Emitter	Base

From the table above, the range between the expected value and the actual value can be obtained. However, there may be a drift in value from the expected data due to the tolerance of the transistor. The drift in the expected value would not have any adverse effect on the device as long as the current range was not exceeded as well as the operational voltage.

CHAPTER SIX

SUMMARY AND CONCLUSION

6.1 SUMMARY

Heartbeat rate and temperature monitor using radio frequency RF. as its mode of communication is a highly sensitive device designed and constructed with the sole aim of combating untimely death caused by cardio-vascular arrest popularly known as heart attack and excessive body temperature which can induce a lot of sickness on the body such as malaria, headache, ulcer and other forms of illness which can be turbulent on the human health. The microcontroller chip plays a key role in the operation of this device. It is programmed to detect changes in the heartbeat condition and body temperature. The alarm unit alerts the concerned persons on the situation of the patient at any instant. The receiver decodes the alert signal and translates it into a readable output for the doctor/family members of the patient to be able to understand. The mechanism of the design is simple and handy to allow for mobility. This device will go a long way in reducing unforeseen situation which claims the lives of millions of people almost on weekly basis all over the world due to inadequate/delay in healthcare delivery to patients with a fragile heat condition.

6.2 PROBLEMS ENCOUNTERED AND SOLUTION

During the design of this system, there were series of problems encountered, most of which were over come via share troubleshooting. In some cases, some parts required redesigning, and the software debugging also posed a bit of a problem. One major setback of this project was the un-availability of some vital components required for the build-up the hardware of the system. In most cases, I had to look through electrical catalogs to obtain replacement of some of the components, which were not available in the market. After developing the software for the microcontroller, it was very difficult to find a firm/individual to help with the programming of the chip (i.e. burning the embedded software on to the chip). This posed a serious problem as it caused a delay in the design, coupled with the fact that it was also costly. This affected the overall cost of the system.

The final packaging of the design was another problem as this actually caused problem on the circuit board. Such problems include partial contact within the circuit board, between components and with the wiring. This was actually one of the most challenging aspects of the circuit implementation phase. Due to this fact, there was a lot of soldering and de-soldering to ensure that the circuit was well implemented and seated.

6.3 CONCLUSION

The planning, design, implementation/execution of this project has really been a tough one. The configuration of the various units into one unit to obtain a desired output of detecting the heartbeat rate through pulses from the blood vessels on the wrist/thumb, and monitoring of the body temperature took a lot of courage and the application of the technical (and theoretical) initiative of the Engineering practice to execute. Thus, this device (integrated with modern technology) have been initiated to help in regularizing the health condition of most individuals by keeping track of their heartbeat rate condition as well as a constant monitoring of their body temperature. Thus, alerting the family members on the patient's real time health situation using RF. as the mode of communication interfaced with LM35 technique.

6.4 RECOMMENDATION

This project, though a prototype design, is recommended for use at the hospitals and at homes for certain individuals who are prone to cardiac arrests or any form of cardio-vascular infection/disease. Patients who occasionally develop an excessive body temperature can as well make use of this device to help them to know their temperature status at a given instant. Athletes, footballers, cyclists and all those who involve themselves with tedious activities can also make use of this device. For future development, the device can be reconfigured and interfaced with the GSM modem and Bluetooth technology.

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APPENDIX A

SYSTEM COMPONENTS LIST

1. Vero Board and LM35

2. Connection Wire and IC sockets

3. Toggle switch

4. Light Emitting Diode

5. Soldering Iron

7. 9v battery

8. Rectifier Diodes

9. 2200uf /25V Capacitor

10. 10uf 16V Capacitor

11. 30pf capacitor

12. Resistors

13. 7805 Voltage Regulator

15. 16 MHz crystal oscillator, AT89S51 Micro controller

17 IC Base Socket (40 pins), Transistors

APPENDIX B

FEATURES OF THE MICROCONTROLLER

- Programmable serial channel
- Compatible with MCS-51TM product
- 4Kbytes of in-system Reprogrammable flash memory - Endurance: 1,000 write/Erase cycles
- Fully static operation:0Hz to 24MHz
- Three-level program memory lock
- 128 x 8-bit internal RAM
- 32 programmable I/O lines
- Two 16-bit timer/counters
- Six interrupt sources
- Low-power idle and power-down modes.