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**CHAPTER-1**

**INTRODUCTION**

**1.1. PROJECT OBJECTIVE**

In this chapter introduction of the **PATIENT MONITORING SYSTEM TO REMOTE DOCTORS USING GSM AND ZIGBEE TECHNOLOGY** are discussed. It gives overall view of the project design and the related literature and the environment to be considered. Chapter wise organization of the thesis and the appendices is given at the end of this chapter. At first we discuss the main processing done using 8051 microcontroller is and then what is the process that can be automated which is within the scope of the work. Then we discuss the implementation aspects.

**1.2. OVERVIEW**

In case of emergency and dangerous situations we have to alert the doctor immediately. For this we are using a Zigbee based network for doctor to patient communication in the hospital and even to communicate and indicate the status of the patient through SMS. This way of communication is actually done with Zigbee network topology and with the GSM network. Each patient will be given this module and with the help of this module the patient health condition is monitored and if there is any change in the condition of the health then it immediately sends that changed data through Zigbee to the local system where the main module is connected to the computer to maintain the status of the patient.

The heart beat is monitored with the pulse rate of the body. The high intensity light sensor senses the expansion and contraction of the heart with the help of the nerves. That beam will transmit the signal to the receiver and the minute change in the pulse is noticed as the heart beat. If there is any change in the pulses then it is noticed as the change in the heart and then the controller will get a disturbed pulse count which indicates the fault or malfunction of the heart. The controller is fixed for a no. of pulses initially. If there is any change in the any of the pulse count then it considers as a malfunction of the heart and then it transmits the pulse count with the patients ID to the doctor in the hospital and at the same to it sends a sms to a fixed number in the microcontroller. This is convenient process to monitor the patients health conditions form any of the distance we present. Since we are using both the networks like Zigbee and GSM this makes the user to communicate for internal system and as well as to the longer distances.

**1.3. AIM OF THE PROJECT**

The main processes involved in this type of control system are to monitor the patient’s health status. Zigbee is a wireless connection network that is used to connect different devices at a frequency of 2.4GHz. For medical applications also this Zigbee is widely used. The Zigbee can communicate with the devices of about 1km. The other network is GSM network. This can be operated from any distance to any point of control. The communication is done with the help of local network support. This can get communicated to any part of the world which the network of the local system is applicable. Here we are using for the hospital communication for monitoring the patient.

**1.4. LITERATURE SURVEY**

The technical brilliance and development in different fields has led to a drastic in our lives, one among them is embedded systems. The application of these devices is to monitor the patient health status. Zigbee is a wireless connection network that is used to connect different devices at a frequency of 2.4GHz. For medical applications also this Zigbee is widely used. The Zigbee can communicate with the devices of about 75 m. The other network is GSM network. This can be operated from any distance to any point of control. The communication is done with the help of local network support. This can get communicated to any part of the world which the network of the local system is applicable. Here we are using for the hospital communication for monitoring the patient.

**1.5. ORGANIZATION OF THE THESIS**

**Chapter 2:** ECG, Heart rate, Body temperature

This chapter gives brief explanation about biological knowledge and measures, physiological conditions of ECG, Heart rate and Body temperature

**Chapter 3:** Detailed system description and development environment

This chapter gives a brief explanation of the overall design processing and detailed functionality of the circuit and also covers the literature survey i.e. general introduction and features of the hardware elements involved.

**Chapter 4:** Design Elements

This chapter describes the complete design elements of the project for the microcontroller along with GSM Modem, Zigbee module, sensors and Liquid Crystal Display.

**Chapter 5:** Circuit Description

This chapter includes the circuit operation of the system.

**Chapter 6:** Software Explanation

In this chapter it includes the total software explanation of the KIEL U VISION 3,microcontroller coding, scope software and flash magic.

**Chapter 7:** Future Scope

This chapter includes the future scope regarding the project.

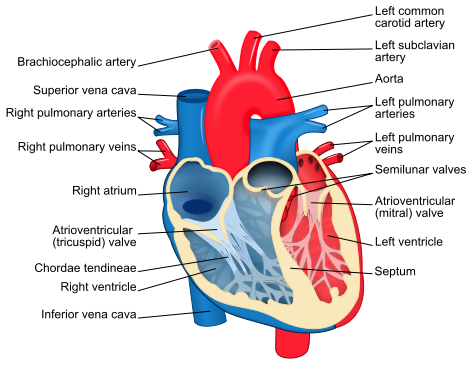
**Chapter 8:** Conclusion

This chapter includes the overall conclusion of the project.

**CHAPTER-2**

**ECG, HEART RATE AND BODY TEMPERATURE**

**2.1 Human Heart**

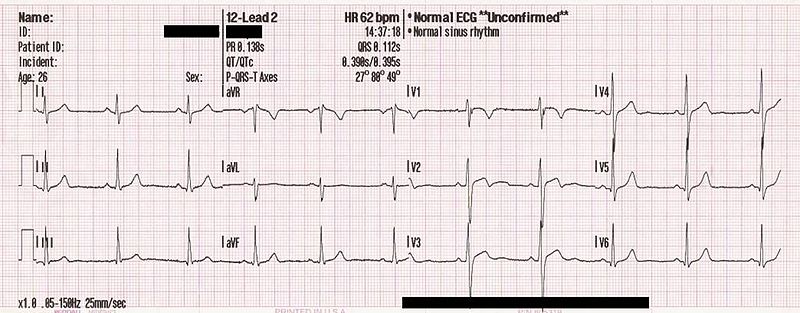
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**FIGURE 2.1: Lateral section of human heart**

The human heart is a muscular organ that provides a continuous blood circulation through the cardiac cycle and is one of the most vital organs in the human body. The heart is divided into four main chambers: the two upper chambers are called the left and right atria and two lower chambers are called the right and left ventricles. There is a thick wall of muscle separating the right side and the left side of the heart called the septum. Normally with each beat the right ventricle pumps the same amount of blood into the lungs that the left ventricle pumps out into the body. Physicians commonly refer to the right atrium and right ventricle together as the rightheart and to the left atrium and ventricle as the left heart.

The electric energy that stimulates the heart occurs in the sinoatrial node which produces a definite potential and then discharges, sending an impulse across the atria. In the atria the electrical signal move from cell to cell while in the ventricles the signal is carried by specialized tissue called the Purkinje fibers which then transmit the electric charge to the myocardium.

**2.2 ELECTROCARDIOGRAPH (ECG)**

****

**FIGURE 2.2:** **12 Lead ECG of a 26-year-old male.**

Electrocardiograph (ECG) is a transthoracic interpretation of the electrical activity of the heart over time captured and externally recorded by skin electrodes. It is a noninvasive recording produced by an electrocardiographic device.

The ECG works mostly by detecting and amplifying the tiny electrical changes on the skin that are caused when the heart muscle "depolarizes" during each heart beat. At rest, each heart muscle cell has a charge across its outer wall, or cell membrane reducing this charge towards zero is called de-polarization, which activates the mechanisms in the cell that cause it to contract. During each heartbeat a healthy heart will have an orderly progression of a wave of depolarization that is triggered by the cells in the sinoatrial node, spreads out through the atrium, passes through "intrinsic conduction pathways" and then spreads all over the ventricles. This is detected as tiny rises and falls in the voltage between two electrodes placed either side of the heart which is displayed as a wavy line either on a screen or on paper. This display indicates the overall rhythm of the heart and weaknesses in different parts of the heart muscle.

**2.3 HEART RATE**

**Heart rate** is the number of heartbeats per unit of time, typically expressed as ***beats per******minute*** (bpm). Heart rate can vary as the body's need to absorb oxygen and excrete carbon dioxide changes, such as during exercise or sleep.

The measurement of heart rate is used by medical professionals to assist in the diagnosis and tracking of medical conditions. It is also used by individuals, such as athletes, who are interested in monitoring their heart rate to gain maximum efficiency from their training. The *R wave to R wave interval* (*RR interval*) is the inverse of the heart rate.

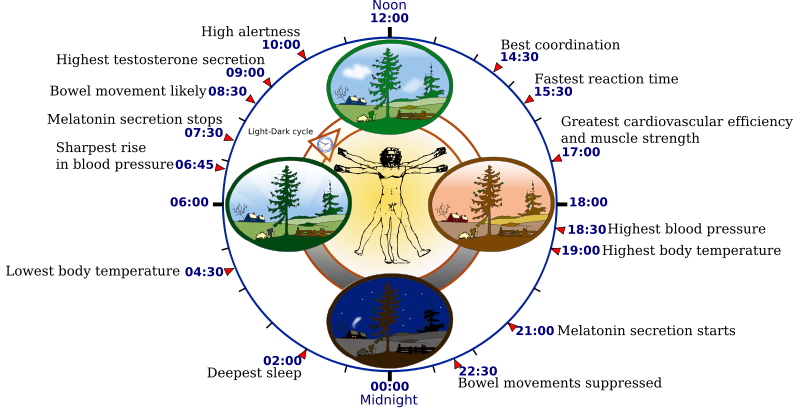
Heart rate is measured by finding the pulse of the body. This pulse rate can be measured at any point on the body where the artery's pulsation is transmitted to the surface by pressuring it with the index and middle fingers; often it is compressed against an underlying structure like bone. The thumb should not be used for measuring another person's heart rate, as its strong pulse may interfere with discriminating the site of pulsation.

The resting heart rate (HRrest) is a person's heart rate when they are at rest, that is lying down but awake, and not having recently exerted themselves. The typical healthy resting heart rate in adults is 60–80 bpm, with rates below 60 bpm referred to as bradycardia, and rates above 100 bpm referred to as tachycardia. Note however that conditioned athletes often have resting heart rates below 60 bpm. and it is not unusual for people doing regular exercise to get below 50 bpm.

**2.4 THERMOREGULATION**

**Thermoregulation** is the ability of an organism to keep its body temperature within certain boundaries, even when the surrounding temperature is very different. This process is one aspect of homeostasis: a dynamic state of stability between an animal's internal environment and its *external* environment or If the body is unable to maintain a normal temperature and it increases significantly above normal, a condition known as hyperthermia occurs. This occurs when the body is exposed to constant temperatures of approximately 55° C, any prolonged exposure (longer than a few hours) at this temperature and up to around 70° C death is almost inevitable. The opposite condition, when body temperature decreases below normal levels, is known as hypothermia

Different parts of the body have different temperatures. Rectal and vaginal measurements, or measurements taken directly inside the body cavity, are typically slightly higher than oral measurements, and oral measurements are somewhat higher than skin temperature. The commonly accepted average core body temperature (taken internally) is 37.0 °C (98.6 °F). The typical oral (under the tongue) measurement is slightly cooler, at 36.8±0.7 °C, or 98.2±1.3 °F. In Russia and former Soviet countries, the commonly quoted value is 36.6 °C (97.9 °F), based on an armpit (auxiliary) reading. Although some people think of these numbers as representing the normal temperature, a wide range of temperatures has been found in healthy people. In samples of normal adult men and women, the observed range for oral temperature is 33.2–38.2 °C (92–101 °F), for rectal it is 34.4–37.8 °C (94–100 °F), for the Tympanic cavity it is 35.4–37.8 °C (96–100 °F) and for auxiliary it is 35.5–37.0 °C (96–99 °F).

** FIGURE 2.3: Overview of biological clock in humans**.

**CHAPTER-3**

**SYSTEM ENVIRONMENT**

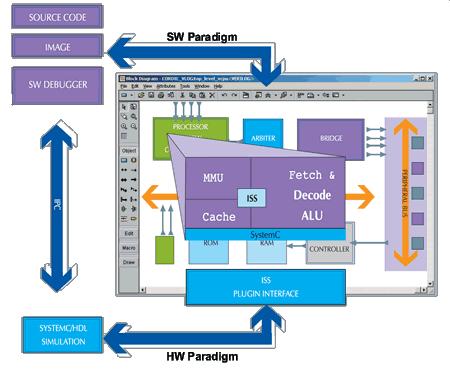
**3.1. INTRODUCTION**

The flat form for this project is based on **Embedded System.** An **Embedded system** is a special-purpose system in which the computer is completely encapsulated by the device it controls. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few pre-defined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded systems are often mass-produced, so the cost savings may be multiplied by millions of items.

An embedded system is a special-purpose [computer](http://en.wikipedia.org/wiki/Computer) system designed to perform a dedicated function. Unlike a general-purpose computer, such as a [personal computer](http://en.wikipedia.org/wiki/Personal_computer), an embedded system performs one or a few pre-defined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded system comprises of both hardware and software. Embedded system is fast growing technology in various fields like industrial automation, home appliances, automobiles, aeronautics etc. Embedded technology is implemented to perform a specified task and the programming is done using assembly language programming or embedded C. Ours being a developing country the power consumption is increasing on large scale to meet the growing need of the people. Power generation is widely based on the non-renewable sources and these sources being depleting some means have to be found for power saving.

**3.2. DESIGN OF EMBEDDED SYSTEMS**

Intelligent, programmable and computing electronic device designed to perform specific tasks based on a fixed time frame. An embedded system is a combination of hardware and software, perhaps with some mechanical and other components designed to perform a specific task. The



**FIGURE 3.1. Embedded System Design.**

Electronics usually uses either a microprocessor or a microcontroller. Some large or old systems use general-purpose mainframes computers or minicomputers.

**3.3. CHARACTERISTICS OF EMBEDDED SYSTEM**

* It is very reactive and real time constrained.
* Increasingly high performance.
* Application specific processor design can be significant component of embedded system.
* It acts as a single function not used as general purpose.

**3.4. REQUIREMENTS OF EMBEDDED SYSTEM:**

**Functional Requirement**

* Direct digital control
* Data collection
* Man-machine interaction

**Temporal Requirement**

* Tasks may have dead lines
* Minimal error detection latency
* Timing requirement
* Human-interface requirements.

**Dependability** **Requirement**

* Reliability
* Safety
* Availability
* Maintainability
* Security

**Block diagram of Embedded System**

**ASICs**   **ANALOG I/Os**

**PROCESSOR** **MEMORY**

**FIGURE 3.2. Block diagram of Embedded System**

**Processor:**

Processor is a digital circuit designed to perform computational tasks. An Embedded system consists of single purpose processor rather than general purpose processor. Single purpose processor better then general-purpose processor.

**ASICs (Application Specific ICs):**

It is the silicon chip with an array of unconnected transistors.It includes gate arrays and standard cell ICs.

**Memory:**

A fixed size volatile memory such as DRAM or SRAM & non-volatile memory such as EPROM or Flash, connected to microcontroller/processor is used.

**Peripherals:**

According to the block diagram analog I/O consists of the several peripherals according to the requirement or the application. some of the peripherals are listed below:

* Timer, counter
* UART
* Pulse Width Modulators
* LCD controller
* DMA controller
* Keypad controller
* Stepper motor controller
* ADC converter
* Real Time clock

**CHAPTER-4**

**DESIGN ELEMENTS**

**4.1. INTRODUCTION**

Mainly the block diagram of the project consists of microcontroller, sensors, GSM modem, Zigbee module, power supply and Liquid Crystal Display. In case of emergency and dangerous situations we have to alert the doctor immediately. For this we are using a Zigbee based network for doctor to patient communication in the hospital and even to communicate and indicate the status of the patient through SMS. This way of communication is actually done with Zigbee network topology and with the GSM network. Each patient will be given this module and with the help of this module the patient health condition is monitored and if there is any change in the condition of the health then it immediately sends that changed data through Zigbee to the local system where the main module is connected to the computer to maintain the status of the patient. The same information is transfer as message to GSM to the corresponding or the relevant person.

In this we check the patient’s health condition by monitoring the heart beat. The heart beat is monitored with the pulse rate of the body. . The high intensity light sensor senses the expansion and contraction of the heart with the help of the nerves. That beam will transmit the signal to the receiver and the minute change in the pulse is noticed as the heart beat. If there is any change in the pulses then it is noticed as the change in the heart and then the controller will get a disturbed pulse count which indicates the fault or malfunction of the heart. The controller is fixed for a no. of pulses initially.

If there is any change in the any of the pulse count then it considers as a malfunction of the heart and then it transmits the pulse count with the patients ID to the doctor in the hospital and at the same to it sends a sms to a fixed number in the microcontroller. This is convenient process to monitor the patients health conditions form any of the distance we present. Since we are using both the networks like Zigbee and GSM this makes the user to communicate for internal system and as well to the longer distances.

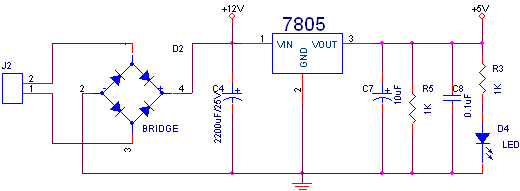


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**FIGURE 4.1: Block diagram of the project**

**4.2. POWER SUPPPLY**

Power supply is a reference to a source of electrical power. A device or system that supplies [electrical](http://en.wikipedia.org/wiki/Electrical) or other types of [energy](http://en.wikipedia.org/wiki/Energy) to an output [load](http://en.wikipedia.org/wiki/External_electric_load) or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.



**FIGURE 4.2. Circuit diagram of power supply**

A 230v, 50Hz Single phase AC power supply is given to a step down transformer to get 12v supply. This voltage is converted to DC voltage using a Bridge Rectifier. The converted pulsating DC voltage is filtered by a 2200uf capacitor and then given to 7805 voltage regulator to obtain constant 5v supply. This 5v supply is given to all the components in the circuit. A RC time constant circuit is added to discharge all the capacitors quickly. To ensure the power supply a LED is connected for indication purpose.

**Voltage Regulator:**



**FIGURE 4.3. Voltage Regulator**

**4.3. SENSORS**

**TEMPERATURE SENSOR:**

Several temperature sensing techniques are currently in widespread usage. The most common of these are RTDs, thermocouples, thermistors, and sensor ICs. The right one for your application depends on the required temperature range, linearity, accuracy, cost, features, and ease of designing the necessary support circuitry. In this section we discuss the characteristics of the most common temperature sensing techniques. But the cost of real time temperature sensor is not affordable. Hence in this project we used a potentiometer to display body temperature. By using this we are showing a prototype how it can works when we use an LM35 sensor.

**HEART BEAT SENSOR:**

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse. However this sensor is of high cost, hence in this project we are using a transducer to demonstrate the measure of heart beat rate. we are just showing a prototype and demonstrating how we can measure heart beat rate and send to remote doctors.

**FEATURES**

* Microcontroller based SMD design
* Heat beat indication by LED
* Instant output digital signal for directly connecting to microcontroller
* Compact Size
* Working Voltage +5V DC

**APPLICATIONS**

* Digital Heart Rate monitor
* Patient Monitoring System
* Bio-Feedback control of robotics and applications.

**4.4. MICROCONTROLLER**

Microcontrollers as the name suggests are small controllers. They are like single chip computers that are often embedded into other systems to function as processing/controlling unit. For example the remote control you are using probably has microcontrollers inside that do decoding and other controlling functions. They are also used in automobiles, washing machines, microwave ovens, toys ... etc, where automation is needed.

Micro-controllers are useful to the extent that they communicate with other devices, such as sensors, motors, switches, keypads, displays, memory and even other micro-controllers. Many interface methods have been developed over the years to solve the complex problem of balancing circuit design criteria such as features, cost, size, weight, power consumption, reliability, availability, manufacturability. Many microcontroller designs typically mix multiple interfacing methods. In a very simplistic form, a micro-controller system can be viewed as a system that reads from (monitors) inputs, performs processing and writes to (controls) outputs. Embedded system means the processor is embedded into the required application. An embedded product uses a microprocessor or microcontroller to do one task only. In an embedded system, there is only one application software that is typically burned into ROM. Example: printer, keyboard, video game player.

Microprocessor - A single chip that contains the CPU or most of the computer

Microcontroller - A single chip used to control other devices

Microcontroller differs from a microprocessor in many ways. First and the most important is its functionality. In order for a microprocessor to be used, other components such as memory, or components for receiving and sending data must be added to it. In short that means that microprocessor is the very heart of the computer. On the other hand, microcontroller is designed to be all of that in one.

**FEATURES:**

* 8K Bytes of In-System Reprogrammable Flash Memory
* Endurance: 1,000 Write/Erase Cycles
* Fully Static Operation: 0 Hz to 24 MHz
* 256 x 8-bit Internal RAM
* 32 Programmable I/O Lines
* Three 16-bit Timer/Counters
* Eight Interrupt Sources
* Programmable Serial Channel
* Low-power Idle and Power-down Modes.

**4.5. GSM MODEM**

**GSM** (**Global System for Mobile Communications**: originally from ***Group Special Mobile***) is the world's most popular [standard](http://en.wikipedia.org/wiki/Comparison_of_mobile_phone_standards) for [mobile telephony](http://en.wikipedia.org/wiki/Mobile_telephony) systems. The [GSM Association](http://en.wikipedia.org/wiki/GSM_Association) estimates that 80% of the global mobile market uses the standard. GSM is used by over 1.5 [billion](http://en.wikipedia.org/wiki/1000000000_(number)) people across more than 212 countries and territories. This ubiquity means that subscribers can use their phones throughout the world, enabled by international [roaming](http://en.wikipedia.org/wiki/Roaming) arrangements between [mobile network operators](http://en.wikipedia.org/wiki/Mobile_network_operator). GSM differs from its predecessor technologies in that both signaling and speech channels are [digital](http://en.wikipedia.org/wiki/Digital), and thus GSM is considered a *second generation* ([2G](http://en.wikipedia.org/wiki/2G)) mobile phone system. This also facilitates the wide-spread implementation of data communication applications into the system.

The GSM standard has been an advantage to both consumers, who may benefit from the ability to roam and switch carriers without replacing phones, and also to network operators, who can choose equipment from many GSM equipment vendors. GSM also pioneered low-cost implementation of the [short message service](http://en.wikipedia.org/wiki/Short_message_service) (SMS), also called text messaging, which has since been supported on other mobile phone standards as well. The standard includes a worldwide [emergency telephone number](http://en.wikipedia.org/wiki/Emergency_telephone_number) feature ([112](http://en.wikipedia.org/wiki/1-1-2)).

Newer versions of the standard were backward-compatible with the original GSM system. For example, [Release '97](http://en.wikipedia.org/wiki/3GPP#Standards) of the standard added packet data capabilities by means of [General Packet Radio Service](http://en.wikipedia.org/wiki/General_Packet_Radio_Service) (GPRS). Release '99 introduced higher speed data transmission using [Enhanced Data Rates for GSM Evolution](http://en.wikipedia.org/wiki/Enhanced_Data_Rates_for_GSM_Evolution) (EDGE).

**4.6. ZIGBEE MODULE**

Zigbee is a [specification](http://en.wikipedia.org/wiki/Specification_(technical_standard)) for a suite of high level communication protocols using small, low-power [digital radios](http://en.wikipedia.org/wiki/Digital_radio) or [Low-Rate Wireless Personal Area Networks](http://en.wikipedia.org/w/index.php?title=Low-Rate_Wireless_Personal_Area_Network&action=edit&redlink=1) (LR-WPANs), such as wireless light switches with lamps, electrical meters with in-home-displays, consumer electronics equipment via short-range radio. The technology defined by the [Zigbee specification](http://en.wikipedia.org/wiki/ZigBee_specification) is intended to be simpler and less expensive than other [WPANs](http://en.wikipedia.org/wiki/Personal_area_network#Wireless_PAN), such as [Bluetooth](http://en.wikipedia.org/wiki/Bluetooth). Zigbee is targeted at [radio-frequency](http://en.wikipedia.org/wiki/Radio_frequency) (RF) applications that require a low data rate, long battery life, and secure networking. Zigbee is a low-cost, low-power, [wireless](http://en.wikipedia.org/wiki/Wireless_mesh_network) [mesh networking](http://en.wikipedia.org/wiki/Mesh_networking) standard. First, the low cost allows the technology to be widely deployed in wireless control and monitoring applications. Second, the low power-usage allows longer life with smaller batteries. Third, the mesh networking provides high reliability and more extensive range.

It is not capable of [power line networking](http://en.wikipedia.org/wiki/Powerline_networking) though other elements of the [Open HAN](http://en.wikipedia.org/wiki/OpenHAN) standards suite promoted by [openAMI](http://en.wikipedia.org/w/index.php?title=OpenAMI&action=edit&redlink=1) and [UtilityAMI](http://en.wikipedia.org/w/index.php?title=UtilityAMI&action=edit&redlink=1) deal with communications co-extant with AC power outlets. In other words, Zigbee is intended not to support power line networking but to interface with it at least for [smart metering](http://en.wikipedia.org/wiki/Smart_meter) and [smart appliance](http://en.wikipedia.org/wiki/Smart_appliance) purposes. Utilities, e.g. Penn Energy, have declared the intent to require them to interoperate again via the [open HAN](http://en.wikipedia.org/wiki/OpenHAN) standards.

**4.7. LIQUID CRYSTAL DISPLAY**

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other. Many microcontroller devices use 'smart LCD' displays to output visual information. LCD displays designed around Hitachi's LCD HD44780 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 8x80 pixels of the display.

They have a standard ASCII set of characters and mathematical symbols. For an 8-bit data bus, the display requires a +5V supply plus 11 I/O lines. For a 4-bit data bus it only requires the supply lines plus seven extra lines. When the LCD display is not enabled, data lines are tri-state and they do not interfere with the operation of the microcontroller. Data can be placed at any location on the LCD.:

**First line**  80 81 82 83 84 85 86 through 8F

**Second line** C0 C1 C2 C3 C4 C5 C6 through CF

**SIGNALS TO THE LCD**

The LCD also requires 3 control lines from the microcontroller:

**1) Enable (E)** This line allows access to the display through R/W and RS lines. When this line is low, the LCD is disabled and ignores signals from R/W and RS. When (E) line is high, the LCD checks the state of the two control lines and responds accordingly.

**2) Read/Write (R/W)**

This line determines the direction of data between the LCD and microcontroller. When it is low, data is written to the LCD. When it is high, data is read from the LCD.

**3) Register selects (RS)**

With the help of this line, the LCD interprets the type of data on data lines. When it is low, an instruction is being written to the LCD. When it is high, a character is being written to the LCD.

**PIN DESCRIPTION**

Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins(Two pins are extra in both for back-light LED connections).



**FIGURE 4.4 Pin diagram of 2x16 LCD display**

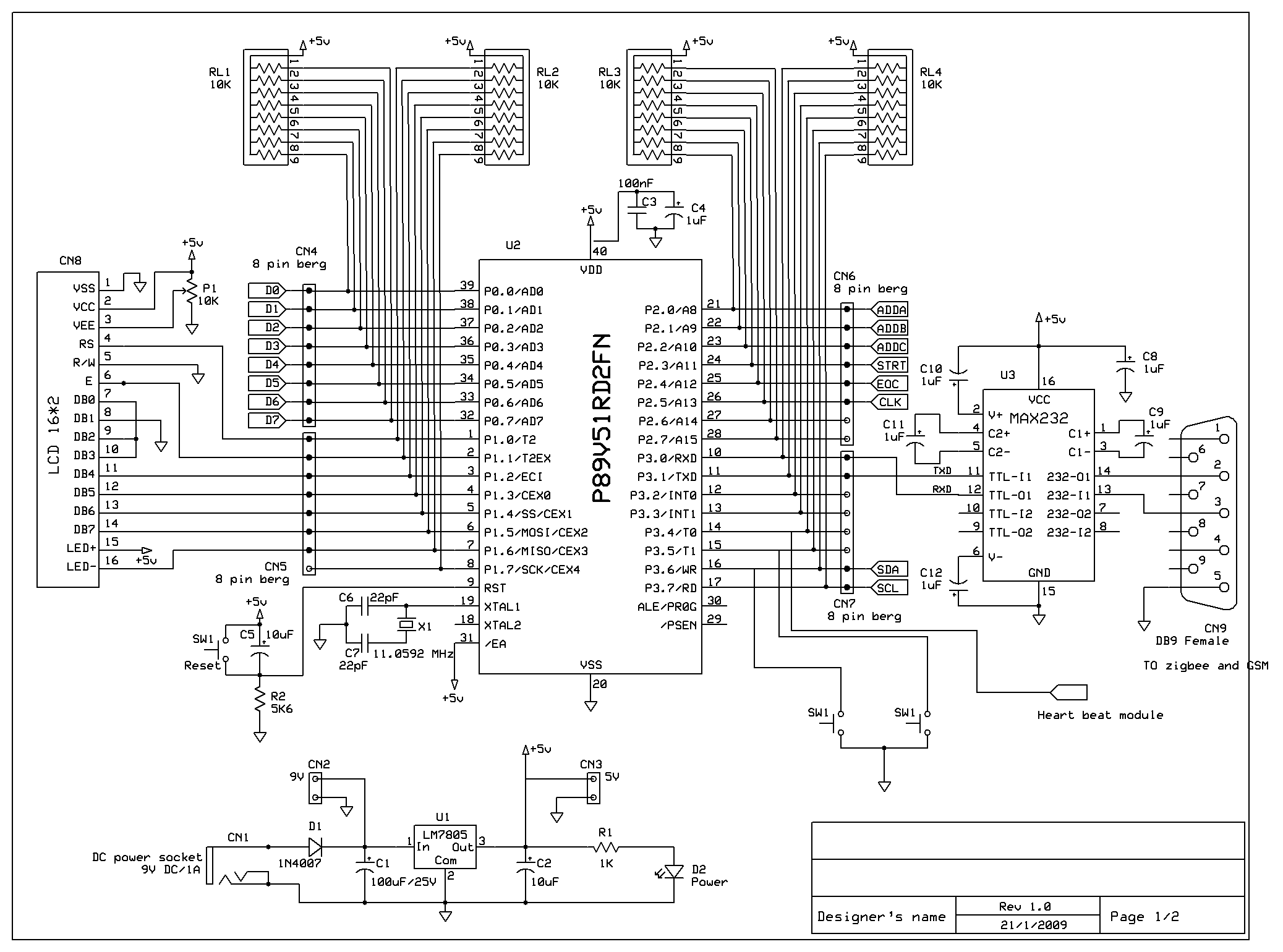


**Table .Pin description of the LCD**

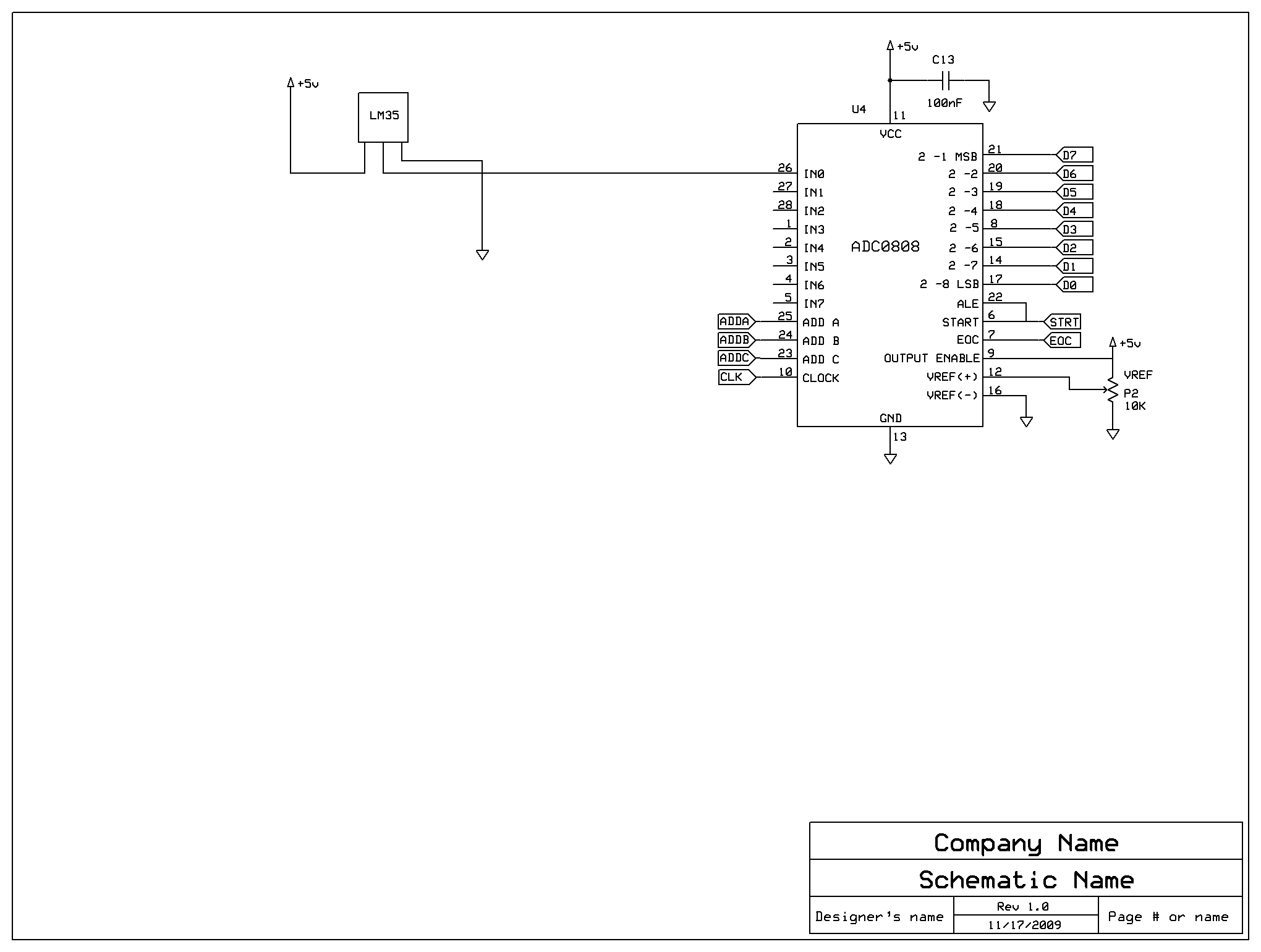
**CHAPTER-5**

**CIRCUIT DESCRIPTION**

The circuit diagram of the project consists of transmitter and receiver circuits. The transmitter circuit transmits the signals to the mobile phone and to the Zigbee receiver module. The below circuits represents the interfacing of Microcontroller to GSM, Zigbee, LCD and Heart Beat Sensor, interfacing of Microcontroller to Zigbee receiver module respectively.

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**FIGURE 5.1. Transmitter Circuit of the project**

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**FIGURE 5.2. Receiver circuit of the project**

**5.1. HEART BEAT SENSOR**

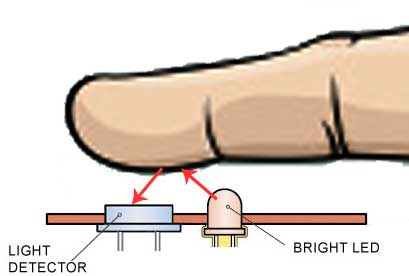
Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

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**APPLICATIONS:**

* Digital Heart Rate monitor
* Patient Monitoring System
* Bio-Feedback control of robotics and applications



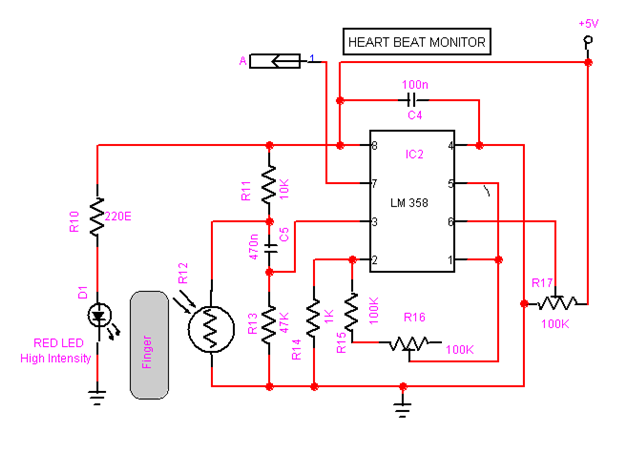
**FIGURE 5.3 Heart beat sensor**

Medical heart sensors are capable of monitoring vascular tissue through the tip of the finger or the ear lobe. It is often used for [health](http://www.ehow.com/health/) purposes, especially when monitoring the body after physical training.

Heart beat is sensed by using a high intensity type LED and LDR. The finger is placed between the LED and LDR. As Sensor a photo diode or a photo transistor can be used. The skin may be illuminated with visible (red) using transmitted or reflected light for detection. The very small changes in reflectivity or in transmittance caused by the varying blood content of human tissue are almost invisible. Various noise sources may produce disturbance signals with amplitudes equal or even higher than the amplitude of the pulse signal. Valid pulse measurement therefore requires extensive preprocessing of the raw signal.  
The new signal processing approach presented here combines analog and digital signal processing in a way that both parts can be kept simple but in combination are very effective in suppressing disturbance signals.

The setup described here uses a red LED for transmitted light illumination and a LDR as detector. With only slight changes in the preamplifier circuit the same hardware and software could be used with other illumination and detection concepts. The detectors photo current (AC Part) is converted to voltage and amplified by an operational amplifier (LM358).

Output is given to another non-inverting input of the same LM358; here the second amplification is done. The value is preset in the inverting input, the amplified value is compared with preset value if any abnormal condition occurs it will generate an interrupt to the controller AT89C2051.



**FIGURE 5.4. Heart beat Monitor Circuit**

This circuit made from an infrared phototransistor and infrared LED.  This transducer works with the principle of light reflection,in this case the light is infrared.  The skin is used as a

reflective surface for infrared light. The density of blood in the skin will affect on the IR reflectivity. The pumping action of heart causes the blood density rises and falls. So that we can calculate the heart rate based on the rise and fall of intensity of infrared that reflected by skin.

**5.2 TEMPERATURE SENSOR:**

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35’s low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies.

As it draws only 60 μA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

**FEATURES:**

* Calibrated directly in ° Celsius (Centigrade)
* Linear + 10.0 mV/°C scale factor
* 0.5°C accuracy guarantee able (at +25°C)
* Rated for full −55° to +150°C range
* Suitable for remote applications
* Low cost due to wafer-level trimming
* Operates from 4 to 30 volts
* Less than 60 μA current drain
* Low self-heating, 0.08°C in still air
* Nonlinearity only ±1⁄4°C typical
* Low impedance output, 0.1 W for 1 mA load

**PIN DIAGRAM:**

****

**FIGURE 5.5. Pin Diagram of LM35**

**APPLICATIONS**

The LM35 can be applied easily in the same way as other integrated-circuit temperature sensors. It can be glued or cemented to a surface and its temperature will be within about 0.01§C of the surface temperature.

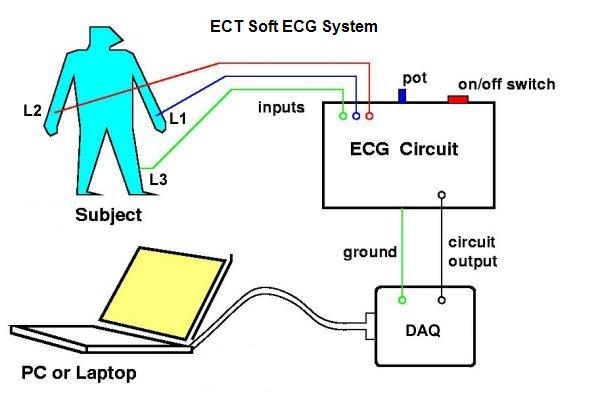
This presumes that the ambient air temperature is almost the same as the surface temperature; if the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature. This is especially true for the TO-92 plastic package, where the copper leads are the principal thermal path to carry heat into the device, so its temperature might be closer to the air temperature than to the surface temperature.

To minimize this problem, be sure that the wiring to the LM35, as it leaves the device, is held at the same temperature as the surface of interest. The easiest way to do this is to cover up these wires with a bead of epoxy which will insure that the leads and wires are all at the same temperature as the surface, and that the LM35 die's temperature will not be affected by the air temperature.

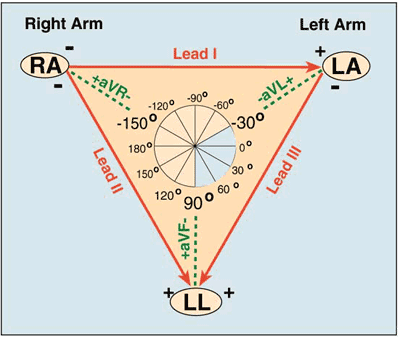
**5.3. ECG FILTER CIRCUIT**

Usually more than 2 electrodes are used and they can be combined into a number of pairs (For example: Left arm (LA), right arm (RA) and left leg (LL) electrodes form the pairs: LA+RA, LA+LL, RA+LL). The output from each pair is known as a **lead**. Each lead is said to look at the heart from a different angle. Different types of ECGs can be referred to by the number of leads that are recorded, for example 3-lead, 5-lead or 12-lead ECGs (sometimes simply "a 12-lead"). A 12-lead ECG is one in which 12 different electrical signals are recorded at approximately the same time and will often be used as a one-off recording of an ECG, typically printed out as a paper copy. 3- and 5-lead ECGs tend to be monitored continuously and viewed only on the screen of an appropriate monitoring device, for example during an operation or whilst being transported in an ambulance. There may, or may not be any permanent record of a 3- or 5-lead ECG depending on the equipment used.

It is the best way to measure and diagnose abnormal rhythms of the heart, particularly abnormal rhythms caused by damage to the conductive tissue that carries electrical signals, or abnormal rhythms caused by electrolyte imbalances. In a myocardial infarction (MI), the ECG can identify if the heart muscle has been damaged in specific areas, though not all areas of the heart are covered. The ECG cannot reliably measure the pumping ability of the heart, for which ultrasound-based (echocardiography) or nuclear medicine tests are used. It is possible to be in cardiac arrest a normal ECG signal (a condition known as pulse less electrical activity).

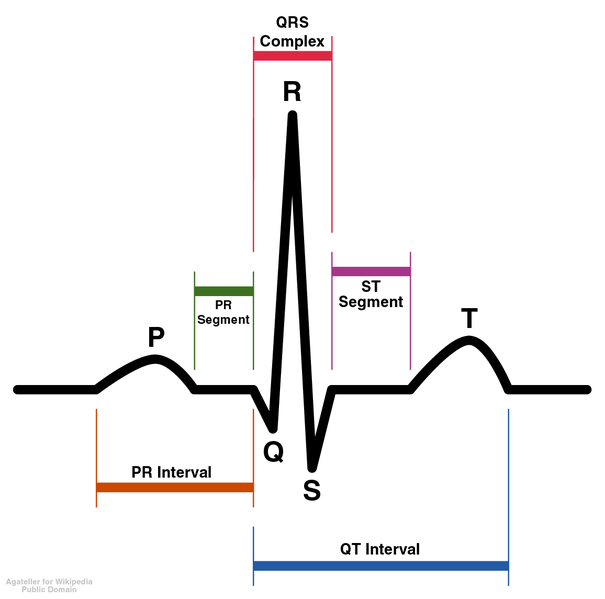


**FIGURE 5.6 ECG data acquisition and processing**

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**FIGURE 5.7 THREE LEAD CONFIGURATION**

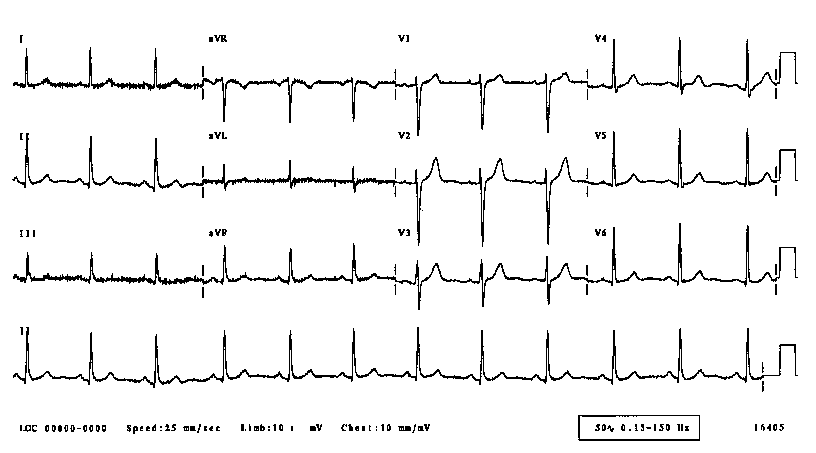
The output of an ECG recorder is a graph (or sometimes several graphs, representing each of the leads) with time represented on the x-axis and voltage represented on the y-axis. A dedicated ECG machine would usually print onto graph paper which has a background pattern of 1mm squares (often in red or green), with bold divisions every 5mm in both vertical and horizontal directions. It is possible to change the output of most ECG devices but it is standard to represent each mV on the y axis as 1 cm and each second as 25mm on the x-axis (that is a paper speed of 25mm/s). Faster paper speeds can be used - for example to resolve finer detail in the ECG. At a paper speed of 25 mm/s, one small block of ECG paper translates into 40 ms. Five small blocks make up one large block, which translates into 200 ms. Hence, there are five large blocks per second. A calibration signal may be included with a record. A standard signal of 1 mV must move the stylus vertically 1 cm, that is two large squares on ECG paper.



**FIGURE 5.8.Schematic representation of normal ECG**

|  |  |  |
| --- | --- | --- |
| **Feature** | **Description** | **Duration** |
| RR interval | The interval between an R wave and the next R wave. Normal resting heart rate is between 60 and 100 bpm | 0.6 to 1.2s |
| P wave | During normal atrial depolarization, the main electrical vector is directed from the SA node towards the AV node, and spreads from the right atrium to the left atrium. This turns into the P wave on the ECG. | 80ms |
| PR interval | The PR interval is measured from the beginning of the P wave to the beginning of the QRS complex. The PR interval reflects the time the electrical impulse takes to travel from the sinus node through the AV node and entering the ventricles. The PR interval is therefore a good estimate of AV node function. | 120 to 200ms |
| QRS complex | The QRS complex reflects the rapid depolarization of the right and left ventricles. They have a large muscle mass compared to the atria and so the QRS complex usually has a much larger amplitude than the P-wave. | 80 to 120ms |
| ST segment | The ST segment connects the QRS complex and the T wave. The ST segment represents the period when the ventricles are depolarized. It is isoelectric. | 80 to 120ms |
| T wave | The T wave represents the repolarization (or recovery) of the ventricles. The interval from the beginning of the QRS complex to the apex of the T wave is referred to as the *absolute refractory period*. The last half of the T wave is referred to as the *relative refractory period* (or vulnerable period). | 160ms |
| ST interval | The ST interval is measured from the J point to the end of the T wave. | 320ms |
| QT interval | The QT interval is measured from the beginning of the QRS complex to the end of the T wave. A prolonged QT interval is a risk factor for ventricular trachyarrhythmias and sudden death. It varies with heart rate and for clinical relevance requires a correction for this, giving the QTc. | 300 to 430 ms |

## Waves and intervals:



**FIGURE 5.9 A normal adult 12-lead ECG**

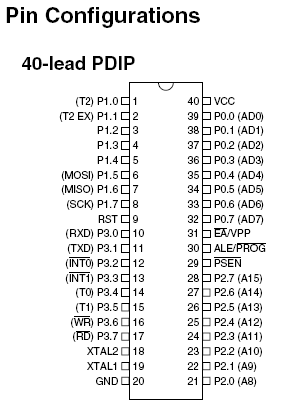
**5.4. MICROCONTROLLER 89C51RD2**

**DESCRIPTION:**

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 8Kbytes of Flash programmable and erasable read only memory (PEROM). The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Philips AT89C51 is a powerful microcomputer, which provides a highly flexible and cost-effective solution to many embedded control applications.

. By the mid-1980s, most of the previously external system components had been integrated into the same chip as the processor, resulting in integrated circuits called microcontrollers, and widespread use of embedded systems became feasible.

* Product specification.
* Partitioning of the design into its software and hardware components.
* Iteration and refinement of partitioning.
* Independent hardware and software design tasks
* Integration of hardware and software components.
* Product testing and release.



**FIGURE 5.10: Pin Diagram of AT89C51**

**PIN DESCRIPTION:**

**VCC -** Supply voltage.

**GND - Ground.**

**Port 0:**

Port 0 is an 8-bit open drain bi-directional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high. Impedance inputs. Port 0 can also be configured to be the multiplexed low-order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups. Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pull-ups are required during program verification.

**Port 1:**

Port 1 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. In addition, P1.0 and P1.1 can be configured to be the timer/counter 2 external count input (P1.0/T2) and the timer/counter 2 trigger input (P1.1/T2EX), respectively.

**PORT PIN ALTERNATE FUNCTIONS:**

**P1.0 T2** (external count input to Timer/Counter 2), clock-out

**P1.1 T2EX** (Timer/Counter 2 capture/reload trigger and direction control

**Port 2:**

Port 2 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 2output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being

pulled low will source current (I IL) because of the internal pull-ups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that uses 16-bit addresses (MOVX @ DPTR). In this application, Port 2 uses strong internal pull-ups when emitting 1s. During accesses to external data memory that uses 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register. Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

**Port 3:**

Port 3 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (I IL) because of the pull-ups. Port 3 also serves the functions of various special features of the AT89C51. Port 3 also receives some control signals for Flash programming and verification.

**PORT PIN ALTERNATE FUNCTIONS:**

P3.0 RXD (serial input port)

P3.1 TXD (serial output port)

P3.2 INT0 (external interrupt 0)

P3.3 INT1 (external interrupt 1)

P3.4 T0 (timer 0 external input)

P3.5 T1 (timer 1 external input)

P3.6 WR (external data memory write strobe)

P3.7 RD (external data memory read strobe).

**RST:** Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

**ALE/PROG:**

Address Latch Enable is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during flash programming. In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. However, that one ALE pulse is skipped during each access to external data memory. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

**PSEN:**

Program Store Enable is the read strobe to external program memory. When the AT89C51 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

**EA/VPP:**

External Access Enable (EA) must be strapped to GND in order to enable the device to fetch code from external pro-gram memory locations starting at 0000H up to FFFFH. However, if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions. This pin also receives the 12V programming enable voltage (VPP) during Flash programming when 12V programming is selected.

**XTAL1:**

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

**XTAL2:**

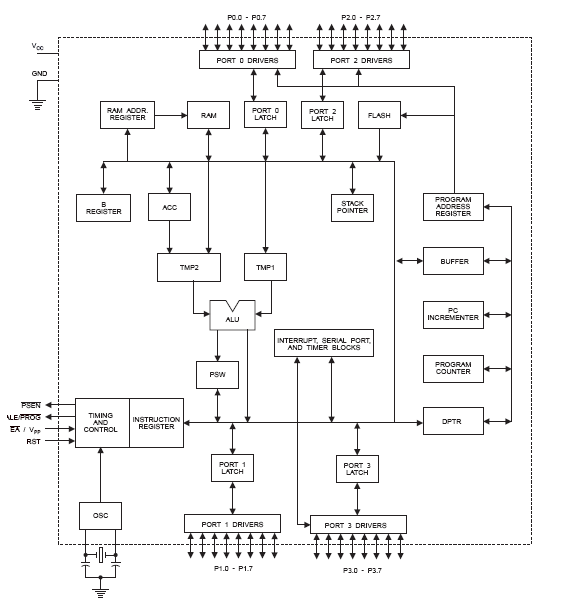
It is an output from the inverting oscillator amplifier.

**BLOCK DIAGRAM OF 89C51**



**FIGURE 5.11: Block Diagram of AT89C51**

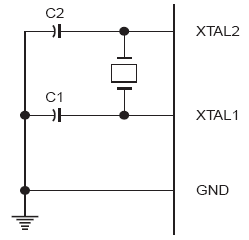
**ARCHITECTURE OF 89C51**



**FIGURE 5.12: Architecture of AT89C51**

**OSCILLATOR CHARACTERISTICS:**

XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier, which can be configured for use as an on-chip oscillator. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven. There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage high and low time specifications must be observed.

 **FIGURE 5.9: FIGURE 5.13 Oscillator Connections**

**Note:** C1, C2 = 30 pF ± 10 pF for Crystals

= 40 pF ± 10 pF for Ceramic Resonators

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**Table 4.1: Port 3 pin alternate function**

**5.5 ANALOG TO DIGITAL CONVERTER (ADC)**

**General Description**

The ADC0808, ADC0809 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter,8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register. The 8-channel multiplexer can

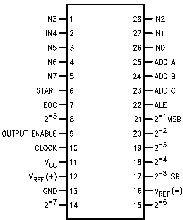
directly access any of 8-single-ended analog signals.

**Features**

* Easy interface to all microprocessors
* Operates ratiometrically or with 5 VDC or analog span
* adjusted voltage reference
* No zero or full-scale adjust required
* 8-channel multiplexer with address logic
* 0V to 5V input range with single 5V power supply
* Outputs meet TTL voltage level specifications
* ADC0808 equivalent to MM74C949
* ADC0809 equivalent to MM74C949-1

**Key Specifications**

* n Resolution 8 Bits
* n Total Unadjusted Error ±1⁄2 LSB and ±1 LSB
* n Single Supply 5 VDC
* n Low Power 15 mW
* nConversion Time 100 μs



**FIGURE 5.14.PIN DIAGRAM OF ADC 0808**

**5.6. UART**

Communicating withoutusing a UART saves hardware, but it can be demanding of processor time. Avoiding serial interface hardware makes sense only for low-cost applications that are not making heavy demands on the processor; otherwise, the processor will be tied up in

fairly rapid, time-critical activities. Use this approach only when you must minimize hardware cost and still have a serial interface.If you are communicating only between nearby devices, consider generating a separately clocked serial protocol like SPI or I2C. Both protocols are compatible with standard 5V ports. Since microcontroller port pins put out only logic levels, for RS-232 you would need a driver chip, although you could use the protocol with TTL levels between two agreeing devices.

**5.7. GSM MODEM**

**[](http://en.wikipedia.org/wiki/File:Deutsches_Museum_-_GSM_cell_site_antennas.jpg)**

**FIGURE 5.15. GSM** [**cell site**](http://en.wikipedia.org/wiki/Cell_site) **antennas in the** [**Detaches Museum**](http://en.wikipedia.org/wiki/Deutsches_Museum)**,** [**Munich**](http://en.wikipedia.org/wiki/Munich)**,** [**Germany**](http://en.wikipedia.org/wiki/Germany)



**FIGURE5.16. GSM modem with accessories**

|  |  |  |
| --- | --- | --- |
|  | **TECHNICAL DETAILS**  GSM is a [cellular network](http://en.wikipedia.org/wiki/Cellular_network), which means that [mobile phones](http://en.wikipedia.org/wiki/Mobile_phone) connect to it by searching for cells in the immediate vicinity. There are five different cell sizes in a GSM network—[macro](http://en.wikipedia.org/wiki/Macrocell), [micro](http://en.wikipedia.org/wiki/Microcell), [Pico](http://en.wikipedia.org/wiki/Picocell), [femto](http://en.wikipedia.org/wiki/Femtocell) and [umbrella cells](http://en.wikipedia.org/w/index.php?title=Umbrella_cells&action=edit&redlink=1). The coverage area of each cell varies according to the implementation environment. Macro cells can be regarded as cells where the [base station](http://en.wikipedia.org/wiki/Base_station) [antenna](http://en.wikipedia.org/wiki/Antenna_(electronics)) is installed on a mast or a building above average roof top level. Micro cells are cells whose antenna height is under average roof top level; they are typically used in urban areas. Pico cells are small cells whose coverage diameter is a few dozen meters; they are mainly used indoors. Femto cells are cells designed for use in residential or small business environments and connect to the service provider’s network via a broadband internet connection. Umbrella cells are used to cover shadowed regions of smaller cells and fill in gaps in coverage between those cells.  **GSM CARRIER FREQUENCIES**  GSM networks operate in a number of different carrier frequency ranges (separated into [GSM frequency ranges](http://en.wikipedia.org/wiki/GSM_frequency_ranges) for 2G and [UMTS frequency bands](http://en.wikipedia.org/wiki/UMTS_frequency_bands) for 3G), with most [2G](http://en.wikipedia.org/wiki/2G) GSM networks operating in the 900 MHz or 1800 MHz bands. Where these bands were already allocated, the 850 MHz and 1900 MHz bands were used instead (for example in [Canada](http://en.wikipedia.org/wiki/Canada) and the [United States](http://en.wikipedia.org/wiki/United_States)). In rare cases the 400 and 450 MHz frequency bands are assigned in some countries because they were previously used for first-generation systems.  Most [3G](http://en.wikipedia.org/wiki/3G) networks in Europe operate in the 2100 MHz frequency band. Regardless of the frequency selected by an operator, it is divided into [timeslots](http://en.wikipedia.org/wiki/Time_division_multiplexing) for individual phones to use. This allows eight full-rate or sixteen half-rate speech channels per [radio frequency](http://en.wikipedia.org/wiki/Radio_frequency). These eight radio timeslots (or eight [burst](http://en.wikipedia.org/wiki/Burst_transmission) periods) are grouped into a [TDMA](http://en.wikipedia.org/wiki/Time_division_multiple_access) frame. Half rate channels use alternate frames in the same timeslot. The channel data rate for all 8 channels is 270.833 Kbit/s, and the frame duration is 4.615 ms. The transmission power in the handset is limited to a maximum of 2 watts in GSM850/900 and 1 watt in GSM1800/1900.  **NETWORK STRUCTURE**  [http://upload.wikimedia.org/wikipedia/commons/thumb/d/d1/Gsm_structures.svg/405px-Gsm_structures.svg.png](http://en.wikipedia.org/wiki/File:Gsm_structures.svg)  **FIGURE 5.17. The structure of a GSM network**  **The network is structured into a number of discrete sections:**   * The [Base Station Subsystem](http://en.wikipedia.org/wiki/Base_Station_Subsystem) (the [base stations](http://en.wikipedia.org/wiki/Base_station) and their controllers). * the [Network and Switching Subsystem](http://en.wikipedia.org/wiki/Network_and_Switching_Subsystem) (the part of the network most similar to a fixed network). This is sometimes also just called the core network. * The [GPRS Core Network](http://en.wikipedia.org/wiki/GPRS_Core_Network) (the optional part which allows packet based Internet connections). * The [Operations support system](http://en.wikipedia.org/wiki/Operations_support_system) (OSS) for maintenance of the network.   **SUBSCRIBER IDENTITY MODULE**  One of the key features of GSM is the [Subscriber Identity Module](http://en.wikipedia.org/wiki/Subscriber_Identity_Module), commonly known as a SIM card. The SIM is a detachable [smart card](http://en.wikipedia.org/wiki/Smart_card) containing the user's subscription information and phone book. This allows the user to retain his or her information after switching handsets. Alternatively, the user can also change operators while retaining the handset simply by changing the SIM. Some operators will block this by allowing the phone to use only a single SIM, or only a SIM issued by them; this practice is known as [SIM locking](http://en.wikipedia.org/wiki/SIM_lock).  **5.8. ZIGBEE MODULE**  Zigbee is a [specification](http://en.wikipedia.org/wiki/Specification_(technical_standard)) for a suite of high level communication protocols using small, low-power [digital radios](http://en.wikipedia.org/wiki/Digital_radio) or [Low-Rate Wireless Personal Area Networks](http://en.wikipedia.org/w/index.php?title=Low-Rate_Wireless_Personal_Area_Network&action=edit&redlink=1) (LR-WPANs), such as wireless light switches with lamps, electrical meters with in-home-displays, consumer electronics equipment via short-range radio. The technology defined by the [Zigbee specification](http://en.wikipedia.org/wiki/ZigBee_specification) is intended to be simpler and less expensive than other [WPANs](http://en.wikipedia.org/wiki/Personal_area_network#Wireless_PAN), such as [Bluetooth](http://en.wikipedia.org/wiki/Bluetooth). Zigbee is targeted at [radio-frequency](http://en.wikipedia.org/wiki/Radio_frequency) (RF) applications that require a low data rate, long battery life, and secure networking.Zigbee is a low-cost, low-power, [wireless](http://en.wikipedia.org/wiki/Wireless_mesh_network) [mesh networking](http://en.wikipedia.org/wiki/Mesh_networking) standard. First, the low cost allows the technology to be widely deployed in wireless control and monitoring applications. Second, the low power-usage allows longer life with smaller batteries. Third, the mesh networking provides high reliability and more extensive range..  The relationship between [IEEE 802.15.4](http://en.wikipedia.org/wiki/IEEE_802.15.4) and Zigbee is similar to that between [IEEE 802.11](http://en.wikipedia.org/wiki/IEEE_802.11) and the [Wi-Fi Alliance](http://en.wikipedia.org/wiki/Wi-Fi_Alliance). The Zigbee 1.0 specification was ratified on 14 December 2004 and is available to members of the Zigbee Alliance. Most recently, the Zigbee 2007 specification was posted on 30 October 2007. The first Zigbee Application Profile, Home Automation, was announced 2 November 2007. As amended by [NIST](http://en.wikipedia.org/wiki/NIST), the Smart Energy Profile 2.0 specification will remove the dependency on IEEE 802.15.4. Device manufacturers will be able to implement any MAC/PHY, such as [IEEE 802.15.4](http://en.wikipedia.org/wiki/IEEE_802.15.4)(x) and [IEEE P1901](http://en.wikipedia.org/wiki/IEEE_P1901), under an IP layer based on [6LoWPAN](http://en.wikipedia.org/wiki/6LoWPAN).  Zigbee operates in the industrial, scientific and medical ([ISM](http://en.wikipedia.org/wiki/ISM_band)) radio bands; 868 MHz in Europe, 915 MHz in the USA and Australia, and 2.4 GHz in most jurisdictions worldwide. The [technology](http://en.wikipedia.org/wiki/Technology) is intended to be simpler and less expensive than other [WPANs](http://en.wikipedia.org/wiki/Personal_area_network) such as [Bluetooth](http://en.wikipedia.org/wiki/Bluetooth). Zigbee chip vendors typically sell integrated radios and microcontrollers with between 60 KB and 256 KB flash memory..  Radios are also available as stand-alone components to be used with any processor or microcontroller. Generally, the chip vendors also offer the Zigbee software stack, although independent ones are also available.  Because Zigbee can activate (go from sleep to active mode) in 30 msec or less, the latency can be very low and devices can be very responsive — particularly compared to Bluetooth wake-up delays, which are typically around three seconds. [[3]](http://en.wikipedia.org/wiki/ZigBee#cite_note-2) Because Zigbees can sleep most of the time, average power consumption can be very low, resulting in long battery life.  **LICENSING**  For non-commercial purposes, the Zigbee specification is available free to the general public. An entry level membership in the Zigbee Alliance, called Adopter, provides access to the as-yet unpublished specifications and permission to create products for market using the specifications. The click through license on the Zigbee specification requires a commercial developer to join the Zigbee Alliance. "No part of this specification may be used in development of a product for sale without becoming a member of Zigbee Alliance." This causes problems for open-source developers because the annual fee conflicts with the [GNU General Public License](http://en.wikipedia.org/wiki/GNU_General_Public_License)  **USES**  Zigbee protocols are intended for use in embedded applications requiring low [data rates](http://en.wikipedia.org/wiki/Data_rate) and low [power consumption](http://en.wikipedia.org/wiki/Power_consumption). Zigbee's current focus is to define a general-purpose, inexpensive, self-organizing [mesh network](http://en.wikipedia.org/wiki/Mesh_network) that can be used for industrial control, embedded sensing, medical data collection, smoke and intruder warning, building automation, [home automation](http://en.wikipedia.org/wiki/Home_automation), etc. The resulting network will use very small amounts of power — individual devices must have a battery life of at least two years to pass Zigbee certification.  **Typical application areas include**   * Home Entertainment and Control — Smart lighting, advanced temperature control, safety and security, movies and music * Wireless Sensor Networks' — starting with individual sensors like Telosb/Tmote, Memsic.   **PROTOCOLS**  The protocols build on recent algorithmic research ([Ad-hoc On-demand Distance Vector](http://en.wikipedia.org/wiki/AODV), [neuRFon](http://en.wikipedia.org/wiki/NeuRFon)) to automatically construct a low-speed ad-hoc network of nodes. In most large network instances, the network will be a cluster of clusters. It can also form a mesh or a single cluster. The current profiles derived from the Zigbee protocols support beacon and non-beacon enabled networks.In non-beacon-enabled networks (those whose beacon order is 15), an unslotted [CSMA/CA](http://en.wikipedia.org/wiki/CSMA/CA) channel access mechanism is used. In this type of network, Zigbee Routers typically have their receivers continuously active, requiring a more robust power supply.  However, this allows for heterogeneous networks in which some devices receive continuously, while others only transmit when an external stimulus is detected. The typical example of a heterogeneous network is a [wireless light switch](http://en.wikipedia.org/wiki/Wireless_light_switch): The Zigbee node at the lamp may receive constantly, since it is connected to the mains supply, while a battery-powered light switch would remain asleep until the switch is thrown. The switch then wakes up, sends a command to the lamp, receives an acknowledgment, and returns to sleep. In such a network the lamp node will be at least a Zigbee Router, if not the Zigbee Coordinator; the switch node is typically a Zigbee End Device.  In beacon-enabled networks, the special network nodes called Zigbee Routers transmit periodic beacons to confirm their presence to other network nodes. Nodes may sleep between beacons, thus lowering their [duty cycle](http://en.wikipedia.org/wiki/Duty_cycle) and extending their battery life. Beacon intervals may range from 15.36 milliseconds to 15.36 ms \* 214 = 251.65824 seconds at 250 [kbit/s](http://en.wikipedia.org/wiki/Kbit/s), from 24 milliseconds to 24 ms \* 214 = 393.216 seconds at 40 kbit/s and from 48 milliseconds to 48 ms \* 214 = 786.432 seconds at 20 kbit/s. However, low duty cycle operation with long beacon intervals requires precise timing, which can conflict with the need for low product cost.  **SOFTWARE AND HARDWARE**  The software is designed to be easy to develop on small, inexpensive microprocessors. The radio design used by Zigbee has been carefully optimized for low cost in large scale production. It has few [analog](http://en.wikipedia.org/wiki/Analog_circuit) stages and uses [digital circuits](http://en.wikipedia.org/wiki/Digital_circuit) wherever possible.  Even though the radios themselves are inexpensive, the Zigbee Qualification Process involves a full validation of the requirements of the physical layer. This amount of concern about the Physical Layer has multiple benefits, since all radios derived from that semiconductor mask set would enjoy the same RF characteristics. On the other hand, an uncertified physical layer that malfunctions could cripple the battery lifespan of other devices on a Zigbee network. Where other protocols can mask poor sensitivity or other esoteric problems in a fade compensation response, Zigbee radios have very tight engineering constraints: they are both power and bandwidth constrained. Thus, radios are tested to the [ISO 17025](http://en.wikipedia.org/wiki/ISO_17025) standard with guidance given by Clause 6 of the [802.15.4](http://en.wikipedia.org/wiki/802.15.4)-2006 Standard. Most vendors plan to integrate the radio and microcontroller onto a single chip getting smaller devices.  **ZIGBEE MODULE INTERFACING WITH 8089C51 MICROCONTROLLER**  http://www.8051projects.info/upload/Image/Interface_ckt.BMP  **FIGURE 5.18. Interfacing of Microcontroller with Zigbee**    **CHAPTER-6**  **SOFTWARE EXPLANATION**  **6.1 INTRODUCTION:**  Many companies provide the 8051 assembler, some of them provide shareware version of their product on the Web, Kiel is one of them. We can download them from their Websites. However, the size of code for these shareware versions is limited and we have to consider which assembler is suitable for our application.  **6.2 KEIL U VISION3:**  Thisis an IDE (Integrated Development Environment) that helps you write, compile, and debug embedded programs. It encapsulates the following components:   * A project manager * A make facility * Tool configuration * Editor * A powerful debugger   **BUILDING AN APPLICATION IN UVISION3:**  To build (compile, assemble, and link) an application in uVision2, you must:   * Select Project–Open Project   (For example, **\C166\EXAMPLES\HELLO\HELLO.UV3**)   * Select Project - Rebuild all target files or Build target. UVision2 compiles, assembles, and links the files in your project.   **CREATING YOUR OWN APPLICATION IN UVISION3:**  To create a new project in uVision2, you must:   * Select Project - New Project. * Select a directory and enter the name of the project file. * Select Project - Select Device and select an 8051, 251, or C16x/ST10 device from the Device * Database * Create source files to add to the project. * Select Project - Targets, Groups, and Files. Add/Files, select Source Group1, and add the source file to the project. * Select Project - Options and set the tool options. Note when you select the target device from the Device Database all-special options are set automatically. You only need to configure memory map of your target hardware. Default memory model settings are optimal for most. * Select Project - Rebuild all target files or Build target.   **DEBUGGING AN APPLICATION IN U VISION3:**  To debug an application created using uVision3, you must:   * Select Debug - Start/Stop Debug Session. * Use the Step toolbar buttons to single-step through your program. You may enter G, main in the Output Window to execute to the main C function. * Open the Serial Window using the Serial #1 button on the toolbar. * Debug your program using standard options like Step, Go, Break, and so on.   **LIMITATIONS OF EVALUATION SOFTWARE:**  There are several very important limitations in the evaluation version of Keil’s Developer's Kit that users need be aware of when writing software for the 8051.  **OBJECT CODE MUST BE LESS THAN 2 KBYTES:**  The compiler will compile any-sized source code file, but the final object code may not exceed 2 Kbytes. If it does, the linker will refuse to create a final binary executable (or HEX file) from it. Along the same lines, the debugger will refuse any files that are over 2Kbytes, even if they were compiled using a different software package.  Few student projects will cross this 2Kbyte threshold, but programmers should be aware of it to understand why code may no longer compile when the project grows too large.  **PROGRAM CODE STARTS AT ADDRESS 0X4000:**  All C code compiled and linked using the Keil tools will begin at address 0x4000 in code memory. Such code may not be programmed into devices with less than 16Kbytes of Read-Only Memory. Code written in assembly may circumvent this limitation by using the "origin" keyword to set the start to address 0x0000. No such work-around exists for C programs, though. However, the integrated debugger in the evaluation software may still be used for testing code. Once tested, the code may be compiled by the full version of the Keil software, or by another compiler that supports the C extensions used by Keil.  The following limitations apply to the evaluation versions of the C51, C251, or C166 tool chains. C51 Evaluation Software Limitations:   * The compiler, assembler, linker, and debugger are limited to 2 Kbytes of object code but source Code may be any size. Programs that generate more than 2 Kbytes of object code will not compile, assemble, or link the startup code generated includes LJMP's and cannot be used in single-chip devices supporting Less than 2 Kbytes of program space like the Philips 750/751/752. * The debugger supports files that are 2 Kbytes and smaller. * Programs begin at offset 0x0800 and cannot be programmed into single-chip devices. * No hardware support is available for multiple DPTR registers. * No support is available for user libraries or floating-point arithmetic.   **PERIPHERAL SIMULATION:**  The u vision3 debugger provides complete simulation for the CPU and on chip peripherals of most embedded devices. To discover which peripherals of a device are supported, in u vision3. Select the Simulated Peripherals item from the Help menu. You may also use the web-based device database. We are constantly adding new devices and simulation support for on-chip peripherals so be sure to check Device Database often.  **6.3 CODES USED IN THIS PROJECT**  **Code for microcontroller**  #include<REG51.h>  #include<LCD.h>  #include<UART.h>  #include<ADC.h>  #include<GSM.h>  #include<string.h>  #define EOM 0X1A  extern char S\_VAL[4];  sbit KEY1= P3^2;  sbit KEY2= P3^3;  sbit REL1= P3^4;  void main()  {  unsigned int i,j,DATA1,DATA2;  unsigned char TX\_DATA[10],TMP[4],HBT[4];  REL1=0;  REL1=0;  LCD\_INIT();  UART\_INIT();  DIS\_LCD("PATIENT MONTORNG");  REL1=1;  DELAY(250);  INIT\_GSM\_SMS();  REL1=0;  LCD\_CMD(0xC0);  DIS\_LCD(" SYSTEM");  DELAY(500);DELAY(500);  while(1)  {  LCD\_CMD(0x01);  DATA1=ADC(0);  DATA1=DATA1\*1.8;  CONVERT\_DAT(DATA1);  for(i=0;i<3;i++)  {  TX\_DATA[i]= S\_VAL[i];  }  TX\_DATA[i]='\*';  strcpy(TMP,S\_VAL);  DIS\_LCD("BODY TMP : ");  LCD\_CMD(0x8A);  DIS\_LCD(S\_VAL);  DATA2=ADC(1);  CONVERT\_DAT(DATA2);  j=4;  for(i=0;i<3;i++)  {  TX\_DATA[j]= S\_VAL[i];  j++;  }  TX\_DATA[j]='\0';  strcpy(HBT,S\_VAL);  LCD\_CMD(0xC0);  DIS\_LCD("HEART BT :");  LCD\_CMD(0xCA);  DIS\_LCD(S\_VAL);  if(DATA2>80)  {  LCD\_CMD(0x80);  DIS\_LCD("CALL THE DOCTOR");  if(KEY1==0)  {  REL1=1;  DELAY(250);  CALL();  REL1=0;  DELAY(250);  }  }  if(DATA2<70)  {  LCD\_CMD(0x80);  DIS\_LCD("CALL THE DOCTOR");  if(KEY1==0)  {  REL1=1;  DELAY(250);  CALL();  REL1=0;  DELAY(250);  }  }  if(KEY2==0)  {  REL1=1;  DELAY(250);  TR1=1;  SEND\_SMS();  SEND\_STRING\_UART("BODY TEMP: ");  SEND\_STRING\_UART(TMP);  SEND\_STRING\_UART("HEART BEAT: ");  SEND\_STRING\_UART(HBT);  SEND\_CRLF(EOM);  REL1=0;  DELAY(250);  }  DELAY(500);  SEND\_STRING\_UART(TX\_DATA);  }  }  **Code for LCD display**  #include<reg51.h>  #include<LCD.h>  unsigned char CMD\_ARRAY[]={0x20,0x28,0x28,0x0e,0x00,0x01,0x00,0x06,0x00,0x80},X;  void LCD\_INIT()  {  for(X=0;X<9;X++)  {  LCD\_CMD(CMD\_ARRAY[X]);  }  }  void LCD\_CMD(unsigned int CMD)  {  unsigned int CMD1,j=0;    CMD1=((CMD&0xf0)>>2);  P1=CMD1;  RS=0;  EN=1;  EN=0;  CMD1=((CMD&0x0f)<<2);  P1=CMD1;  RS=0;  EN=1;    EN=0;  DELAY(1);  // for(j=0;j<5;j++);  }  void DIS\_LCD(unsigned char \*dat)  {  unsigned char i;  for(i=0;\*dat!='\0';i++)  {  unsigned int dta1;  if(i==16)  LCD\_CMD(0xc0); //stepping to 2nd line  if(i>=16)  LCD\_CMD(0x06); //to increment the cursor  dta1=((\*dat&0xf0)>>2);  P1=dta1;  RS=1;  EN=1;  DELAY(10);  EN=0;  dta1=((\*dat&0x0f)<<2);  P1=dta1;  RS=1;  EN=1;  DELAY(10);  EN=0;  DELAY(10);  dat++;  }  }  void DELAY(unsigned int n)  {  unsigned int i,j;  for(i=0;i<=n;i++)  for(j=0;j<=100;j++);  }  **Code for ADC:**  #include<ADC.h>  #include<REG51.h>  #include<LCD.h>  sbit a=P2^0; // channel select bits  sbit b=P2^1;  sbit c=P2^2;  sbit SC=P2^3; // start of conversion  sbit EOC=P2^4; // end of conversion  //sbit OE=P3^5;  sfr adcdata=0x80;  sbit CLOCK=P2^5;//for adc  unsigned char S\_VAL[4];  unsigned int ADC(unsigned int AD)  {  unsigned int value;  TH0|=0XD2; //timer settings(time period 100 micro sec)  IE=0X82; // intrpt enable  TR0=1;  EOC=1;  // OE=0;  SC=0;  a=AD;  b=0;  c=0;  DELAY(50);  SC=1;  DELAY(50);  SC=0;  while(EOC==1);  while(EOC==0);  // OE=1;  DELAY(50);  value=adcdata;  // OE=0;  return(value);  }  void timer(void) interrupt 1  {  CLOCK = ~CLOCK;  }  void CONVERT\_DAT(unsigned int hex)  {  unsigned int msb1=0,msb2=0,lsb0=0;  S\_VAL[0]='\0';S\_VAL[1]='\0';S\_VAL[2]='\0';  while(hex>=100)  {  hex=hex-100;  msb1++;  }  while(hex>=10)  {  hex=hex-10;  msb2++;  }  lsb0=hex;    msb1=msb1+0x30;  msb2=msb2+0x30;  lsb0=lsb0+0x30;    S\_VAL[0]=msb1;  S\_VAL[1]=msb2;  S\_VAL[2]=lsb0;  S\_VAL[4]='\0';  }  **Code for GSM:**  #include<GSM.h>  #include<REG51.h>  #define CR 0X0D  #define LF 0X0D  unsigned char code CMD\_6[]="AT+CMGS=\"9739461441\"";  unsigned char code CMD\_7[]="AT+VGT=45";  unsigned char code CMD\_8[]="ATD+919739461441;";  unsigned char ASD;  void INIT\_GSM\_SMS()  {    unsigned char code CMD\_1[]="AT";  unsigned char code CMD\_2[]="ATE0";  // unsigned char code CMD\_3[]="AT&W";  unsigned char code CMD\_4[]="AT+CMGF=1";  unsigned char code CMD\_5[]="AT+CNMI=2,2,0,0,0";    SEND\_CMD(CMD\_1,2);  while((ASD=RECIEV\_MSG())!='K');    SEND\_CMD(CMD\_2,4);  while((ASD=RECIEV\_MSG())!='K');  SEND\_CMD(CMD\_4,9);  while((ASD=RECIEV\_MSG())!='K');  SEND\_CMD(CMD\_5,17);  while((ASD=RECIEV\_MSG())!='K');  // RECIEV\_MSG();  // RECIEV\_MSG();  }  void SEND\_CMD(unsigned char \*BASE\_ADD,unsigned char COUNT)  {  unsigned char I;  for(I=0;I<COUNT;I++)  {  SBUF=\*BASE\_ADD;  while(TI==0);  TI=0;  BASE\_ADD++;  }  SEND\_CRLF(CR);  SEND\_CRLF(LF);  }  void SEND\_CRLF(unsigned char b)  {  SBUF=b;  while(TI==0);  TI=0;  }  unsigned char RECIEV\_MSG()  {  unsigned char MESSAGE;  RI=0;  while(RI==0);  MESSAGE=SBUF;  return(MESSAGE);  }  void SEND\_SMS()  {  SEND\_CMD(CMD\_6,21);  // while((ASD=RECIEV\_MSG())!='>');  }  void CALL()  {  //SEND\_CMD(CMD\_7,9);  SEND\_CMD(CMD\_8,17);  }  **6.4 SCOPE SOFTWARE**  This software can be used for the display and analysis of sound waves. The data can be recorded both directly from the sound card (with a microphone or LINE input), or from a source such as a CD or Mediaplayer. The input to the oscilloscope is defined by the Windows sound mixer . The software obtains its input data for the sound card via the Windows interface. It does not communicate directly with the sound card. Therefore sound card problems should be troubleshot at the operating system level.  The user interface is arranged like a conventional oscilloscope. However, in the program window, additional XY display, frequency analysis, and settings are provided.  **Oscilloscope:**  **FIGURE 6.1 Sound card oscilloscope**    The software shows the left and right channel of the sound card in the oscilloscope window. The left channel is represented as a green line and the right channel as a red line. In the user interface window there are knobs and input windows for the following three functions: Amplitude, Time, and Trigger.  In this project we used this software to represent ECG wave forms which are acquired from ecg filter circuit..this will be displayed in Doctors computer. when ECG is acquired it sends to doctors mobile using GSM network. The doctor mobile handset is connected to PC.there the doctor can analyses the ECG waveforms    **CHAPTER-7**  **ADVANTAGES AND LIMITATIONS**  **ADVANTAGES:**   * Zigbee technology enables doctor to monitor the patients conditions even sitting in his room . * Doctor will get call when patients body temperature and heart beat rises so that he can take precautionary .measures even though he will be in remote place. * Patient care takers can monitor the equipment easily.   **LIMITATIONS:**   * Bitter Expensive. * Accumulation of noise with ECG signal. * Communication for longer distance is quite difficult through Zigbee technology * Interference of noise in GSM modem due to high Radio frequency signals. * Accuracy will be less.   **CHAPTER-8**  **FUTURE SCOPE**  Monitoring the patient’s condition can be done by using biomedical telemetry method where there is a mobile communication between microcontrollers. The temperature, heart beat and blood pressure are all sensed by using the appropriate sensors which are placed near the patient’s body that is under investigation. The biomedical telemetry system consists of temperature sensor, heart beat sensor, pressure sensor, A/D converter, signal conditioning circuit, microcontroller, data cable, mobile phone, LCD display. The temperature sensor is used to sense the temperature value of the patient’s body.  The sensed output is given to A/D converter where the analog signal is converted to digital signal. The digital output is given to microcontroller. The microcontroller delivers the signal for mobile phone through data cable. Then the signal is transmitted to other mobile through GSM network. The receiver mobile receives the signal and it is given for a PC. The signal from data cable is given to PC and the value gets displayed using monitor. The pressure sensor is used to sense the pressure value of the patient’s body .The sensed output is given to A/D converter where the analog signal is converted to digital signal. The digital output is given to microcontroller.  The microcontroller delivers the signal for mobile phone through data cable. Then the signal is transmitted to other mobile through GSM network. The receiver mobile receives the signal and it is given for a PC. The signal from data cable is given to PC and the value gets displayed using monitor. Heart beat can be sensed by using heart beat sensor which is then given to a signal conditioning circuit. This unit delivers a train of pulses to microcontroller and the value gets displayed using LCD display.    **CHAPTER-9**  **CONCLUSION**  We presented the design and implementation of a Remote Patient Monitoring system based on wireless technology using a cellular phone, to send an SMS (Short Message Service) to the medical staff. The proposed system combines two commonly used technologies namely, Global System for Mobile (GSM) and Zigbee technology. This indeed is an easy, practical, inexpensive and yet very effective way for transmitting vital information to the healthcare staff and healthcare providers.  The system monitors patient's health status, such as ECG, heart rate, and temperature. In case, the value for any of these parameters exceeds preset critical values, the position parameters, from the attached GPS module, are transmitted to pre-defined phone number in form of SMS using a GSM module.  All the information obtained from the human body from sensors and ECG filter circuit is then transmitted to the microcontroller system as digital values. The values obtained from like ECG, heart rate and temperature is also displayed on to the attached LCD in alphanumerical form. In the conclusion we consider how this system can be further improved in future, may be by adding new type of sensors as well as using new approaches for the security and triggering alarm. |  |
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