PROJECT REPORT ON

HEART RTAE MEASUREMENT USING FINGERTIP

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Submitted in partial fulfillment of the Degree of

Bachelor of Technology

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CERTIFICATE

This is to certify that the work titled "HEART RATE MONITOR USING FINGERTIP" submitted by "ROHINI THAKUR (ROLL NO. 101356)" in partial fulfillment for the award of degree of Bachelor of Technology in Computer Science Engineering of Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

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Date	15TH May 2010

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I would like to thank many people who have helped me directly or indirectly in the successful completion of the project. I would like to thank one and all from the core of my heart.

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Signature

Rohini Thakur

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SUMMARY

This project describes the design of a simple, low-cost microcontroller based heart rate measuring device which shows an LCD output. Heart rate measurement is one of the most important part of the human cardiovascular system. The average heart rate of a healthy person at rest is around 72 beats per minute (bpm). Heart rate measurement is an important diagnostic tool because it reflects the state of mind and physical condition of a particular person. So, I am trying to make a project which will be an indication of how healthy the body is, by measuring and monitoring the heart beat.

The objective of the project is to develop heart rate monitor and then interface it with the computer system for measuring the heartbeat using finger using microcontroller and optical sensors.

Heart rate is measured from the finger by placing the thumb in between the LDR and LED and the rate is then averaged and displayed on a text based LCD.

CHAPTER 1- INTROUCTION

This project demonstrates a technique to measure the heartbeat while the heart is pumping the blood by sensing the change in blood volume in a finger artery. This project consists of an infrared LED that transmits an IR signal through the fingertip of the subject, and these signals are reflected by the blood cells. These reflected signals are detected by a photo diode sensor.

In this, infrared LED transmits an IR signal through the fingertip. 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.

Therefore, a two-stage high gain, active low pass filter is designed using two Operational Amplifiers to filter and amplify the signal to appropriate voltage level so that the pulses can be counted by a microcontroller. The heart rate is displayed on display using LCD.

Current medical techniques for measuring the heart rate and other vital signs use electrodes attached to the body, which are impractical for patients who want to move around. This technique creates a problem especially in the rural areas where we do not have the required infrastructure and commuting to the nearest hospital or primary health centre is a daunting task.

Keeping in mind the difficulties faced by people, we have designed a system which is portable, can be effectively and efficiently used without the need of a doctor in close proximity. It also saves the important time of both the patient and the doctor.

The project has been divided into various chapters giving a detailed description of the project's components and also for a better understanding of the project working. This has been supplemented by the images and the interfacing programs between the various components used in this project.

In the end I have drawn a conclusion to the project giving its future scope. Additional information related to the project has been given in the appendices. I have also mentioned the references and literature reviews which provide me great help for successful completion of the project.

1.1 LITERATURE RIVIEW

The following papers were used as reference in making this project.

- Low cost computer based Heart Rate Monitoring System using fingertip.

By Miah, M.A.R.; Dept. of Electr. & Electron. Eng., Bangladesh Univ. of Eng. & Technol., Dhaka, Bangladesh Basks, S.; Huda, M.R.; Roy, A. Informatics, Electronics & Vision published in 2013

Heart rate of a human body can be measured considering the change of blood volume in fingertip using microcontroller based methods. In this paper, a low cost and portable method is proposed and implemented to measure heart rate from fingertip using the microphone port of a computer. The method detects the volume change of blood by an optical sensor based on infrared technology. The noisy output signal from the sensor is stripped out of unwanted components with the help of a hardware level active low pass filter. After interfacing through the microphone port, this signal is processed at software level to measure and monitor real time heart rate. The accuracy, noise suppression, and cost effectiveness of this method make it a suitable candidate for a low cost computer based heart monitoring system which can study and detect heart diseases like sleep arrhythmia.

- Design and development of a heart rate measuring device using fingertip.

By Hashem , M.M.A. Dept. of Comput. Sci. & Eng., Khulna Univ. of Eng. & Technol. (KUET), Khulna, Bangladesh ; Shams, R. ;Kader, M.A. ; Sayed, M.A. published in 2010.

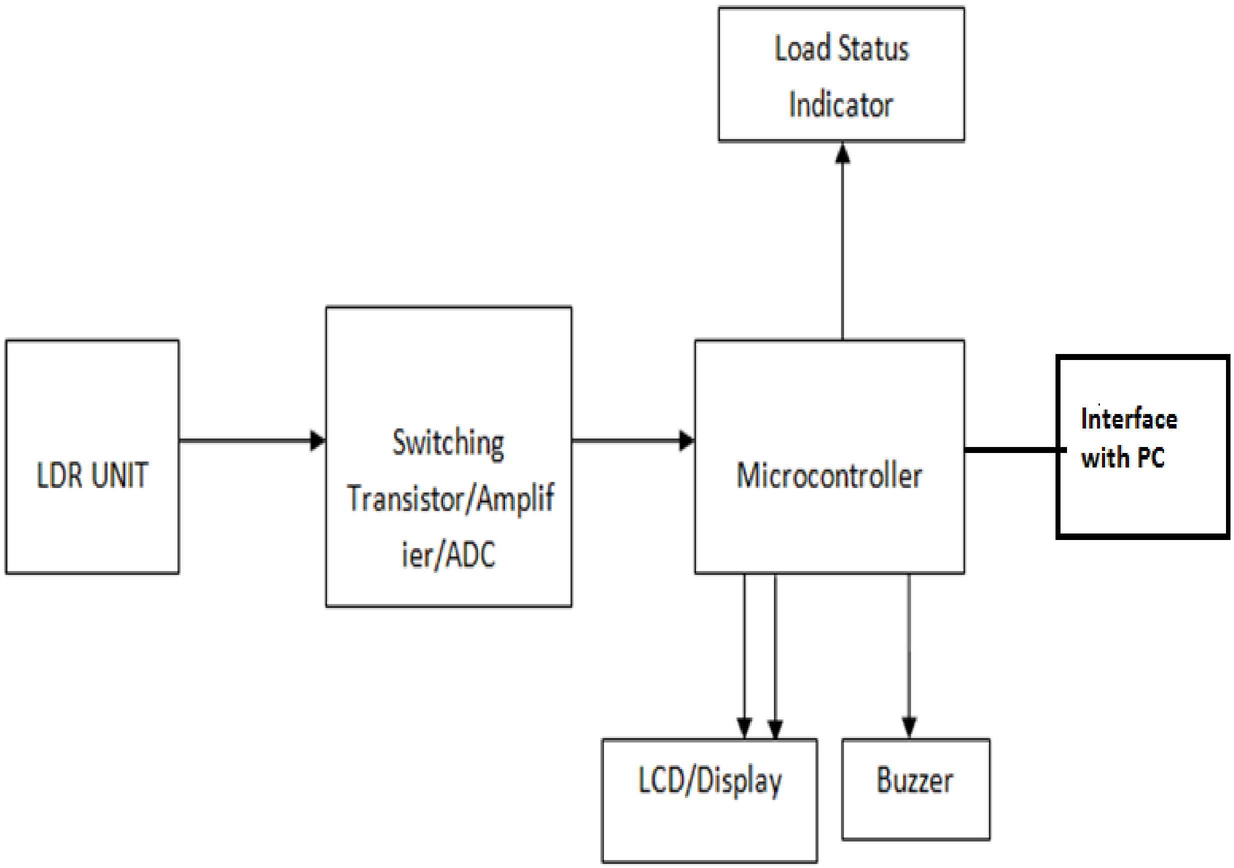
In this paper, we presented the design and development of a new integrated device for measuring heart rate using fingertip to improve estimating the heart rate. As heart related diseases are increasing day by day, the need for an accurate and affordable heart rate measuring device or heart monitor is essential to ensure quality of health. However, most heart rate measuring tools and environments are expensive and do not follow ergonomics. Our proposed Heart Rate Measuring (HRM) device is economical and user friendly and uses optical technology to detect the flow of blood through index finger. Three phases are used to detect pulses on the fingertip that include pulse detection, signal extraction, and pulse amplification. Qualitative and quantitative performance evaluation of the device on real signals shows accuracy in heart rate estimation, even under intense of physical activity. We compared the performance of HRM device with Electrocardiogram reports and manual pulse measurement of heartbeat of 90 human subjects of different ages. The results showed that the error rate of the device is negligible.

- Microcontroller Based Heart Rate Monitor using Fingertip Sensors

BY Sharief F. Babiker, Liena Elrayah Abdel-Khair, Samah M. Elbasheer

The important feature of this research is the use of Discrete Fourier Transforms to analyze the ECG signal in order to measure the heart rate giving result that Heart Rate Measuring (HRM) device is economical and user friendly.

CHAPTER 2- BLOCKS DIAGRAM



2.1 DESCRIPTION

The block diagram of the measurement device is shown in the above Figure . The block diagram basically consists of 2 operational amplifiers, a low-pass filter, a microcontroller, and an LCD. The first amplifier is set for a gain of just over 100, while the gain of the second amplifier is around 560. During the laboratory trials it was found necessary to use a low pass filter in the circuit to filter out any unwanted high frequency noise from nearby equipment. The cut-off frequency of the filter was chosen as 2Hz. The output time response of the amplifier and filter circuit which consists of pulses. An LED, connected to the output of the operational amplifiers flashes as the pulses are received and amplified by the circuit.

In the above diagram, the LDR unit that is Light Dependent Resistor is connected to the ADC convertor which will convert the analog voltage to the digital, and then amplified version is connected to the pin of the Atmega 8 microcontroller.

The output of the amplifier and filter circuit was fed to one of the digital inputs of a atmega8 type microcontroller. In order to reduce the cost of the circuit the microcontroller is operated from a 4MHz resonator. The microcontroller output ports drive the LCD

- The circuit consists of two identical active low pass filters with a Cut-off frequency of about 2.5 Hz.
- The operational amplifier IC, a dual OpAmp chip operates at a single power supply .

The two stage amplifier/filter provides sufficient gain to boost the weak signal coming from the photo sensor unit and convert it into a pulse.

- An LED connected at the output blinks every time a heart beat is Detected.
- The output from the signal conditioner goes to the input of microcontroller

- The microcontroller activates the IR transmission in the sensor unit for 15 sec.
- During this interval, the number of pulses arriving at the input is counted.
- The actual heart rate would be 4 times the count value, and the resolution of measurement would be 4.

CHAPTER 3- HARDWARE DESCRIPTION

There are a number of components in this module and they are following:

1. Micro controller-ATmegha8
2. A/D Converter
3. Temperature sensor-LM358
4. LCD Display
5. Buzzer
6. Reset switch
7. LDR
8. LED
9. 10K SIP
10. Potentiometer-50K
11. Transistors-BC547
12. Capacitors
13. Resistors
14. Voltage regulator
15. 5v DC supply

3.1 - MICROCONTROLLER

MICROCONTROLLER

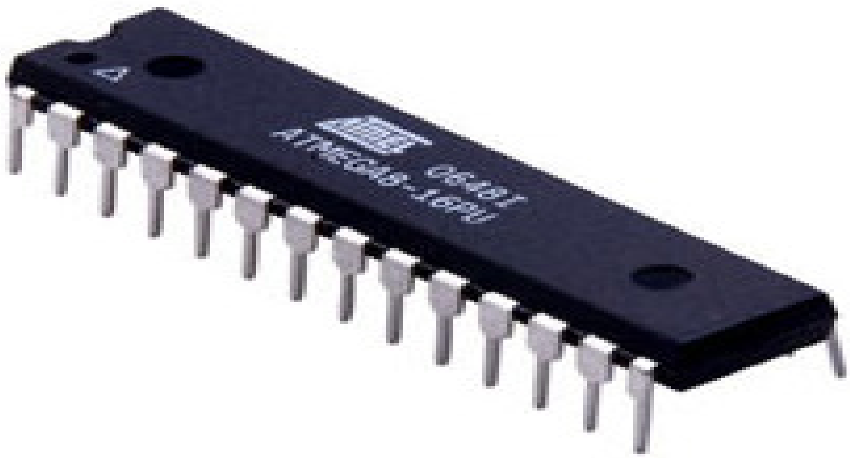


Fig:- Atmega8 Microcontroller

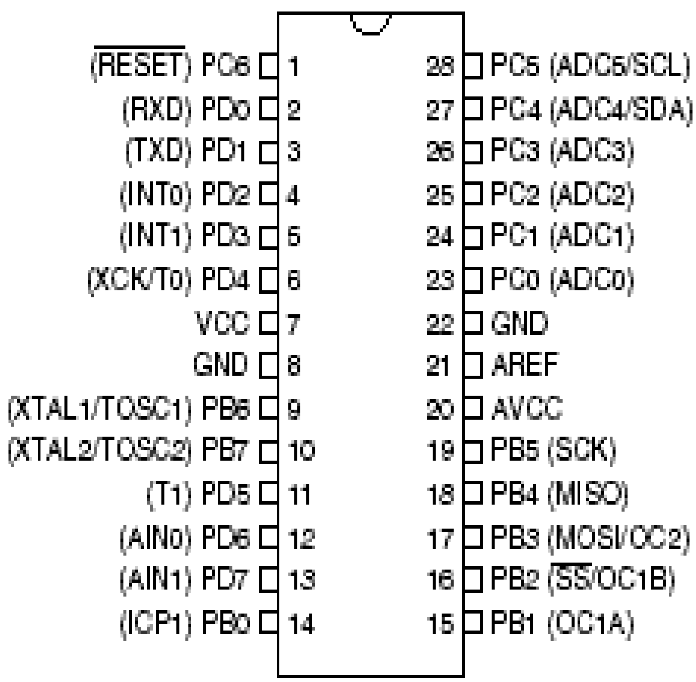
A Microcontroller is single integrated circuit and contains a processor core, memory, and programmable input/output peripherals. Neither programs memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for the embedded applications, as compared to the microprocessors used in personal computers or other general purpose applications.

Microcontrollers are used in the products and devices which are automatically controlled, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other controlled embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non digital electronic systems.

AVR FAMILY

The AVR is a modified Harvard architecture 8-bit RISC single chip microcontroller which was made by Atmel in 1996. The AVR was one of the first microcontroller families to use on chip flash memory for program storage, as opposed to one-time programmable ROM, EPROM, or EEPROM used by other microcontrollers at the time.

Atmega8



Features

• High-performance, Low-power AVR® 8-bit Microcontroller

• Advanced RISC Architecture

– 130 Powerful Instructions – Most Single-clock Cycle Execution

– 32 x 8 General Purpose Working Registers

– Fully Static Operation

– Up to 16 MIPS Throughput at 16 MHz

– On-chip 2-cycle Multiplier

• High Endurance Non-volatile Memory segments

– 8K Bytes of In-System Self-programmable Flash program memory

– 512 Bytes EEPROM

– 1K Byte Internal SRAM

– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM

– Data retention: 20 years at 85°C/100 years at 25°C(1)

– Optional Boot Code Section with Independent Lock Bits

In-System Programming by On-chip Boot Program

True Read-While-Write Operation

– Programming Lock for Software Security

• Peripheral Features

– Two 8-bit Timer/Counters with Separate Prescaler, one Compare Mode

– One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture

Mode

– Real Time Counter with Separate Oscillator

– Three PWM Channels

– 8-channel ADC in TQFP and QFN/MLF package

Eight Channels 10-bit Accuracy

– 6-channel ADC in PDIP package

Six Channels 10-bit Accuracy

– Byte-oriented Two-wire Serial Interface

– Programmable Serial USART

– Master/Slave SPI Serial Interface

– Programmable Watchdog Timer with Separate On-chip Oscillator

– On-chip Analog Comparator

• Special Microcontroller Features

– Power-on Reset and Programmable Brown-out Detection

– Internal Calibrated RC Oscillator

– External and Internal Interrupt Sources

– Five Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, and Standby

• I/O and Packages

– 23 Programmable I/O Lines

– 28-lead PDIP, 32-lead TQFP, and 32-pad QFN/MLF

• Operating Voltages

– 2.7 – 5.5V (ATmega8L)

– 4.5 – 5.5V (ATmega8)

• Speed Grades

– 0 – 8 MHz (ATmega8L)

– 0 – 16 MHz (ATmega8)

• Power Consumption at 4 Mhz, 3V, 25°C

– Active: 3.6 mA

– Idle Mode: 1.0 mA

– Power-down Mode: 0.5 µA

Atmega8, which is an 8-bit high performance microcontroller of Atmel Mega AVR family have low power consumption. It is based on enhanced RISC (Reduced Instruction Set Computing) architecture with 131 powerful instructions.

Atmega8 consists of 28 pin microcontroller. Atmega8 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripheral.

3.1.1 A/D CONVERTER

The ADC families are 8-Bits, successive approximation. A/D converters which use a modified potentiometer ladder and are designed to operate with the 8080A control bus via three-state outputs. These converters appear to the processor as memory locations or I/O ports, and hence no interfacing logic is required. The differential analog voltage input has good common mode - rejection and permits offsetting the analog zero-input voltage value. In addition, the voltage reference input can be adjusted to allow encoding any smaller analog voltage span to the full 8 bits of resolution.

Absolute Maximum Ratings Thermal Information

Supply Voltage: 6.5V

Voltage at Any Input: -0.3V to (V+ +0.3V)

Operating Conditions

Temperature Range: 0 C to 70 C

Thermal Resistance (Typical, Note 1) _JA (oC/W)

3.2- LCD (Liquid Crystal Display)

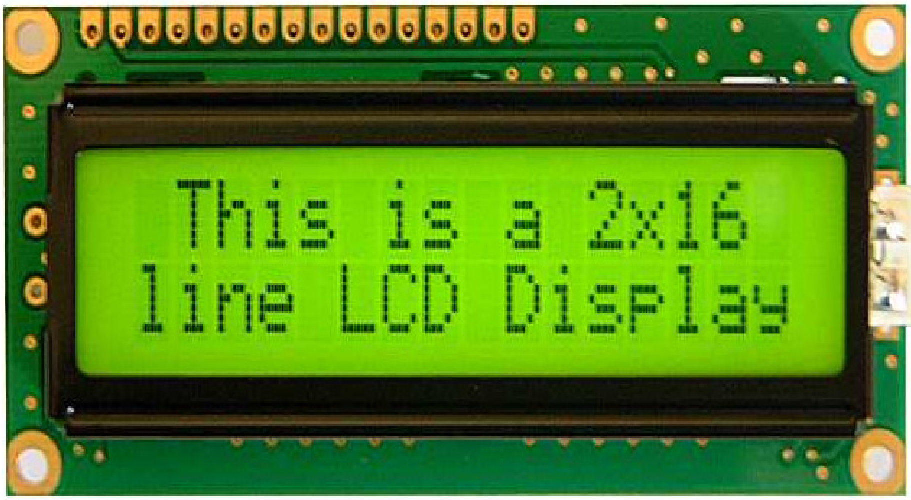


Fig :- 16*2 LCD

LCD known as Liquid Crystal Display uses the light modulating properties of liquid crystals. LCD displays is made up of two sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid which causes the crystals to get aligned so that light cannot pass through them. Each crystal, therefore, is like a shutter, either allowing light to pass through or blocking the light.

An LCD monitor consists of five different layers: a backlight, a sheet of polarized glass, a "mask" of pixels, a layer of liquid crystal solution responsive to a wired grid of x, y coordinates, and a second polarized sheet of glass. By manipulating the orientations and directions of crystals through precise electrical charges of changing degrees and voltages, the crystals act like tiny shutters, opening or closing in response to the stimulus, thereby allowing degrees of light that have passed through specific colored pixels to illuminate the screen, creating a picture.

Each pixel of an LCD mainly consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters, the axes of transmission of which are (in most of the cases) perpendicular to each other. With no actual liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer.

The surfaces of the electrodes that are in contact with the liquid crystal material are treated so as to align the liquid crystal molecules in a particular direction. This treatment typically consists of a thin polymer layer that is unidirectional rubbed using, for example, a cloth. The direction of the liquid crystal alignment is then defined by the direction of rubbing. Electrodes are made of a transparent conductor called Indium (ITO). The Liquid Crystal Display is intrinsically a passive device; it is a simple light valve. The managing and control of the data to be displayed is performed by one or more circuits commonly denoted as LCD drivers.

Before applying an electric field, the orientation of the liquid crystal molecules is determined by the alignment at the surfaces of electrodes. In a twisted nematic device (still the most common liquid crystal device), the surface alignment directions at the two electrodes are perpendicular to each other, and so the molecules arrange themselves in a helical structure, or twist. This reduces the rotation of the polarization of the incident light, and the device appears grey. If the applied voltage is large enough, the liquid crystal molecules in the center of the layer are almost completely untwisted and the polarization of the incident light is not rotated as it passes through the liquid crystal layer. This light will then be mainly polarized perpendicular to the second filter, and thus be blocked and the pixel will appear black. By controlling the voltage applied across the liquid crystal layer in each pixel, light can be allowed to pass through in varying amounts thus constituting different levels of gray.

The optical effect of a twisted nematic device in the voltage-on state is far less dependent on variations in the device thickness than that in the voltage-off state. Because of this, these devices are usually operated between crossed polarizer such that they appear bright with no voltage (the eye is much more sensitive to variations in the dark state than the bright state). These devices can also be operated between parallel polarizes, in which case the bright and dark states are reversed. The voltage-off dark state in this configuration appears blotchy, however, because of small variations of thickness across the device.

Both the liquid crystal material and the alignment layer material contain ionic compounds. If an electric field of one particular polarity is applied for a long period of time, this ionic material is attracted to the surfaces and degrades the device performance. This is avoided either by applying an alternating current or by reversing the polarity of the electric field as the device is addressed.

TYPES OF LCD

There are mainly two types of LCD. They are as follows:-

- Passive Display
- Active display

Passive Display- Passive displays are widely used with segmented digits and characters for small readouts in devices such as calculators, fax machines and remote controls, most of which are monochrome or have only a few colors.

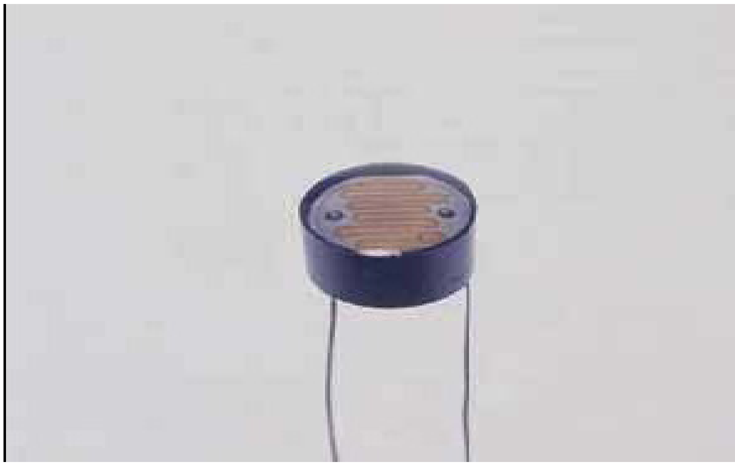
Active Display- Used in all LCD TVs and desktop computer monitors and 99.9% of all laptops, active displays are essentially "active matrix" displays and almost always color. The reason for the 99.9% is that OLED is emerging.

CHARACTERISTICS OF LCD

Here by 16*2 we mean that there are 16 characters can be displayed in one line and 2 means there are 2 lines in our display.

- 5 x 8 dots with cursor
- Built-in controller (KS 0066 or Equivalent)
- + 5V power supply (Also available for + 3V)
- 1/16 duty cycle
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED) N.V. optional for + 3V power supply

3.3 -LDR (Light Dependent Resistor)



A photo resistor or light dependent resistor or cadmium sulfide (CdS) cell is a resistor whose resistance decreases with increasing incident light intensity. It can also be referred to as a photoconductor photo resistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance

Light Dependent Resistor is a component that is sensitive to light. When light falls upon it then the resistance changes. Values change as the level of light increases.

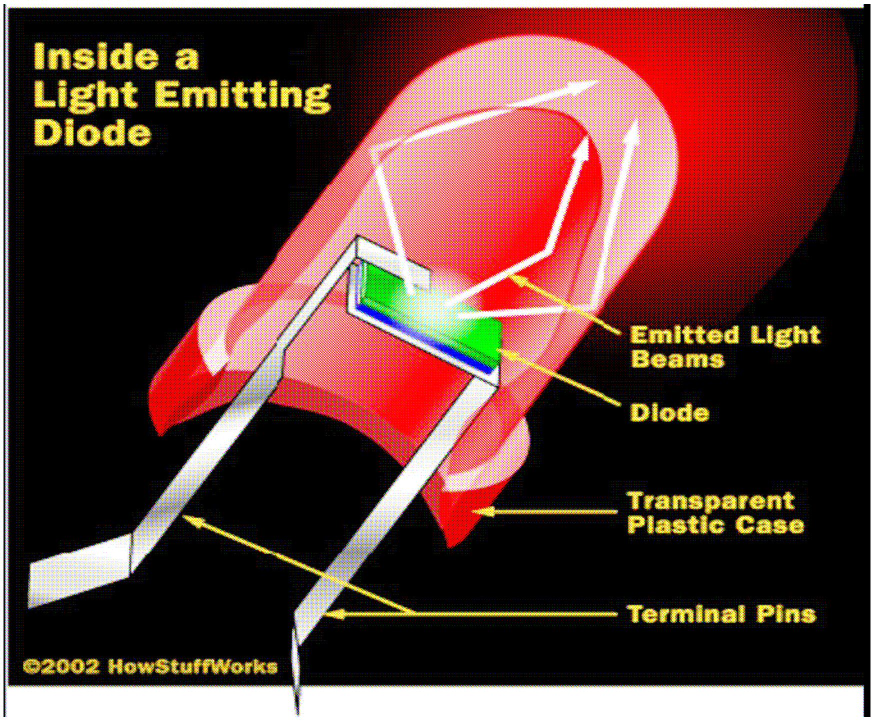
A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, e.g. silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire band gap.

Extrinsic devices have impurities, also called do pants, and added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (i.e., longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor.

Photo resistors come in many different types. Inexpensive cadmium sulfide cells can be found in many consumer items such as camera light meters, street lights, clock radios, alarms, and outdoor clocks.

They are also used in some dynamic compressors together with a small incandescent lamp or light emitting diode to control gain reduction.
Lead sulfide (PbS) and indium antimonide (InSb) LDRs (light dependent resistor) are used for the mid infrared spectral region.
Transducers are used for changing energy types.

3.4 - LED (Light Emitting Diode)



Light emitting diode is a semi conductor light source. Led's are used as a indicator lamps in many devices.

Introduced as a practical electronic component in 1962, early LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet and infrared wavelengths, with very high brightness. When a light-emitting diode is forward biased (switched on), electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor.

An LED is usually small in area (less than 1 mm2), and integrated optical components are used to shape its radiation pattern and assist in reflection.[3] LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved robustness, smaller size, faster switching, and greater durability and reliability.

LEDs powerful enough for room lighting are relatively expensive and require more precise current and heat management than compact fluorescent lamp sources of comparable output.

Light-emitting diodes are used in applications as diverse as replacements for aviation lighting, automotive lighting (particularly indicators) and in traffic signals. The compact size of LEDs has allowed new text and video displays and sensors to be developed, while their high switching rates are useful in advanced communications technology.

Infrared LEDs are also used in the remote control units of many commercial products including televisions, DVD players, and other domestic appliances.

3.5- SENSOR

Features of heart beat sensor

Heat beat indication by LED Instant output digital signal for directly connecting to microcontroller, compact size ,works on +5v dc supply ,Connect regulated DC power supply of 5 Volts. Black wire is Ground, Next middle wire is Brown which is output and Red wire is positive supply. These wires are also marked on PCB .to test sensor we only need power the sensor by connect two wires +5V and GND. we can leave the output wire as it is. When Beat LED is off the output is at 0V.Put finger on the marked position, and we can view the beat LED blinking on each heartbeat. The output is active high for each beat and can be given directly to microcontroller for Interfacing applications.

The sensor consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in finger and detected by detector. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This signal is amplified and triggered through an amplifier which outputs +5V logic level signal. The output signal is also indicated by a LED which blinks on each heart beat

A sensor which is also known as detector is a convertor that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. For example, a mercury in -glass thermometer the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube. A thermocouple converts temperature to an output voltage which can be read by a voltmeter. For accuracy, most sensors are calibrated against known standards.

Sensors are used in everyday objects such as touch-sensitive elevator button (tactile sensor) and lamps which dim or brighten by touching the base. There are also various innumerable applications for sensors of which most people are never aware. Applications include cars, machines, aerospace, medicine, manufacturing and robotics.

A sensor is a device which receives and responds to a signal when touched. A sensor's sensitivity indicates how much the sensor's output changes when the measured quantity changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature change (it is basically the slope Dy/Dx assuming a linear characteristic). Sensors that measure very small changes must have very high sensitivities. Sensors also have an impact on what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors need to be designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages. Technological progress allows more and more sensors to be manufactured on a microscopic scale as micro-sensors. In most cases, a micro sensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches.

A good sensor obeys the following rules:

- Is sensitive to the measured property only
- Is insensitive to any other property likely to be encountered in its application
- Does not influence the measured property

Ideal sensors are designed to be linear or linear to some simple mathematical function of the measurement, typically logarithmic. The output signal of such a sensor is linearly proportional to the value or simple function of the measured property. The sensitivity is then defined as the ratio between output signal and measured property. For example, if a sensor measures temperature and has a voltage output, the sensitivity is a constant with the unit, this sensor is linear because the ratio is constant at all points of measurement

.Passive sensors detect the reflected or emitted electro-magnetic radiation from natural sources, while active sensors detect reflected responses from objects which are irradiated from artificially generated energy sources, such as radar. Each is divided further in to non-scanning and scanning systems.

A sensor classified as a combination of passive, non-scanning and non-imaging method is a type of profile recorder, for example a microwave radiometer. A sensor classified as passive, non-scanning and imaging method, is a camera, such as an aerial survey camera or a space camera, for example on board the Russian COSMOS satellite.

Sensors classified as a combination of passive, scanning and imaging are classified further into image plane scanning sensors, such as TV cameras and solid state scanners, and object plane scanning sensors, such as multispectral scanners (optical-mechanical scanner) and scanning microwave radiometers.

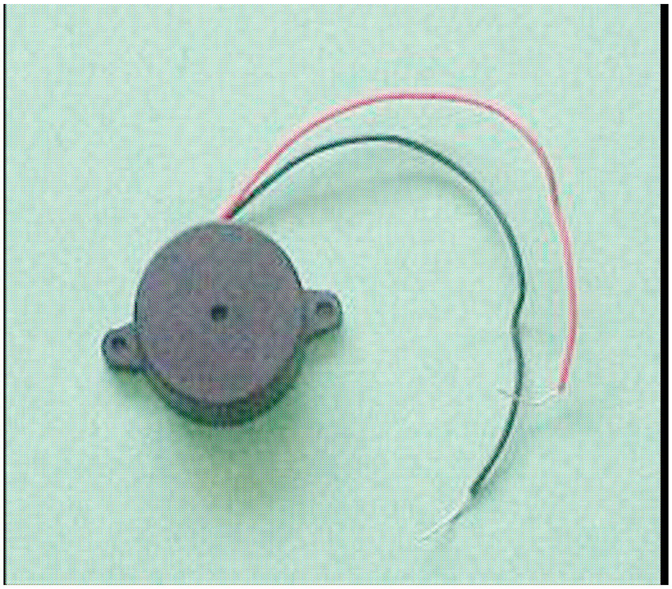
An example of an active, non-scanning and non-imaging sensor is a profile recorder such as a laser spectrometer and laser altimeter. An active, scanning and imaging sensor is a radar, for example synthetic aperture radar (SAR), which can produce high resolution, imagery, day or night, even under cloud cover.

The most popular sensors used in remote sensing are the camera, solid state scanner, such as the CCD (charge coupled device) images, the multi-spectral scanner and in the future the passive synthetic aperture radar.

Laser sensors have recently begun to be used more frequently for monitoring air pollution by laser spectrometers and for measurement of distance by laser altimeters.

Those sensors which use lenses in the visible and reflective infrared region, are called optical sensors.

3.6 - BUZZER:



A **buzzer** or **beeper** is an audio signaling device, which may be mechanical, electromechanical, or electronic. Typical uses of buzzers and beepers include alarms, timers and confirmation of user input such as a mouse click or keystroke.

A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep. Electronic buzzers find many applications in modern days.

CHAPTER 4 – SOFTWARE COMPONENTS

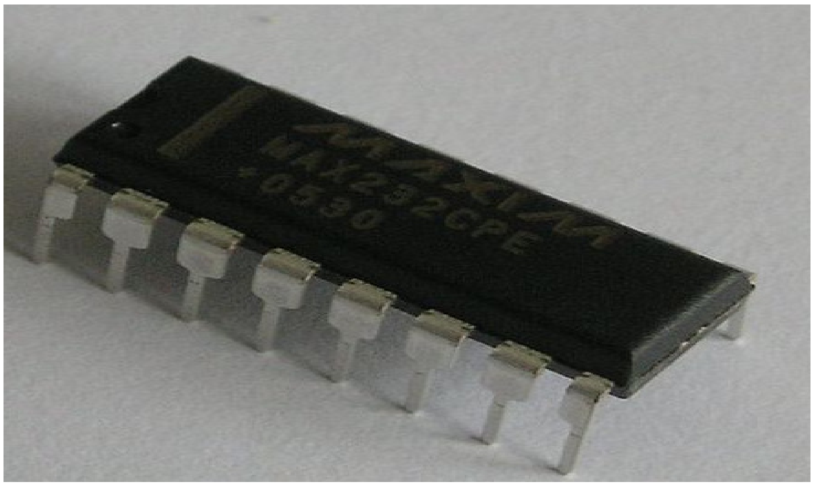
The software components used in the project are as follow:

1. USB-RS232 Converter Cables
2. MAX232

The software part of the project consists of these above cables so as to connect the hardware device with the computer system and to make it portable as as to display the heart rate easily on the computer.

The description of the above components is given on next page.

4.1 MAX232



The MAX232 is an integrated circuit, first created by Maxim Integrated Products, that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals.

The drivers provide RS-232 voltage level outputs from a single + 5 V supply via on - chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case.

The receivers reduce RS-232 inputs , to standard 5 V TTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V.

The later MAX232A is backwards compatible with the original MAX232 but may operate at higher baud rates and can use smaller external capacitors in place of the capacitors used with the original device.

The newer MAX3232 is also backwards compatible, but operates at a broader voltage range, from 3 to 5.5 V. Pin to pin compatible: ICL232, ST232, ADM232, and HIN232

Voltage levels when a MAX232 IC receives a TTL level to convert, it changes a TTL Logic 0 to between +3 and +15 V, and changes TTL Logic 1 to between -3 to -15 V, and vice versa for converting from RS232 to TTL. This can be confusing when you realize that the RS232 Data Transmission voltages at a certain logic state are opposite from the RS232 Control Line voltages at the same logic state. To clarify the matter, see the table below.

For more information see RS-232 Voltage Levels.

RS232 Line Type & Logic Level	RS232 Voltage	TTL Voltage to/from MAX232
Data Transmission (Rx/Tx) Logic 0	+3 V to +15 V	0 V
Data Transmission (Rx/Tx) Logic 1	-3 V to -15 V	5 V
Control Signals (RTS/CTS/DTR/DSR) Logic 0	-3 V to -15 V	5 V
Control Signals (RTS/CTS/DTR/DSR) Logic 1	+3 V to +15 V	0 V

4.1.1 APPLICATIONS

The MAX232 has two receivers (converts from RS-232 to TTL voltage levels), and two drivers (converts from TTL logic to RS-232 voltage levels). This means only two of the RS-232 signals can be converted in each direction. Typically, a pair of a driver/receiver of the MAX232 is used for TX and RX signals, and the second one for CTS and RTS signals.

There are not enough drivers/receivers in the MAX232 to also connect the DTR, DSR, and DCD signals. Usually these signals can be omitted when e.g. communicating with a PC's serial interface. If the DTE really requires these signals, either a second MAX232 is needed, or some other IC from the MAX232 family can be used. Also, it is possible to directly wire DTR (DB9 pin #4) to DSR (DB9 pin #6) without going through any circuitry. This gives automatic (brain dead) DSR acknowledgment of an incoming DTR signal.

4.2 USB-RS232 Converter Cables

The USB_RS232 cables are a family of USB to RS232 levels serial UART converter cables incorporating USB to serial UART interface IC device which handles all the USB signaling and protocols. The cables provide a fast, simple way to connect devices with a RS232 level serial UART interface to USB.High Speed USB Serial Adapter FTDI Chip Built in Driver Support for Windows Vista 32/64 and XP 32/62 as well as Windows 7.

This USB RS-232-Port DB9 Serial Adapter provides the perfect solution for using all of your legacy serial devices with your new USB only computer. With plug-and-play compatibility, installation is a breeze. This adapter is ideal for connecting PDAs, digital cameras, GPS units, barcode scanners and many other serial devices to a USB port.

US232-100 is a premium USB to RS232 evaluation cable which can be used for testing the functionality of the FT232R device. This adapter cable is family of communication devices. This model, US232R adapter provides simple method of adapting legacy serial devices with Rs232 interface to modern USB ports. Each us232 adapter contains a small internal electronic circuit board. The maximum RS232 level data rate is 1MBaudrate

Adds one RS232 serial port by connecting to USB.

Special high gloss white finish enclosure design.

Side lit blue RXD and TXD traffic indicator.

Easy plug and play installation

Work with USB1.1 & 2.0 Host and Hub ports.

Communications and networks

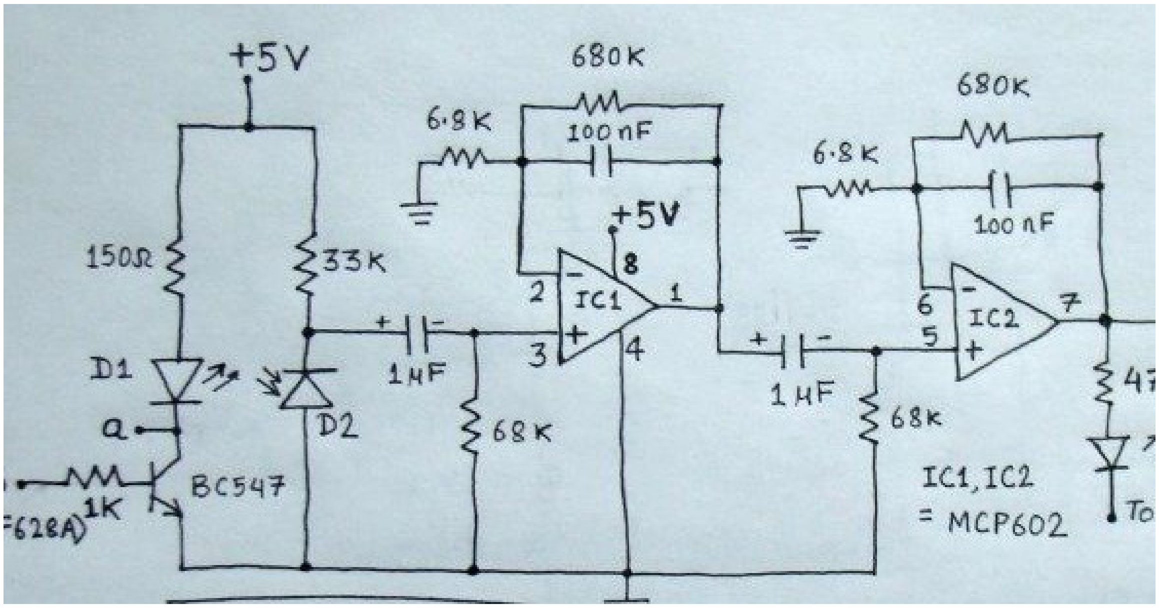
Audio

Imaging, video, & vision.

Consumer electronics

CHAPTER 5 - WORKING OF HEART RATE MONITOR

5.1 CIRCUIT DIAGRAM



5.2 EXPLAINATION

The circuit diagram of the measurement device is shown in the above Figure. The block diagram basically consists of 2 operational amplifiers, a low-pass filter, a microcontroller, and an LCD. The first amplifier is set for a gain of just over 100, while the gain of the second amplifier is around 560. During the laboratory trials it was found necessary to use a low pass filter in the circuit to filter out any unwanted high frequency noise from nearby equipment. The cut-off frequency of the filter was chosen as 2Hz. The output time response of the amplifier and filter circuit which consists of pulses. An LED, connected to the output of the operational amplifiers flashes as the pulses are received and amplified by the circuit.

The output of the amplifier and filter circuit was fed to one of the digital inputs of a atmega8 type microcontroller. In order to reduce the cost of the circuit the microcontroller is operated from a 4MHz resonator. The microcontroller output ports drive the LCD

The input we are using is a voltage of magnitude 5 volts. It consists of an AC input of 230 V and a bridge circuit of diodes which acts as a rectifier.7805 is also used which is connected to the bridge circuit in order to get an output of 5 volts DC.

Firstly, on speaking about the temperature measuring unit, we are using LM35A as the temperature sensor. And, the other part which measures the heart rate consists of an LED which is connected to the input Vcc through a resistance of 330KOHM and an LDR with a potentiometer. The function of an LED is it shows the property of electroluminescence. When LDR absorbs the light from the LED, its resistance varies inversely with respect to the intensity of light it absorbs. Potentiometer does the work of finding the voltage magnitude. The input of 5volts is connected to a pin of LM358.The pin 2A is connected to the input(+IN) of an ADC(Analog to Digital Converter).Here, the analog to digital converter we are using is ADC0804.And the pin 3A is connected is grounded.

LM35A(temperature sensor), is exposed to certain temperature which acts as an input. LM35A does the function of varying its output with respect to the change in the temperature that is given as input. There by, the output voltage corresponds to the temperature that is sensed by LM358.

Now, coming to ADC, each of the pins 1(CS), 7(-IN), 8(AGND) and 10(DGND) are grounded. The pin4 (CLKIN) is connected to the pin1(CS) through 150pF capacitor and the pin19(CLKR) is connected to the pin4(CLKIN) THROUGH A 10KOHM resistance. These connections help in the timing function of ADC. The pins 11,12,13,14,15,16,17,18 which are DB7,DB6,DB5,DB4,DB3,DB2,DB1,DB0 respectively are connected to the resistance pins 2,3,4,5,6,7,8,9 respectively of 10K sip which in turn are connected to the pins
39(P0.7/AD7),38(P0.6/AD6),37(P0.5/AD5),36(P0.4/AD4),35(P0.3/AD3),34P0.2/AD2),33 (P0.1/AD1),32(P0.0/AD0) of the microcontroller AT89S52 respectively.

ADC0804 converts the input analog signal into an electrical signal in which is in the form of digital data.

Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. The first pin of 10K sip is connected to the input voltage i.e., Vcc=5 volts. The 20th pin (Vref/Vcc) of ADC0804 is also connected to the input voltage of magnitude 5 volts which is needed for ADC0804 to work. The pins 2(RD),3(WR),5(INTR) are connected to the pins 10(P3.0),11(P3.1),12(P3.2) of the microcontroller 89S52 respectively.

The microcontroller AT89S52's 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 (IIL) because of the pull-ups. Port 3 receives some control signals for Flash programming and verification. The connection between the pins 2, 3, 5 of ADC0804 and 10, 11, 12 of AT89S52 function based on the program that is shown below

```
rd=1;

intr =1;

adcdata =0xff;

while(1){

lcdcmd(0xc2);

//delay(500);

wr=0;

_nop_();

_nop_();

_nop_();

_nop_();

wr=1;

delay(50);
```

```
delay(10);

a=adcdata;

convert(a);

delay(500);
```

The RST PIN of ATMEGA-8 is connected to a capacitor of capacitance 10micro farads and a reset switch(RESET SW) which are drawn from the input Vcc i.e., 5 volts. Reset input, a high on this pin for two machine cycles while the oscillator is running resets the device. This pin drives high for 98 oscillator periods after the Watchdog times out. XTAL2 which is the output from the inverting oscillator amplifier is connected to a 33pF capacitance which, in turn connected to the pin9 through 8.2KOHM resistance and is grounded.XTAL1 which is the input to the inverting oscillator amplifier and input to the internal clock operating circuit is connected with a capacitance of 33pF and parallels the frequency of 11.0592MHz.The Vcc pin and EA pin of AT89S52 are connected to the input of magnitude 5 volts which are in turn connected to the pins 1 and 15 of LCD.EA enables the external access for ATMEGA8.

Port 1 is an 8-bit bidirectional 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. The pins 6, 7,8 help in system programming. The pins 9,8,7,6,5,4,3 of ATMEGA8 are connected to 4,6,11,12,13,14 pins of LCD respectively.

The pin 15 is connected to a buzzer through a resistance of 1kohm and a transistor BC547 and is grounded. Buzzer is a piezo electric material which converts the sound activity (here, the heart beat rhythm) into an electric signal. Buzzer is also given the input Vcc ie., 5volts (DC) and the same input is also given to the base of the transistor BC547.The emitter of the transistor is grounded. The pin 2 of LCD is grounded. And the pins 1,5 and 16 are grounded. The pin 2 is grounded through a resistance that is connected to rheostat that connects to pin3 which is also grounded. The function of buzzer and its dependence on

LCD for the display of values of heartbeat count is carried out using the following program instructions:

```
void main()
{
buz=0;
finger=1;
lcd_init();
lcdcmd(0x85);
msgdisplay("WELCOME");
lcdcmd(0x01);
msgdisplay("temp hbeat");
rd=1;
intr=1;
adcdata=0xff;
while(1)
{
lcdcmd(0xc2);
//delay(500);
wr=0;
_nop_();
_nop_();
_nop_();
_nop_();
wr=1;
delay(50);
rd=0;
delay(10);
a=adcdata;
convert(a);
delay(500);
for(i=0;i<100;i++)
```

```
{
count+=1;
if(finger==0)
{
delay(1000);
if(!finger)
{
buz=1;
delay(500);
pp=1;
buz=0;
break;
}
else
{   pp=0; delay(500);
lcdcmd(0xca);
if(pp)
{
convert(count);
}
else
convert(0);
pp=0;
}
}
```

The above program asserts the input data. If the sensor senses the subject's finger, then the input of the buzzer is set to higher logic state otherwise the input of the buzzer is set to 0. And finally the LCD also shows the temperature readings based on the following program instructions:

```
void convert(unsigned char temp_ value)
{
unsigned char value,d1,d2,d3;
temp_ value = temp_ value;
value=temp_value/10;
d3=temp_value%10;
d1=value/10;
d2=value%10;
d1=d1+0x30;
lcddata(d1);
delay(10);
d2=d2+0x30;
```

- The circuit consists of two identical active low pass filters with a Cut-off frequency of about 2.5 Hz.
- The operational amplifier IC, a dual Op Amp chip operates at a single power supply .

The two stage amplifier/filter provides sufficient gain to boost the weak signal coming from the photo sensor unit and convert it into a pulse.

- An LED connected at the output blinks every time a heart beat is detected.
- The output from the signal conditioner goes to the input of microcontroller
- The microcontroller activates the IR transmission in the sensor unit for 15 sec.
- During this interval, the number of pulses arriving at the input is counted.

- The actual heart rate would be 4 times the count value, and the resolution of measurement would be 4.

. LTH1550-01 is simply a IR diode – photo transistor pair in single package. The front side of the IR diode and photo transistor is exposed and the remaining parts are well isolated. When the finger tip is placed over the sensor the volumetric pulsing of the blood volume inside the finger tip due to heart beat varies the intensity of the reflected beam and this variation in intensity is according to the heart beat.

When more light falls on the photo transistor it conducts more, its collector current increases and so its collector voltage decreases. When less light falls on the phototransistor it conducts less, its collector current decreases and so its collector voltage decreases. This variation in the collector voltage will be proportional to the heart rate. Any way this voltage variation is so feeble and additional signal conditioning stages are necessary to convert it into a microcontroller recognizable form.

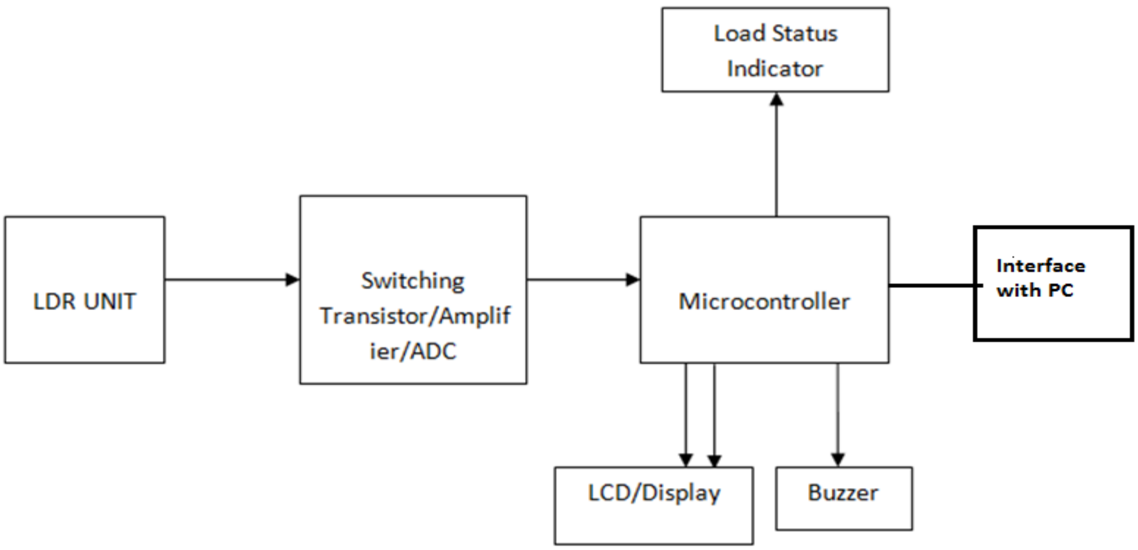
The next part of the circuit consists of a two active low pass filters using opampLM358. The LM358 is a quad Op amp that can be operated from a single rail supply. Resistor R15, R16 and capacitor C5 sets the gain and cut off frequency of the first filter.

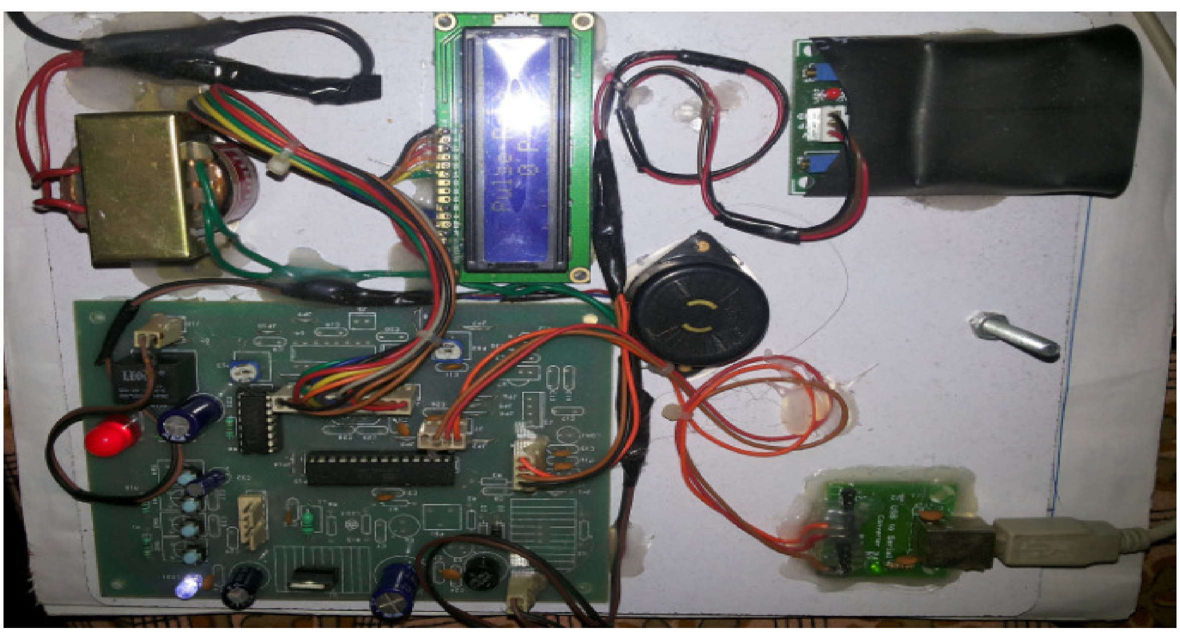
SETTING UP THE CIRCUIT

When power is switched ON, the indicator LED D4 will glow an continues in that state. Now place your finger tip over the sensor and adjust preset R14 so that the LED D4 starts blinking. After you got the LED blinking, reset the power and wait for 15 seconds. The display will show your heart rate in beats per minute.

CHAPTER 6- INTERFACING AND PROGRAMMING

6.1 INTERFACING





6.2 SOFTWARE SYSTEM

The software part of the project consists two ports that are MAX232 that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals.

And USB232 converting cables which handles all the USB signaling and protocols. The cables provide a fast, simple way to connect devices with a RS232 level serial UART interface to USB.

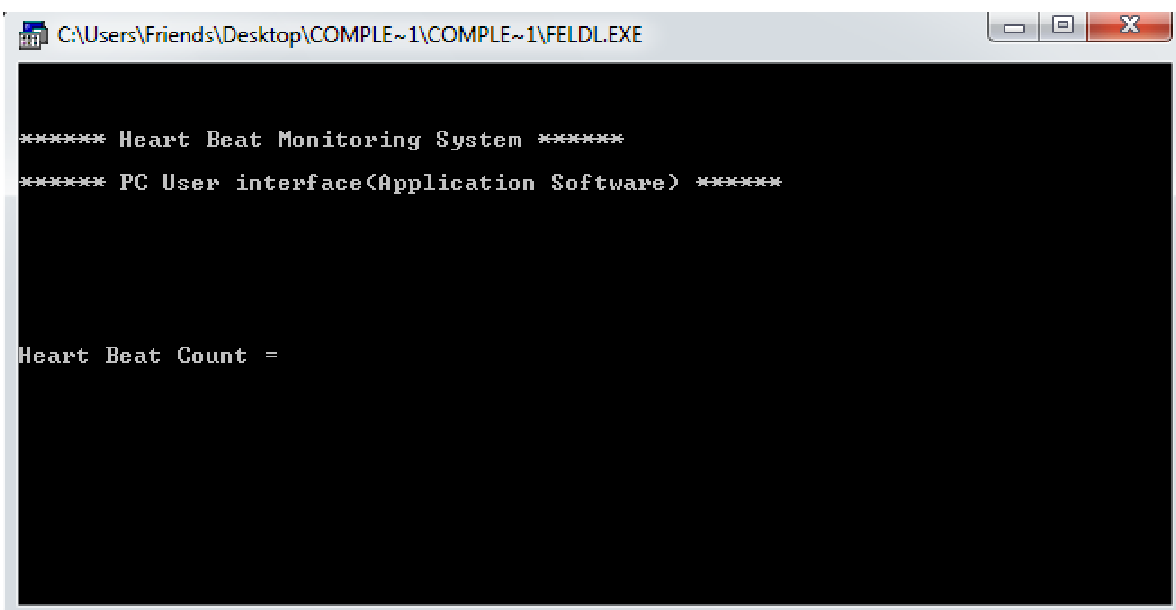
Program for interfacing

```
#include<stdio.h>

#include<conio.h>

#include<dos.h>

#define port1 0x3f8                //RS232 Port Adress

void main()

{

unsigned char Byte;

int c;

clrscr();

outportb(port1+1,0x00);
```

```
outportb(port1+3,0x80);

outportb(port1+0,0x0c);//9600 baud rate

outportb(port1+1,0x00);

outportb(port1+3,0x03);

outportb(port1+2,0xc7);

outportb(port1+4,0x0b);

printf("\n\n\n****** Heart Beat Monitoring System ******");

printf("\n\n****** PC User interface(Application Software) ******");

printf("\n\n\n\n\n\n\n\nHeart Beat Count =");

while(1)

   {

 c=inportb(port1+5);

    if(c & 1)

        {

         Byte=inportb(port1);

         gotoxy(20,14);

         printf("%3d\n",Byte);



         if(Byte <= 50)
```

```
            {
                    printf("\n\nLOW Heart Beat! PLZ Check     ");
            }
        else if(Byte >= 100)
            {
                    printf("\n\nHigh Heart Beat! PLZ Check    ");}
        else{
                    printf("\n\nNormal Heart Beat             ");
            } }   }
}
```

OUTPUT:



DEFINATION

```
#define F_CPU 8000000

#define True 1

#define False 0

#define ON 1

#define OFF 0

//--------------------------------Port Bits for LCD

typedef struct

{	unsigned char b0:1;

	unsigned char b1:1;

	unsigned char b2:1;

	unsigned char b3:1;

	unsigned char b4:1;

	unsigned char b5:1;

	unsigned char b6:1;

	unsigned char b7:1;

} bits;

#define PIN_B (* (volatile bits *) &PINB)

#define PORT_B (* (volatile bits *) &PORTB)
```

```
#define DDR_B (* (volatile bits *) &DDRB)

#define PIN_C (* (volatile bits *) &PINC)

#define PORT_C (* (volatile bits *) &PORTC)

#define DDR_C (* (volatile bits *) &DDRC)

#define PIN_D (* (volatile bits *) &PIND)

#define PORT_D (* (volatile bits *) &PORTD)

#define DDR_D (* (volatile bits *) &DDRD)

//-----------------------------------LCD Definition

#define RS_Dir DDR_C.b3

#define RS PORT_C.b3

#define RW_Dir DDR_C.b2

#define RW PORT_C.b2

#define E_Dir DDR_D.b4

#define E PORT_D.b4

#define DB4_Dir DDR_D.b5

#define DB4 PORT_D.b5

#define DB5_Dir DDR_D.b6

#define DB5 PORT_D.b6

#define DB6_Dir DDR_D.b7
```

```
#define DB6 PORT_D.b7

#define DB7_Dir DDR_B.b0

#define DB7 PORT_B.b0

//------------------------------LED Definition

#define GREEN_LED_Dir DDR_B.b1

#define GREEN_LED PORT_B.b1

//-------------------------------Buzzer

#define Buzzer_Dir DDR_B.b2

#define Buzzer PORT_B.b2

#define ADC_Channel_0_Dir DDR_C.b0

#define ADC_Channel_1_Dir DDR_C.b1

//---------------------------------------------------------------Header File

#include <avr/io.h>

#include <util/delay.h>

#include <avr/eeprom.h>

#include <avr/interrupt.h>

#include <stdio.h>

//--------------------------------------------------------------Global Variable

extern unsigned char LCD_Message_Buffer[34];
```

```
extern unsigned int Timer;

extern unsigned Buzzer_timer;

//--------------------------------------------------------------Function Prototype

extern void Delay_ms(unsigned long int);

extern void Delay_us(unsigned long int);

extern void Init_Complete(void);

extern void UART_Init(unsigned long int);

extern void UART_Byte_Transmit(unsigned char);

extern int UART_Byte_Received(unsigned int);

extern int UART_Byte_Received_Block(void);

extern void UART_String_Transmit(unsigned char*);

extern void Command_LCD(unsigned char);

extern void Data_LCD(unsigned char);

extern void Init_LCD(void);

extern void Clear_LCD(void);

extern void Display_ON_Cursor_Blink_LCD(void);

extern void Shift_Cursor_At_Begining_1st_Line_LCD(void);

extern void Shift_Cursor_At_Begining_2nd_Line_LCD(void);

extern void LCD_Message_Disply(unsigned char*);
```

```
extern void Next_Char_LCD(void);

extern void Last_Char_LCD(void);

void Cursor_Position(unsigned char , unsigned char);

extern void ADC_Init(void);

extern unsigned int ADC_Avg_Value(void);
```

CONCLUSION

I have proposed a low-cost solution to enhance the remote monitoring capability of existing health care system. It conducted a feasibility study of network based heart rate monitoring system.. It combines the design and problem solving skills of engineering with medical and biological sciences to improve patient's health care and the quality of life of individuals. A medical device is intended for use in the diagnosis of disease, or in the cure, treatment, or prevention of diseases

In this project, the design and development of a low cost HRM device has been presented. The device is ergonomic, portable, durable, and cost effective. The HRM device is efficient and easy to use. It is in excellent agreement with actual heartbeat rates. This device could be used in clinical and nonclinical environments. It can also be easily used by individual users, e.g. athletes during sporting activities. The device could be further developed into a continuously monitoring device that could be used to detect the heart beat anomalies associated with certain heart conditions. This would be made possible by analyzing the heartbeat and informing the authorized personnel in time.

This project will eventually reduce man power in the very near future. Final goals of this paper are reducing the hospitalization and assistance costs. In addition, patients and families quality of life are increased. Furthermore, we believe that elderly people as well, may benefit from this system.

FUTURE SCOPE

- It is secure, robust and low-power consuming.

- It can operate on multiple channels so as to avoid interference with other wireless devices or other equipments in the hospital.

- EEG, ECG and other health parameters can also be monitored.
- Continuous monitoring and future diagnosis can be performed via the same system (TELEMEDICINE).
- More than a single patient at different places can be monitored using single system.

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