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ELDERLY POPULATION'S VOICE-BASED HEART RATE MONITORING AND MODIFICATION SYSTEM

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ABSTRACT:

The Heart Rate Monitoring system is developed using IOT technology with an objective of detecting the heartbeat of the patient in order to monitor the risk of heart attack and also the regular checkup. Body health monitoring is very important to us to make sure our health is in excellent condition. One of the vital parameter for this device under consideration is the heart rate (HR). In this project we describe the design of low cost heart rate monitoring device from fingertips based on the Bluetooth technology. The entire system is comprised of several parts such as Heart Rate module, Android application and Bluetooth module. The Heart Rate (HR) module picks up heart rate signal by a noninvasive technique (Photoplethysmography) from the subject (patients) and sends it (signal) wirelessly to computer or android application using Bluetooth module. This system can be embraced and combined as a part of telemedicine constituent. The data received from heart rate module can be saved and viewed for further medical usage. The result from this device prototype can be utilized for various clinical investigations, indeed these Bluetooth's signal can be transmitted between 15 to 20 meters radius

CHAPTER 1

INTRODUCTION TO DOMAIN

1.1 Introduction Of Embedded System

Typically, an embedded system is housed on a single microprocessor board with the programs stored in ROM. Virtually all appliances that have a digital interface -- watches, microwaves, VCRs, cars -- utilize embedded systems. Some embedded systems include an operating system, but many are so specialized that the entire logic can be implemented as a single program.

Physically, Embedded Systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants.

1.2 Definition of an Embedded System

Embedded system is defined as, For a particular/specific application implementing the software code to interact directly with that particular hardware what we built. Software is used for providing features and flexibility,Hardware = {Processors, ASICs, Memory,...} is used for Performance (& sometimes security)

1.3Features of Embedded Systems

The versatility of the embedded computer system lends itself to utility in all kinds of enterprises, from the simplification of deliverable products to a reduction in costs in their development and manufacture. Complex systems with rich functionality employ special operating systems that take into account major characteristics of embedded systems. Embedded operating systems have minimized footprint and may follow real-time operating system specifics.

The special computers system is usually less powerful than general-purpose systems, although some expectations do exist where embedded systems are very powerful and complicated. Usually a low power consumption CPU with a limited amount of memory is used in embedded systems. Many embedded systems use very small operating systems; most of these provide very limited operating system capabilities.

1.4 Characteristics of Embedded Systems

Embedded computing systems generally exhibit rich functionality—complex functionality is usually the reason for introducing CPUs into the design. However, they also exhibit many non-functional requirements that make the task especially challenging:

• Real-time deadlines that will cause system failure if not met;

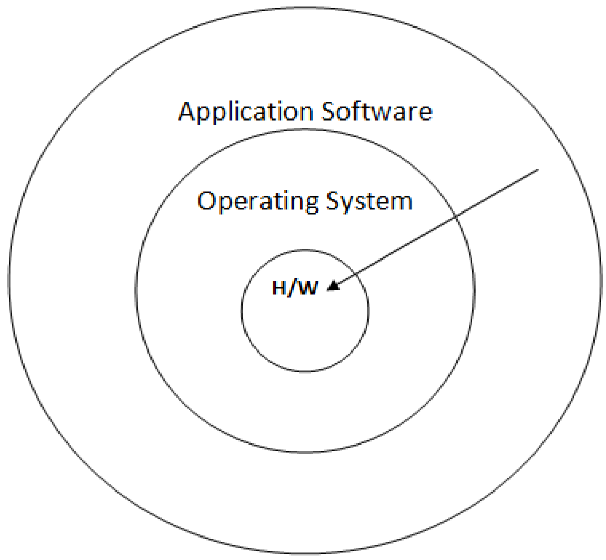
• Multi-rate operation;

• In many cases, low power consumption;

• Low manufacturing cost, which often means limited code size.

Overview of an Embedded System Architecture

Every Embedded system consists of a custom-built hardware built around a central processing unit. This hardware also contains memory chips onto which the software is loaded.



The operating system runs above the hardware and the application software runs above the operating system. The same architecture is applicable to any computer including desktop computer. However these are significant differences. It is not compulsory to have an operating system in every embedded system. For small applications such as remote control units, air conditioners, toys etc.

1.5 Applications of Embedded Systems

Some of the most common embedded systems used in everyday life are

Control systems: Often use DSP chip for control computations (e.g., automotive engine control)

Distributed embedded control: Mixture of large and small nodes on a real-time

Home Appliances, intercom, telephones, security systems,garage door openers, answering machines, faxmachines, home computers, TVs, cable TV tuner,VCR, camcorder, remote controls, video games,cellular phones, musical instruments, sewingmachines, lighting control, paging, camera, pinballmachines, toys, exercise equipment

Office Telephones, computers, security systems, faxmachines, microwave, copier, laser printer, colorprinter, paging

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1.6 TYPES OF EMBEDDED SYSTEMS

Based on functionality and performance embedded systems categorized as 4 types

1. Stand alone embedded systems
2. Real time embedded systems
3. Networked information appliances
4. Mobile devices

1.6.1 Stand alone embedded systems:-

As the name implies, stand alone systems work in standalone mode. They take i/p, process them and produce the desire o/p. The i/p can be an electrical signal from transducer or temperature signal or commands from human being. The o/p can be electrical signal to drive another system an led or LCD display

ex digital camera, microwave oven, CD player, Air conditioner etc

1.6.2 Real time embedded systems:-

In this type of an embedded system a specific work has to be complete in a particular period of time.

Hard Real time systems: - embedded real time used in missiles

Soft Real time systems: - DVD players

1.6.3 Networked information appliances:-

Embedded systems that are provided with n/w interfaces and accessed by n/w such as local area n/w or internet are called Network Information Appliances

Ex A web camera is connected to the internet. Camera can send pictures in real time to any computers connected to the internet

1.6.4 Mobile devices:-

Actually it is a combination of both VLSI and Embedded System

Mobile devices such as Mobile phone, Personal digital assistants, smart phones etc are special category of embedded systems.

Microcontroller section

A microcontroller is basically a microprocessor in addition to a fixed amount of RAM, ROM, I/O ports and timer all on a single chip. In other words, the processor, the RAM, ROM, I/O ports, and timer all are embedded together on one chip. Therefore the designer cannot add any external memory, I/O, or timer to it.

Philips P89V51RD2 Microcontroller

I am using Philips P89V51RD2 as 8051 Microcontroller Unit (MCU). And I have been developing my code with Open source C Compiler SDCC. Please visit my Tools page for software preparation guides.

The Flash program memory supports both parallel programming and in serial In-System Programming (ISP). Parallel programming mode offers gang-programming at high speed, reducing programming costs and time to market. ISP allows a device to be reprogrammed in the end product under software control. The capability to field/update the application firmware makes a wide range of applications possible. The P89V51RD2 is also In-Application Programmable (IAP), allowing the Flash program memory to be reconfigured even while the application is running.

Features

- 80C51 Central Processing Unit
- 5 V Operating voltage from 0 MHz to 40 MHz
- 64 KB of on-chip Flash user code memory with ISP (In-System Programming) and IAP.
- Supports 12-clock (default) or 6-clock mode selection via software or ISP

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- SPI (Serial Peripheral Interface) and enhanced UART
- PCA (Programmable Counter Array) with PWM and Capture/Compare functions
- Four 8-bit I/O ports with three high-current Port 1 pins (16 mA each)
- Three 16-bit timers/counters
- Programmable watchdog timer
- Eight interrupt sources with four priority

ARCHITECTURE AND PROGRAMMING OF 8051/89C51

Random Access Memory (RAM)

Random Access Memory (RAM) is a type of memory used for temporary storing data and intermediate results created and used during the operation of the microcontrollers. The content of this memory is cleared once the power supply is off. For example, if the program perform an addition, it is necessary to have a register standing for what in everyday life is called the “sum”. For that purpose, one of the registers in RAM is called the "sum" and used for storing results of addition. The size of RAM goes up to a few KBs. Electrically Erasable Programmable ROM (EEPROM) The EEPROM is a special type of memory not contained in all microcontrollers. Its contents may be changed during program execution (similar to RAM), but remains permanently saved even after the loss of power (similar to ROM). It is often used to store values, created and used during operation (such as calibration values, codes, values to count up to etc.), which must be saved after turning the power supply off. A disadvantage of this memory is that the process of programming is relatively slow. It is measured in milliseconds.

Special Function Registers (SFR)

Special function registers are part of RAM memory. Their purpose is predefined by the manufacturer and cannot be changed therefore. Since their bits are physically connected to particular circuits within the microcontroller, such as A/D converter, serial communication module etc., any change of their state directly affects the operation of the microcontroller or some of the circuits. For example, writing zero or one to the SFR controlling an input/output port causes the appropriate port pin to be configured as input or output. In other words, each bit of this register controls the function of one single pin.

3.4. INTERFACING TO EXTERNAL MEMORY

The number of bits that a semiconductor memory chip can store is called chip capacity

1. It can be in units of K bits (kilobits), M bits (megabits), and so on
2. This must be distinguished from the storage capacity of computer systems
3. While the memory capacity of a memory IC chip is always given bits, the memory capacity of a computer system is given in bytes
4. 16M memory chip – 16 megabits
5. A computer comes with 16M memory – 16 megabytes

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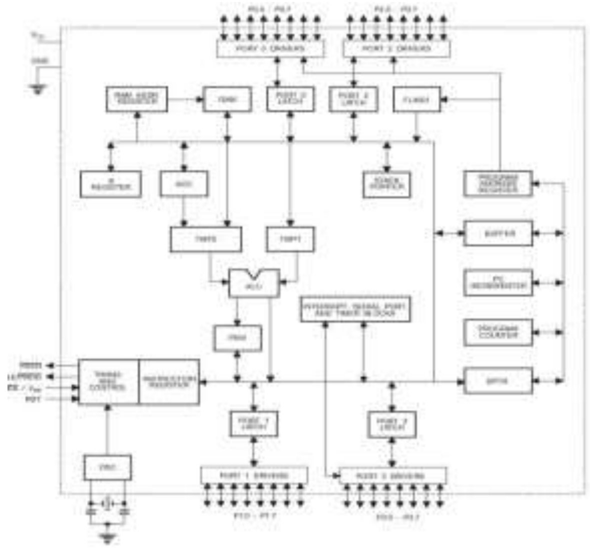

Fig. 3.1: Block

diagram of 8051

3.5. PIN DESCRIPTION

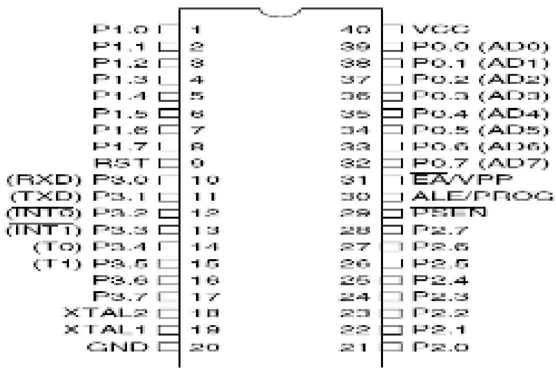

Fig. 3.2: Pin Diagram

Pins 1-8 (Port 1): Each of these pins can be configured as an input or an output.

Pin 9 (**RESET**)**:** It is an input and is active high. Upon applying a high pulse to this pin the microcontroller will reset and terminate all activities. This is often referred to as a power on reset .Activating a power on reset will cause all values the registers to be lost. It will set program counter to all 0s.In order for the RESET input to be effective it must have a minimum duration of two machine cycles.

Pins 10-17 (**Port 3**)**:** Similar to port 1, each of these pins can serve as general input or output. Besides, all of them have alternative functions.

Pin 10 (**RXD**)**:** Serial asynchronous communication input or Serial synchronous communication output.

Pin 11 (TXD): Serial asynchronous communication output or Serial synchronous communication clock output.

Pin 12 (**INT0**)**:** Interrupt 0 inputs.

Pin 13 (INT1): Interrupt 1 input.

Pin 14 (**T0**)**:** Timer 0 clock input.

Pin 15 (**T1**)**:** Timer 1 clock input.

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Pin 16 (WR): Write to external (additional) RAM.

Pin 17 (RD): Read from external RAM.

Pin 20 (GND): Ground.

Pins 21-28 (Port 2): If there is no intention to use external memory then these port pins are configured as general inputs/outputs. In case external memory is used, the higher address byte, i.e. addresses A8-A15 will appear on this port. Even though memory with capacity of 64Kb is not used, which means that not all eight port bits are used for its addressing, the rest of them are not available as inputs/outputs.

Pin 29 (PSEN): If external ROM is used for storing program then logic zero (0) appears on it every time the microcontroller reads a byte from memory.

3.6. TMOD (Timer mode, Addresses 89H)

The Timer Mode SFR is used to configure the mode of operation of each of the two timers. Using this SFR program may configure each timer to be a 16-bit timer, an 8-bit auto reload timer, a 13-bit timer, or two separate timers. Additionally, one may configure the timers to only count when an external pin is activated or to count "events" that are indicated on an external pin.

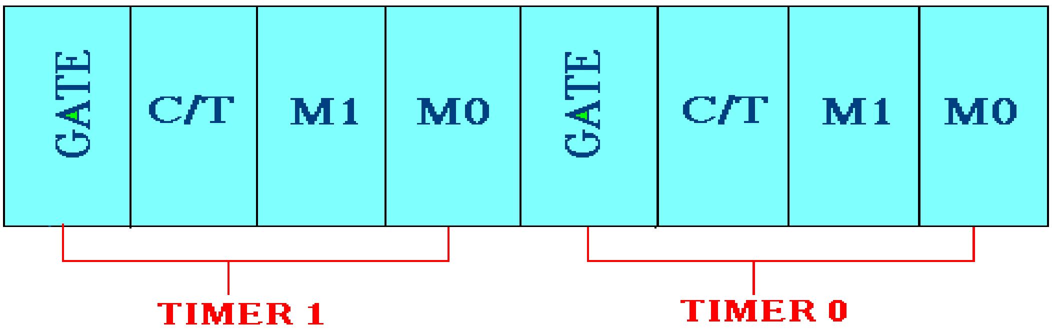

Fig. 3.3: TMOD register

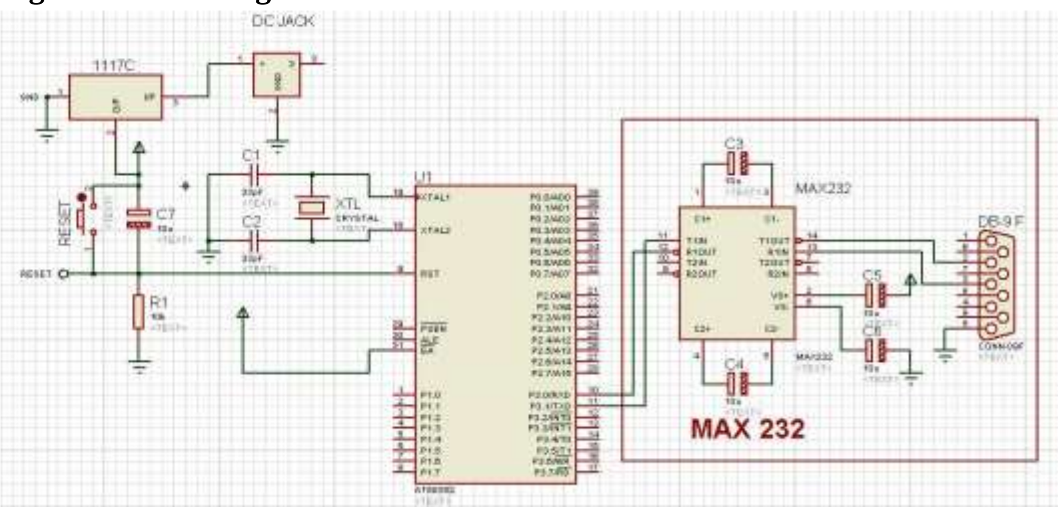

Fig. 3.4: Circuit diagram of microcontroller board

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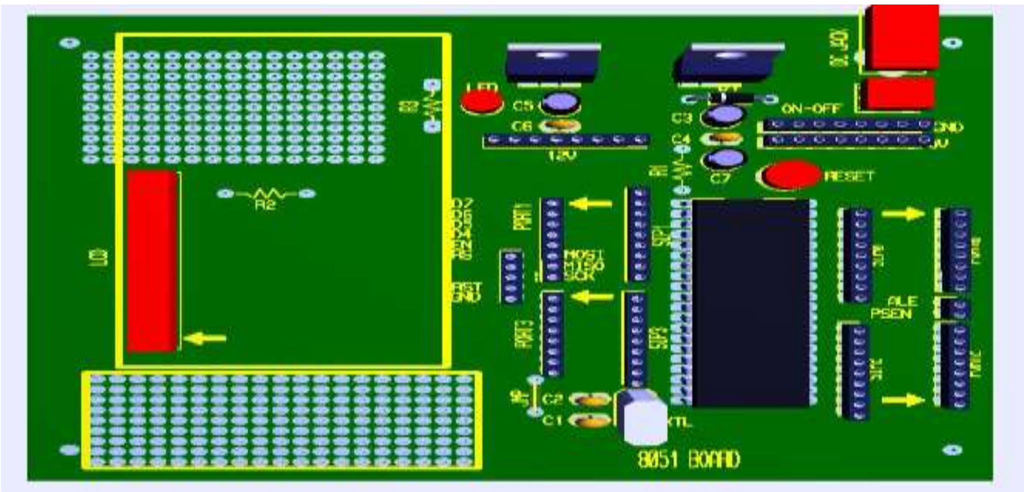

Fig. : 3d view of microcontroller board

CHAPTER 2

INTRODUCTION TO DOMAIN

The heart is one of the most important organs in the human body. It acts as a pump for circulating oxygen and blood throughout the body, thus keeping the functionality of the body intact. A heartbeat can be defined as a two-part pumping action of the heart which occurs for almost a second. It is produced due to the contraction of the heart. When blood collects in upper chambers, the SA(Sino Atrial) node sends out an electrical signal which in turn causes the atria to contract. This contraction then pushes the blood through tricuspid and the mitral valves; this phase of the pumping system is called diastole. The next phase begins when the ventricles are completely filled with blood. The electrical signals generating from SA node reach the ventricle and cause them to contract. In today's scenario, health problems related to heart are very common. Heart diseases are one of the most important causes of death among men and women. It claims approximately 1 million deaths every year. Heart rate is a critical parameter in the functioning of the heart. Therefore heart rate monitoring is crucial in the study of heart performance and thereby maintaining heart health. This paper proposes a heart rate monitoring detection system using IoT. Nowadays treatment of most of the heart-related diseases requires continuous as well as long term monitoring. IoT is very useful in this aspect as it replaces the conventional monitoring systems with a more efficient scheme, by providing critical information regarding the condition of the patient accessible by the doctor. In addition, the nurses or the duty doctor available at the hospital can monitor the heart rate of the patient in the serial monitor through the real-time monitoring system.

CHAPTER 3

LITERATURE SURVEY

1. A MICROCONTROLLER-BASED AUTOMATIC HEART RATE COUNTING SYSTEM FROM FINGERTIP:

This article describes the design process of a low cost and portable microcontroller based heart-rate counting system for monitoring heart condition that can be implemented with off-the-shelf components. The raw heart-rate signals were collected from finger using IR TX-RX (Infrared Transmitter and Receiver pair) module which was amplified in order to convert them to an observable scale. The inherent noise signal was then eliminated using a low pass

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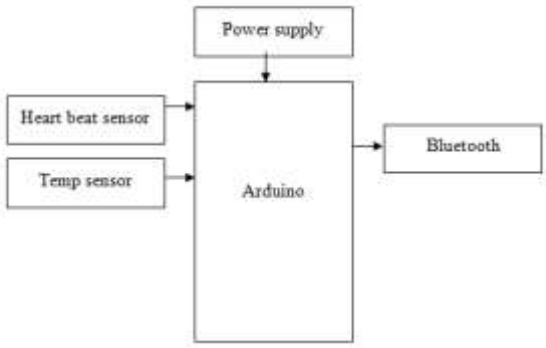
filter. These signals were counted by a microcontroller module (ATmega8L) and displayed on the LCD panel. An algorithm has been developed which was programmed into the microcontroller to run the proposed heart rate counting system. The results obtained using the developed device when compared to those obtained from the manual test involving counting of heart rate was found satisfactory. The proposed system is applicable for family, hospital, clinic, community medical treatment, sports healthcare and other medical purposes. Also, fit for the adults and the pediatrics. However, presented method in the developed system needs further investigation and need more functionality, which may be useful to consider advance in future research.

2. Heartbeat and Temperature Monitoring System for Remote Patients using Arduino:

This paper describes the working of a wireless heartbeat and temperature monitoring system based on a microcontroller ATmega328 (arduino uno). Most monitoring systems that are in use in today's world works in offline mode but our system is designed such that a patient can be monitored remotely in real time. The proposed approach consists of sensors which measures heartbeat and body temperature of a patient which is controlled by the microcontroller. Both the readings are displayed in LCD monitor. Wireless system is used to transmit the measured data from the remote location. The heartbeat sensor counts the heartbeat for specific interval of time and estimates Beats per Minute while the temperature sensor measures the temperature and both the data are sent to the microcontroller for transmission to receiving end. Finally, the data are displayed at the receiving end. This system could be made available at a reasonable cost with great effect.

CHAPTER 4

HARDWARE AND SOFTWARE REQUIREMENTS



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Power supply:

In mains-supplied electronic systems the AC input voltage must be converted into a DC voltage with the right value and degree of stabilization. In these basic configurations the peak voltage across the load is equal to the peak value of the AC voltage supplied by the transformer's secondary winding. For most applications the output ripple produced by these circuits is too high. However, for some applications - driving small motors or lamps, for example - they are satisfactory. If a filter capacitor is added after the rectifier diodes the output voltage waveform is improved considerably. The section b-c is a straight line. During this time it is the filter capacitor that supplies the load current.

The resistor R must be dimensioned so that the zener is correctly biased and that sufficient base current is supplied to the base of Q1. For high load currents the base current of Q1 is no longer negligible. To avoid that the current in the zener drops to the point where effective regulation is not possible a Darlington may be used in place of the transistor. When better performance is required the op amp circuit shown in Figure is recommended. In this circuit the output voltage is equal to the reference voltage applied to the input of the op amp. With a suitable output buffer higher currents can be obtained. The output voltage of the Figure 14 circuit can be varied by adding a variable divider in parallel with the zener diode and with its wiper connected to the op amp's input.

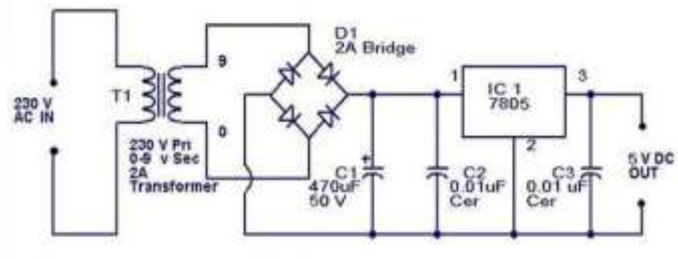

Fig. 2.1: Circuit diagram of regulated power supply section

1) AC Input: This is the input supply from the public utility where the device will be energized. It is also supplied directly to the relay contacts in the device which connects the load to the supply when the supply is within 200V – 240V range.

(2) Step down transformer: It steps down the AC supply into 5v on the secondary side. It is therefore a 230/5 v transformer. Any change in the primary reflects in the secondary of the transformer. So any fluctuations in the input are also reflected as a fluctuation in the output.

Arduino:

The Arduino is a family of microcontroller boards to simplify electronic design, prototyping and experimenting for artists, hackers, hobbyists, but also many professionals. People use it as brains for their robots, to build new digital music instruments, or to build a system that lets your house plants tweet you when they're dry. Arduinos (we use the standard Arduino Uno) are built around an ATmega microcontroller essentially a complete computer with CPU, RAM, Flash memory, and input/output pins, all on a single chip. Unlike, say, a Raspberry Pi, it's designed to attach all kinds of sensors, LEDs, small motors and speakers, servos, etc. directly to

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these pins, which can read in or output digital or analog voltages between 0 and 5 volts. The Arduino connects to your computer via USB, where you program it in a simple language (C/C++, similar to Java) from inside the free Arduino IDE by uploading your compiled code to the board. Once programmed, the Arduino can run with the USB link back to your computer, or stand-alone without it no keyboard or screen needed, just power.

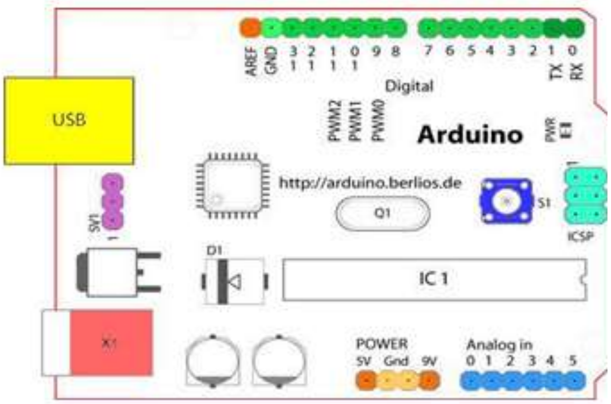

Figure Structure of Arduino Board

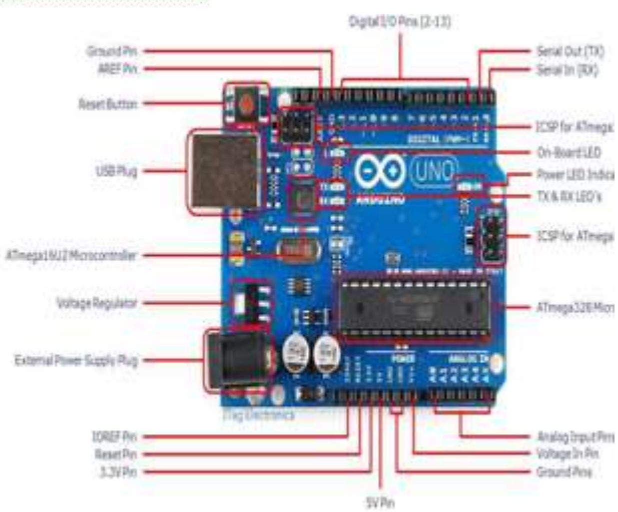

Figure: Arduino Board

Looking at the board from the top down, this is an outline of what you will see (parts of the board you might interact with in the course of normal use are highlighted). Starting clockwise from the top center:

- Analog Reference pin (orange)
- Digital Ground (light green)
- Digital Pins 2-13 (green)
- Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - These pins cannot be used for digital i/o (DigitalRead and DigitalWrite) if you are also using serial communication (e.g. Serial.begin).
- Reset Button - S1 (dark blue)
- In-circuit Serial Programmer (blue-green)
- Analog In Pins 0-5 (light blue)
- Power and Ground Pins (power: orange, grounds: light orange)

Digital Pins

In addition to the specific functions listed below, the digital pins on an Arduino board can be used for general purpose input and output via the pin Mode(),Digital Read(),and DigitalWrite()commands. Each pinhas an internal pull-up resistor which can be turned on and off using digitalWrite() (w/ a value of HIGH or LOW, respectively) when the pin is configured as an input. The maximum current per pin is 40mA.

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. On the ArduinoDiecimila, these pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip. On the Arduino BT, they are connected to the corresponding pins of the WT11Bluetooth module. On the Arduino Mini and LilyPad

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Arduino, they are intended for use with an external TTL serial module (e.g. the Mini-USB Adapter).

- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, arising or falling edge, or a change in value. See the attach Interrupt() function for details.

- **PWM: 3, 5, 6, 9, 10, and 11** Provide 8-bit PWM output with theanalog Write()function.Onboardswith an ATmega8, PWM output is available only on pins 9, 10, and 11.

Analog Pins

In addition to the specific functions listed below, the analog input pins support 10-bit analog-to-digital conversion (ADC) using the analog Read()function. Most of the analog inputs can also be used as digital pins: analog input 0 as digital pin 14 through analog input 5 as digital pin 19. Analog inputs 6 and 7 (present on the Mini and BT) cannot be used as digital pins.

Power Pins:

- **VIN** (sometimes labeled "9V"): The input voltage to the Arduino board when it's using an externalpowersource (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. Also note that the Lily Pad has no VIN pin and accepts only a regulated input.**5V:** The regulated power supply used to power the microcontroller and other components on theboard. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.

- **3V3** (Diecimila-only) :A 3.3 volt supply generated by the on-board FTDI chip.

- **GND:**Ground pins.

Reset: (Diecimila-only) Bring this line LOW to reset the microcontroller. Typically used to add areset button to shields which block the one on the board.

Heartbeat sensor:

A person’s heartbeat is the sound of the valves in his/her’s heart contracting or expanding as they force blood from one region to another. The number of times the heart beats per minute (BPM), is the heart beat rate and the beat of the heart that can be felt in any artery that lies close to the skin is the pulse.

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- **Manual Way**: Heart beat can be checked manually by checking one's pulses at two locations- wrist (the **radial pulse**) and the neck (**carotid pulse**). The procedure is to place the two fingers (index and middle finger) on the wrist (or neck below the windpipe) and count the number of pulses for 30 seconds and then multiplying that number by 2 to get the heart beat rate. However pressure should be applied minimum and also fingers should be moved up and down till the pulse is felt.

Principle of Heartbeat Senso

There are two types of photophlethysmography:

Transmission: Light emitted from the light emitting device is transmitted through any vascular region of the body like earlobe and received by the detector.

Reflection: Light emitted from the light emitting device is reflected by the regions.

Working of a Heartbeat Sensor

The basic heartbeat sensor consists of a light emitting diode and a detector like a light detecting resistor or a photodiode. The heart beat pulses causes a variation in the flow of blood to different regions of the body. When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate.

This signal is actually a DC signal relating to the tissues and the blood volume and the AC component synchronous with the heart beat and caused by pulsatile changes in arterial blood volume is superimposed on the DC signal. Thus the major requirement is to isolate that AC component as it is of prime importance.

Practical Heartbeat Sensor

Practical heartbeat Sensor examples are Heart Rate Sensor (Product No PC-3147). It consists of an infrared led and an ldr embedded onto a clip like structure. The clip is attached to the organ (earlobe or the finger) with the detector part on the flesh.

Temperature sensor:

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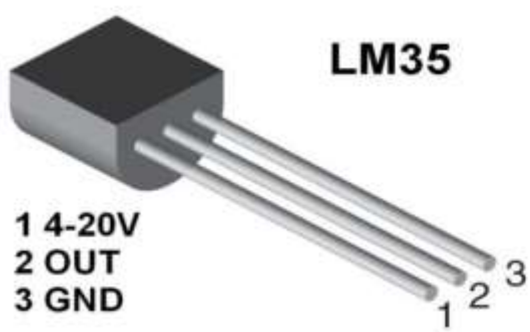
Temperature is the most often-measured environmental quantity. This might be expected since most physical, electronic, chemical, mechanical, and biological systems are affected by temperature. Certain chemical reactions, biological processes, and even electronic circuits perform best within limited temperature ranges. Temperature is one of the most commonly measured variables and it is therefore not surprising that there are many ways of sensing it. Temperature sensing can be done either through direct contact with the heating source, or remotely, without direct contact with the source using radiated energy instead. There are a wide variety of temperature sensors on the market today, including Thermocouples, Resistance Temperature Detectors (RTDs), Thermistors, Infrared, and Semiconductor Sensors.



5 Types of Temperature Sensors

- **Thermocouple**: It is a type of temperature sensor, which is made by joining two dissimilar metals at one end. The joined end is referred to as the HOT JUNCTION. The other end of these dissimilar metals is referred to as the COLD END or COLD JUNCTION. The cold junction is actually formed at the last point of thermocouple material. If there is a difference in temperature between the hot junction and cold junction, a small voltage is created. This voltage is referred to as an EMF (electro-motive force) and can be measured and in turn used to indicate temperature.
- **Thermistors**: Similar to the RTD, the thermistor is a temperature sensing device whose resistance changes with temperature. Thermistors, however, are made from semiconductor materials. Resistance is determined in the same manner as the RTD, but thermistors exhibit a highly nonlinear resistance vs. temperature curve. Thus, in the thermistors operating range we can see a large resistance change for a very small temperature change. This makes for a highly sensitive device, ideal for set-point applications.
- **Semiconductor sensors**: They are classified into different types like Voltage output, Current output, Digital output, Resistance output silicon and Diode temperature sensors. Modern semiconductor temperature sensors offer high accuracy and high linearity over an operating range of about 55°C to +150°C. Internal amplifiers can scale the output to convenient values, such as 10mV/°C. They are also useful in cold-junction compensation circuits for wide temperature range thermocouples. A brief

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details about this type of temperature sensor are given below.

Sensor ICs

There are a wide variety of temperature sensor ICs that are available to simplify the broadest possible range of temperature monitoring challenges. These silicon temperature sensors differ significantly from the above mentioned types in a couple of important ways. The first is operating temperature range. A temperature sensor IC can operate over the nominal IC temperature range of -55°C to +150°C. The second major difference is functionality.

Features of LM35 Temperature Sensor:

- Calibrated directly in ˚ Celsius (Centigrade)
- Rated for full l −55˚ to +150˚C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Low self-heating,
- ±1/4˚C of typical nonlinearity

Operation of LM35:

The LM35 can be connected easily in the same way as other integrated circuit temperature sensors. It can be stuck or established to a surface and its temperature will be within around the range of 0.01˚C of the surface temperature.

Bluetooth:

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

Specifications Hardware features

Typical -80dBm sensitivity

Up to +4dBm RF transmit power

Low Power 1.8V Operation ,1.8 to 3.6V I/O

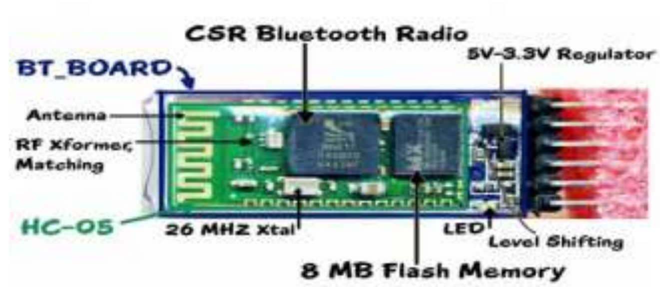
PIO control

UART interface with programmable baud rate

With integrated antenna

With edge connector

Software features



AT command Default: How to set the mode to server (master): 1. Connect PIO11 to high level. 2. Power on, module into command state.

3. Using baud rate 38400, sent the "AT+ROLE=1\r\n" to module, with "OK\r\n" means setting successes.

4. Connect the PIO11 to low level, repower the module, the module work as server (master). AT commands: (all end with \r\n)

1. Test command: Command Respond Parameter AT OK –

2. Reset Command Respond Parameter AT+RESET OK –

3. Get firmware version Command Respond Parameter AT+VERSION? +VERSION: OK Param : firmware version

Conclusion:

An IoT-based human heartbeat rate monitoring and control system is developed. This system uses the capability of a heart pulse sensor for data acquisition. A human's heartbeat is captured as data signals and processed by the microcontroller. The processed data are transmitted to the IoT platform for further analytics and visualization. Experimental results obtained were found to be accurate as the system was able to sense and read the heartbeat rate of its user and transmits the sensed data via Bluetooth to the Android mobile app(Blynk) . The implemented device can be deployed to the medical field to assist the medical practitioners to efficiently and reliably do their work without difficulties.

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