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Human Health Intimate using Bluetooth and Smartphone

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ABSTRACT

This Project is the design and implementation of Electro-Cardiogram with instant notification and storage of the report. It includes Different Communication Techniques like Bluetooth and LABVIEW for Graphical Interaction. Different Sensors are used to check the Arterial pressure and the pulse is converted into a digital format by using ADC (Analogue to Digital Converter). The value is Intimated or Displayed on The Smartphone specified. This communication is done by using Bluetooth. As well the Graphical data can be seen on the PC with the help of LABVIEW Software. The data acquisition and Storage are the main features in this project, which does not need any additional Storage or Display Device. The Simple Smartphone does all the work. The Smart phone was installed with an android app that helps to check the current Blood Pressure of a Human being as well as reading the data from the data base with simple one touch facility available on the app. The app also helps to forward the current report to the specific department or the doctor related to the treatment.

I. SYSTEM REQUIREMENT

For the implementation of current proposal various hardware and software requirement are needed. Sensors and Actuators are interfaced with the microcontroller and interfaced with PC for virtual instrumentation purpose. The detailed analysis is given below.

HARDWARE REQUIREMENT

The control interface card consists of Pressure sensor, Temperature sensor, Switches, Display unit, DC motor driver, Buzzer, Serial driver, ADC. Various analog sensors are used which are interfaced through ADC with the MCU unit. For communication with PC serial driver is being used.

SOFTWARE REQUIREMENT

All the hardware are integrated with MCU and interfaced with PC through DB9 connector. In the PC, Lab-VIEW software is needed for the Hardware and Software co-design and simulation. By using Lab-VIEW software, graphical interface design is being developed. Also KEIL software (C-51 compiler) is needed for writing the code for microcontroller unit. Circuit simulation of the proposed interface card is done through PROTEUS software. For PCB designing ARES software is used.

HARDWARE MODELLING

For the fulfillment of individual sensor and actuator interfaces various driving units are used. MCS is used as the heart of the card. Individual hardware sections are described in details as follows.

Industrial sensors are to be continuously monitored. These sensors may be Analog or Digital. Analog sensors need ADC to be digitized. Analog signal is observed to check the continuous report of the heart. Whereas the digital output from the ecg module helps to detect the current pulse as well blood pressure through serial communication. The ecg is observed through the PC. The ecg module provides the analogue data to the ADC that converts the data into a digital form and the microcontroller sends the data through serial communication port. ADC0808 is used for the implementation of the digital conversion. For wireless communication link Bluetooth is used which is a low power low cost device communicates through serial communication (RS232). 8051 microcontroller supports UART for serial communication. The communication between Bluetooth module and microcontroller is done through serial port. The PC is connected through a TTL logic voltage converter IC (MAX232). To check the ecg output graphically, PC with Lab-VIEW is designed for data logging and control. The model can work on two different modes that are output on Smart phone or on PC. In Smart phone mode according to the android app, the mobile phone is connected to the Bluetooth module. Once the connection is done, upon each reset the report is being displayed on the smart phone screen containing the android app. The App. also helps to use the gsm technology by which the current report could be sent as a message to the doctor or the observation team instantly. All the modules need power supply to be developed for the necessary hardware and peripherals connected. In general 230 VAC needed to be converted to 12/9/5/3.3 VDC which can be carried out by transformer, rectifier, voltage regulator, filter, indicator and switches consequently.

ARDUINO - UNO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

- **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50
- **Cross-platform** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- **Simple, clear programming environment** - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.
- **Open source and extensible software** - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.
- **Open source and extensible hardware** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

DISPLAY UNIT

LCD 20x4 is used as a display device through which user interface near card can be visualized and various statuses of sensor and actuators can be monitored for user friendliness.

Liquid crystal display (LCD) has material which combines the properties of both liquid and crystals. They have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an order form similar to a crystal.

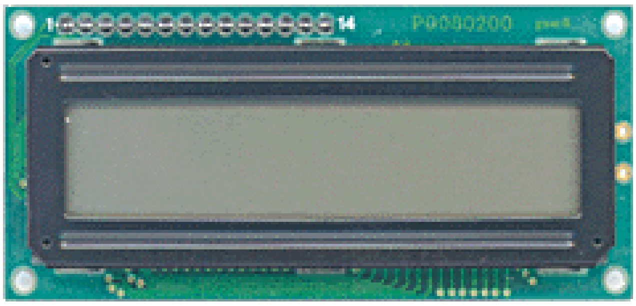


Figure 3.20 (LCD DISPLAY)

More microcontroller devices are using 'smart LCD' displays to output visual information. The following discussion covers the connection of a Hitachi LCD display to a PIC microcontroller. 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 8 x 80 pixels of the display. Hitachi LCD displays have a standard ASCII set of characters plus Japanese, Greek and mathematical symbols.

HEART BEAT SENSOR

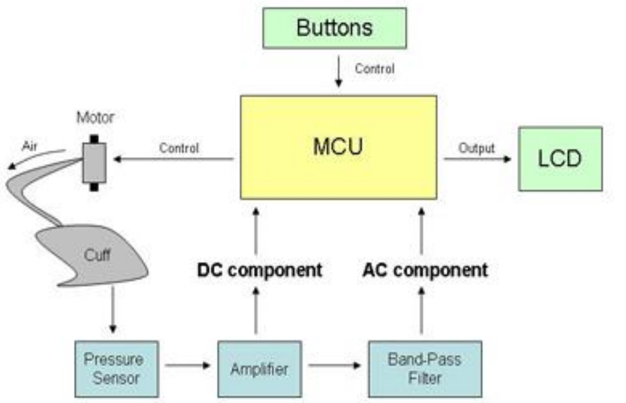
Our final project is to design and build a portable blood pressure monitor device that can measure a user's blood pressures and heart rate through an inflatable hand cuff. The device is consisted of three main parts: external hardwares (such as cuff, motor, valve, and lcd), analog circuit, and microcontroller. The anolog circuit converts the pressure value inside the cuff into readable and usable analog waveforms. The MCU samples the waveforms and performs A/D convertion so that further calculations can be made. In addition, the MCU also controls the operation of the devices such as the button and lcd display. Since we have the word 'portable' in our title, for sure all of the components are put together in one package which allows a user to take it anywhere and perform a measurement whenever and wherever he/she wants.

High Level Design

1) How blood pressures are measured

Usually when the doctor measures the patient's blood pressure, he will pump the air into the cuff and use the stethoscope to listen to the sounds of the blood in the artery of the patient's arm. At the start, the air is pumped to be above the systolic value. At this point, the doctor will hear nothing through the stethoscope. After the pressure is released gradually, at some point, the doctor will begin to hear the sound of the heart beats. At this point, the pressure in the cuff corresponds to the systolic pressure. After the pressure decreases further, the doctor will continue hearing the sound (with different characteristics). And at some point, the sounds will begin to disappear. At this point, the pressure in the cuff corresponds to the diastolic pressure.

II. HARDWARE BLOCK DIAGRAM



Hardware Description

After the motor pumps the pressure up to 160 mmHg which is approximately more than the systolic pressure of normal healthy people, the cuff starts deflating and the program enters Sys_Measure state. In this state, the program will looks at the AC waveform from ADC0 pin. When the pressure in the cuff decreases to a certain value, the blood begins to flow through the arm. At this time if we look at the oscilloscope, we will see the onset of the oscillation. The systolic pressure can be obtained at this point.

The way we program this is that we set a threshold voltage of 4V for the AC waveform. At the start, there is no pulse and the voltage at the ADC0 pin is constant at approximately 2.5 V. Then when the pressure in the cuff decreases until it reaches the systolic pressure value, the oscillation starts and grows. We then count the number of pulses that has maximum values above the threshold voltage. If the program counts up to 4, the program enters the Sys_cal state. At this state, the program records the DC voltage from pin ADC1. Then it converts this DC voltage value to the pressure in the cuff to determine the systolic pressure of the patient.

From the transfer characteristic of the pressure transducer and the measured gain of the DC amplifier, we can determine the systolic pressure by looking at the DC voltage of the ADC1 pin. We will explain the conversion procedure here. Let's the DC voltage that we read off of the ADC1 pin be �DC_voltage', and the gain of the DC amplifier be �DC_gain'. Then the differential voltage that comes out of the DC amplifier is calculated as

$$transducer\_voltage = \frac{DC\_voltage}{DC\_gain}$$

2.2) Pulse Rate Measurement

After the program finished calculating the systolic pressure, then it starts monitoring the pulse rate of the patient. We choose to determine the pulse rate right after determining the systolic pressure because at this point the oscillation of the waveform is strongest. The program samples the AC waveform every 40 millisecond. It then records the time interval when the values of the AC waveform cross the voltage value of 2.5 volts. The program then takes the average of five time intervals so that the heart rate will be as accurate as possible. The variable used for counting the number of time intervals is count_average as shown in the state diagram. After the heart rate is determined, the program then enters the Dias_measure state, in which it tries to measure the diastolic pressure of the patient.

2.3) Diastolic Pressure Measurement

After the pulse rate is determined, the program enters the Dias_Measure state. In this state, the program is still sampling the signal at every 40 millisecond. We then define the threshold for the diastolic pressure. While the cuff is deflating, at some point before the pressure reaches diastolic pressure, the amplitude of the oscillation will decrease. To determine the diastolic pressure, we record the DC value at the point when the amplitude of the oscillation decreases to below the threshold voltage. This is done by looking at the time interval of 2 seconds. If the AC waveform does not go above the threshold in 2 seconds, it means the amplitude of the oscillation is actually below the threshold. The DC value can then be converted back to the pressure in the arm cuff using the same procedure as described in the Systolic Pressure Measurement section.

III. SOFTWARE DESIGN

1) Design for the operating control

The block diagram for the operating control is consisted of a total of 7 states. We first start at the START state where the program waits for the user to push the white button of the device. Once the white button has been pushed, the measurement process begins by inflating the hand cuff. While the cuff is being inflated, if the user feels very uncomfortable or painful, he/she can push the grey button(emergency button) to stop the motor, quickly deflate the cuff and stop the measurement. This will ensure that the safety of the user is well maintained while using the device.

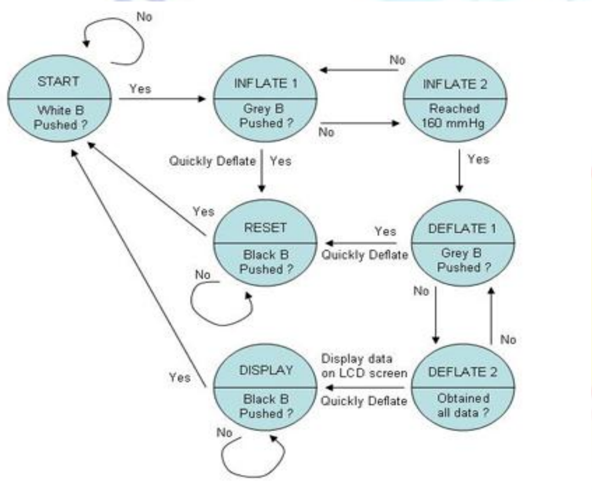


Figure 3.29 (Operation Control)

IV. HARDWARE RESULTS

PCB MODELLING AND INTERFACE CARD

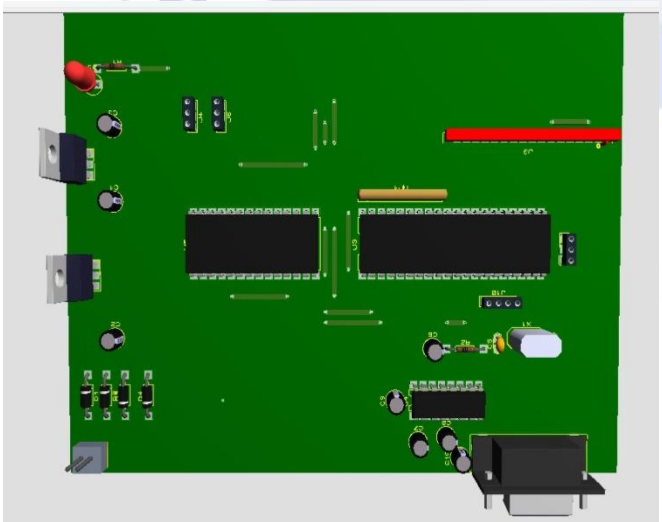
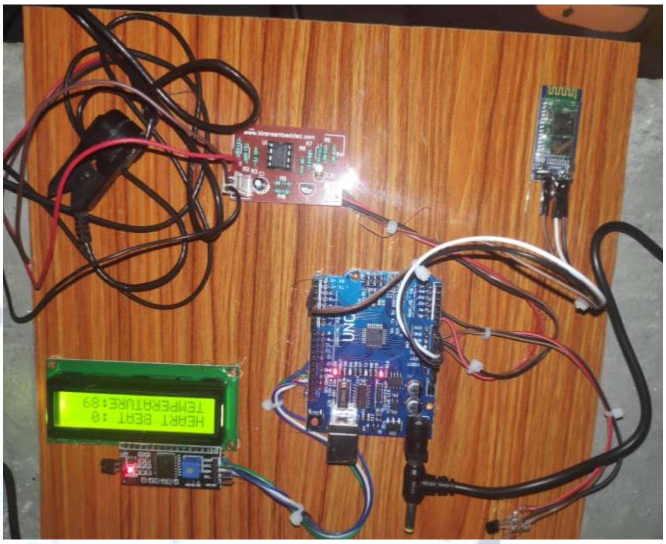
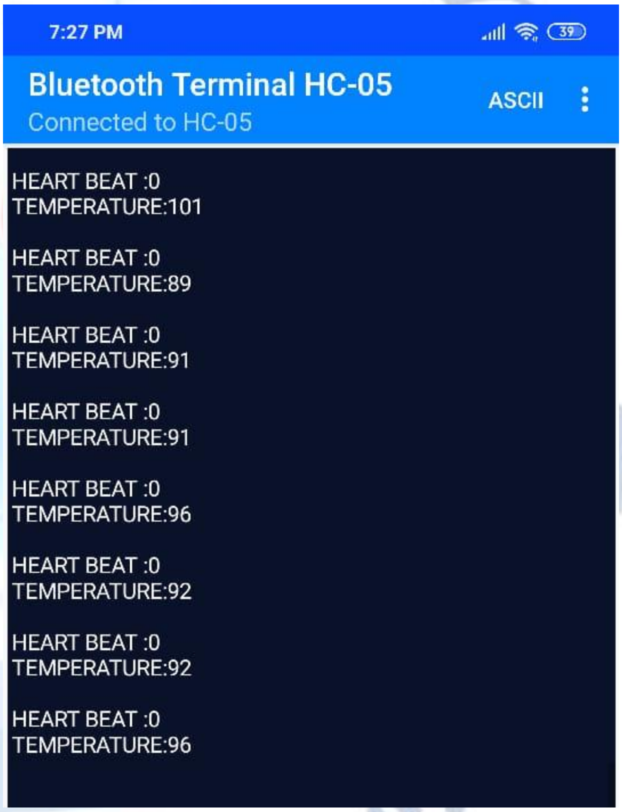


Figure 5.1 (PCB Model & Interface Card)





V. RESULTS

The results of the project are as expected and satisfactory to us. If the user stays still during the operation, the device can measure blood pressures(both systolic and diastolic) and heart rate without any problem.

1) Duration of measurement

From the start until all the measurements are done, it takes about 1.5 minutes. However, this also depends on each individual and how the cuff is worn. For each person, the amplitude of the waveforms may differ causing the operating time to vary. Still, the difference is small and is usually within 10 seconds.

2) Accuracy

As mentioned earlier, all the measurements are mainly dependent on the waveforms from the circuit and the pressure sensor is very sensitive to even a slight movement of the user. As a result, it is possible that sometimes the device fails to obtain the desired data, especially if the user does not stay still or wear the cuff improperly.

3)Safety in Design

Since this is a medical instrumentation device, the safety of the user is the first concern to us. The cuff while driven by a 5 volts motor can squeeze the arm really hard and cause injury if being used improperly. So in our device we have 3 levels of security, making sure that the operation can be aborted by the user at anytime.

4)Interference with other people's designs

Since our project only performs measurements on an individual (user), there should not be any interference produced by the device besides the sound of the motor running (which is very quiet compared to regular motors).

5) Usability

Our project should be useable to most adults, since it is basically a regular blood pressure moniotor sold in the markets nowadays. The instructions LCD screen are pretty straight forward and easy to understand. Since this device is built to be portable, it can be used anywhere and any time as long as the battery still has power.

Conclusions

1) Analysis and expectations

Most of the designs that we proposed before we started the project are met in our final result. In fact, we are really happy and satisfied with the final result of our project. The measurements are acceptably accurate (please see 'Accuracy' section in results part). The operations of the device are reliable and have not produced any major problems. The power consumption of the device is decent as we have already tried lots of measurements(more than 20) and the set of two 9-volt batteries has not died yet.

VI. CONCLUSION

This project could save the most valuable thing in the world, i.e: the human life with the help of handy Smart phones. With the implementation of Low Cost Interface Card various smaller applications can be easily automated. Graphical interface also makes the system more effective. Various sensors can be more added for further extension. The specific system can be implemented in real time with little or no change in the hardware and software. One needs to have a proper maintenance for the specific product. According to the user requirement the system can be redesigned. Also it can be used in academic sectors for the practical technological improvements of students. Manpower reduction, decreasing manual handling error, lower risk factor, increased automation, higher safety, saving time, quality control, increasing accuracy, higher production rate etc can be closely obtained along with the implementation of the present proposal.

Advantages:

- Wireless remote access
- Data acquisition
- Database maintenance
- Reduced manpower
- Increasing automation
- Graphical user control
- Easy to handle
- Low maintenance cost
- Secured transaction
- Auto voice alert system
- Low Power Consumption
- Instant observation
- Life Saver

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