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E-Health Monitoring Network with Android Based Mobile Device

Koppolu Sethaiah
M.Tech (VLSI Systems Design)
Nova College of Engineering and Technology
Vegavaram, Jangareddygudem.

Mr.Y.Kanakaraju, M.Tech
Assistant Professor
Nova College of Engineering and Technology
Vegavaram, Jangareddygudem.

Abstract

In the last decade the healthcare monitoring systems have drawn considerable attentions of the researchers. The prime goal was to develop a reliable patient monitoring system so that the healthcare professionals can monitor their patients, who are either hospitalized or executing their normal daily life activities. In this we design a system which is connected to a patient to know Temperature, Pulse Rate, and ECG. The data will be obtained from the Temperature Sensor; Pulse rate Sensor and ECG Sensor respectively, this data is given to the Controller. The Controller will communicate with PC using Serial Communication. The Readings of Patient will be displayed on PC and this PC can be used as a server.

Introduction

The electronics technology has entered almost in all aspects of day-to-day life, and the medical field is not exception for that. The need for well-equipped hospitals and diagnostic centers is increasing day by day as the people are becoming more conscious about their health problems. In biomedical fields special units are used, such as intensive care unit or coronary care unit. All of these units are designed to offer the advantage of the low Nurse - Patient ratio and concentration of the equipment and the resources needed; to take care of critically ill or seriously injured units. The medical world today faces two basic problems when it comes to patient monitoring, firstly the need of healthcare providers present bedside the patient and secondly the patient is restricted to bed and wired to large machines. In order to achieve better quality patient care, the above cited problems have to be solved. As the technologies are advancing it has become feasible to design to home based vital sign monitoring system to display, record and transmit signals from human body to any other location. The computer based Signal Acquisition, processing and analysis system using ANDROID to display status. This paper discusses the aspects of acquisition of physiological Parameters like Saline level, Temperature, Body status, Heartbeat pre-processing them and displaying them in a graphical user interface for being viewed by the doctor and also observe the clinically useful data, Firstly on Doctors LCD and secondly on Android Mobile which contains a android application. This system is expected to monitor patient under critical care more conveniently and accurately for diagnosing which can be interfaced with computer to bring it under a network system widely for the doctor to monitor the patient's condition sitting in his own office without being physically present near to the patient's bed.

Objective

The main aim the project is to design a system which is used to monitor the patient condition using Bluetooth and Wi-Fi technology which is called “Remote Health monitoring for elderly persons by using android based mobile data acquisition system”. The Data Acquisition (DAQ) solution, which collects personalized health information of the end-user, store analyze and visualize it on the Smart mobile Phone and optionally sends it towards to the data center for further processing. The smart mobile device is capable to collect information from a large set of various wireless (Bluetooth, and Wi-Fi) and wired (USB) sensors. Embedded sensors of the mobile device provide additional useful status

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information (such as: user location, acceleration, temperature, etc.). The user interface of our software solution is suitable for different skilled users and highly configurable which provides a better and more effective health monitoring system.

This Project is based on monitoring of patients. I have designed and developed a reliable, energy efficient patient monitoring system. It is able to send parameters of patient in real time. It enables the doctors to monitor patient's health parameters (temp, heartbeat, position) in real time. Here the parameters of patient are measured continuously (temp, heartbeat, position) and wirelessly transmitted using Wi-Fi or Bluetooth. This project provides a solution for enhancing the reliability and flexibility by improving the performance and power management of the patient monitoring system.

Along with patient monitoring, it is possible to monitor remotely not only the patient's status, but also some mobile hardware and software specific parameters (such as: battery level of sensors), and we also to redesigned the whole user interface of the handheld device to support elderly persons with low IT skills. Based on the received result both PC and Android based DAQ solutions are capable to provide seamless remote monitoring of elderly persons not only at home, but with Mobile Hub also abroad. The developed system provides important feedbacks about health status to the patient and to the medical experts.

Existing Method

In the previous existing method PC (Personal Computers) devices used as Data Acquisition (DAQ) systems which will able to collect vital information about the elderly patients. Existed system which monitors temperature & pulse rate of different patients and immediate action is taken using Bluetooth technology. In Existing Method the PC is also called as Home Hub (Shown in Figure 1.1) able to run on Linux. The Home Hub software are designed to be suitable for different skilled users. User interfaces are highly configurable to support elderly persons (high contrast, huge characters,). For the Home Hub a large GUI was designed with huge buttons and characters to make touch screen usage easy.

The Home Hubs are optionally equipped with touch screen, and it has also significant limitations such as power, memory, storage size and external connection support. The PC based Home Hub solution requires significant amount of electricity, and the increased electricity costs can become a limiting factor at the number of potential users. So in this Project work the Home Hub has been replaced with a Smart Mobile device called Mobile Hub. Both Mobile Hub and Home Hub are used to analyze data received from sensors. The user interface of the Home Hub is shown in Figure1.1.

Figure 1.1 Home Hub

Proposed Method

The Mobile Hub has many attractive features cheaper price, portable, location awareness, inbuilt touch screen , however on the other side it has also significant limitations compared to a full PC hardware like limited CPU power, memory, storage size and external interface connection support, The Mobile Hub is targeting different functionalities compared to the Home Hub solution due to the smaller screen size and fewer

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hardware interfaces, and it can extend the usability with additional special features, such as mobility, location awareness and small size. Mobile Hub software is capable to run almost all Bluetooth enabled and Android based Smartphone. In a sudden panic situation an alarm can be activated manually (by the patient) or automatically (by e.g. the accelerometer) with the mobile device. When an alarm signal initiated the central dispatcher is able to acquire location information (based on GSM/GPRS cell information) immediately. The Mobile Hub given in Figure 1.2 shows the Android enabled Sensor equipment for collection of Data from Patient.
The Smart mobile has small touch screen. To overcome all the usage limitation problems, two user skill sets are developed. These can be categorized based on the hardware/software utilization ability level of the patient.

- GUI for elderly persons without any IT knowledge (single button type GUI).
- GUI for normal and expert end-users

The panic button is just an icon and all the in-build additional software/hardware functionalities of a normal Android mobile phone are available (menu sets, SMS, dialling, applications, etc.). Patient can manually initiate sensor management and can manually provide measurement inputs on the GUI.

Figure 1.2 Mobile Hub

LITERATURE SURVEY

The aging population of industrialized countries increases the health care costs. Alternatively embedded remote health care can become a new cost effective paradigm, which can solve most of the problems in Health Care system. Currently, there is a large number of enabling technologies to measure the patient's physiological signals. With handheld and PC devices used as Data Acquisition (DAQ) systems can able to collect vital information about the (elderly and demented) patients. Due to the different sensor technologies and solutions, it is a hard task to create an user friendly DAQ systems. There are already remote patient monitoring solutions available such as the Android based MyFitnessCompanion [1], which is able to support Fitness, Diabetes, Asthma, Obesity, Hypertension, CHD, or the iCare[2] which provides medical guidance, emergency alarm functionality and collects personal health information. Other example is the Microsoft HealthVault [3], which supports care of elderly persons, additionally it provides online web interface to manage health information.

All Several health care projects are in full swing in different universities and institutions, with the objective of providing more and more assistance to the elderly. CAST (Center for Aging Services Technologies) [4] is organizing multiple projects.

In The Centre for Future Health [5], a five-room house has been implanted with several infrared sensors, monitoring devices and bio-sensors. The ultimate goal of the project is to provide a unified solution for the seniors in the home, enabling them to closely participate in disease detection and health management by themselves. A similar type of project named AHRI (Aware Home Research Initiative) [6] is going on at GeorgiaTech University. MobiHealth project [7] [8] [9] is going on to build a system for collecting vital body signals and manipulating those in distant health care institutes. The Terva [10] monitoring system had been introduced to collect data related to health condition like blood

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pressure, temperature, sleep conditions, weight, etc., over quite a long time. Here data has been collected four times a day (morning, noon, evening and night) and saved in the form a TOD (time-of-day) matrix and analyzed later. The whole system has been housed in a suitcase that includes a laptop, blood pressure monitor and several other monitoring devices. As a result, this system loses its mobility and becomes feasible to be used in a static manner in the home. A feedback-based self monitoring system for managing obesity named Wireless Wellness Monitor [11] has been devised using Bluetooth and Jini network to supports Java dynamic networking. The system consists of measuring devices, a home server as the base station, mobile terminals (e.g. PDA or smart phone) and databases which are connected through the internet. The measuring devices collect data and place that in the home server. Mobile terminals can access information wirelessly from the home server or can collect data from the external databases through the home server.

This Project work shows the development of remote patient monitoring environment using a client side software and Health care provider. Later on we present how this software environment has been used to do patient's location/sudden event monitoring, Pulse, and Patient's temperature in living room. By the integration of medical expertise and developing Assisted Living Patterns (ALPs), the realized system offers personalized monitoring solution for monitoring and prevention of elderly people, particularly who suffer from stroke, neurological diseases such as dementia or depression.

In the current proposed system the patient health is continuously monitored and the acquired data is analyzed at a centralized ARM [12] microcontroller. If a particular patient's health parameter falls below the threshold value, an automated SMS is sent to the pre-configured Doctor's mobile number using a standard GSM module interfaced to the ARM microcontroller. The Doctor can get a record of a particular patient's information by just accessing the database of the patient on his PC which is continuously updated through Wi-Fi or Bluetooth module.

The Mobile Hub [13] has many attractive features such as cheaper price, portable, location awareness, inbuilt touch screen. The Mobile Hub is targeting different functionalities, and it can extend the usability with additional special features, such as mobility, location awareness and small size. Bluetooth [14] enabled smart phone can collect data from different Sensors.

Temperature sensing technique RTD [15] is used to collect patient's Temperature which will be transferred to the Android based Mobile device for further processing. Liquid Crystal Displays [16] are required to display the data collected from sensors. Keil [17] performs a very detailed simulation of a micro controller along with external signals and interfaces all the modules with LPC2148 board.

OVERVIEW OF THE HEALTH MONITORING SYSTEM

Mainly the block diagram of the project consists of microcontroller, sensors, Bluetooth, Wi-Fi module, power supply and Liquid Crystal Display which is shown in Figure 3.1. In case of emergency and dangerous situations we have to alert the doctor immediately. For this we are using a Wireless network for doctor to patient communication in the hospital and also through SMS. This way of communication is actually done with Wi-Fi and with the GPS.

Each patient will be given this module and with the help of this module the patient health condition is monitored and if there is any change in the condition of the health then immediately an alarm alerts the doctor by sending a message. The same information is transferred as message to the corresponding or relevant person

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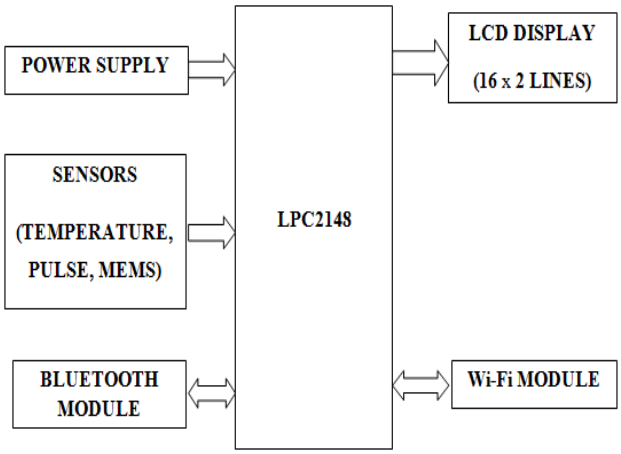

Figure: 3.1 Block Diagram of the Project

The project will use ARM7 TDMI-S based NXP's (National Semiconductors and Philips) LPC 2148 microcontroller in LQFP (Liquid Quad Flat Package) with 64 pins. The Power requirement of LPC2148 Microcontroller is 3.3VDC and VSS ground. The power supply for the LPC2148 is produced by using available 1 Φ 230VAC with the help of conversion AC to DC supply which includes four most basic steps of step down the available power to required level of power supply, Rectification of 1Φ supply to the pulsated DC supply, filtering of Pulsated DC supply to non regulated DC supply and then through regulator a pure regulated DC supply is produced.

The Mobile Hub has many attractive features cheaper price, portable, location awareness, inbuilt touch screen , however on the other side it has also significant limitations compared to a full PC hardware like limited CPU power, memory, storage size and external interface connection support, The Mobile Hub is targeting different functionalities compared to the Home Hub solution due to the smaller screen size and fewer hardware interfaces, and it can extend the usability with additional special features, such as mobility, location awareness and small size.

Mobile Hub software is capable to run almost all Bluetooth enabled and Android based Smartphone. In a sudden panic situation an alarm can be activated manually (by the patient) or automatically (by e.g. the accelerometer) with the mobile device. When an alarm signal initiated the central dispatcher is able to acquire location information (based on GSM/GPRS cell information) immediately (see Figure 3.2 shown below).

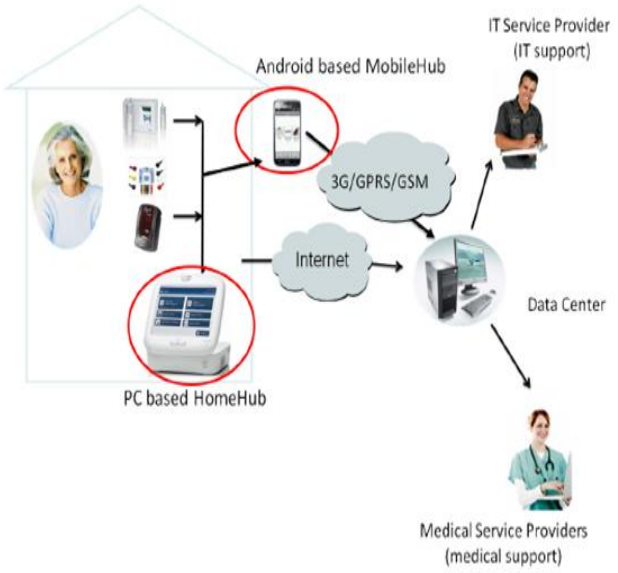

Figure: 3.2 Overview of the Health Monitoring System

LPC2148 ARM7 PROCESSOR

The LPC2148 (Low Pin Count) microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support. They will combine the microcontroller with embedded high-speed flash memory ranging from 32kB to 512kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. It is used to interface all the modules.

Block Diagram of LPC2148

The block diagram of LPC2148 is shown in Figure 4.3 below.

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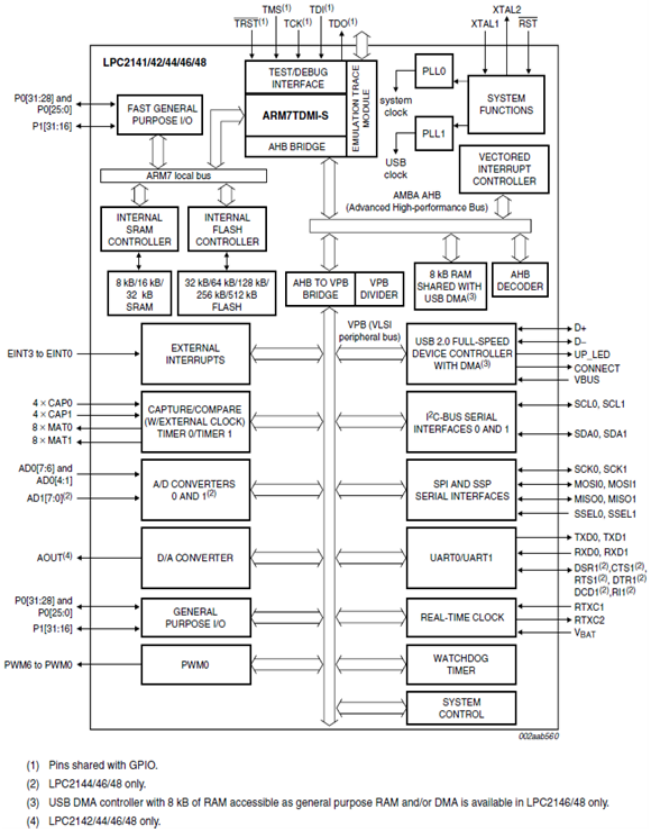

(1) Pins shared with GPIO.
(2) LPC2144/46/48 only.
(3) USB DMA controller with 8 kB of RAM accessible as general purpose RAM and/or DMA is available in LPC2146/48 only.
(4) LPC2142/44/46/48 only.

Figure 4.3 Block Diagram of LPC2148

Pin Configuration

The Pinning of LPC2148 is shown in Figure 4.4.

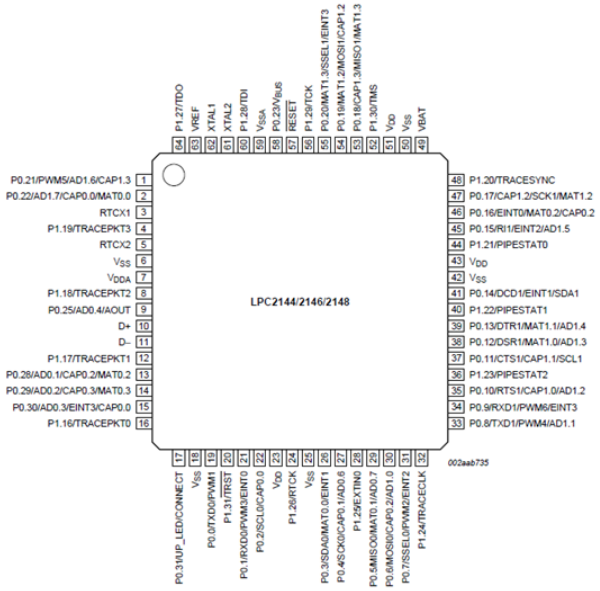

Figure 4.4 Pin Configuration

Working of LM35

The LM35 can be applied easily in the same way as other integrated-circuit temperature sensors. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60µA from the supply, it has very low self-heating of less than 0.1°C in still air. The temperature-sensing element is then buffered by an amplifier and provided to the V_{out} pin. The amplifier has a simple class A output stage with typical 0.5Ω output impedance. Therefore the LM35 can only source current and its sinking capability is limited to 1µA. The 8th pin is connected to supply voltage of 4V dc. The 4th pin is connected to ground and the output is drawn from 1st pin.

The accuracy specifications of the LM35 are given with respect to a simple linear transfer function:

$$V_{out} = 10\ mv/°F \times T$$

Where

V_{out} is the LM35 output voltage

T is the temperature in °C

The only functional mode of the LM35 (see in Figure 4.12) is that it has an analog output directly proportional to temperature. Typical arrangement of LM35 is shown below,

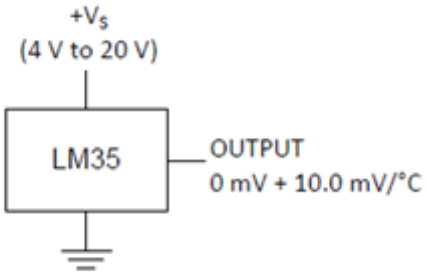

Figure 4.12 Basic Centigrade Temperature (2˚C to 150˚C)

Applications

The features of the LM35 make it suitable for many general temperature sensing applications. Multiple package options expand on its flexibility. The most common applications of LM35 are,

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- Power supplies
- Battery management
- HVAC
- Appliances

RESULTS

The developed system is verified at different conditions with different temperatures. The Temperature, Pulse, and Movement of different Persons are collected using the developed equipment which is shown below. The Person's behavior can also estimated with collected Pulse measurement, whether the Person is angry or normal. The screen shots of Health Monitoring Android App and Measurement of Pulse, Temperature, Movement of Persons are displayed below.

This system presents an upgrade to the existing health monitoring systems in the hospitals by providing monitoring capability and a thus a better cure. This system is based upon wireless technology Wi-Fi or Bluetooth low cost effective solution. As it is wireless device, the cost of cables is reduced here. It provides continuous monitoring of the vital signs of the patient over long periods of time until an abnormal condition is captured and hence critical situations can be overcome. This Health monitoring system provides long term monitoring capability useful for the staff in the hospitals and reduces their work load. Future work may include more number of sensors in a single system to provide flexibility.

The proposed system has the following advantages

Easy and Reliable for Doctors

In a hospital, either the nurse or the doctor has to move physically from one person to another for health check, which may not be possible to monitor their conditions continuously. Thus any critical situations cannot be found easily unless the nurse or doctor checks the person's health at that moment. This may be a strain for the doctors who have to take care of a lot number of people in the hospital.

Increase efficiency

The number of nurses required for keeping a check on patients in ICU can be reduced to a large extent.

More Accurate

Chances of human error in checking different health parameters is also reduced, also the database can be updated time to time.

Working condition of the System

When we power on the circuit shown in the Figure 6.1, all the LEDs on PCBs are glowing, indicating that circuit is working properly shown in Figure 6.1. Here there is a use of the industrial temperature sensor i.e. LM 35 which gives us room temperature in ˚C. That temperature is displayed on the LCD as shown in Figure 6.1. All the Sensors are interfaced to the LPC2148 Microcontroller.

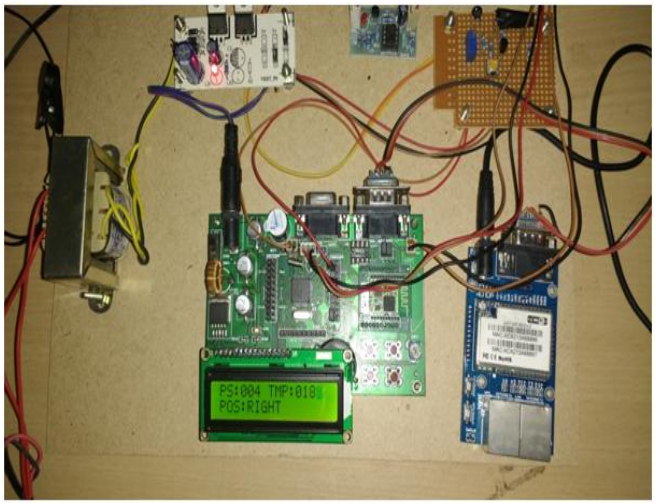

Figure 6.1 PCB development of Health Monitoring System

Sensor Measurement

As shown in Figure 6.2 there is a cavity for measurement of the heartbeat, which consist of a arrangement of LED and LDR. By placing your finger in between a LED and LDR, we can detect the pulses of heart. Result is displayed on the LCD. This collected data is transmitted using Wi-Fi module (see Figure 6.2).

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Figure 6.2 Wi-Fi Module

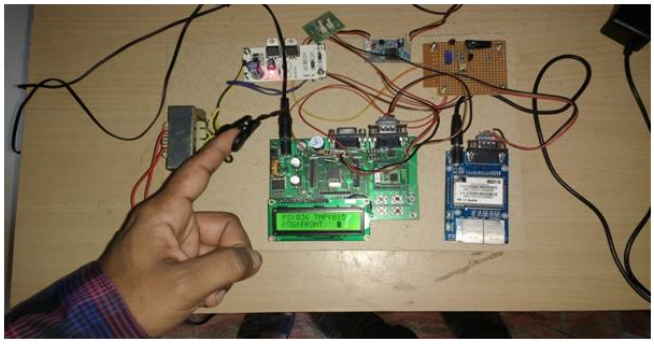

Figure 6.3 Measurement of Pulse

Use of Smart Phone

Android based Smart Phone is used to show the results. An Android App called Connection Terminal is configured and connected to the Health Monitoring System. The Figures 6.4 and 6.5 shows the Connection Terminal (circled in red) and its configuration respectively.

Figure 6.4 Screen Shot of Android App

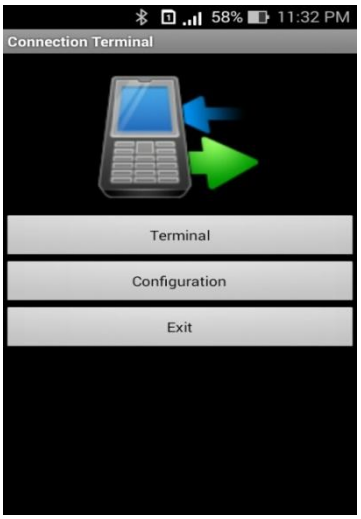

Figure 6.5 Screen Shot of Connection

Terminal

The measured parameters such as Temperature, Position and Pulse Rate of the Person are updated every time. When we place our finger in between the clips of the Pulse Sensor, the measured Pulse Rate is transferred to the Wi-Fi or Bluetooth enabled Smart Phone which is already configured. Screen Shots of Measurement of Pulse, Temperature, and Movement of different Persons are shown below. The Figure 6.6 has high Pulse indicates that the person is in angry or hurry with his work. The Figure 6.7 indicates that the person is in normal condition. The measured information using the system can be transferred to the Doctor or care givers.

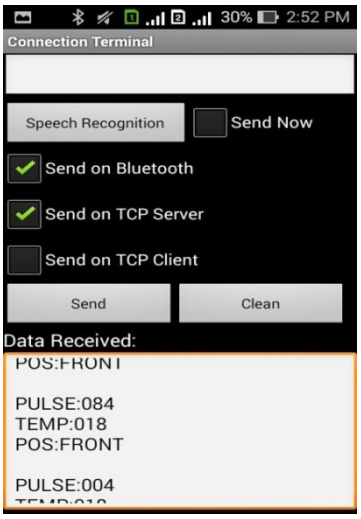

Figure 6.6 Screen Shot1

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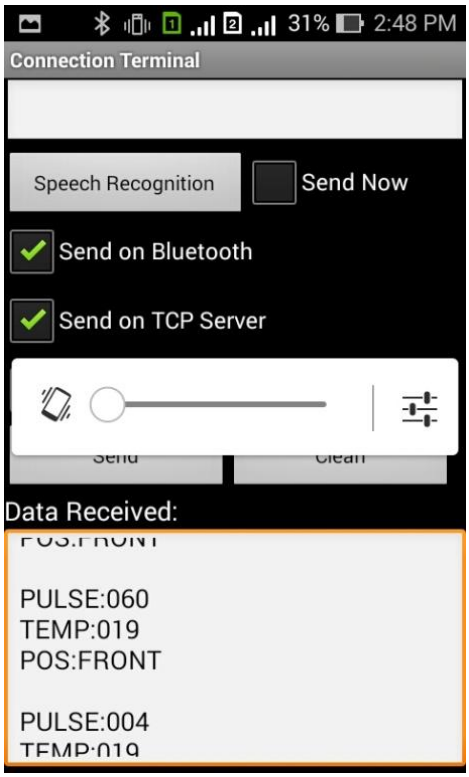

Figure 6.7 Screen Shot2

CONCLUSION AND FUTURE WORK

The project Health Monitoring System has been rigorously tested in the Lab environment. Beside patient monitoring mobile hardware and software specific parameters (such as: battery level of sensors) also redesigned and modified the device to support elderly persons with low IT skills. According to the received results the Monitoring solutions are capable to provide seamless remote monitoring of elderly persons at home. The developed solutions provide important feedbacks about health status to the patient and to the medical experts.

The project "E-Health Monitoring Network with Android Based Mobile Device" has been successfully designed and tested. It has been developed by integrating features of all the hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit.

The developed Android App is configured to only one Person, but we can also provide DAQ solutions to multiple numbers of Patients. According to the availability of sensors or development in biomedical trend more parameter can be sense and monitor which will drastically improve the efficiency of the Health monitoring system in the society.

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