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Patient Monitoring System using Arduino Nano and Android Application

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***Abstract*— Recent years have seen a rising interest in wearable sensors and today several devices commercially available for personal health care, fitness, and activity awareness, researchers have also considered applications of such technologies in clinical applications in remote health monitoring systems for long term recording, management and clinical access to patient's physiological information. Based on current technological trends, one can readily imagine a time in the near future when the routine physical examination is preceded by a two–three day period of continuous physiological monitoring using inexpensive wearable sensors. Wireless technology has completely transformed the way we live, but health care is yet to enter the digital life at least at remote areas. This will overcome the problem of people living in remote areas where the availability of health care centers and facility of transportation are not good enough. This will also help the people who don't have enough time to look after their health and go for regular checkup to the health care centers.**

***Index Terms*—** Health Care, Wearable sensors, Wireless technology**.**

I. INTRODUCTION

Wireless technology, in the long run has completely transformed the way people live, but health care of people at remote areas is yet another critical thing that ought to enter the digital age for the complete technological development in the wireless field. The main goal of the project is to make room for quicker and quality health assistance to patients at locations that are physically too remote to the well-equipped hospitals consisting of doctors (specialists) in every medical domain using modernized communication and for people with not enough time to look after their health and go for regular checkup to the health centers. By exposing the human body to biosensors (Wearable sensors), one can measure any physiological parameters blood pressure level, body temperature and pulse rate etc.

II. OBJECTIVE AND METHODOLOGY

The aim of this project is to design a system which can continuously monitor the health of the person, in order to do this two sensors have been interfaced to a Arduino Nano and the physiological parameters like heart rate and body temperature are sensed which is then transmitted via Bluetooth to android application which is coded to display two variables one is pulse rate sensor (BPM) and body temperature (ºC) in the smart phone.

In Arduino the sensors and Bluetooth are interfaced and the sensor output is serially transmitted using

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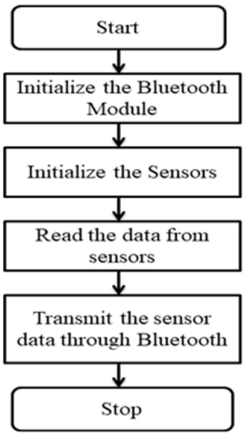
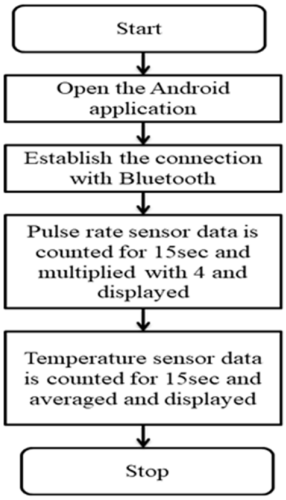
Bluetooth device. The sensors used are pulse rate and temperature sensor.
The android application is built which calibrates the data for 15sec.For pulse rate sensor, the sensor output is counted for 15 sec and is multiplied by 4 and is displayed on android application. For temperature sensor the temperature values are counted for 15 sec and average value is displayed on the android application



Flowchart for Arduino interfaced with sensors and Bluetooth.



Flowchart for Android application.

III. System Block Diagram

Data Acquisition is performed by multiple wearable sensors that measure physiological biomarkers, such as ECG, skin temperature, respiratory rate, EMG muscle activity, and gait (posture). The sensors connect to the network though an intermediate data aggregator or concentrator, which is typically a smart phone located in the vicinity of the patient. Sensors used are pulse rate sensor and LM35 which measures the pulse rate and body temperature respectively. These sensors are interfaced to a microcontroller (Arduino Nano), via Bluetooth module (HC-05) the sensor data is transmitted to the smart phone as shown in the Figure 1.

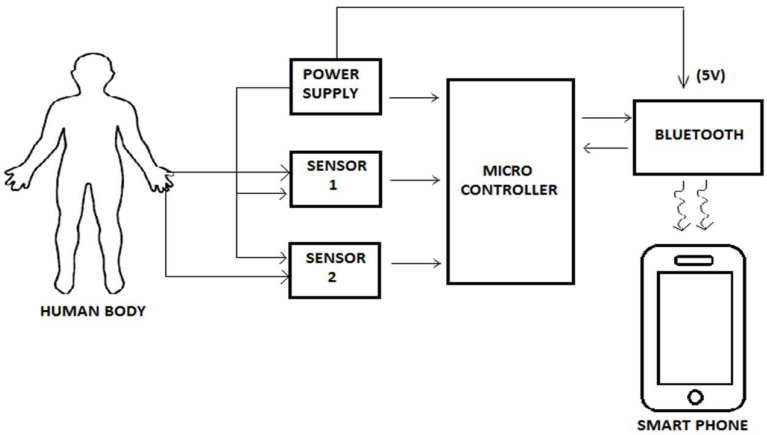
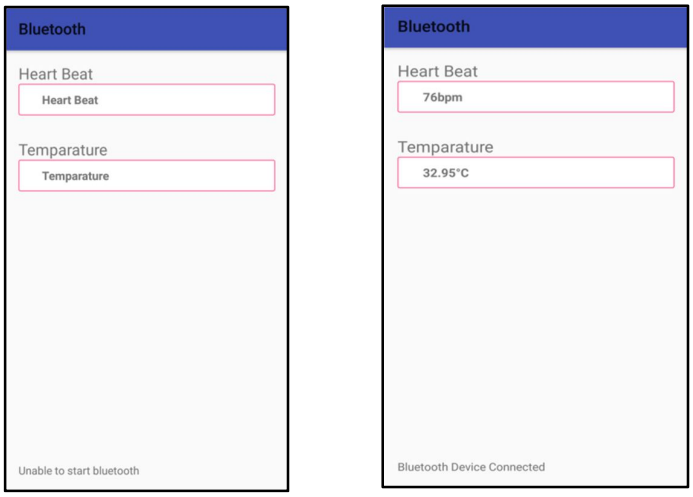


Figure 1: Patient Monitoring System Block Diagram

Sensors transmit the gathered information to a gateway server through a Bluetooth connection. The gateway server turns the data into an Observation and Measurement file and stores it on a remote server for later retrieval by clinicians through the Internet. In addition to the technology for data gathering, storage and access, medical data analysis and visualization are critical components of remote health monitoring systems. Accurate diagnoses and monitoring of patient's medical condition relies on analysis of medical records containing various physiological characteristics over a long period of time.
Smartphone This is a concentrator where the data is received from the Bluetooth (HC-05) or to an android application. IoT based devices in remote health monitoring systems are not only capable of the conventional sensing tasks but can also exchange information with each other, automatically connect to and exchange information with health institutes through the Internet, significally simplifying set up and administration tasks.

IV. Android Application

The android application designed is shown in Figure 3.3. Using the Android Studio the sensor data is being calibrated for 15 sec. For heart rate sensor the beats are counted for 15 sec's by using a heartbeat counter and is multiplied by 4 (i.e. 15 sec *4= 60 sec's = 1 min, heart beat per minute) and is displayed in the android application. For temperature sensor the temperature values for 15sec is stored in a buffer and the average of temperature for 15 sec is displayed in the android application as shown in the Figure 2.



Android software development is the process by which new applications are created for the Android operating system. Applications are usually developed in Java programming language using the Android software development kit (SDK).
The Android software development kit (SDK) includes a comprehensive set of development tools. These include a debugger, libraries, a handset emulator based on QEMU, documentation, sample code, and tutorials. Currently supported development platforms include computers running Linux (any modern desktop Linux distribution), Mac OS X 10.5.8 or later, and Windows 7 or later. As of March 2015, the SDK is not available on Android itself, but software development is possible by using specialized Android applications.

V. Test and Results

The temperature sensor LM35 Sensitivity is tested in lab and the corresponding output voltage is noted for change in input temperature as shown in the graph below.

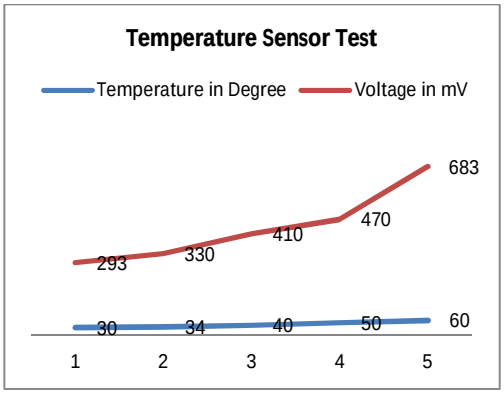


Figure 2: LM35 Sensor Test Results

Pulse Rate Sensor: Pulse Rate Sensor is interfaced with Arduino Nano and tested for 7 patients for 15 sec each and the pulse rate count is noted as shown in the Table I.

TABLE I: PULSE RATE SENSOR TEST RESULTS

Patients	Pulse Rate count
1	18
2	16
3	19
4	15
5	17
6	18
7	15

After interfacing both the sensors to the Arduino Nano the device is tested on 7 individuals. The obtained pulse rate and temperature is tabulated and shown in Table 3.

TABLE II: END MODULE RESULT

Parameters	Pulse Rate (BPM)	Temperature (°C)
Patient 1	62bpm	35.12
Patient 2	72bpm	37.45
Patient 3	68bpm	34.18
Patient 4	80bpm	36.72
Patient 5	76bpm	35.68
Patient 6	65bpm	37.00
Patient 7	74bpm	37.10

V. CONCLUSION AND FUTURE SCOPE

A smart phone based health monitoring system has been presented in this work by using a wearable sensor. The system is simple. It is just few wires connected to a small kit (Arduino Nano) with a smart phone. The system is very power efficient. It is easy to use, fast, accurate, high efficiency, and safe (without any danger

of electric shocks). In contrast to other conventional medical equipment the system has the ability to save data for future reference. Finally, the reliability and validity of the system have been ensured via field tests. The field tests show that the system can produce medical data that are similar to those produced by the existing medical equipment.

The product developed can be modified and improved by interfacing more number of sensors, For example: EEG electrodes can be interfaced etc. Using Internet of Things (Raspberry pi board) different sensors can be interfaced and can be implemented in such a way that the data is accessible for both the patients as well as health care centers which can be done using cloud storage by updating data to the cloud and this can be continuously monitored in health care centers which reduces the time and cost.

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