Remotely Accessible Real Time Health Monitoring System

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Abstract— **In India, lives are getting affected because the patients are not getting proper and on time treatment. Also Sometimes it becomes difficult for doctors to frequently check patient's conditions. This paper presents the design of an smart network based Telemedicine system. The main aim of the system is to prevent delays in the arrival of patient's medical information to the healthcare providers, particularly in accidental conditions and emergency situations, to stop manual data logging. Monitoring of patient's blood pressure, ECG, body temperature and Respiration rate using Raspberry Pi. After connecting Internet to the Raspberry Pi board acts as a server, it automatically sends data to the web server .Then these parameters are monitored using web page or mobile application anywhere in the world using laptops, smartphone etc. If these parameters show any abnormality then it will automatically sends alert message to the doctor.**

Index Terms— **Telemedicine System, Raspberry Pi board, Temperature sensor, Internet of Things, ECG.**

I. INTRODUCTION

Growth of the "Internet of Things" is changing the world and the greater drop in price for typical IoT components is allowing engineers to innovate new designs and products at home [1]. The fusion of novel advances in technology with the healthcare systems provide us with a wide window for improvements in the areas of patient care and communications, support for decision making and reducing the inaccuracies.

A major aspect in the healthcare system is the monitoring of the patient's vital signs such as temperature, blood pressure and heart rate. Many monitoring devices that display the patient's vital signs are commonly present in the critical care units in operating rooms [2] .This paper reports the system in which the body sensors like Temperature, Blood Pressure and ECG sensors gives accurate value of the patient's vital signs using Body Area Network (BAN) and upgrade the current status to the Raspberry Pi based server continuously so that, the doctors no need to check up their patient personally.

The Raspberry Pi works as a server. When it is connected to the internet, automatically data is sent to the webpage or cloud. Then the collected data of blood pressure, Body temperature, Breathing rate and ECG) are monitored. If any parameters goes abnormal values then it will automatically send an alert message to the doctors and relatives to take the necessary actions. Internet Of Things (IOT) based health monitoring system provides with centralized storage and processing of data collected from various locations (no boundaries as long as connectivity to internet is available) which increases the convenience of data management.

II. WORKS DONE IN THE PAST

Vivek Pardeshi et al [4] monitor patient's body temperature, blood pressure, heart beat and ECG using Raspberry Pi. All the information is first acquired, processed and stored at memory of Raspberry Pi. The stored information is then transferred to the receiver by means of IoT server. The Receiver section is present at doctor end. At receiver section, all the information is received. Monitor displays the result of each sensor which is attached to Raspberry Pi.
Megha Koshti et al [5] proposed a system to gather ECG data, Process it using Matlab software with accuracy of 95.4%, then it is stored on server using IOT.

M. Wcislik et al [3] monitor patient's body , ECG wave, pulse rate, patient's body position and body temperature using ARM cortex M4F Microcontroller. Android app is created for monitoring of these values. Bluetooth is used for connecting microcontroller and Android phone. We are focusing on monitoring of patient's body temperature, breathing rate, ECG and blood

pressure using Raspberry Pi board and sensors connected in star topology. Android app is supported only in android phones. Bluetooth is very short distance for communication. It's range is within 100 meters.

Amir-Mohammad Rahmani [6] monitor's ECG wave using panda board. Ethernet is used for connecting internet to the panda board. Panda board is quite expensive when compared to Raspberry Pi

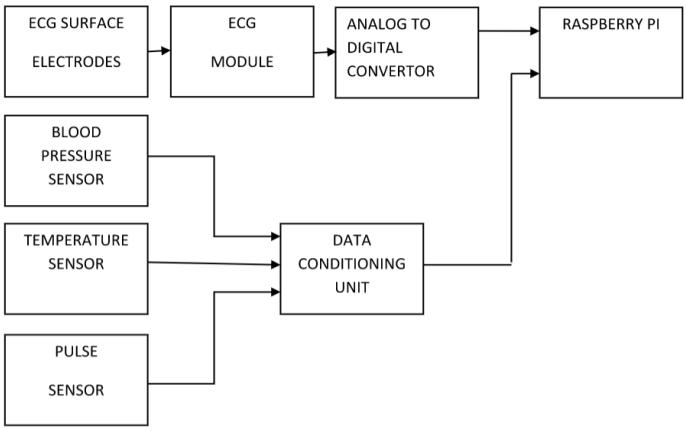

Figure 1- Block diagram of system

Figure 1 shows block diagram of data acquisition system. Raspberry Pi is selected as main controller of the system. First, Raspberry Pi is installed using SD card successfully. Sunrom Blood Pressure and Pulse Sensor was connected to the serial port of Arduino Nano. An obstructive cuff is placed on the left arm and is connected to an air pump and a pressure sensor. Inflation of cuff is done until a pressure greater than the typical systolic value is achieved, then the cuff is slowly deflated. As the cuff deflates, when systolic pressure value approaches, pulsations start to appear. The pulsations produced in this process represent the pressure changes due to heart ventricle contraction and can be used to calculate the Pulse readings. Temperature sensor is connected with digital pins of the Arduino Nano, The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. For Electrocardiogram measurement ECG adhesive electrodes are places on body parts to collect biomedical signals i.e ECG signal. These signals are very weak .So it needs to be amplified. So ECG data acquisition module such as AD8232 is selected. It amplifies and filters the ECG signals. Further module is connected to Analog to Digital converter (ADC) of Arduino Nano to produce digital readings of sampled data to plot the ECG graph.

All the digital values acquired from the above mentioned sensors were sent to the Raspberry Pi through USB port present in Raspberry Pi using Universal Asynchronous Receiver-Transmitter (UART). A user interface is developed using java based platform named Processing, it is a flexible software sketchbook and a language for learning how to code within the context of the visual arts [9], it is an Integrated Development Environment where graphical user interface and graph plotting can be done with greater ease, especially when non programmers are considered. To view the final display with programmed GUI, VNC server was configured in Raspberry Pi and then Raspberry Pi can be configured and displayed on respective computers and smartphones by installing VNC viewer. So that now completely encrypted connection is established and if Raspberry Pi is active then respective data can be visualized, sitting on any place across the globe.

III. DEVELOPED SYSTEM

IV. HARDWARE REQUIREMENTS

A. Electrodes

Electrodes used in developed system are adhesive. These are placed on body parts to get ECG signals. Generally electrodes are coated with Ag-AgCl. There are 3 electrodes used form a single lead System. It creates potential difference in between them. It will generate the ECG plot[7].

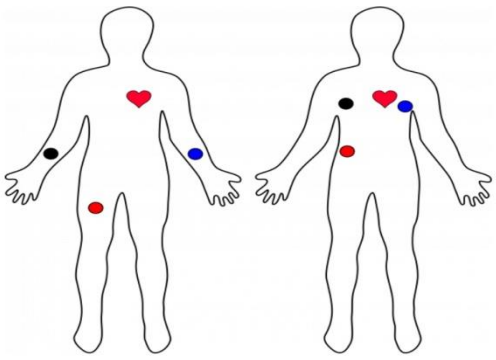

Figure 2- Electrode Placement

B. ECG Data Acquisition Module

It is fully integrated signal conditioning ECG front end circuit. It is used to amplify and filter ECG signals obtained from ECG electrodes. AD8232-ECG acquisition module has output pin to which ADC is connected. Single supply operation is within 2.0 V to 3.5 V. Output pin of Ad8232 is further connected to ADC[7].

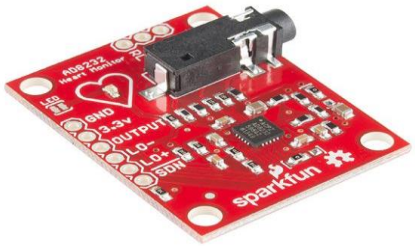

Figure 3- AD8232 Module

C. Sunrom Blood Pressure and Pulse Sensor

This sensor is has Intelligent automatic compression and decompression system which makes it easy to operate with switching button to start the measurements with Large-scale digital liquid crystal display screen. It works on 200mA regulated current from 5v power supply. Its Output Format is Serial Data at 9600 baud rate (8 bits data, No parity, 1 stop bits). Outputs three parameters in ASCII[8].

Figure 4- Blood pressure sensor

D. Raspberry Pi

The Raspberry Pi is a pocket sized, low cost computer that is plugged into a computer monitor or TV and uses a standard keyboard and mouse. The Raspberry Pi Model B uses Quad Core Broadcom BCM2837 64-bit ARMv8 processor with clock speed of 1.2GHz on the Pi 3, it contains BCM43438 WiFi chip BUILT-IN so it is WiFi ready. There's also Bluetooth Low Energy (BLE) on board making the Pi an excellent IoT solution (BLE support is still in the works, software-wise). It works on 5V, 2.5 Amps allowing it to power even more powerful devices over USB ports.

Figure 5 - Raspberry Pi 3 (Model B)

E. DS18B20 Temperature sensor

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply[10]. Due to one wire interface it requires only One Port Pin for Communication. Measures Temperatures from range of -55°C to +125°C (-67°F to +257°F), With an accuracy of ±0.5°C.

Figure 6- DS18B20 Temperature sensor

F. Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the microcontroller ATmega328P, operating voltage of

5v with 14 digital input-output pins and 8 analog input pins and offers the same connectivity and specs of the UNO board in a smaller form factor. The Arduino Nano is programmed using the Arduino Software (IDE) Integrated Development Environment common to all Arduino boards and running both online and offline[11]. Arduino Nano has 8 channel ADC (Analog to Digital Converter), through which analog data can be converted to digital data for digital processing. All the data acquired through various pins can be transmitted serially using UART.

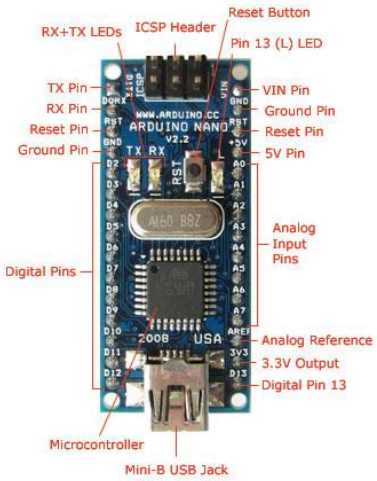

Figure 7- Arduino Nano

V. SOFTWARE REQUIREMENTS

A. Processing 3

Processing is an open-source computer programming language and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching non-programmers the fundamentals of computer programming in a visual context. The Processing language builds on the Java language, but uses a simplified syntax and a graphics user interface[12]. It is more visual oriented and best for plotting graph and development of viewer interface.

B. VNC viewer

In computing, **Virtual Network Computing** (**VNC**) is a graphical desktop sharing system that uses the Remote Frame Buffer protocol (RFB) to remotely control another computer. It transmits the keyboard and mouse events from one computer to another, relaying the graphical screen updates back in the other direction, over a network.

VNC is platform-independent – there are clients and servers for many GUI-based operating systems and for Java. Multiple clients may connect to a VNC server at the same time. Popular uses for this technology include remote technical support and accessing files on one's work computer from one's home computer, or vice versa[13].

VNC server is freely available with Raspberry Pi, it gets started once it is configured. VNC viewer is an application, which is available on various platforms for various platforms for example windows, linux, android, Ios etc. so raspberry pi can be remotely handled and observed using VNC viewer application through gadgets having above mentioned platforms.

VI. RESULTS

ECG measurement electrodes were connected to the body as shown in figure 2, analog signal from electrodes were processed in ADC of Arduino Nano to produce digital data which was sent serially over USB. The data from the USB port is observed through processing visualizer by plotting the incoming digital values with time.

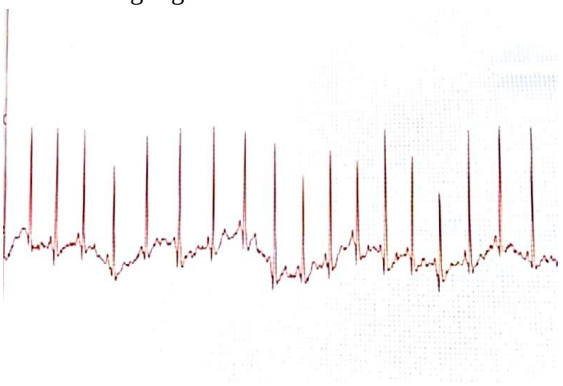

Figure 8- ECG plot

Blood pressure, pulse and temperature measurement was done using using the sensor mentioned above and serial data was formatted to differentiate the received data at the Raspberry Pi end and displayed by the Processing developed interface.

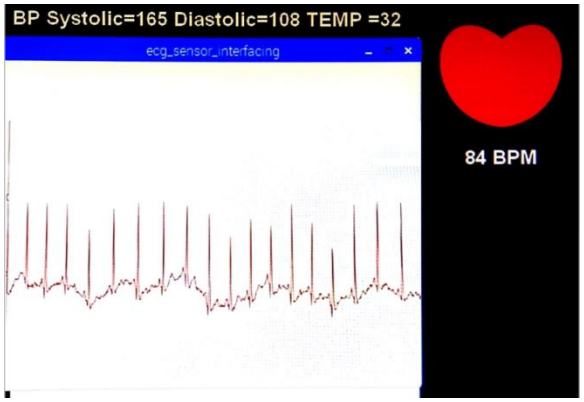

Figure 9- Final screen representing outputs

Final screen represents Blood pressure values (systolic and diastolic), body temperature temperature in degree celsius and pulse rate in Beats Per Minute.

Final output can be observed on respective PC or smart phones with necessary condition of internet connectivity using VNC viewer application installed on respective PC or smartphones. Major benefit of using VNC server is that data is completely encrypted and security is high along with the live streaming of ECG graph.

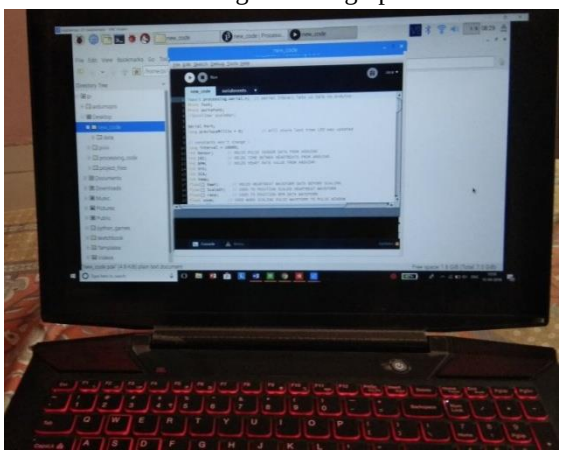

Figure 10- Raspberry Pi access using VNC server on laptop

Overall accuracy of system was close to 95% which includes body temperature, pulse and blood pressure management.

VII. CONCLUSION AND FUTURE WORK

The objective of this project was to build a low power, low cost, reliable, non-intrusive, and non-invasive monitoring system that would accurately measure the vital signs. A reliable and continuous vital sign monitoring system targeted towards individuals, According to the research and projects that had been discussed, developed health monitoring system have the potential to revolutionize healthcare by providing low-cost solutions for ubiquitous, real-time, unobtrusive mobile health monitoring. An early detection will allow treatments to be rendered and this will help to save more lives. However, the current status of developing integrated, reliable, cost-effective and user-friendly wearable medical systems is far from the goal of "affordable, real-time, anywhere, high security and accuracy", and only a minority of the projects can achieve this goal. Clinical validation is also a significant component to realize the worth of these systems, but in fact, not all of them are used or applied to the public.Sensors, battery and on-body hardware size tend to miniaturize as well as low power requirement serve as a powerful impetus to medical devices to be used widely[14].

Given the scope of this project, the ECG and temperature measurement circuits accurately measure the heart rate signal and body temperature T in due time limitations.

This project can be improved and expanded in numerous ways. First of all, the target group for this product can be expanded to include people of all ages, the sensors can be wirelessly connected to the phone and microcontroller / processor, making it comfortable and non-intrusive for the user to wear.

Some recommendations for future work is to add more functionality to the system by interfacing more sensing nodes like sensors to detect oxygen level in the blood, glucose level in body, calorie burn by body, total distance walked.

Image processing can also be added in the system to make it a complete directory for list of the vital habits including hygiene and kind of food that people using this system should eat, depending upon the past history of health issues they had.

Connecting to GPS with an emergency button can provide extra support by calling ambulance directly to the respective location at which the person wearing the designed embedded system is present.

REFERENCES

[1] R.Kumar, Dr.M.Pallikonda Rajasekaran, "AN IOT BASED PATIENT MONITORING SYSTEM USING RASPBERRY PI" International Conference on Current Research in Engineering Science and Technology (ICCREST-2016)

[2] M. Surya Deekshith Gupta, Vamsikrishna Patchava, V irginia Menezes, " Healthcare based on loT using Raspberry Pi "978-1-4673-7910-6/15/$31.00 ©20 15 IEEE {paper3}

[3] M. Wcislik, M. Pozoga, P. Smerdzynski "Wireless Health Monitoring System", IFAC (International Federation of Automatic Control) Hosting by Elsevier Ltd. pp 312–317 , 2015.

[4] Vivek Pardeshi, Saurabh Sagar, Swapnil Murmurwar, Pankaj Hage, "Health Monitoring Systems using IoT and Raspberry Pi – A Review" International Conference on Innovative Mechanisms for Industry Applications (ICIMIA 2017) 978-1- 5090-5960- 7/17/$31.00 ©2017 IEEE.

[5] Megha Koshti, Prof. Dr. Sanjay Ganorkar "IoT Based Health Monitoring System using Raspberry Pi" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (An ISO 3297: 2007 Certified Organization) Vol. 5, Issue 8, August 2016

[6] Amir-Mohammad Rahmani, Nanda Kumar Thanigaivelan, Tuan Nguyen Gia, Jose Granados, Behailu Negash, Pasi Liljeberg, and Hannu Tenhunen, "Smart e-Health Gateway: Bringing Intelligence to Internet-of-Things Based Ubiquitous Healthcare Systems", IEEE consumer communications and networking pp 826-834, 2015.

[7] RASPBERRY PI BASED ECG DATA ACQUISITION SYSTEM Ms.Gauravi.A.Yadav, Prof. Shailaja.S.Patil, Department of electronics and telecommunication Engineering Rajarambapu Institute of Technology, Rajaramnagar (India)

[8] https://www.sunrom.com/p/blood- pressure-sensor-serial-output

[9] https://processing.org/

[10] https://www.maximintegrated.com /en/products/analog/sensors-and-sensor-interface/DS18B20.html/tb_tab0

[11]https://www.arduino.cc/en/Guide/ArduinoNano

[12]https://en.wikipedia.org/wiki/Processing_(programming_language)

[13]https://en.wikipedia.org/wiki/Virtual_Network_Computing

[14] Ting Liang and Yong J Yuan*, "Wearable medical monitoring systems based on wireless networks: A Review" 1530-437X (c) 2016 IEEE.