IoT based Real Time Patient Monitoring and Analysis using Raspberry Pi 3

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***Abstract* – As global ageing and chronic diseases are increasing day by day, the diagnosis from hospital centric to home centric is needed. The idea presented here is a real time remote patient monitoring and analysis using Raspberry Pi 3. Raspberry Pi is credit card sized single board computer with ARM11 microprocessor with LINUX based operating system. Python is used as the programming language in Raspberry Pi, which is an open source programming language. The presented system involves sensors to acquire the biological parameters from the patient's body and transmit it wirelessly to the website that can be accessed by any medical expert across the world for diagnosis. This parameters are stored in the MySql database and the acquired parameters is processed in Pi and trigger a message if there is any abnormality in the parameters. In the previous methods, Zigbee, Bluetooth modules are used for transmission. But they are restricted by the short range of communication. The presented system reduces man power and cost.**

Keywords– Internet of Things (IoT), HTTP (Hypertext Transfer Protocol), Electrocardiogram (ECG), Global System for Mobile Communication (GSM), Graphical User Interface (GUI)

I. INTRODUCTION

The Internet of Things (IoT) is the inter-networking of physical devices and other embedded electronics, sensors, actuators and network connectivity that enable these objects to collect and exchange data. It is a fastest growing technology in wireless communication. Using IoT, devices or objects are always stay connected to the real world which means that physical devices can be stay connected to the virtual world and can be accessed remotely through anywhere from the world. The real time applications of IoT are smart media, environment monitoring, smart manufacturing, intelligent medical and healthcare, smart building with home automation, energy management, transportation etc.

The main goal of the presented system is to develop a reliable patient monitoring system so that doctors can monitor the patients, who are either hospitalized or executing their normal daily life activities. The healthcare professionals play the major role in the traditional approach [3] - [5]. They need to visit to the patient's ward for necessary diagnosis and advising. This approach has two basic problems. Primary, they must be present on site of the patient all the time and secondary, the patient remains admitted in the hospital and provided with bedside biomedical instruments, for a period of time. The solution for those problems is that the patient's are given aware of the real time patient monitoring and analysis system [1].

II. THE SYSTEM ARCHITECTURE

A. Client

The client section consists of Raspberry Pi 3, Blood Pressure Sensor (Model No. 1437), Temperature Sensor (DS18B20), ECG Sensor (AD8232) and GSM Module (SIM 800C). The blood pressure sensor is fixed on the wrist of the patient. A 3 lead ECG sensor is used here. MCP3008 is used for interfacing AD8232 to the Raspberry Pi 3. MCP3008 is an 8-channel, 10-bit ADC with SPI interface. Raspberry Pi 3 acquires the biological parameters from these three sensors. These parameters are processed in Pi and if there is any variation in the acquired parameters, a message will be sent to the pre-defined number via a GSM module. Python is used as programming language in the client section.

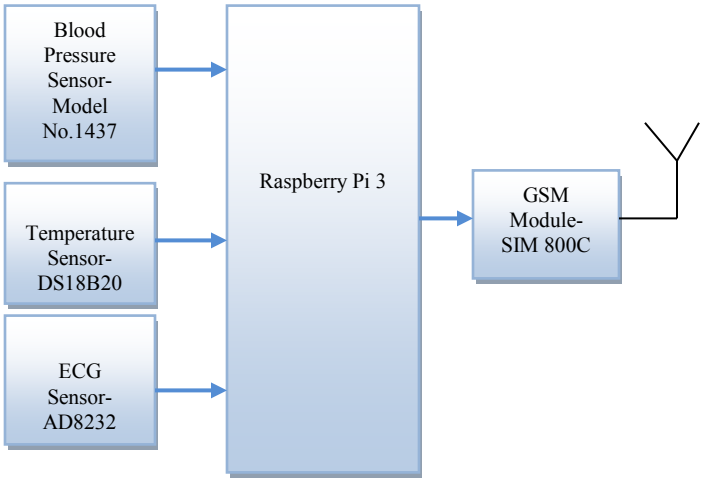

Figure 1: Client Section

B. Server

In the server side, the python clients post the biological parameters acquired from the sensors in the server [7]. HTTP is used as the communication protocol for client and the server. It functions as a request-response protocol in the client-server computing model. The client submits an HTTP request

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message to the server. The server returns a response message to the client. PHP is used as the server-side scripting language. The server stores these values in the MySql database [2]. The server side provides the facility to the end users to monitor the patients requested parameters along with the date and time.

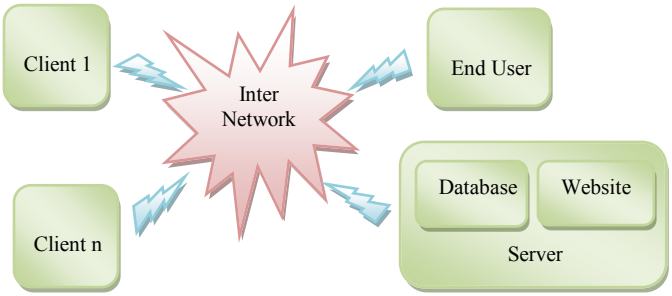

Figure 2: Server Section

III. HARDWARE DESCRIPTION

A. Blood Pressure Sensor

The blood pressure sensor used here is Model No. 1437. The sensor reads blood pressure and heart rate and outputs at 9600 baud rate. The output reading from sensor is 8 bit value in ASCII format fixed digits, from 000 to 255 and it is given to USB to TTL UART adapter.

Pin out Configurations:

1) TX-OUT = Transmit output. It outputs serial data of 3V logic level. It is connected to RXD pin of USB-UART.
2) +5V = Regulated 5V supply input. It is connected to the +5V pin of USB-UART.
3) GROUND = Board Common Ground. It is connected to the 39th pin of Raspberry Pi 3.

B. Temperature Sensor

The DS18B20 provides 9 to 12 bit temperature readings, which can be interfaced to Raspberry Pi using a 1-wire interface. 1-wire is a device communications bus system that provides low-speed data, signaling and power over a single conductor [10].

Pin out Configurations:

1) GROUND (Black) = It is connected to 6th pin of Raspberry Pi 3.
2) DATA (Yellow) = It is connected to GPIO4 of Raspberry Pi 3.
3) POWER (Red) = It is connected to 1st pin of Raspberry Pi 3.

C. ECG Sensor

The ECG Sensor outputs analog readings. This sensor is a cost-effective board which is used to measure the electrical activity of the heart. This signal can be chartered as an ECG or Electrocardiogram and outputs as an analog reading. Since the output of AD8232 is an analog signal, it has to be converted to digital. For this MCP3008 [8], ADC is used. MCP3008 uses an SPI protocol for interfacing with Raspberry Pi 3. The SPI is a synchronous serial communication interface specification used for short distance communication. ECGs can be extremely noisy, the AD8232 [9] Single Lead Heart Rate Monitor acts as an op-amp, that helps to obtain a clear signal from PR and QT intervals easily.

Pin out Configurations:

1) GROUND = It is connected to ground pin.
2) POWER = It is connected to 3.3V.
3) OUTPUT = It is connected to CH0 of MCP3008.

The biological parameters from these sensors are processed in the Raspberry Pi 3 and if there is any variation in the parameters collected, then a message will be sent to the pre-defined number via a GSM Module. Here SIM 800 C module is used. It is a quad- band GSM/GPRS module that works on frequencies 850 MHz, 900 MHz.

IV. EXPERIMENTAL RESULTS

The website displays the real time biological parameters along with the Patient ID. The website can be accessed by any medical expert across the world for diagnosis. It provides the facility to analyze the record of the patients. The acquired parameters is processed in Raspberry Pi 3 and if there is any abnormality in the acquired parameters, then a message is sent to the pre-defined number via a GSM module.

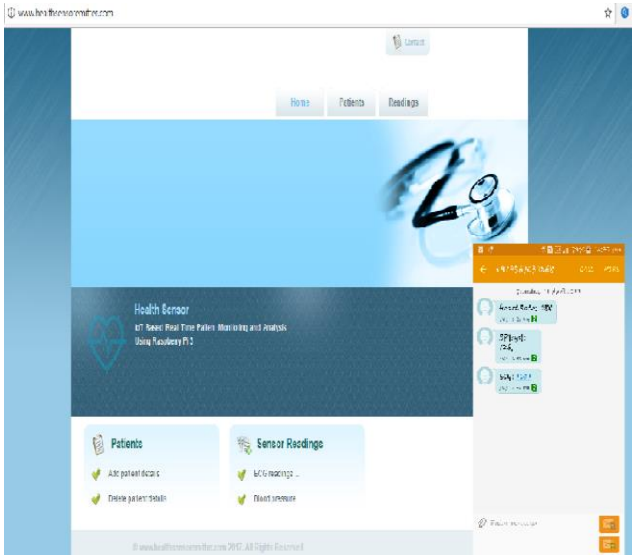

Figure 3: Front End of Website

It provides the facility to add or delete patients and also the details of the existing patients can be updated through this website.

V. CONCLUSION

In this paper, IoT based real time patient monitoring and analysis using Raspberry Pi 3 is implemented. In this method, Raspberry Pi 3 acquire the biological parameters from the

sensors connected to the patient's body and transmit it wirelessly to website. The medical expert anywhere in world can access and diagnose those parameters. In case, if there is any variation in these parameters, then a message will also be sent to the pre-defined number.

In the previous methods, Zigbee, Bluetooth modules are used for transmitting the values. But they have only short range of communication. Also the patient has to visit hospital every time. By using this technique, the patient by sitting in home can measure Blood Pressure, Temperature, ECG and Heart Beat and can transmit those parameters wirelessly to the website. The medical experts can analyse and make suggestions if there is any variations in the parameters. This reduces the time and cost of the patients.

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