

Health Monitoring Systems using IoT and Raspberry Pi – A Review

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Abstract— Now-a-days health problems like cardiac failure, lung failures & heart related diseases are arising day by day at a very high rate. Due to these problems time to time health monitoring is very essential. A modern concept is health monitoring of a patient wirelessly. It is a major development in medical arena. Thus paper based on the monitoring of the patient that is done by the doctor continuously without actually visiting the patient. Health professionals have developed a brilliant and inexpensive health monitoring system for providing more comfortable living to the people suffering from various diseases using leading technologies like wireless communications, wearable and portable remote health monitoring device. As a result, visits of doctors to the patients constantly are decreased as the information regarding patient's health directly reaches to doctor's monitor screen from anywhere the patient resides. Also, based on this doctors can save many lives by imparting them a quick & valuable service. In this, IoT is becoming a major platform for many services & applications, also using Raspberry Pi not just as a sensor node but also a controller here. Paper propose a generic health monitoring system as a step forward to the progress made in this department till now.

Keywords— *Raspberry Pi, IoT, GSM, Health Condition, ECG*

I. INTRODUCTION

In today's era, health problems are increasing day-by-day at a high pace. The death rate of 55.3 million people dying each year or 151,600 people dying each day or 6316 people dying each hour is a big issue for all over the world. Hence it is the need of hour to overcome such problems. We, therefore, proposing a change in wireless sensors technology by designing a system which included different wireless sensors to receive information with respective human body temperature, blood pressure, saline level, heart rate etc. that will be undoubtedly further transmitted on an IoT platform which is accessible by the user via internet. An accessible database is created about patient's health history which can be further monitored & analyzed by the doctor if necessary. The data storage can be saved on the server permanently or can be reset via the software. This paper proposes a health monitoring system which is capable of detecting multiple parameters of our body such as blood pressure, temperature, heart rate, ECG

& further transmitting this information on an IoT server through 2G/3G/4G GSM technologies. Also in case of emergency, automatically generating alerts will be sent to doctors and family members if any unusual activity is detected by or near the patient.

A continuous record of body health parameters can be used to detect the disease in a more efficient manner. Now-a-days, people pay more attention towards prevention & early recognition of disease. In addition to it, new generation mobile phones technologies & their services provides an important impact on the development of network varieties (3G, Bluetooth, wireless LAN, GSM) etc.

Various sensors have been used like AD8232 ECG sensor for remote ECG monitoring, blood pressure sensor (4811) is used to measure systolic pressure and diastolic pressure & pulse rate for few seconds. LM35 temperature sensor is used to measure surface temperature of skin.

Satisfactory work is done in health monitoring by using raspberry pi as well as IoT, but this paper gives embedded concept of both the platform. By using combination of these, the proposed structure will be more effective. In this paper, we investigated recent papers related to health monitoring systems & IoT. IoT is nothing but an advanced concept of ICT (Information Communication Technology). IoT is the interconnecting of devices and services that reduces human intervention to live a better life. This paper as showing the advancements in health care management technology, it would save patients from the future health problems that would arise and would also help doctors to take an appropriate measure or action at a proper time regarding patient's health.

II. COMPONENTS USED IN IMPLEMENTATION

For implementing the health diagnosis system, there is a need of essential components that are suitable and manipulate health problems. The components use generally includes temperature sensor LM-35, blood pressure sensor, heartbeat sensor, ECG sensor, raspberry pi and GSM module.

A. Temperature Sensor-LM35

It is an IC sensor that is used to measure temperature with an output voltage linearly proportional to the Centigrade temperature. The LM35 sensor has an advantage over linear temperature sensor, as the user has not to make the conversion of Kelvin to Centigrade. This is major significance of LM-35 that it calibrate directly in Celsius and it is also suitable for remote applications. It has better efficiency than thermistor.

B. Blood pressure sensor

The blood pressure sensor is designed to measure human blood pressure. It also measures the systolic and diastolic pressure and pulse rate is also recorded by this sensor. It is more accurate and reliable than the sphygmomanometer, the instrument attached to inflatable air bladder cuff and used with a stethoscope for measuring blood pressure in an artery. In simple word, pressure of blood against blood vessels walls or arteries is measure using blood pressure sensors.

C. Heartbeat Sensor

It is used to measure the heartbeat of the patient. It gives a digital output of heart beat when a finger is placed on it. It is compressed in size. The working voltage of heart beat sensor is +5V DC. It works on the principle of light modulation by blood flow through finger at each pulse. Heart beat sensor is used to measure heart beat which normally lies between 60-100bpm.

D. ECG Sensor

Electrocardiography (ECG) is the process of recording the activity of the heart for a period of time using electrodes placed on the skin. These electrodes detect even a small electrical change on the skin that emerges from the heart muscle's pattern. The fundamental component of ECG is the Instrumentation Amplifier, which is responsible for taking the voltage difference between leads and amplifying the signals.

E. Raspberry Pi

It is a powerful, low cost, and a small card sized device which is a perfect platform for interfacing with many devices. The board contains a processor, graphics chip, RAM memory, interfaces to other devices and connectors for external devices, of which some are necessary and some are optional. There are much versions of Raspberry Pi but the CPU (BCM2835) of all the models of Raspberry Pi remains same. The CPU is somewhat cheap, powerful and efficient and it does not consume a lot of power. It works in the same way as a standard PC requiring a keyboard for giving commands, a display unit and power supply. Here, in Raspberry Pi, SD card is used in the same way as the hard disc in the computer. The connectivity of raspberry pi to the internet may be via a LAN (Local Area Network) cable / Ethernet or via a USB modem. The main advantage of Raspberry Pi is that it has a large number of applications. It also has 4 pole stereo output and composite video port. Video processing applications are also possible using raspberry pi like video compression.

Compressed video can successfully decrease the bandwidth required to transmit the video through terrestrial broadcast, cable TV, or satellite TV services [19]. The Raspberry-Pi runs on Linux based OS, an open source operating system. In this system we used Raspbian OS which is Linux based OS. The programming language for the Raspberry-Pi for the system implementation is Python.

F. Communication network

In health monitoring system, wireless network is used to forward measurement through a gateway towards cloud. The main network used here is IoT. The meaning of IoT is Internet of Things, simply called as Internet of everything. Different wireless communication technologies can be used for (i) connecting the IoT device as local networks, and (ii) connecting these local networks (or individual IoT devices) to the Internet. The connectivity technologies are NFC, Bluetooth, zigbee, cellular network etc. In this paper, we use cellular network connectivity because of it has widespread mobile networks like 3G and LTE provide reliable high-speed connectivity to the Internet. However, they have a high power consumption profile and they are not suitable for M2M or local network communication [10].

III. SYSTEM DESIGN

The system is classified into two parts, viz. Hardware & Software; whereas hardware unit consists of transmitter section and receiver section and software unit consists of software languages like python, MATLAB, etc as well as their interfacing. Here we discuss IoT applications that are useful to health monitoring.



Fig. 1 IoT application stages

The general operation stages of an IoT application include 1) data acquisition, 2) data processing, 3) data storage, and 4) data transmission. The first and last stages exist on every application, while the processing and storage may or may not exist in some applications [10].

Here data acquisition is used as real-time raw data transmission, raw data transmission and real time on-board process. The energy consumption of data acquisition can be reduced with MEMS technology. Many IoT applications have the data sparsity property and can exploit the compressed sensing paradigm. In health monitoring applications and wireless body sensor network, compressed sensing has been investigated and studied extensively [12].

Energy efficiency in a processing unit can be achieved by 1) ultra-low power processors [13] and 2) efficiently

customized co-processors [14]. An ultra low power near-threshold processor alongside with a high performance processor in addition to a task scheduling framework brings energy efficiency for IoT applications.

Energy reduction in memory has received significant industrial and academic attention in embedded system design community [16], but there are some characteristics specific to IoT applications that can be exploited for further improvements in energy efficiency of memory in IoT embedded devices.

Data transmission can be improved by integrating radio transceivers into SoCs, providing low power multi-radio chips, etc. In order to reduce the amount of data to be stored or transmitted, new data compression techniques, especially for the streams of data, are needed [17]. Figure 2 shows a general architecture of the main components of an IoT SoC platform [16]. An IoT embedded device has many - if not most- of these components, e.g. at least one RF component for the connectivity.

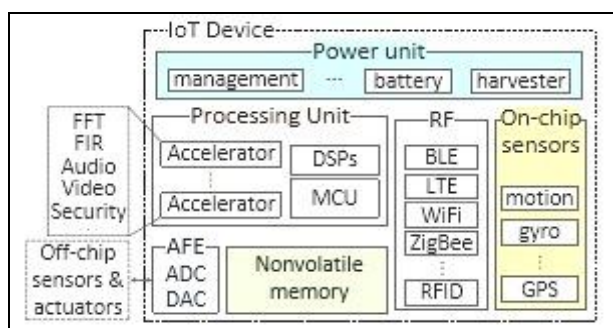


Fig. 2 Architecture of IoT device

IV. THE PROPOSED METHOD

As discussed in section III, system is divided into hardware and software section. Software is responsible for better working of the system, also for interfacing. Both sections work in parallel process. Hardware is again classified into transmitter section and receiver section. Implementation of transmitter is important part, because transmitter section is directly attached to the patient or human body.

Raspberry Pi is a master device in proposed system; all the other devices like different sensors are connected to it. A DC power supply of 5V is provided for working of raspberry pi.

IoT server is attached to the system; it allows the connectivity for data exchange with other devices. IoT allows connected objects to identify and control remote access across network. The output of temperature sensor and heartbeat sensor is displayed on LCD at user end too. The output of ECG is sent to the receiver or doctor end. 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.

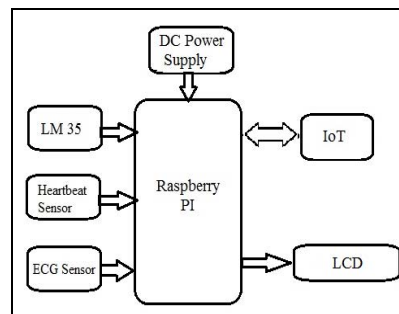


Fig. 3 Transmitter Section

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.

V. CONCLUDING REMARK

In this paper, we have analyzed Raspberry-Pi based health monitoring system using IoT. Any abnormalities in the health conditions can be known directly and are informed to the particular person through GSM technology or via internet. The proposed system is simple, power efficient and easy to understand. It acts as a connection between patient and doctor. The hardware for the project is implemented and the output results are verified successfully.

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