# A Wearable Remote Patient Monitoring System using Raspberry Pi

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***Abstract***

In India, everyday many humans are affected because the patient are not timely and properly and also for real time conventional parameters are not efficiently work on different situations, frequently check-up for patient condition also not possible. To overcome these kinds of situations, our system is beneficial. Our system is designed to be used in Home or hospital for measuring and monitoring various parameters like ECG, Body temperature and Blood pressure. By using new technology Internet of Things (IOT) makes all objects interconnected and it has been recognized as the next technical revolution. The results can be recorded using Raspberry Pi displayed on a HMI interface display. Also the results can be sent to server using IOT and text message using GSM module. Relatives or Doctors can login to a website and view those results.

*Keywords:* Raspberry Pi, Sensors, GSM Module, Internet of Things (IOT)

## 1. Introduction

In today's life, health problems are occur quite last 25-30 years ago due to modernization, industrialization. Therefore, make device as portable which may handle by anyone person and even have ability to produce more flexibility. Normally occur health related problems are Temperature, Heart related problems, stomach problem and then on. Researchers design health monitoring system using different hardware platform provide integration of various biomedical sensor on single system on-chip like temperature sensor, rate sensor then on. this system gives more flexibility, reliability and portability for user. Here temperature sensor use for measuring vital sign, vital signs sensor use to live pulse rate of patient body. So, integration of various biomedical sensors is depending upon researchers design which meets to their needs. Various health monitoring systems are designed with different specification. Wireless wearable ECG, pressure level and Temperature monitoring system embedded in an IoT platform that integrates heterogeneous nodes and applications, incorporates a long battery life, and provides a high-quality ECG signal. The system allows monitoring multiple patients on a comparatively large indoor area (home, building, home, etc.). Another remarkable feature of our system could be a very low cost per added sensor, since our architecture enables one low-cost gateway to manage multiple sensors. Our work will specialize in monitoring additional health related parameters employing a broader combination of transducers, sensors, and correlation techniques, and on improving system reliability and robustness to patient movement and connectivity losses.

## 2. Literature Survey

Modre-Osprian [1] monitors pressure level level using confine Touch (KIT) and closed-loop system healthcare services. In KIT method, KIT is connected to the JAVA based itinerant with the assistance of near field communication. It works on magnetic, inductive coupling so the gap is brief. After touching the KIT, the info is send to itinerant. In control system services, the information is getting from movable, then the information is send to the secure website. Using this website anybody can monitor patient's pressure level.

Junaid Mohammed [2] monitors patient's ECG wave anywhere within the world using IOIO- OTG Microcontroller. Android application is formed for ECG Monitoring. IOIO-OTG microcontroller is connected to android phone using USB cable (or) Bluetooth dongle. After collecting data, the wave is send to android application. Monitor and store ECG waves in this android based application. Mohammed S. Jasses [3] focused on blood heat monitoring using Raspberry pi board in cloud based system. in this paper, Raspberry pi is monitor blood heat so these parameters are transfer by wireless sensor networks (WSN). Then these data's are added to the cloud based websites. Using this website, blood heat can be monitored

Hasmah Mansor [4] monitors temperature using LM35 temperature sensor. The LM35 temperature sensor is connected to the Arduino Uno board. then creating a web site in SQL database format. Arduino Uno board is connected thereto website. Then sensor output is send to the web site. Using this website anybody can monitor blood heat in login process Mathan Kumar [6] discussed about monitors ECG, Respiration rate, pulse rate and blood heat. These sensors are connected to PIC16F887A microcontroller. After collecting data from sensors, the information is upload to the web site manually. For monitoring purpose created an android application and webpage for monitoring health status.

Nithin P. Jain [8] monitors temperature, pressure level, vital sign of patient's. Microcontroller AT Mega 32 is employed for connecting these sensors. GSM module is connected to the present microcontroller. After collecting data, if the worth is low SMS is send to the doctor.

Soumya Roy [9] monitors ECG waves of patient's. AT Mega 16L microcontroller is employed for monitoring ECG waves. ZigBee module is employed for transferring ECG waves. ZigBee module is sends data to nearest connected system for ZigBee. Rajeev Piyare [10] implement controlling and monitoring home appliances using android based smart phone. Arduino Uno board is connected to home appliances (light, fan, etc.). Creating an android application for this smart home, Arduino Uno board and android app is connected by internet. Using this android app, controlling and monitoring home appliances can be done anywhere within the world.

Karandeep Malhi [7] monitors blood heat, pulse rate using C8051F020 microcontroller. Wearable sensors are wont to collect data and so send to micro controller. ZigBee module is connected to the current microcontroller and so that module is transfer data to the closest receiver.

Subhas Chandra Mukhopadhyay [11] a rise in world population together with a major aging portion is forcing rapid rises in healthcare costs. The healthcare system goes through a metamorphosis within which continuous monitoring of inhabitants is feasible even without hospitalization. The advancement of sensing technologies, embedded systems, wireless communication technologies, Nano technologies, and miniaturization makes it possible to develop smart systems to watch activities of persons continuously. Wearable sensors detect abnormal and/or unforeseen situations by monitoring physiological parameters together with other symptoms. Therefore, necessary help will be provided in times of dire need. This paper reviews the most recent reported systems on activity monitoring of humans supported wearable sensors and issues to be addressed to tackle the challenges

Shanzhi Chen [12] Internet of Things (IoT), which is able to create a large network of billions or trillions of "Things" communicating with each other, face many technical and application challenges. With China's perspective, this paper depicts such challenges on technologies, applications, and standardization, and also proposes an open and general IoT architecture consisting of three platforms to fulfill the architecture challenge. Finally, this paper discusses the chance and prospect of IoT.

John A. Stankovic [13] many technical communities are vigorously pursuing research topics that contribute to the net of Things (IoT). Nowadays, as sensing, actuation, communication, and control become even more sophisticated and ubiquitous, there's a major overlap in these communities, sometimes from slightly different perspectives. More cooperation between communities is inspired. to produce a basis for discussing open research problems in IoT, a vision for a way IoT could change the globe within the distant future is first presented.

Andrea Zanella [14] the web of Things (IoT) shall be able to incorporate transparently and seamlessly an oversized number of various and heterogeneous end systems, while providing open access to chose subsets of knowledge for the event of a plethora of digital services. Building a general architecture for the IoT is hence a really complex task, mainly thanks to the extremely large sort of devices, link layer technologies, and services which will be involved in such a system. during this paper, we focus specifically to an urban IoT system that, while still being quite broad category, are characterized by their specific application domain. Urban IoTs, in fact, are designed to support the Smart City vision, which aims at exploiting the foremost advanced communication technologies to support added-value services for the administration of the town and for the citizens. Furthermore, the paper will present and discuss the technical solutions and best-practice guidelines adopted within the Padova Smart City project, a proof-of-concept deployment of an IoT island within the city of Padova, Italy, performed united with the town municipality.

P.Karthick [15] the most focus of the paper is to implement a prototype model for the 000 time patient monitoring system. The proposed is employed to live the physical parameters like temperature, heartbeat, ECG, glucose, and oxygen level monitoring with the assistance of biosensors. within the novel system the patient health is continuously monitored and therefore the acquired data is transmitted to an ARM server using zigbee wireless sensor networks. Embedded processor supports for analyzing the input from the patient and therefore the results of all the parameters are stored within the database. If any abnormality felt by the patient automatic alarm sound will arrive and also the message will send to the doctor mobile automatically by using GSM module

**3. Methodology**

In this paper we've got ECG & force per unit area reading results are monitored. These sensors signals send to the Raspberry Pi via amplifier circuit and signal conditioning unit (SCU), because the signals levels are low (gain), so amplifier circuit is employed to achieve up the signal and transmit the signals to the Raspberry Pi. Raspberry pi could be a linux based software package works as atiny low pc processor system. Here patients ECG & vital sign is measured using respective sensors and it are often monitored within the monitor screen of computer using Raspberry Pi likewise as monitoring through anywhere within the world using internet source. Raspberry Pi is programmed for the actual project need that via USB dongle (or) Ethernet for patient's health monitoring through internet. It sends all the present health data of the actual patient to the net database. Anybody can access the net and might see the health of patients

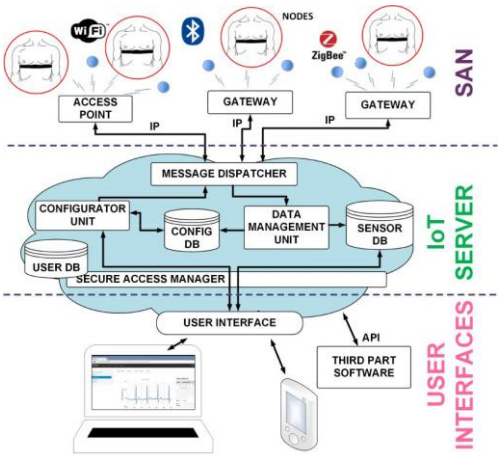


**Fig 1:** Overview of ECG & Blood Pressure Monitoring system using Raspberry Pi

Sensor and actuator nodes (SANs). Light weight wearable ECG sensors and other ambient sensors collect data and send them in real time via a wireless protocol (ZigBee, Bluetooth, WiFi) to a gateway connected to the house ADSL router (Fig. 1).

Both the gateway and therefore the message dispatcher are transparent at the logical communication level between sensors and IoT server. The architecture has been developed with the aim of enabling the mixing of sensor networks supported different networks protocols (WiFi, ZigBee, Bluetooth…) the sole component tuned in to the local sensor network protocol is that the gateway, which runs a firmware that may manage the corresponding protocol. The gateway encapsulates the packets of the sensors during a universal format which preserves all the data present within the native format. Hence sensors send messages in their native format to the IoT server, where the information management unit extracts information and enters it during a "universal" format into the sensor database. When sensors have to be configured or interrogated, the configuration unit prepares a command per the target sensor protocol.

The IoT server converts the raw payload from heterogeneous nodes into a "universal" format, containing object identifier, object type, measurement unit, data field, geographical position, and timestamp. Then, it makes the information available to applications and users. during this way, data visualization and processing is separated from measurement and data collection, and doesn't must take into consideration the communication protocol of the originating source. Additionally, the IoT server receives data from users so as to configure and manage the SANs.

The main components of the IoT server are illustrated within the cloud of Fig. 1, since they'll be a part of a distributed data system. The message dispatcher manages the bidirectional communication

with the sensor networks, using no information on the network protocol or on the kind of application. the info management unit may be a collection of software modules interpreting data from sensors and storing them in an exceedingly universal format within the sensor database. The configuration unit receives inputs from users or applications and translates them into protocol-specific commands to the SANs, consulting the configuration database. Finally, the secure access manager provides access to stored information and SAN configuration only to authorized users and applications, per information contained within the user database.

**User interfaces**. The whole system is configurable and controllable through an intuitive web interface from any computer, smart phone or tablet connected to the web. Within the IoT server, health data is combined with other data, merged, processed by users and/or authorized clinicians

**I. Hardware Design**

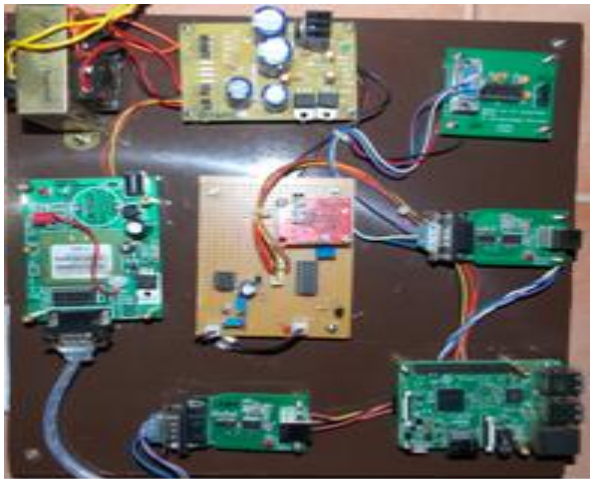

**Fig. 2** Hardware design

The interconnection between different components is explained using the architecture of system. Architecture diagram is shown in figure 2. The patients connect the sensors to their body and also the other end of the sensors is connected to Raspberry Pi. the info acquired by sensors is stored within the Raspberry pi B+. the information values are shown on HMI interfaced display and at the identical time if the values exceed the conventional range, the alarm triggers. The values stored are sent to server with the assistance of IOT. All the values are stored on the server and therefore the most up-to-date value is displayed on webpage and send Text message using GSM Module. The doctor together with their login credentials can login and see the patient data. Doctors can see all previous records of a patient and suggest medicines and changes in prescription. Also patients are given unique user id and password to look at their records.

The design of the system is divided into two parts: Hardware components and software components

**II. Hardware components**

**Temperature sensor (LM35):**
It could be a sensor accustomed measure temperature. The LM35 series( Figure 3) are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. It measures temperature more accurately than thermistor. It is sealed and doesn't undergo oxidation. It doesn't require output voltage to be amplified.

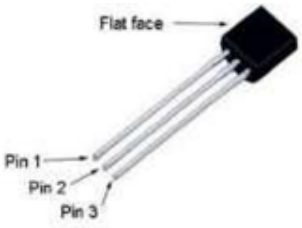


**Fig. 3** Temperature sensor (LM 35)

**ECG sensor:**
ECG electrode (figure 4) sticks to chest to select up ECG signals. Then wires are connected to AD8232. This sensor may be a cost-effective board wont to measure the electrical activity of the heart. ECGs will be extremely noisy; the AD8232 Single Lead vital sign Monitor acts as an op amp to assist obtain a transparent signal from the PR and QT Intervals easily.

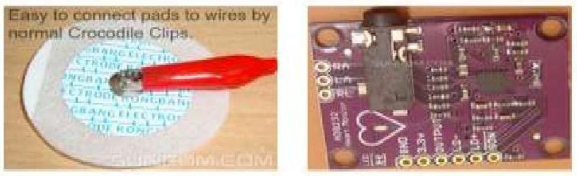


**Fig. 4** ECG sensor

**Raspberry Pi:** The Raspberry Pi shown in figure 5 could be a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a typical keyboard and mouse. The Raspberry Pi 3 Model B+ has dual core ARM11 processor with 1GB SDRAM and powers through Micro USB socket of 5V. Sensors are connected to the Raspberry Pi 3 Model B+. Raspberry Pi sends the data to servers through GSM module.

**Fig.5** Raspberry Pi

**GSM module:** It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. GSM module shown in figure 6 sends health information to webpage. This gives patient the ability to leave the hospital but still he has to stay in some known places to ensure the ability to reach him in emergency cases. Even with this solution the patient can't move freely and be far from his home.

**Fig. 6** GSM SIM300 Module

### III. Software Components

*Server* - The data send by Raspberry pi is stored on a server. The detailed information of patients and doctor is registered through website on stored on server. The website can be accessible from anywhere.

### 4. Result

Problem definition of our underlying system which is basically useful for doctor's for monitoring patient's health parameter virtually and gets the accurate result.

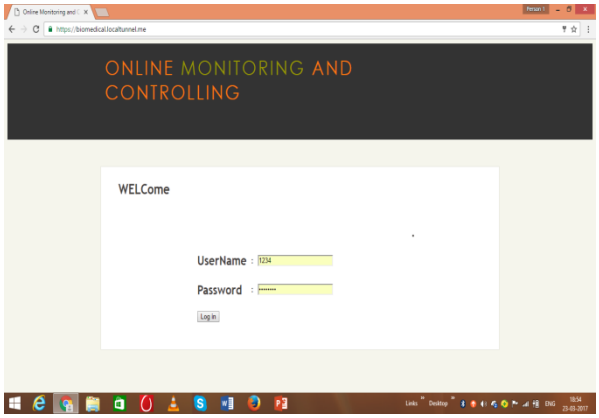


**Fig. 7** Webpage of system

Fig.7 Shows that the webpage login for the tip user who knows to the results of concern patient report. Also through this technique real time parameter values is measured so this technique is useful for homes likewise as in clinic also. Through this technique, the doctor can ready to calculate temperature, ECG, vital sign values efficiently and store data on raspberry pi temporarily. The values are in type of - Temperature we have gotten Celsius, vital sign, ECG in percentage shown on display further as on website.

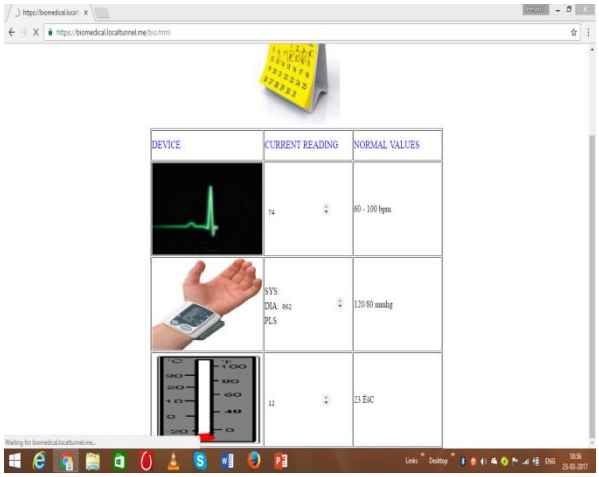


**Fig. 8** Result Window of working system

If the current value increases above the normal value means send the message to patient relatives to alert them. So we can help patient when they need doctor's help.

### 5 Conclusion

As health care services are important a part of our society, automating these services lessen the burden on humans and eases the measuring process. Also the transparency of this technique helps patients to trust it. When threshold value is reached, the alarm that consists of buzzer and LED alerts the doctors and he can act more quickly. The target of developing monitoring systems is to cut back health care costs by reducing physician office visits, hospitalizations, and diagnostic testing procedure.

The IoT technology helps the server to update the patient data on website. Many further improvements are often made in our system to form it better and simply adaptable like adding more advanced sensors. The biometric information of the patient which is stored and published online & transmits to cellular is given to scientists and researchers of medical fields to research the worth and find patterns or for other research work. To simplify the hardware and reduce wiring we will have used wireless sensors.

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