Intelligence Health Gateway Based on Internet-of-Things for Ubiquitous Healthcare Systems

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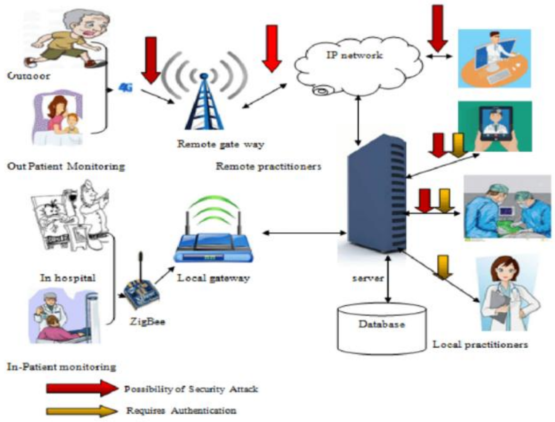
Abstract-*The increase in popularity for wearable technologies has opened the door for an Internet of Things (IoT) solution to healthcare. One of the most prevalent healthcare problems today is the poor survival rate of out-of-hospital sudden cardiac arrests. The objective of this study is to present a multisensory system using fog-enabled IoT that can collect physical activity heart rates and body temperature. For this study, we implemented an embedded sensory system with a Low Energy (LE) high speed raspberry pi module will collect ECG, BP, Heart rate and body temperature data collect and storage inevitable. Fog Computing (FC) is an environment where data are stored and pre-processed before transmitting them to the cloud, having a number of advantages like scalable real-time services, fault detection and isolation, enhanced security and privacy, etc. In this work, we present a fog-enabled IoT platform used for sensory data collection, presenting several metrics that can be used as the basis for a Management-Platform-as-a-Service, able to efficiently monitor with the use of signal processing and machine learning techniques for sensor data analytics for sudden cardiac arrest and or heart attack prediction on the IoT platform and predict potential failures and transfer the decision and data to cloud storage and get all details can monition in android apps.*

KEYWORDS: Healthcare; Health Monitoring; IoT; Medical Services etc.

1. INTRODUCTION:

Health is one of the global challenges for humanity. In the last decade the healthcare has drawn considerable amount of attention. The prime goal was to develop a reliable patient monitoring system so that the healthcare professionals can monitor the patients, who are either hospitalized or executing their normal daily life activities. Recently, the patient monitoring systems is one of the major advancements because of its improved technology. Currently, there is need for a modernized approach. In the traditional approach the healthcare professionals play the major role. They need to visit the patient's ward for necessary diagnosis and advising. There are two basic problems associated with this approach. Firstly, the healthcare professionals must be present on site of the patient all the time and secondly, the patient remains admitted in a hospital, bedside biomedical instruments, for a period of time. In order to solve these two problems, the patients are given knowledge and information about disease diagnosis and prevention. Secondly, a reliable and readily available patient monitoring system (PMS) is required. In order to improve the above condition, we can make use of technology in a smarter way. In recent years, health care sensors along with raspberry pi play a vital role. Wearable sensors are in contact with the human body and monitor his or her physiological parameters. We can buy variety of sensors in the market today such as ECG sensors, temperature sensors, pulse monitors etc. The cost of the sensors varies according to their size, flexibility and accuracy. The Raspberry Pi which is a cheap, flexible, fully customizable and programmable small computer board brings the advantages of a PC to the domain of sensor network. In our system we are measuring patient's parameters (ECG, temperature, heart rate, pulse, etc) with different available sensors. These sensors collected data i.e. biometric information is given to raspberry pi and then it is transferred to server.



2. OBJECTIVES

The objective of this study is to present a multisensory system using fog-enabled IoT that can collect physical activity heart rates and body temperature. For this study, we implemented an embedded sensory system with a Low Energy (LE) high speed raspberry pi module will collect ECG, BP,Heart rate and body temperature data collect and storage inevitable. Fog Computing (FC) is an environment where data are stored and pre-processed before transmitting them to the cloud, having a number of advantages like scalable real-time services, fault detection and isolation, enhanced security and privacy, etc. In this work, we present a fog-enabled IoT platform used for sensory data collection, presenting several metrics that can be used as the basis for a Management-Platform-as-a-Service, able to efficiently monitor with the use of signal processing and machine learning techniques for sensor data analytics for sudden cardiac arrest and or heart attack prediction on the IoT platform and predict potential failures and transfer the decision and data to cloud storage and get all details can monition in android apps.

Data Collection:

The sensors data collection interface is shown while walking which is used to collect users' ECG pattern, BP, Heart rate and body temperature for a period of time. Fog computing monitor temperature variation and ECG patterns with signal processing tool boxes then make a decision and store to cloud storage to representation on a smartphone. We collected data for different test subjects in different environments for 160 samples in per second. Each segment is 25 seconds long. We collected sensor data for sitting, walking, and climbing upstairs. We first used these datasets for training our system. Later we used the trained system with real people to verify the detection accuracy of the proposed system. Since we cannot test potential heart attack or cardiac arrest with the people who have experienced heart attacks, we recruited 10 participants from both genders including a variety of age groups, and a range of heights (see Table I for statistics).

Gender		Age [yrs.]		Height [cm]
F:	3	21-24:	β	150-159: 4
M:	7	25-30:	4	160-169: 2
		30-35:	3	170-179: 2
				180-200: 2

Wearable technology has made significant progress in recent years, with millions of devices being sold to consumers and steady advances being made in technological capabilities. Although the form and function of contemporary wearable's have changed from Shannon and Thorpe's 1961 experiment, many of the same conflicting design issues have to be taken into consideration when developing modern technologies that are intended to be worn. Al- though wearable's have benefited from advances in mobile technologies, functionality remains limited compared to smart phones. Additional- ly, smart phones do not need to be comfortable to wear while in motion, are less restricted by weight and size requirements, and have more well-defined aesthetic requirements. However, wearable's present a tremendous opportunity for capturing a continuous stream of data about our physiology and kinesiology, which can empower consumers with self-knowledge.

Table.1.Normal Blood Pressure Values

Age Group	Gender	**Min/Max (mmHg)**
<18	Male	80/120
18 to 20	Male	80/125
21 to 40	Male	85/135
40 and above	Male	85/135
<20	Female	80/123
21 to 40	Female	85/133
40 and above	Female	85/133

Table.2.Pulse rate Range

Status	BPM
Rest / Normal	60-100
Sleeping	40-50
Tachycardia	>100

Human health and fitness are areas in which wearables can offer insights that smart phones cannot. This is evident from the immense popularity of fitness trackers (e.g., the Fitbit Blaze, Jawbone UP, and Nike+ FuelBand) and smart watches (e.g., the Apple Watch and Samsung Gear) being used by consumers to self-monitor physical activity. Additionally, wearables are being used for self-monitoring and preventing health conditions such as hypertension and stress. Donald Jones with the Scripps Translational Science Institute says, "My favourite wearable's to- day are those that measure blood pressure and that can be used to impute stress. I think these are some of the most interesting areas of feedback that we have today. Hypertension is a cause of many illnesses, and stress is obviously a big contributor". Research continues to explore how wearables can help patients and physicians before, during, and after medical procedures, such as surgery. For example, telemedicine can be performed by on-site paramedics wearing Google Glass, a head-mounted display with a camera and mi- crop hone and communicating with off-site medical doctors to provide expert care during disaster relief efforts. Ad-additionally, wearable's can pro- vide a more expedient means of monitoring a patient's vital signs during surgical procedures by reducing the size of equipment and the number of wires leading to external de- vices. Such applications could improve the quality of medical.

Even so, many issues need to be taken into consideration when deploying wearable's for general health care. For example, John Feland, chief executive officer of Argus In- sights, says, "People get tired of the fitness bands and throw them in the sock drawer. They stop being useful, people lose their fitness momentum. Furthermore, data security and privacy are primary concerns for both patients and hospitals. Therefore, new technologies need to be integrated with devices and systems already in place, and approval by regulatory agencies can take years and millions of dollars before benefits are realized.

In this project we have temperature, blood pressure, ECG and heart beat readings which are monitored using Raspberry Pi. These sensors signals are send to Raspberry Pi via amplifier circuit and signal conditioning unit (scu), because the signals level are low (gain), so amplifier circuit is used to gain up the signal and transmit the signals to the Raspberry Pi. Raspberry Pi is a Linux based operating system works as a small pc processor system. Here patients body temperature, blood pressure , ECG and heart rate is measured using respective sensors and it can be monitored in the screen of computer using Raspberry Pi as well as monitoring through anywhere in the world using internet source. The proposed method of patient monitoring system monitors patient's health parameters using Raspberry Pi. After connecting internet to the Raspberry Pi it acts as a server. Then the server automatically sends data to the website. Using IP address anybody can monitor the patient's health status anywhere in the world using laptops, tablets and smart phones. If these parameters goes abnormal it will automatically send alert information to the doctors and relatives.

Wearable's are steadily becoming the most prevalent personal devices, offering users the ability to interact with other tools and physical objects around them.

Once the IoT becomes more widely adopted—creating a truly hyper connected world—common interactions via the Internet and connected objects may shift to more active engagement of content and environment, specifically in health care. Let's take a look at a few case studies that showcase how wearable's and other technologies integrate to form an IoT solution in different domains.

three-dimensional projection instead of in traditional, cadaver-filled laboratories. Through the combination of AR, wearable technology, and the IoT, environments will become more responsive and digitally manipulable.

3. Block Diagram:

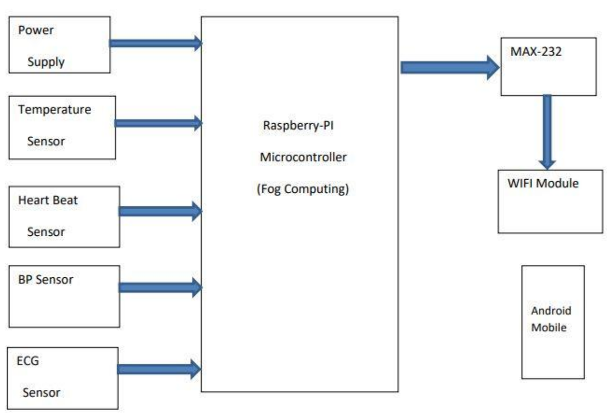


Fig-1: Proposed Block Diagram

The Raspberry Pi board as our platform, it's associate degree ARM SOC with integrated peripherals like USB, LAN and serial etc. On this board putting in Linux package with necessary drivers for all peripheral devices and user level software package stack which has a lightweight weight interface supported XServer, API for interacting with sensors and devices like Temperature, Heartbeat, TCP/IP stack to speak with network devices and a few commonplace system libraries for system level general IO operations. The Raspberry Pi board equipped with the on top of software package stack is connected to the surface network and a sensing element like temperature, heartbeat, BP, ECG is connected to the Raspberry Pi through USB bus or the serial. Of these sensors have input and output connectors, input connectors are connected to the patient and output connectors are connected to Raspberry Pi module. After connecting all the sensors power up the device, once the device starts booting from flash, its initial masses the Linux to the device and initializes all the drivers and therefore the core kernel. Once data formatting of the kernel it initial checks weather all the sensors operating properly or not. At the moment it masses the classification system and starts the startup scripts for running necessary processes and daemons. Finally, it starts the most application. Temperature, pressure level, and heart beat readings that are monitored by means of Raspberry Pi these sensors signals will send to Raspberry Pi via electronic equipment circuit and signal learning unit (scu), as a result of the signals level area unit low (gain), therefore electronic equipment circuit is employed to achieve up the signal and transmit the signals to the Raspberry Pi. Raspberry Pi may be a Linux based package works as a little computer processor system. Python code derelict on Raspberry Pi module to validate the info that reads from of these sensors and additional processes the info through the raspberry pi module to output devices. Patients temperature, pressure level and heart rate is measured via several sensors and it is monitored within the screen of mobile by means of Raspberry Pi still as observation through anyplace within the world using web supply api. Once connecting web to the Raspberry Pi it acts as a server. Then the server continuously stores in cloud in a very secured way. Using api get all the details and anybody can monitor the patient's health standing anyplace within the world via laptops, tablets and smart phones. We have developed a small android app to see the results. If these parameters standing is abnormal it'll send notifications to the doctors and relatives. software package implementation is visualized.

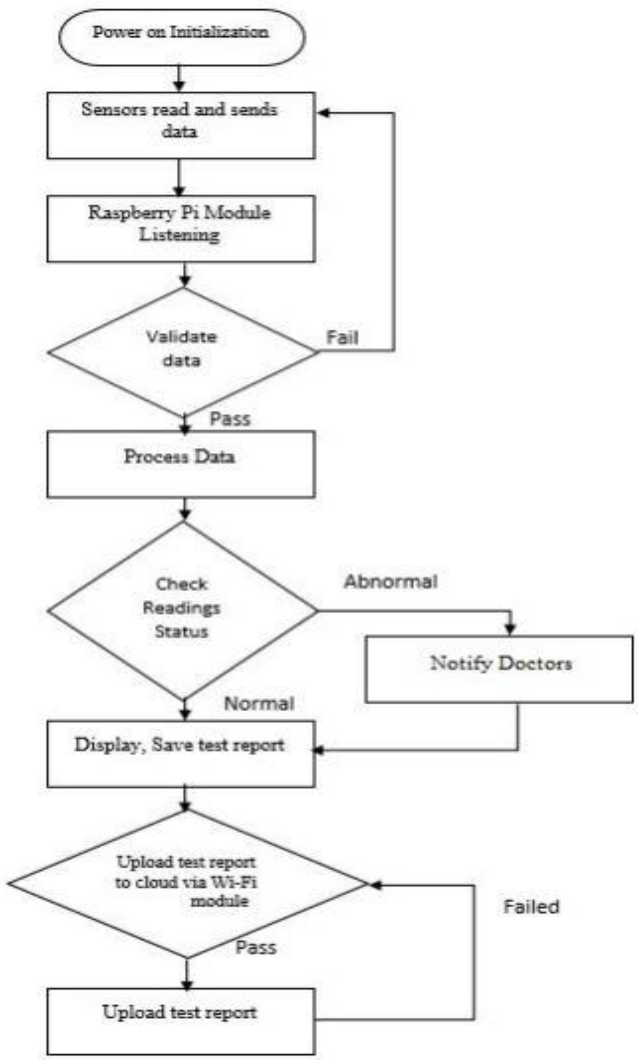


Fig-2: Flow chart of proposed system Implementation

4. HARDWARE SPECIFICATION

The Lm35 Temperature Sensor:

The LM35 series are precision integrated circuit LM35 temperature sensors, whose output voltage is linearly proportional to the temperature in Celsius (Centigrade). The LM35 sensor thus has an advantage over linear temperature sensors, calibrated in °Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient centigrade scaling. The LM35 sensor does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°Cover a full -55 to +150°C temperature range. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air.

ECG Sensor:

ECG is primarily a tool for examination of cardiac diseases. An ECG sensing device commonly consists of a group of electrodes to detect electrical events of a heart. The ECG is the electrical manifestation of the contractile activity of the heart and can be recorded fairly easily with surface electrodes on the limbs or chest. The rhythm of the heart in terms of beats per minute (BPM) may be easily estimated by counting the readily identifiable waves. The amplifier takes the input from 3 electrodes which are connected to the patient.

BP Sensor:

Blood pressure sensor is a non-invasive sensor designed to measure human blood pressure. It measures systolic and diastolic and mean arterial pressure utilizing the oscillometric approach

Heartbeat Sensor:

Heart beat sensor is designed to give digital output of heat beat when a finger is placed inside it. This digital output can be connected to raspberry pi directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger each pulse. IC LM358 is used for this sensor. Its dual low power operational amplifier consists of a super bright red LED and light detector. One will act as amplifiers and another will be used as comparator. LED needs to be super bright as the light must pass through finger and detected at other end. When heart pumps a pulse of blood through blood vessels, finger becomes slightly more opaque so less light reach at the detector. With each heart pulse, the detector signal varies which is converted to electrical pulse.

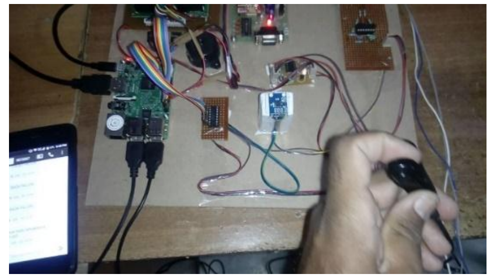
Raspberry-Pi:

ARM virtual addresses (standard Linux kernel only)

As is standard practice, the standard BCM2835 Linux kernel provides a contiguous mapping over the whole of available RAM at the top of memory. The kernel is configured for a 1GB/3GB split between kernel and user-space memory.

The split between ARM and GPU memory is selected by installing one of the supplied start*.elf files as start.elf in the FAT32 boot partition of the SD card. The minimum amount of memory which can be given to the GPU is 32MB, but that will restrict the multimedia performance; for example, 32MB does not provide enough buffering for the GPU to do 1080p30 video decoding. Virtual addresses in kernel mode will range between 0xC0000000 and 0xEFFFFFFF. Virtual addresses in user mode (i.e. seen by processes running in ARM Linux) will range between 0x00000000 and 0xBFFFFFFF.

5. RESULT AND ANALYSIS: The current design is an IOT application, which will continuously monitor patient heartbeat, blood pressure and body temperature. The system takes the data from the IoT devices for every sixty seconds and update in the database connected to the server. The doctor can view the patients' health condition in his or her phone every sixty seconds through the developed android app.



6. CONCLUSION:

The health monitoring system proposed in this paper is developed to provide much needed patient health history in the real time to the doctors. The primary need of our paper is to monitor the system using wireless sensor system with high accuracy and security. Based on the survey, we have been able to use mobile devices and can be implemented in a global network with the help of the Raspberry-Pi.

7. FUTURE SCOPE:

According to the availability of sensors or development in biomedical trend more parameter can be sensed and monitored which will drastically improve the efficiency of the wireless monitoring system in biomedical field. A graphical LCD can be used to display a graph of rate of change of health parameters over time. The whole health monitoring system which we have framed can be integrated into a small compact unit as small as a cell phone or a wrist watch. This will help the patients to easily carry this device with them wherever they go. In addition, with medical application we can use our system in industrial and agricultural application by using sensors like humidity sensors, fertility check sensors, etc.

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