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A Review of IoT based Health Monitoring and Future Health Prediction System

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Abstract - *Internet of Things (IoT) rises as a powerful platform where sensors can connect and exchange information over the Internet. This review paper presents the idea of solving health related issues such as body temperature, blood pressure, heart rate using latest technology, Internet of Things. According to various related work there are multiple IoT protocols and wireless technologies are used to monitor the health of a patient. The proposed system use wearable sensor network on different object which interact with each other. The sensor data transmitted via node MCU. From node MCU we can retrieve our data and store in MongoDB. MongoDB stores the data in unstructured manner. This unstructured data converted in structured format by using multi- sensor fusing algorithm such as kalman algorithm or ARMA algorithm which will also gives the future prediction of health. For transmission and reception of data MQTT IoT protocol is used. Patient can see the predicted data on IoT web page or in Android App.*

***Key Words*: IoT, Wearable sensor network, Multi- Sensor Fusing Algorithm, MongoDB, Cloud**

1.INTRODUCTION

The Internet of Things (IoT) has become one of the most powerful communication paradigms and attracted many research interests in the 21st century. IoT supports many input-output numerous objects, such as sensors, vehicles, houses, and appliances, together to the internet, which allows users to share information, data and resources.[1] Nowadays, using technologies like IoT sensors, tablets, wearable devices, etc. became indispensable for monitoring your health. The data provided by these devices is useful not just for real-time self-monitoring of health but also for health care organizations, hospitals and pharmaceutical companies for a better management of health care costs and wellness[4] .

Wireless Body Sensor Network (BSNs) are wearable sensors with varying sensing, storage, computation, and transmission capabilities. When data is obtained from multiple devices, multi- sensor fusion is desirable to transform potentially erroneous sensor data into high quality fused data. [10].

Wearable sensor nodes are generally deployed inside a wearable body area network (WBAN) to monitor vital health conditions , such as the heart rate (HR), respiration rate (RR), electrocardiography (ECG), body temperature, body position, and blood pressure (BP) . In addition to medical applications, WBAN can also be used to monitor environmental conditions around people [1][2]. Such applications can provide useful information for users to gain a deeper understanding of their surroundings, especially for safety-related applications. Wearable technology means smart devices integrated with different types of accessories such as wristband, wristwatches, eyeglasses and smart phones.

Monitoring your health through such devices helps you save time and improve care. Also, using wearable devices, you can collect data for a long time, which is much more beneficial than a single medical test for your overall health. However, to monitor thehealth issues multiple measurements are needed. These measurements are based on a set of statistics taken from different devices and mobile applications that helps monitoring the health continuously[3]

2. RELATED WORK

In the suggested scheme, each patient's bed have an arduino board interfaced with raspberry pi. A body temperature sensor is connected to the arduino board. The arduino board is programmed to read the body temperature sensor and write it to its serial port. A python script running on raspberry pi reads the serial port data received from the board and writes it into a file. All raspberry pi's are connected with each other via a wired or wireless network formed Linux cluster. One raspberry pi will serve as cluster head node. The server pi stores the collected patients vital sign data received from client nodes. The server raspberry Pi is located in the medical staff room; therefore, the medical staff can continuously monitor the medical data for all patients at a single point. The collected information may be manipulated for generating alert signals in case a vital sign data exceeds some predefined dangerous limits. The server pi may be accessed via web[2].

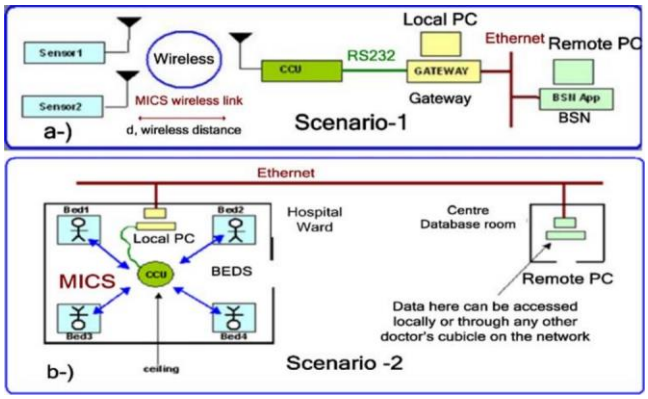
According to the paper, the wearable sensors provide four functions : vital signs monitoring, location tracking, medical record storage, and triage status tracking. The pulse oximeter

attaches to the patient's finger and measures heart rate (HR) and blood oxygenation level (SpO2). We also integrated two types of location sensing capabilities – a GPS to provide geo location, and indoor location detection system to provide location where the GPS signal cannot be reached. The ability to track the location of the patients indoors will be a very useful feature for helping medics quickly locate a specific patient whose conditions have deteriorated. The blood pressure sensor is the most power hungry peripheral, and when it is not used, the battery life of the overall device increases to 1-2 days.[5][21]

In this paper, wireless body sensor network comprises of sensor nodes, a Central Control Unit (CCU) that transmits data to a local PC and a receiver station (i.e remote PC) at a medical center. After obtaining raw data from a human body, sensor nodes transmit those data to the CCU via the wireless RF link using the MICS band. The CCU then repackages the data and transmits to the local PC.

Fig (1): A wireless network system for medical monitoring, **a)** when the device is used individually, or **b)** for Multi- patient monitoring in medical centers [7][13]

The data collected at the local PC is transferred to a



remote PC across the network in a medical center or through internet if it is at a different location than the medical center[22]. In the second scenario, more than one patient can share a CCU box that is attached to a local PC in the room. The local PC transfers data to other remote CCU via Ethernet cables[7]. This arrangement can both be used for one room or more in a medical center[7]. In case of a single patient, the CCU box can be worn around a patient's waist to offer a better mobility. For the patients with limited mobility, the CCU will be replaced at an accessible location with a distance of up to 10 meter in a room. The CCU is connected to a local PC that displays the real-time information received from the sensor nodes and records the information locally[7]. The stored information can be sent via internet to the database of the medical center (i.e. the remote PC) on a periodic basis. When more than one patient is accommodated in a room as in the case of a hospital, the necessary software packages are installed in the CCU and in the local PC in order to obtain physiological signals from sensors of each patient[22]. Data gathering by the remote PC can be performed at some certain time intervals assigned to a local PC and its CCU in each room when the WBSN is used for more than one room[7][13][22].

In [8], Signal inputs from the patient are those normally used for monitoring purposes, such as the ECG (and heart rate), blood pressure, body temperature. These signals are fed to the bluetooth - enabled processor unit, where they are digitized and stored in memory. Next, the digitized data are transmitted to a bluetooth mobile telephone and subsequently via the GPRS cellular network to a base station, then to a hospital via conventional PSTN lines or a cellular network. The data received at the hospital server are available to a clinician via the hospital's LAN, either through the personal computer (PC), laptop, or personal digital assistant (PDA). Alternatively, the clinician away from the vicinity of the hospital may receive a patient's data via a mobile telephone and a PDA.

According to this paper, the system uses node MCU as micro controller which is connected to temperature sensor, pressure sensor, heartbeat sensor. All sensors will be in sensing state to gather vital signs of the patient. Patient condition will be recorded constantly and if the data shows any if the data is above the critical value buzzer is alerted. The users can see the data of the patients by accessing to the URL of the network they have connected. Mostly this can be used for the people who stay constant at bed and for elders who are to be monitored continuously[9].

In this work, a data fusion enabled ensemble approach is proposed to work with medical data obtained from BSNs in a fog computing environment. Daily activity data is obtained from a collection of sensors which is fused together to generate high quality activity data. The fused data is later input to an ensemble classifier for early heart disease prediction. The ensembles are hosted in a fog computing environment and the prediction computations are performed in a decentralized manners. The results from the individual nodes in the fog computing environment are then combined to produce a unified output. For the classification purpose, a novel kernel random forest ensemble is used that produces significantly better quality results than random forest. An extensive experimental study supports the applicability of the solution and the obtained results are promising, as we obtain 98% accuracy when the tree depth is equal to 15, number of estimators is 40, and 8 features are considered for the prediction task[10].

In this paper, a Mobile Health Monitoring System (MHMS) based on a smart phone with build-in GPS and a RFID ring type physiological sensor has been presented. All physiological measurements are transmitted to the smart phone through bluetooth. The user can monitor his/her own pulse and temperature from the smart phone. Then these data are transmitted to a remote server through the mobile

communication of the smart phone, such as HSDPA, Wi-Fi, Wi-Max, GPRS, etc. The build-in GPS further provides the position information of the monitored person. The remote server not only collects physiological measurements but also tracks the position of the monitored person in real time[11] [24-28].

In this paper, we propose an improvement of our previous work in this field by developing a heart rate , body temperature and blood pressure monitor system based on new arduino mega micro-system device. It offers the advantage of portability over old embedded system (tape- based recording systems). The paper focus on: how we implemented algorithms to analyze heart beat rate signals in real-time, how to fusion data of different sensors mainly here temperature and blood pressure and to transmit the data via radio frequency (X bee module). Then explain a web server application for health care givers to access the data. In addition, it allows doctors to get the heart beat rate file of the patient by email every twenty four hours. It can also be used to control patients or athletic person over a long period. The system reads, stores and analyses the heart beat rate signals, body temperature repetitively in real-time. The hardware and software design are oriented towards a single- chip micro controller based system, hence minimizing the size. The important features of this paper are the implementation of extreme and energy in the algorithm to compute patient heart rate and detect any anomaly within the P wave in ECG signal. The first tests were encouraging[19].

In this paper we have temperature, respiration, patient movements and heart beat reading results are monitored. These sensors signals send to the raspberry pi via amplifier circuit and signal conditioning unit (scu), because the signal levels 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, body movements, respiration and heart rate is measured using respective sensors and it can be monitor in the monitor screen of computer using raspberry pi as well as monitoring through anywhere in the world using internet source. raspberry pi is programmed for the need that via USB dongle (or) ethernet for patient health monitoring through internet. It sends all current health data of particular patient to the web database. Anybody can access the web and see health of patient [20][29][30].

3. WIRELESS TECHNOLOGIES USED FOR HEALTH CARE MONITORING

Technology	Frequency	Data Rate	Range	Power Usage	Cost
Bluetooth/ BLE	2.4GHz	1,2,3 Mbps	~300 feet	Low	Low
LoRa	Sub GHz	<50kb ps	1-3 miles	Low	Medium
NB-IoT	Cellular Band	1-10 Mbps	Several Miles	Medium	High
Wi-Fi	subGHz, 2.4GHz, 5GHz	0.1-54 Mbps	<300 Feet	Medium	Low
ZiggBee	subGHz	40kbps	~100 Feet	Low	Medium

Table (1) : Comparison of Various wireless Technologies for Health care Application

4 .COMPARATIVE ANALYSIS

For Comparative analysis we summarize some recent physiological parameters with respect to wireless technology used, range, IoT realization, sensor node location and power requirement.

Parameter	Wireless Technology	Range	Health Parameter	IoT realization	Sensor node location	Power requirement	Application
[15]	BLE	Short	ECG,Respiration, Heart rate, Body temperature, Blood oxygen	Yes	Cloth	Rechargable battery	Healthcare
[16]	6Lo WPAN, RFID	Short	Motion, ECG	Yes	-	3V rechargable battery	Healthcare system for hospitals
[17]	BLE	Short	PPG, Hydration	-	Wrist	Solar with 20mAh Rechargeable Battery	Health care
[18]	BLE	Short	PPG,Motion, Skin Impedance, ECG, VOC, Ozone, Respiration rate	-	Chest, Wrist, Hand hold	Rechargeable Battery	Health care Chronic Respiration Disease

Table (2): Comparative analysis of Health care monitoring[15][16][17][18]

5. CONCLUSION AND FUTURE WORK

For Future work , Wearable IoT Sensors such as ESP32 Node MCU module , Pulse sensor, ECG - AD 8232, DHT -22 From these sensors we monitor Temperature of a body, Pulse rate, and heart beat respectively. The data from Individual wearable IoT sensor are collected in real time on hourly basis. The sensor data are transmitted using ESP 32 Node MCU module which have both Wi-Fi and Bluetooth en-ability. From Node MCU we retrieve our data and stored in MongoDB. MongoDB stores this data in unstructured manner in own cloud. After that we use Multi - sensor Data fusing algorithms which combines all Sensors unstructured data from MongoDB cloud and converted into structured format. For data fusing algorithm we may use Kalman Algorithm, Least mean square algorithm or ARMA algorithm. For these algorithms we either consider MATLAB or Python. From data fusing algorithm we can predict the users vital signs are good or bad. These predicated data analyse on the basis of hour, day,week or month. User can see the predicted data on IoT web page or in Android App.

Also we are using MongoDB application for the storing data which is also use for security purpose. Then the real time data monitoring is done by using matlab also matlab predict the data on time to time bases

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