MONITORING OF PATIENT HEALTH USING IOT SENSORS

Nabi M
M.Tech Student
Dept of Studies in Computer Science & Engineering
University BDT College of Engineering
(A Constituent College Of VTU Belagavi)
Davangere, Karnataka, India

B N Veerappa
Associate Professor & Chairman
Dept of Studies in Computer Science & Engineering
University BDT College of Engineering
(A Constituent College Of VTU Belagavi),
Davangere, Karnataka, India

Abstract: Internet of Things (IoT) is the emerging paradigm, which contains huge amount of smart object and smart devices connected to the internet for communicating with each other. IoT devices are used in many fields which make the users' day to day life more comfortable. These smart devices are used to collect temperature, blood pressure, sugar level etc., which are used to evaluate the health condition of the patient. Communicating the collected information to the doctor, making accurate decision on the data collected and notifying the patient is the challenging task in the IoT. In this paper, the architecture of the Patient Health Monitoring System (PHMS) using IoT devices is proposed to collect the required parameters and evaluate the data obtained from the IoT devices. PHMS also notifies the patient with possible precautionary measures to be practiced by them. This system suggests the patient with medical care and next step to be followed in case of critical situation. The PHMS is evaluated for certain parameters and the decisions made on the data obtained from the source are assumed to evaluate the system. The simulated results experiments the correctness and effectiveness of the proposed system.

Index Terms **- Healthcare, Internet of Things, Wireless sensor, Body Area Network, Pulse rate.**

I. INTRODUCTION

In recent years, the growth of internet is tremendous and has been further extended to connecting things through internet. All devices are connected to one another with various smart technologies to create worldwide ubiquitous network called Internet of Things (IoT). The development of technologies such as IoT generates huge amount of data, leads to new age of information. Data generated by the IoT devices are used for analysis and decision making process. The applications of IoT can be grouped into domains like (i). Transport and logistics, (ii). Health care (iii). Smart Environment (iv). Personal and Social [1]. The roles of IoT in all these domains are remarkably high. In Transport and logistics vehicle identification, vehicle to vehicle communication, traffic communication etc. are the major advancements in the field of IoT. Nowadays Government focuses on creating smart cities to use all the emerging technologies and developing the nation to compete internationally. Each and every person is surrounded by smart devices, which is used to connect to the 3G/4G network, social networks and other intelligent technologies. The strength of IoT is its high impact on every person's day today life such as entertainment, work, communication and so on. The key enabling factor of IoT is in medical and health care. IoT devices are used to collect, monitor, evaluate and notify the patient with the information. According to Borgia [2], the penetration of IoT devices in medical and health care is (i). Remote monitoring medical parameters (ii). Diagnostics (iii). Medical Equipment tracking (iv). Secure and access the indoor environment (v). Smart hospital services (vi). Entertainment services. The remote monitoring of a patient by the doctor is still a challenging task. To analyze the health condition of the patient, various medical parameters are needed about the patient. Collecting the parameters and communicating them to the doctor through the proper networking channel is another challenging task. The paper is organized as follows. In section II) The related work of IoT devices in health care is provided. III) Existing & Proposed system. IV)The architecture of PHMS is explained in section \V)Experimental setup. VI) The conclusion of the proposed system and the possible future works are given in section.

II. LITERATURE SURVEY

Gennaro et. al. [4] developed a personal health diagnosis based on the symptoms of the patient. A huge amount of collected data is used to analyze the disease and risk of the patients. Franca discussed that the innovations of the new generation systems are the development of continuous monitoring features for the patient and the improvement of workflows and productivity of medical personal. He also emphasized the various wireless technologies and the advantages of using those technologies for faster communication [5]. Tao et. al developed a wearable sensor system to monitor the movements of the patients. The system was calibrated to a threshold level less than 5% with the aim of minimizing the error rate of the captured data[6]. Stefano et. al[7] proposed a detection system to monitor the movements of patients which recognizes a fall and automatically sends a request for help to the caretakers. Security is a key concern in the IoT devices management. The four identified requirements are [9] (i). Secure authentication and authorization, (ii).Secure bootstrapping of objects and transmission of data, (iii).Security of IoT data, (iv). Secure access to data by authorized persons. Mohammed discussed that the key distribution is required to secure the e-health applications. He modeled a protocol for key management which allows the captured data to be transferred in a secured channel [8]. An IoT deployment in healthcare needs more security because the data of any patients is more sensible and it should not be misused by any bad elements in the society. Debiao and Sherali discussed the security requirements and authentication schemes for RFID based on elliptic Curve Cryptography (ECC)[12]. Cristina et. al [10] developed an approach to maintain health care data

of a patient collected in different geographic locations. The data is available to doctors, hospitals, laboratories etc., to check the medical history of the patients. Jieran et al. [11] developed a Radio Frequency Identification technology and intelligent systems, which detect the disinfected articles and alerts the medical staff to wash the hands after the contact with the disinfectant articles. IoT techniques can be used to promote healthcare in a better way. The health related information could be interacted with doctors who are in emergency. Even in the absence of the doctor near the patient or in the hospital, the doctor can know the patients' status so that the doctor's advice is given in critical cases. Brian Blake commented that the human users could be alerted proactively based on their fitness and historical medical or genetics history [12]. Data sensed and transmitted through the wireless devices are received in the local system that needs to support accessing of data in heterogeneous formats, can be useful in building real time applications and to be updated in the mobile application of the doctor as well as the user (patients or caregiver). Boyi et. al. presented IoT based system for providing support to emergency medical services by demonstrating how IoT data can be collected and integrated for interoperability[13]. Long et. al. discussed the necessary and requirements details of the software for healthcare and proposed an architecture for healthcare and IoT. He has taken the parameters like ECG, blood oxygen, respiration, temperature etc., [14]. With the increasing health related problems and lack of proper solution in healthcare to monitor the patients in the absence of doctor, the patients face serious problems and lost life in critical conditions, Hence to overcome these problems the new Patient Health Monitoring System (PHMS) is proposed to monitor and evaluate the status of each patient by the doctor even in their absence in hospital or near the patient.

III. EXISTING SYSTEM 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.

Disadvantage:

1. In order to solve these two problems, the patients are given knowledge and information about disease diagnosis and prevention.
2. Secondly, a reliable and readily available patient monitoring system (PMS) is required.

PROPOSED SYSTEM

The designed model of health monitoring system using Wireless Body Area Sensor Network (WBASN). In this framework, the sensors used here Temperature sensor, Blood pressure sensor, Heart beat sensor(Pulse Rate). These sensors are placed on human body which are helps to monitor the health condition without disturbing the daily routine of the patients and these health related parameters are then communicated to physicians through server using long range wireless technology.

Advantages

1. Time related event setting can be achieved
2. Authentication level setting can be achieved
3. System is globally accessed
4. Improve the speed due to fast respond
5 .Emergency is detected & Responded quickly.
6. No need of manual updating of data
7.Shift from a clinic-oriented, centralized healthcare system to a patient oriented, distributed healthcare system
8.Reduce healthcare expenses through more efficient use of clinical resources and earlier detection of medical conditions

Challenges

9.Performance, Reliability, Scalability, QoS, Privacy, Security.

IV. ARCHITECTURE OF PATIENT HEALTH MONITORING SYSTEM(PHMS)

The architecture of PHMS contains three phases; they are collection phase, transmission phase, utilization phase. Body Area Network (BAN) is constructed to collect the required data from the patient. The parameters used to diagnose the disease may vary from one disease to another. Therefore each parameter is sensed by separate IoT devices which are connected to the patient. All the devices connected in the body of the patient are known as BAN in the data collection phase. Blood pressure module, heart rate monitor, temperature etc. are the basic devices used to collect the blood pressure, heart rate and temperature of the patient. The data collected in the collection phase is communicated to the doctor to evaluate the parameter for diagnosis. The collected data is communicated to the doctor through different communication channel depend on the patient's position. The transmission device used in the transmission phases are Wi-Fi or Bluetooth devices. All information collected from the IoT devices are communicated to the local system which contains the software to check the threshold levels of parameter. The normal minimum and maximum of blood pressure for each age category is shown in Table.1. The average of normal body temperature for the human being is 98.6°F (37°C). This can be measured by the temperature sensor and transmitted to the monitoring system through the wireless device. The temperature greater than 98.6°F (37°C) will be considered as abnormal. The heartbeat sensor which is connected with 8051 microcontroller is used to monitor the heartbeat of the patient. The collected data is updated in the PHMS..

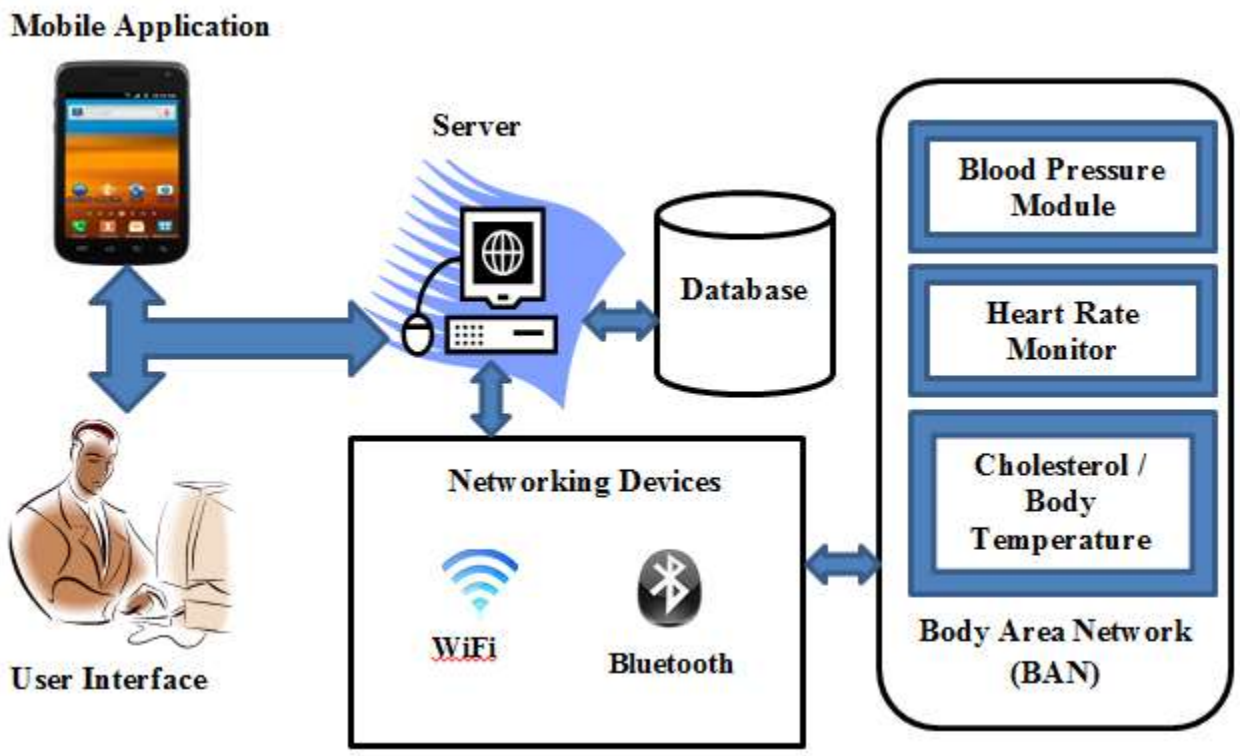

Figure.1. Architecture of Patient Health Monitoring System (PHMS)

The doctors, Trusted person of the patient (authorized to view) and the patients can view the details using the mobile application or through the web. The mobile application is accessed by doctors through their user name and password. The doctors can view all the details associated with their patients. Information such as body temperature, blood pressure, heart rate etc is updated in the server for every 60 seconds. If the doctor wants to access any of his patient's data he can request to send the current status of the patients and retrieve the data from the IoT devices to their mobile devices after updating with the server. If patients or caretakers of patients' want to access the details of the patient they have to use the patient identification number/Registration number to login and view the details. The mobile application automatically shows the risks in red colour to warn the patient if the temperature is high, blood pressure level increases and the heart rate is not in the normal pulse. The normal heart rate is in Table.2.

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

Table.3.Temperature Range of Body

V. EXPERIMENTAL SETUP

The IoT devices like temperature sensor, Wireless Blood Pressure Monitor, and Heartbeat monitor are connected to the body of the patient to form the BAN. The devices sense the data from the patient's body and send them to the local system through the wireless sensor devices. Mobile application is designed for the benefit of doctors and patients. The health status of the patient is updated in the application for every 60 seconds after the update in the server. The data collected from the IoT devices to the system is huge and the information only for last three days can be viewed in mobile application. All parameters for the last three days can be viewed through the mobile application anywhere any time. To evaluate the PHMS, sample data is collected to monitor the patient health. Sample data on blood pressure, temperature and pulse rate are collected from ten patients are given in Table.3, Table.4 and Table.5.

RESULTS AND DISCUSSION

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 every sixty seconds. The system gets the blood pressure data and check with the Table.1 to evaluate the status of the patient. Similarly the pulse rate is compared with the Table.2. For temperature the average temperature falls above 98.6°F (37°C) is considered as abnormal temperature. The data collected from the patients and its evaluation by the application, showed that the observed data is updated correctly.

Table.3. Sample Blood Pressure data of Ten Patients under observation.

Patient ID	Age	Gender	Day 1		Day 2		Day 3	
			Min/Max (mmHg)	Status	Min/Max (mmHg)	Status	Min/Max (mmHg)	Status
P1	16	Male	80/120	Normal	82/120	Normal	85/110	Normal
P2	19	Female	80/125	Normal	90/110	Normal	80/120	Normal
P3	21	Male	85/135	Normal	85/150	Abnormal	90/150	Abnormal
P4	23	Male	80/135	Abnormal	75/135	Abnormal	70/130	Abnormal
P5	26	Female	85/125	Normal	80/123	Abnormal	75/140	Abnormal
P6	45	Female	85133	Normal	90/130	Normal	85/130	Normal
P7	60	Female	70/133	Abnormal	92/128	Normal	90/128	Normal
P8	19	Male	80/145	Abnormal	70/130	Abnormal	75/135	Abnormal
P9	25	Male	78/135	Abnormal	90/130	Normal	85/130	Normal
P10	40	Male	85/135	Normal	90125	Normal	80/150	Abnormal

Table.4. Sample Temperature data of Ten Patients under observation

Patient ID	Day 1		Day 2		Day 3	
	Current Temperature	Status	Current Temperature	Status	Current Temperature	Status
P1	96.5°F	Normal	93.3°F	Normal	94.7°F	Normal
P2	94.3°F	Normal	98.6°F	Normal	98.1°F	Normal
P3	99.3°F	Abnormal	101.4°F	Abnormal	106.2°F	Abnormal
P4	102.6°F	Abnormal	97.2°F	Normal	98°F	Normal
P5	101.2°F	Abnormal	102.6°F	Abnormal	105.3°F	Abnormal
P6	112.8°F	Abnormal	97.5°F	Normal	101.1°F	Abnormal
P7	92.6°F	Normal	100.2°F	Abnormal	105.1°F	Abnormal
P8	108.1°F	Abnormal	94.3°F	Normal	95.3°F	Normal
P9	95.4°F	Normal	114.2°F	Abnormal	96.2°F	Normal
P10	96.8°F	Normal	107.3°F	Abnormal	100°F	Abnormal

Table.5. Sample Pulse rate data of Ten Patients under observation

Patient ID	Day 1		Day 2		Day 3	
	Pulse rate (bpm)	Status	Pulse rate (bpm)	Status	Pulse rate (bpm)	Status
P1	102	Abnormal	107	Abnormal	109	Abnormal
P2	90	Normal	75	Normal	89	Normal
P3	105	Abnormal	109	Abnormal	104	Abnormal
P4	108	Abnormal	72	Normal	82	Normal
P5	94	Normal	104	Abnormal	107	Abnormal
P6	103	Abnormal	74	Normal	104	Abnormal
P7	98	Normal	100	Normal	78	Normal
P8	106	Abnormal	83	Normal	83	Normal
P9	91	Normal	106	Abnormal	86	Normal
P10	87	Normal	107	Abnormal	102	Abnormal

VI. Conclusion and Future work

An efficient PHMS is developed to monitor the up to date status of the patient irrespective of the presence of the doctor. The system collects information like temperature, blood pressure and pulse rate of the patient and updates the same to the doctor. The system is evaluated experimentally and collected the sample data of ten patients to verify the status of patients. The doctor can monitor the progress of patients' health now and then to advise them about their health. The system can be extended by adding more features to the mobile application like linking the ambulance services, leading doctor's list and their specialities, hospitals and their special facilities etc., Doctors can create awareness about diseases and their symptoms through the mobile application. From the evaluation and the result obtained from analysis the system is better for patients and the doctor to improve their patients' medical evaluation.

Acknowledgement

It is with immense pleasure that I present this paper which is a part of my project work. It has been a learning experience and an enhancement for my technical expertise. I take this opportunity to express my deep sense of gratitude to my colleagues and guide.

.

REFERENCES

[1] Luigi Atzori et al, "The Internet of Things: A survey", Computer Networks, Vol.54, pp. 2787-2805, 2010.
[2] Eleonora Borgia, "The Internet of Thigs vision: Key features, application and open issues", Computer Communication, Vol.54, pp.131, 2014.
[3] https://www.elprocus.com/wp-content/uploads/2014/07/heartbeat-sensor.jpg
[4] Gennaro Tartarisco, Giovanni Baldus, Daniele Corda, Rossella Raso, Antonino Arnao, Marcello Ferro, Andrea Gaggioli, Giovanni Pioggia, "Personal Health System architecture for stress monitoring and support to clinical decisions", Computer Communications Vol.35, pp.1296–1305, 2012.
[5] Franca Delmastro, "Pervasive communications in healthcare", Computer Communications Vol.35, pp.1284–1295,2012.
[6] Tao Liu , Yoshio Inoue, Kyoko Shibata, "Development of a wearable sensor system for quantitative gait analysis", Measurement Vol. 42, pp.978–988, 2009.
[7] Stefano Abbate, Marco Avvenuti, Francesco Bonatesta, Guglielmo Cola, Paolo Corsini, Alessio Vecchio, "A smartphone-based fall detection system", Pervasive and Mobile Computing Vol. 8,pp.883–899 , 2012.
[8] Mohammed Riyadh Abdmeziem, Djamel Tandjaoui, "An end-to-end secure key management protocol for e-health applications", Computers and Electrical Engineering Vol.44, pp.184-197, 2015.
[9] Eleonora Borgia, "The Internet of Things vision: Key features, applications and open issues", Computer Communications Vol .54 ,pp. 1–31, 2014.
[10] Cristina Elena Turcua, Cornel Octavian Turcua, "Internet of Things as Key Enabler for Sustainable Healthcare Delivery" , Procedia - Social and Behavioral Sciences Vol. 73, pp. 251 – 256, 2013.
[11] Jieran Shi, Lize Xiong, Shengxing Li, Hua Tian, "Exploration on intelligent control of the hospital infection -the intelligent reminding and administration of hand hygiene based on the technologies of internet of things", Journal of Translational Medicine, Vol.10., No.2, pp.55, 2012.
[12] M. Brian Blake, "An Internet of Things for Healthcare", IEEE Internet Computing, pp.4-6,2015.
[13] Boyi Xu, Li Da Xu, , Hongming Cai, Cheng Xie, Jingyuan Hu, and Fenglin Bu, "Ubiquitous Data Accessing Method in IoT-Based Information System for Emergency Medical Services", IEEE Transactions on Industrial Informatics, Vol. 10, No. 2, May 2014.
[14] Long Hu, Meikang Qiu, Jeungeun Song, M.Shamim Hossain and Ahmed Ghoneim, "Software Defined Healthcare Networks", IEEE Wireless Communications, Vol. 22 No. 6, pp. 67-75, December 2015.