IOT Based Remote Patient Health Monitoring System

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***Abstract*: Remote patient health monitoring system is an IoT device which could be used with patients or elderly at our homes whose real time health readings such as temperature, blood pressure and electro-cardiogram could be monitored remotely on a hand held device. This IoT device will automatically send alert to the users in case of an emergency which in this case would be fluctuation of the readings of the sensors beyond the normal range. This device is build using thermometer, electro-cardiogram sensor and sphygmomanometer attached to an arduino which transfer its data to servers using a wifi-module. The servers then compute the data which can be displayed on hand held devices. In case the values received from the sensors is outside the normal range then an alert will be sent to the user from the server.**

Keywords – Thermometer, Electro-cardiogram Sensor, Sphygmomanometer, Arduino, Wifi-module, Internet of Things

I. INTRODUCTION

Post-operative patient care is a tedious and an expensive task for the hospitals as in most of the cases the patient is well enough to be discharged but a strict monitoring is required as there are cases with anomalies and risks which could be harmful for the patient. It is not just post-operative patients but also the elderly members in our families require constant monitoring of their health[1]. Most of the time, patients at home are not able to get proper medical attention due to delay in understanding that something is actually wrong with the patient which results in serious problems.

So, to overcome this problem of health, a remote patient health monitoring system is designed through which the health status of a person can be remotely monitored on a hand held device such as a mobile phone or a tablet with internet connectivity. Sensors attached to the patient will transmit data to a server which will compute the raw data received and process it whether it lies in the normal range. If the data is outside the normal range then an alert will be issued to the hand held device of the remote viewer who can then take the required immediate action. In case the user wishes to monitor the readings of the patient at any given point of time the user can login to the system through any device and monitor the readings.

The most important part of this device is that the user can be anyone who needs to monitor the patient such as a family member or the doctor and they do not need to be anywhere near the patient without maintaining any contact with the patient. The user can remotely monitor the live status of the patient from anyplace with the only constraint that there should be internet connectivity as to receive the live updates about the patient.

II. LITERATURE SURVEY

Dohr et. al [2] checked up blood pressure of a person with the help of Keep In Touch connected to Android based Smart Phone through a Near Field Communication. It is based on inductive and magnetic coupling. Upon getting the readings from Keep in Touch all the data is transferred on the smart phone. Since the data is in closed loop so the data is transferred to a secure website and with the help of this website anyone can monitor the readings of blood pressure level.

Junaid Mohammed et. al[3] evaluated the Electrocardiogram of the person and monitored the readings anywhere around the globe using IOIO- OTG Microcontroller. An Android application was developed for displaying the readings of Electrocardiogram reading monitoring. IOIO-On the Go microcontroller is able to transfer the data to the android device using a universal serial bus connection, Bluetooth connection or a Near field communication. Once the data is collected then it is transferred to the Android Application on the smartphone. Where the electrocardiogram readings can be monitored.

Mohammed S. Jasses et. al [4] is based on the monitoring of the temperature of human body using a Raspberry-pi motherboard that is connected to a cloud based system. The sensor attached to Raspberry pi captured the human body temperature and these readings are sent with the help of a wireless sensor networks (WSN). Thereby this set of data is sent to cloud based website where the data can be monitored.

Hasmah Mansor et. al, [5] used a LM35 temperature sensor for the purpose of capturing the human body temperature. This

sensor is there upon connected to an Arduino Uno motherboard which processes the data that is received and transfers it to a secure website in database format of Structured Query Language.

Karandeep Malhi et. al [6] made the use of C8051F020 microcontroller to measure the body temperature and heart rate. The sensors that were created could be worn which collected data and transfer data to microcontrollers which were connected to Zigbee modules which could transfer this data to the nearest receiver that is available.

Soumya Roy et. al, [7] made the use of AT Mega 16L microcontroller for the monitoring of electrocardiogram waves of a patient. The data collected by the sensor makes the use of Zigbee module for the transfer of data.

Rajeev Piyare et. al[8] uses an Android based mobile phone for the monitoring and controlling of home appliances. An Arduino uno motherboard is connected to home appliances such as bulbs and fans which could be controlled by the mobile phone.

III. METHODOLOGY

The methodology adapted in this research is to live stream data from the sensors to the servers which would then process that data. Any data that lies outside the defined limit will be flagged and it would raise alert in the system.

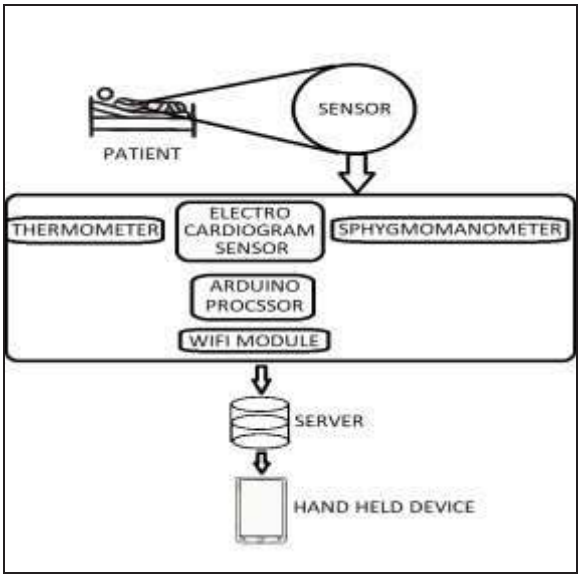

Fig. 1. System Architecture

Fig. 1 shows the architecture of the proposed system for remote patient health monitoring where sensors are attached to a person whose health readings are to be monitored. There are multiple sensors that are contained in the main sensor. These sensors are placed there for taking out different parameters from the person. These sensors include a thermometer, electro cardiogram sensor [9] and a sphygmomanometer [10]. There are two other devices in the sensor namely Arduino and Wifi Module. This data is then transferred to the server which then computes the data and is makes the data ready to be viewed on any hand held device such as a smartphone or tablet.

With the help of this device it becomes easier to monitor the health condition of a person in need weather elderly or post-operative without actually being around them all the time. This device also helps in reducing the expensive cost of patient monitoring at the hospitals. The device provides real-time conditions of the patient attached to the sensors which include the heart rate, blood pressure, temperature, electro cardiogram and other readings that tell the accurate conditions of the human body. These readings are taken through various medical sensors such as thermometer, electro-cardiogram sensor, sphygmomanometer and others which are then processed through an Arduino processor and sent over to the servers using a Wi-fi module.

IV. RESEARCH AND DEVELOPMENT

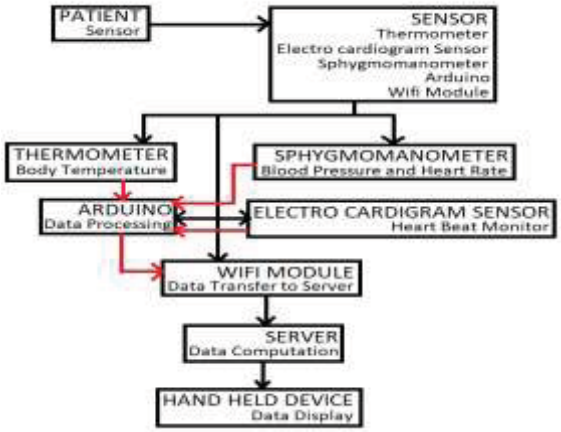

Fig. 2 Block Diagram

Fig. 2 shows sensors are attached to the patient for monitoring various parameters. Sensors such as thermometer takes the temperature readings of the patient, a sphygmomanometer takes the blood pressure reading and heart rate readings, and an electro cardiogram sensor takes heart beat readings of the patient. These readings are taken directly from the patient which are received by the Arduino processor in the sensor. The readings are processed and saved in the sensor and further transferred to the servers using the Wi-fi Module attached to the

Arduino processor. This data on being transferred to the servers is computed and stored in the databases in the form of tables which can be viewed on the user interface of any hand held device such as mobile phones, tablets or laptops. In case readings captured by sensors lie outside the normal range of the values, then an alert is issued and actions need to be taken immediately.

The most important task in the whole system was fetching the EKG readings and displaying them live on the screen as the readings received from the sensors are in graphical format. We used MuseJS which accepted input in the form of graphical co-ordinates and generated a graph based on readings.

V. SIMULATION & IMPLEMENTATION RESULTS

The prototype is tested using the sensors for temperature, blood pressure and heart rate. As test samples three hypothetical patients are used who were monitored over the course of four days.

Fig. 3 explains the circuit diagram of the device that contains the sensors namely thermometer, electro cardiogram and sphygmomanometer, Arduino processor and a Wifi Module.

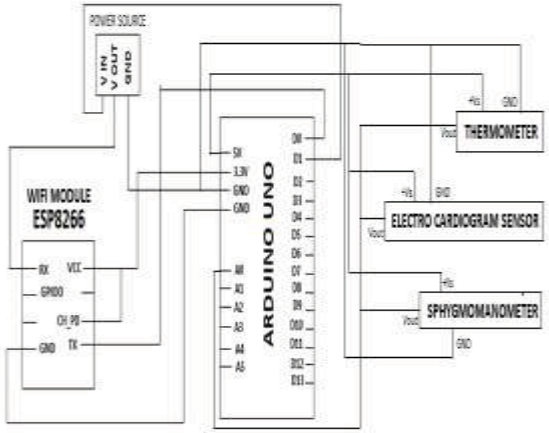

Fig. 3 Circuit Diagram of the Sensor

Table 1 shows the body temperature of three patients over a period of four days from 15th October, 2018 to 18th October, 2018. The data can be monitored easily as in Fig. 4.

Table I. Body Temperature Reading for 3 Patients

Sensor	Patient ID	Test Date	Sensor Reading
Thermometer	P010	Oct 15, 2018	98.2
Thermometer	P011	Oct 15, 2018	102.2
Thermometer	P012	Oct 15, 2018	98.5
Thermometer	P010	Oct 16, 2018	97.5
Thermometer	P011	Oct 16, 2018	101.0
Thermometer	P012	Oct 16, 2018	98.2
Thermometer	P010	Oct 17, 2018	98.0
Thermometer	P011	Oct 17, 2018	99.0
Thermometer	P012	Oct 17, 2018	98.3
Thermometer	P010	Oct 18, 2018	98.1
Thermometer	P011	Oct 18, 2018	98.2
Thermometer	P012	Oct 18, 2018	98.0

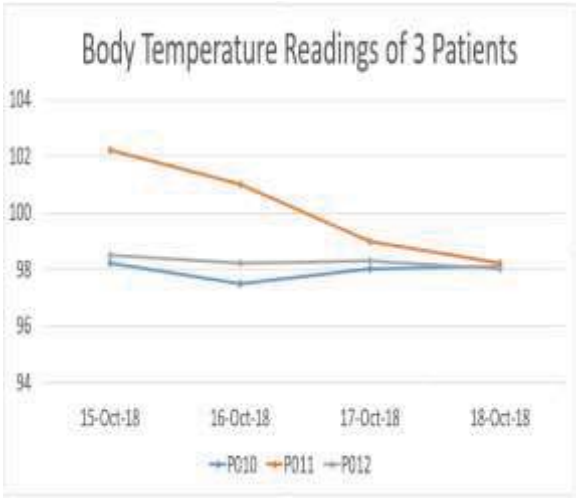

Fig. 4 Body Temperature Readings of 3 Patients

As the normal range set for temperature readings for the human body is 97F-99F. Any values of temperature outside this range would raise an alarm.

Alert was issued to patient-2 (P011) for 2 days i.e. on 15th and 16th October, 2018 as the readings of temperature for this patient was greater than 99F.

Table II. BP and Heart Rate Readings of 3 Patients

Patient ID	Date	Systolic BP	Diastolic BP	Heart Rate
P010	Oct 15,	82	110	75

	2018			
P011	Oct 15, 2018	90	144	84
P012	Oct 15, 2018	80	116	76
P010	Oct 16, 2018	85	108	72
P011	Oct 16, 2018	92	140	82
P012	Oct 16, 2018	82	115	75
P010	Oct 17, 2018	84	112	82
P011	Oct 17, 2018	90	138	86
P012	Oct 17, 2018	80	118	74
P010	Oct 18, 2018	89	124	88
P011	Oct 18, 2018	92	144	89
P012	Oct 18, 2018	82	125	76

Table II. shows the systolic, diastolic and heart rate readings of three patients over a course of four days from 15th October, 2018 to 18th October, 2018. These readings were taken with the help of sphygmomanometer which takes readings of heart rate and blood pressure and sends those readings to the Arduino processor.

Fig. 5 BP According to Age

Fig. 5 shows the ranges of blood pressure according to age of a person. It shows the readings for low, normal, elevated, stage 1 hypertension and stage 2 hypertension readings of a person according to their ages.

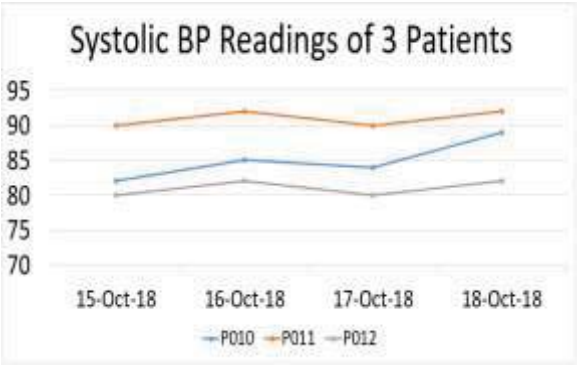

Fig. 6 Systolic Blood Pressure Readings of 3 Patients

Fig. 6 shows systolic blood pressure readings of three patients over a period of four days of monitoring from 15th October, 2018 to 18th October, 2018. Patient-2 (P011) will be alerted as the readings are constantly outside the normal range and Patient-1(P010) will be alerted on 18th October, 2018 as the reading for the day are outside normal range while there will be no alerts for Patient-3(P012) as the readings were always in between the normal range.

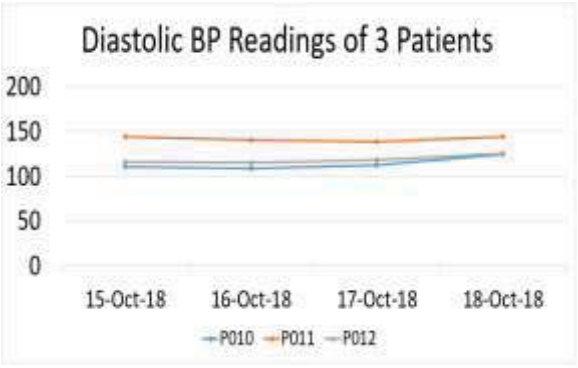

Fig. 7 Diastolic Blood Pressure Readings of 3 Patients

Fig. 7 shows diastolic blood pressure readings of three patients over a period of four days of monitoring from 15th October, 2018 to 18th October, 2018. Patient-2 (P011) will be alerted as the readings are constantly outside the normal range while there will be no alerts for Patient-3(P012) and Patient-1(P010) as their readings lie within the normal range.

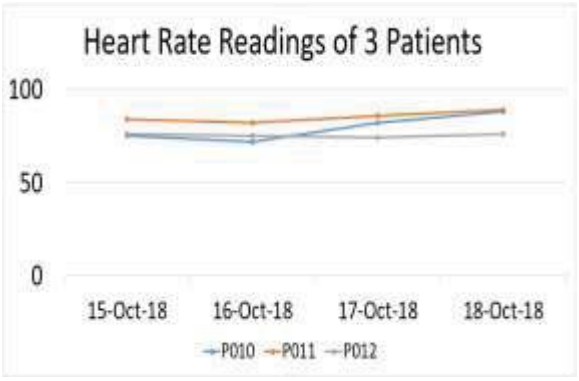

Fig. 8 Heart Rate Readings of 3 Patients

Fig. 8 shows heart rate readings of three patients over a period of four days of monitoring from 15th October, 2018 to 18th October, 2018. There will not be any alerts issued to any of the patients as all their readings lie within the normal range.

VI. CONCLUSIONS

In this paper, we have proposed an IOT based model for remote patient health monitoring. With the help of sensors, the proposed system is able to track the basic vitals like temperature, blood pressure, heartbeat rate and Electro-cardiogram readings of patients at home or remote site. The user can remotely monitor the live status of the patient from anyplace with the only constraint that there should be internet connectivity as to receive the live updates about the patient. The proposed model is extremely useful for the society and would supplement the existing solutions for health monitoring.

VII. FUTURE WORK

This model in the near future can be modified to build micro sized sensors which can be placed on everyone such as a watch or mobile phones. These sensors would monitor every user closely and show the live status of the users on their smart phones. The system may also be enhanced by including a module on diabetic patients who need insulin injections. This module would check blood sugar level of the users, in case the blood sugar level rises then it would alert the user to inject themselves with the insulin shot to maintain their blood sugar level.

Another work in the future could be implementing the first aid in the software model. Any person wearing the sensor would have its display on their smartphones. In case if any of their readings fall of the normal range then this device would display what the person is suffering from for example heart condition such as arrhythmia or tachycardia and the device would show the first aid in such conditions which would mainly include performing CPR (Cardiopulmonary resuscitation).

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REFERENCES

[1] Qasim Ali, Faisal Murad, Mussarat Abdullah, "The Role of Telemedicine for Pre and Post Operative Evaluation of Elective Surgical Patients", 2007 9th International Conference on e-Health Networking, Application and Services, IEEE, July 2007

[2] A. Dohr, R. Modre-Osprian, M. Drobics, D. Hayn, G. Schreier, "The Internet of Things for Ambient Assisted Living", Seventh International Conference on Information Technology, 2010.

[3] Junaid Mohammed, Abhinav Thakral, Adrian Filip Ocneanu, Colin Jones, Chung-Horng Lung, Andy Adler, "Internet of Things: Remote Patient Monitoring Using Web Services and Cloud Computing", 2014 IEEE International Conference on Internet of Things (iThings 2014), Green Computing and Communications (GreenCom2014), and CyberPhysical, 2014

[4] Mohammad S. Jassas, Abdullah A. Qasem, Qusay H. Mahmoud, "A Smart System Connecting e-Health Sensors and the Cloud A Smart System Connecting e-Health Sensors and the Cloud" Proceeding of the IEEE 28th Canadian Conference on Electrical and Computer Engineering Halifax, Canada, May 2015.

[5] Hasmah Mansor, Muhammad Helmy Abdul Shukor, Siti Sarah Meskam, Nur Quraisyia Aqilah Mohd Rusli, Nasiha Sakinah Zamery, "Body Temperature Measurement for Remote Health Monitoring System" IEEE International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA)26-27 November 2013

[6] Karandeep Malhi, Subhas Chandra Mukhopadhyay, Fellow, IEEE, Julia Schnepper, Mathias Haefke, and Hartmut Ewald, "A Zigbee-Based Wearable Physiological Parameters Monitoring System" IEEE Sensors Journal, March 2012.

[7] Soumya Roy, Rajarshi Gupta, "Short range centralized cardiac health monitoring system based on ZigBee communication", IEEE Global Humanitarian Technology Conference - South Asia Satellite (GHTCSAS) Trivandrum, September 2014.

[8] Rajeev Piyare, "Internet of Things: Ubiquitous Home Control and Monitoring System using Android based Smart Phone", International Journal of Internet of Things, 2013.

[9] Paradiso, Rita, Giannicola Loriga, and Nicola Taccini. "A wearable health care system based on knitted integrated sensors." IEEE transactions on Information Technology in biomedicine, 2005

[10] Weight, B.M., and C.F. Dore. "A random-zero sphygmomanometer." The Lancet, 1970.