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IoT Based Emergency Health Monitoring System

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***Abstract*—This paper represents the system for monitoring the patient's body 24/7 by using IoT. Now a days, patient monitoring system is getting much more popularity to the researcher and patient guardian. This system has the capability to monitor physiological parameters form patient body at every 15 seconds. This system is responsible for collecting pulse, body temperature and heart bit from the patient's body and send the data into IoT Cloud platform by using WIFI-Module and health condition of patient stored in the cloud. It enables the medical specialist or authorized person to monitor patient's health, where the medical specialist or authorized person can continuously monitor the patient's condition on the cloud server. The proposed outcome of this research is to give suitable and effective health facilities to patients.**

Keywords—IoT, Wi-Fi Module, Health Care, Medical Services, authorized, efficient.

I. INTRODUCTION

In present day, people are suffering from various kinds of disease and many health problems such as CHF (Chronic Heart Failure) is commonly seen in elderly persons. CHF is a cause of hospital admission particularly for older adults reaching a prevalence of 1.3%, 1.5, and 8.4% in 55-64 year old, 64-74 year, and 75 years or older segment respectively. Hospital stuffs face severe difficulty when they are faced with the task of taking care of multiple patients simultaneously. Problems such as waiting in the queue, travelling time, moving patient, waiting for doctor etc are some of the issues faced by the patients [1]. During an emergency, the situation might get worse. Monitoring the critical patient 24/7 is very important for reducing life threating risk. Wireless application put the great impact in the health care services. It also reduces operating costs of the hospital. In medical science wireless application has several number of advantages such as, ease of use, reduced risk of infection and enhanced mobility [2]. With the help of wireless system, it is very easy to monitor several patients simultaneously. In this paper, an IOT based health monitoring system has been proposed which is able to perform different types of functions within limits of specified time, accuracy and cost. This IoT base system is cheap and can operate remotely. Biological parameters of patients is detecting by sensors. The use of sensor with Arduino, GPRS and GMS has made the patient monitoring system more effective [1]

II. LITERATURE REVIEW

In this decade, IoT based system place the key role in medical appliances. For that reason, many researchers are trying to develop numerous IoT based medical appliances. Some the researcher work is given below;

A researcher [3] implemented a patient monitor system, which aim is to gather data for clinical research and academic studies. PHS will enable faster and safer preventive care, lower overall cost, improved patient centered practice and enhanced sustainability. In this paper [4] researchers implemented a system, which is monitoring the body parameter such as pulse rate, ECG. ARM7LPC 2138 processor is used as a main interface and the data displayed by using graphical user interface. If any of the parameter goes to normal range then a notification sends to the mobile via SMS. In this work [5], an electronic device is described which monitors the elderly people's health in their own home with the help of wireless sensor technology. Implement [6] a remote healthcare system is monitoring the patient health condition by using the medical care provider instrument.

III. METHODOLOGY

Here, we used three sensors one is pulse rate sensor another one is body temperature sensor (LM35) and last one is Heartbeat sensor (ECG). These sensors signal are send to microcontroller. Arduino Mega is the main infrastructure, which was connected by Wi-Fi module.

A. System architecture

In this article, we describe about sensors which are essential, easy to use and has proper effectiveness. Here we considered three fundamental sensors, three for monitoring the vital signs of pulse, ECG sensor, and body temperature, all are recorded in a hospital environment.

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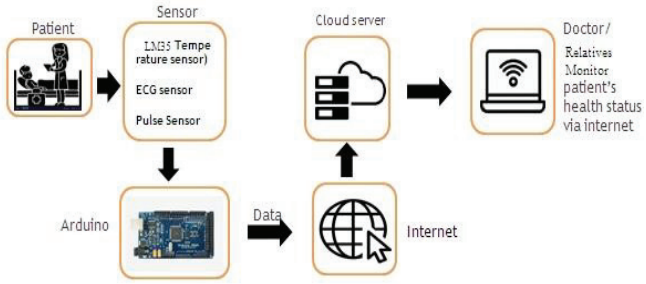


Fig. 1. Block diagram of proposed model.

B. *Software Architecture*

Software execution is one of the major part of this project, which is working as a brain of health monitoring system and maintain the user's flexibility. Microcontroller is the main infrastructure, where we put the data and got accordingly to the sensor value. The data is exerted by Arduino and sent to the Thingspeak online software. The cloud storage is well developed server site which is very useful to store the real time data. Using the proper user ID, password and write API key the website takes the information and shows it to different fields of particular channel. This database is password protected, which is only give the authorized entry and secure the personal information of patient. The following step of the figure was taking for software development.

Fig. 2. Software architecture of remote health monitoring system

C. *Hardware Implementation*

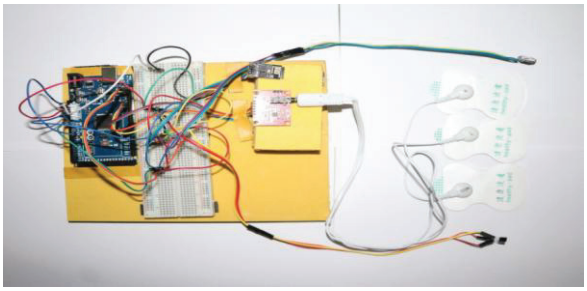


Fig. 3. Hardware setup

D. *Cost analysis*

TABLE I. COST ANALYSIS

Component	Unit Price (BDT)	Unit	Cost (BDT)
Arduino Mega 2560	850 /=	1	850/=
LM35	55 /=	1	55/=
Pulse Sensor	350 /=	1	350/=
ECG(AD8232)	1500 /=	1	1500/=
ESP8266	200 /=	1	200/=
Jumper wire	2 /=	40	80/=
Others	300 /=		300/=
Total			3335/=

IV. RESULT ANALYSIS

A. *Analysis of PPG Signal from Heart Pulse Sensor*

The Pulse sensor takes reading from the blood capillaries through the principle of Photo Plethysmography. From the PPG signal obtained, with corresponding coding algorithms, the heart rate of the person was defined along with the Inter-Beat Interval. The following figure is an extraction of a PPG signal that was obtained from a person during the process of validation. Following that, to get a graphical user interface of the serial plot along with the values of Heart Rate in BPM and Inter-Beat Interval, the Processing Visualize was used in order to do so.

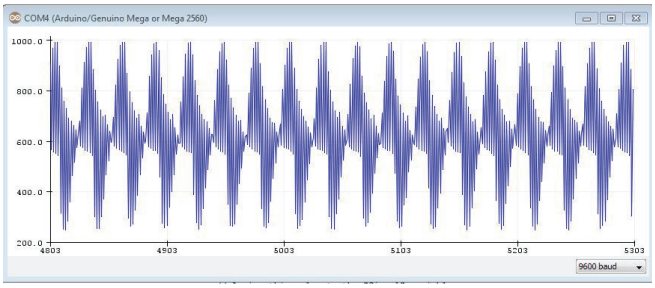


Fig. 4. PPG signal displayed in Arduino IDE serial plotter

In this figure, we obtained 121BPM heart rate from the patient, who was monitored and IBI of 1826ms. We collected the data from two mode of patient, one of the modes was relaxing mode and another one was excited mode. We got 80-90 BPM at the relaxing mode position and above 120BPM had found at exciting mode, which was consisting of anxiety, stress. So, the final value we get from the Pulse Sensor is shown below.

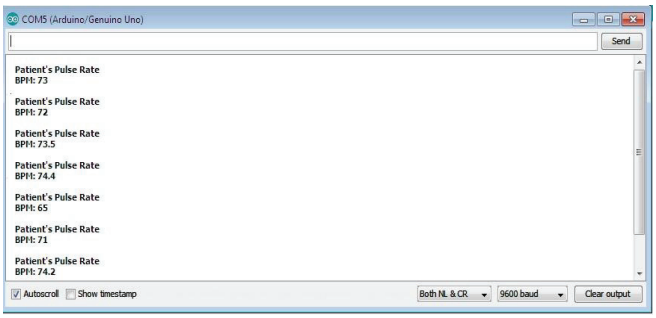


Fig. 5. BPM signal displayed in Arduino IDE serial plotter

B. *Analysis of Body Temperature*

The body temperature is one of the most vital parameters of a person's health. Any fluctuations in the boy temperature

affects the functionality of the blood circulation hence the heart rate. The blood circulates through the body faster when the temperature rises to bring the temperature back to its optimum value.

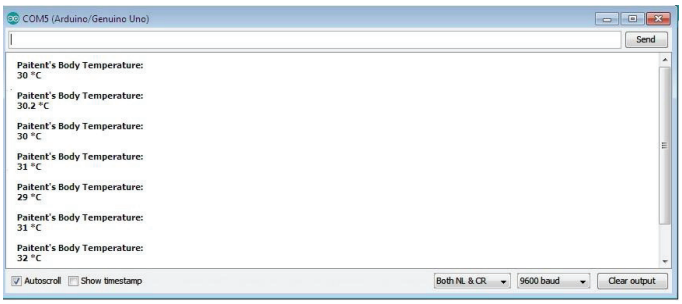


Fig. 6. Readings from body temperature sensor

The above figure shows a pattern of body temperature fluctuations while a patient was monitored. The representation of an increase in temperature of the body when the patient was physically stressed, the temperature of the surroundings is also a factor. When the patient stopped the physical activity and came to rest, the body temperature started to drop to its optimum value. So, it can be established that a significant increase in activity of the patient of due to other physical reasons or environmental reasons, the temperature of the body fluctuates accordingly and causes the heart to pump faster or slower for changing the blood circulation to bring back the temperature to its optimum value.

C. *Real life outcome of this device*

After connecting all the sensors to a patient, we run the module. To measure the values of Heart rate, Body temperature and ECG we ensure that all the sensor were connected properly. The sensors were very much sensitive so sometimes it is difficult to obtain actual standard value. Following that, the extracted values of each of the sensors were stored in the cloud storage which was later accessed by ThingSpeak cloud server.

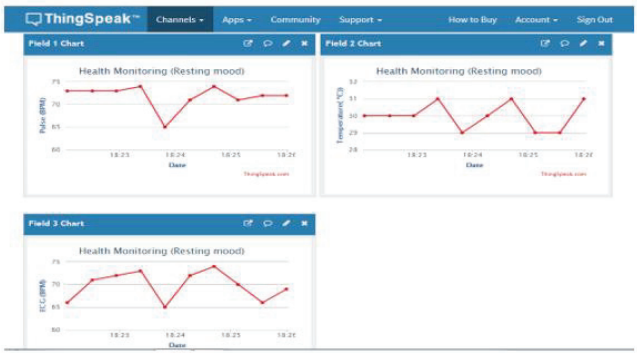
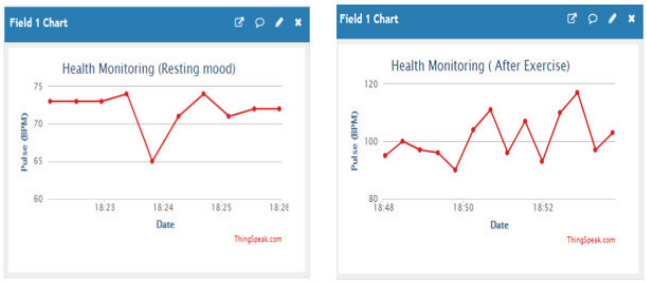


Fig. 7. Monitoring health condition in thingsperk

Now for analyzing we had taken the data at two different conditions. In the figure 7 shows a pattern of the patient's health fluctuations while the patient was monitored during resting and after having exercise. The left side picture represents while the patient was resting and pulse rate looks quite normal condition. During resting time, the pulse rate was like around 65-75 BPM. The right-side picture shows the health condition after having an exercise and pulse rate was fluctuated between 105-125 BPM. The Figure 8 shows a pattern of the patient's health fluctuations while the patient was monitored during resting and after having exercise. The left side picture represents while the patient was resting and pulse rate looks quite normal condition. During resting time, the pulse rate was like around 65-75 BPM. The right-side picture shows the health condition after having an exercise and pulse rate was fluctuated between 105-125 BPM.



A B

Fig. 8. Pulse monitoring during resting (A) & after exercise (B)

The Figure 9 shows a pattern of the patient's body temperature at resting mood and after exercise. The left side picture represents while the patient was resting and body temperature was around 31 degree Celsius. From the figure it can be easily observed that the temperature rises about 5 degree after having exercise.

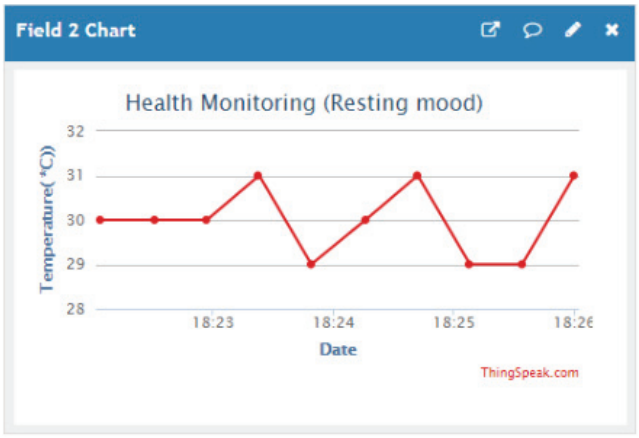
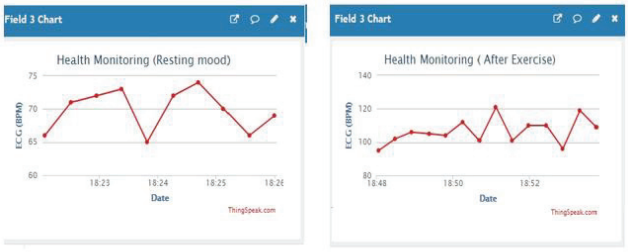


Fig. 9. Body temperature monitoring during resting

The Figure 10 shows a pattern of a patient's health fluctuations while a patient was monitored during resting and after having exercise. The left side picture represents while the patient was resting and ECG rate looks quite normal condition. During resting time, the ECG rate was observed around 65-73 BPM. The right side picture shows the health condition after having an exercise and ECG rate was fluctuated between 98-120 BPM.



A B

Fig. 10. ECG monitoring during resting (A) & after exercise (B)

D. Comparison Table

Here, comparison of the device is shown with pathological value. The percentage of error is also calculated.

TABLE II. HEALTH MONITORING SYSTEM REPORT

Parameter	Proposed system	Pathological value	% of Error
ECG Hr	67 63 76	65 65 77	3.07 3.071.29
Blood pressure	124/86 117/80 129/92	122/85 117/91 127/93	1.60/1.17 0.00/1.23 1.57/1.07
Body Temperature	96.7 99.8 100.1	99.2 100.2 100.9	2.52 0.39 0.79

V. NOVELTY OF THE WORK

In order to reduces the human casualty, the health risk, hospital visits for primary health issues and provide comfort ability for patients by reducing the stress of going to doctors, several projects were done based on health monitoring system over several decades. With the help of our project, the feature allows the users to monitor patients from distance without the need of physical interaction and hence enables the possibility of virtual consultation. This project is IoT base, so this project could be an introduction of cloud-based innovation in health-care and could create a huge impact on the society.

VI. RECOMMENDATION ON FUTURE DEVELOPMENT

Day by day, health sector has been improving by using advancement of technology. Researcher have been continuously working on developing the medical appliances. In the further development, numerous sensors can be added to measure the more parameter from patient body such as respiratory sensor, blood pressure sensor and glucose sensor. Also, GSM may be introducing to give the patient condition at the patient guardian. After adding this sensor, this device will be worked as complete package of health monitoring system.

VII. LIMITATION OF THE WORK

This IoT based Emergency health monitoring system has a particular number of limitations which include the accuracy, the number of sensor and cost utility. It is very complex to analyze and determine a patient's health status by only three parameters. Hence, an addition of a greater number of sensors is a necessity and a good quality sensor is costly. On the other hand, the accuracy of the sensors is a major factor for this project. Different sensors and methods of measuring health parameters establish different results and hence, a different accuracy of the parameters. However, the lack of accuracy of the system could be reduced by using sensors with more precision and good quality sensor. It may be used different kind methods and respective comparisons could be made, from which the one with the closest to accurate result will be further used for the product.

VIII. CONCLUSION

In this paper, our main concern was ensuring the uninterrupted health monitoring system for the patients. This project was proposed prototype model. Our main gold was to focus on monitoring patient health monitoring with wireless body area network. By using the system, the professional can monitor, advice and diagnose their patient and family member before arriving to the emergency. The data are stored and published online. Hence, the professional and family member can monitor their patient from a remote location at any time. Android application is used for monetizing the patient. Before beginning of the project, every sensor was calibrated individually. Each of the signal analysed by taking different data. All the observed signal was matched by experimental signal. The final results were transferred to the cloud through Arduino, and the users got the output from the system through a message. We can use this system in real life and people will be benefited. This system is user-friendly and cost effective.

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