International Journal of Research in Engineering, Science and Management
Volume-2, Issue-5, May-2019
www.ijresm.com | ISSN (Online): 2581-5792

Implementation of Critical Patient eHealth Monitoring System using Wearable Sensors Based on IoT-Internet of Things

Shashikala P. Patil[1], H. T. Priyanka[2], G. Mallikarjun[3]
[1]*Associate Professor, Dept. of Computer Science and Engg., Government Engineering College, Bellary, India*
[2,3]*UG Student, Dept. of Computer Science and Engg., Government Engineering College, Bellary, India*

***Abstract*: Patient monitoring has advanced over the years, from bedside monitors in the hospital to wearable devices that can monitor patients and communicate their data remotely to medical servers over wireless networks. It is a process that involves monitoring major vital signs of a patient, to check if their health is normal or deteriorating within a period of time. In a remote situation, vital signs information can help health care providers to easily send help to patients when their health is at immediate risk. The problem with this kind of remote monitoring system is that most times the patients must be within a specified location to either monitor their health or receive emergency help. This paper presents a potential solution in the form of a global vital sign monitoring system and consists of two components to demonstrate the functionality; a wearable wireless monitoring device that records the temperature and pulse rate of the patient wearing it and a web application, which allows the patient and the emergency response unit to interact together over cellular network.**

***Keywords*: eHealth, Patient Monitoring, Smart Health, Wearable Sensors.**

1. Introduction

Patient health monitoring is a very important process which helps doctors and other medical workers to offer various assistance, such as emergency services to patients when their health is deteriorating, etc. Without constant health monitoring, doctors may not be able to diagnose some sicknesses on time which may lead to the patients being in various critical conditions [1]. Over the years a number of systems have been developed to cater for some of the issues related to health monitoring, however, the aspect of continuous remote health monitoring of patients when they leave their homes temporarily for either a long or short period of time or permanently has not been greatly considered. This aspect can be really critical, because the patient's registered hospital may not be able to reach the patient, during an emergency in such situations. This can lead to the patient getting into very serious conditions or led to death in extreme cases. Thus there is a need for a system to cater for this kind of health monitoring in remote situations. If such a system is put in place, patients can move freely while their health, will still be continuously monitored wherever they go and get the required help where ever they might be in the event of a medical emergency.

Health monitoring using a wireless sensor network, is a wireless-based biomedical monitoring system, which constantly monitors vital signs of a patient such as their body temperature, heart rate, blood pressure, ECG, etc. and provides the data to a health-care provider to either assist in health diagnosis or check for health improvements of patients. Recently, there have been various research carried out on how health services can reach the masses, and also increase the interactivity between patients and doctors within and outside the hospital [2]. With every research, new methods, techniques are proposed and some implemented, with the aim of improving the way a patient's health can be easily monitored either within or outside the hospital.

According to [3], constant medical checkups can be very helpful in various cases such as early detection of sicknesses, faster diagnosis during emergency cases and much more. Due to terminal illness or a particular medical issue, some people need to constantly monitor their health and visit the hospital regularly for constant check-ups. Thus this becomes very stressful, expensive and time consuming for them. With the newly available technologies, a doctor can monitor his patient's health remotely by the use of wireless sensors [4]. Although these existing systems help in cost reduction and quality health services [5], there are still threats to confidentiality, integrity, and availability of the data retrieved by these sensors. As stated in [6], there is also need for interoperability to enable data gathered to be used, fully or partly across multiple health platforms and portability of these health monitoring sensors, to enable a large amount of data to be constantly collected without affecting an individual's daily activities. By doing this, health data analysis becomes easier and diagnosis is more precise [7]. However, some systems have tried to address some of these needs, but each of them still lack in one way or the other, thus leading to quest of a hybrid health monitoring system that will have all these functions in its architecture and be able to work independently rendering emergency assistance to patients wherever they may be and irrespective of the hospital they are registered to. This system will work with hospitals, by providing them with basic health details of a patient thus enabling them to provide a quick and accurate diagnosis.

The rest of the paper is as follows. Section II surveys previous literature - it discusses the basic concept of health monitoring, including the types and ways in which patients' health have been monitored over the past years. In this section, various wearable health sensors are discussed and a comparison is performed based on the various communication technologies that can be used in eHealth monitoring. Finally, major related works of this research are critically discussed and reviewed. Section III introduces the system's architecture and Section IV looks at the initial results of the system and it discusses the testing of the prototype. Finally, the benefits and weaknesses of the proposed system, are discussed and the paper concluded in Section V.

A. Patient health monitoring

Patient health monitoring is the continuous observation of conditions or several medical parameters (vital signs) of a patient over time by a doctor or nurse. Most often this is carried out manually, using various devices to monitor the vital signs of patients. These devices can be thermometers for checking a patient's temperature, sphygmomanometers for checking blood pressure, manually counting pulse to determine the respiratory rate, etc. Since this requires a health practitioner to check from one patient to the other, there can be a high tendency of inaccurate data records and it can be time-consuming which makes this not feasible in a scenario where a large number of patients need to be monitored. Recently, the health monitoring process has become automated by the use of sensors and various management systems, to continuously check the patient's health without any physical assistance from the health practitioners. This has led to the remote patient health monitoring, whereby no further assistance from a health practitioner is required.

2. Requirements for Remote Medical Sensors

Below are requirements that remote monitoring systems should satisfy. These include wear-ability, reliability, and security.

- *Wear-ability:* This is a key requirement for remote medical sensors, as clinical sensors tend to be obtrusive and can limit the movement of patients. Therefore, in remote monitoring, small sized sensors should not affect mobility.
- *Reliable Communication:* Remote monitoring requires a reliable always-on communication channel to ensure that sensor data arrives at the remote processing server in the minimum amount of time.
- *Security:* In remote monitoring, security is paramount: personal data will be transmitted, so to ensure the privacy of the patient and authenticity of data, several mechanisms have to be put in place [9]. This can range from secured network communication to the encryption of transmitted data to avoid malicious interception [10].

It was developed to facilitate remote cardiac patients monitoring only.

- *Strengths of the Reviewed Systems:* Below is the major strengths of the reviewed systems: Vital Signs can be monitored remotely. Most are cost effective and can be implemented with ease in reality. They eliminate the use of cables transmitting data from monitoring devices placed on the patient. They help to constantly monitor several patients at the same time.
- *Weaknesses of the reviewed systems:* Below is the major weaknesses of the reviewed systems; Dependent on only one particular hospital. No patient authentication when health monitoring commences.

No Redundancies in the systems, as they all have just one means of alerting during an emergency. No location tracking of patients when an emergency occurs, so if the patient is not in the registered residence address at the time of emergency, the hospital may most times not be able to reach the patient. Also false negatives and false positives in the systems, as they throw alert when an emergency occurs. This may be an issue where the system generates false alerts due to maybe weather change or other environmental factors.

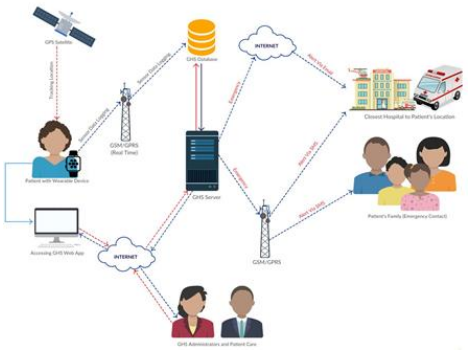

Fig. 1. System architecture

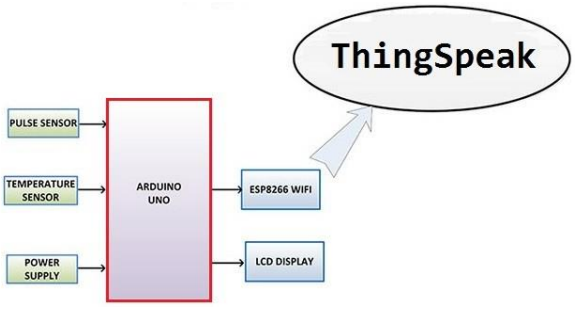

Fig. 2. Interface diagram

The device will then use its in-built cellular module to log this information, on a remote database which stores the data. The database will work in conjunction with the web application to provide a GUI dashboard to registered patients. The main part of this system is emergency management, this includes the various algorithms used to detect and distinguish between health emergencies and environmental factor change. The

system will notify a patient's emergency contact when any of the vital signs are going out of range, this will be done to prevent the system from throwing unnecessary emergency alerts to health-care providers. The system only raises an alert to health-care providers when the vital signs have gone completely out of range before the situation becomes worst. During such emergencies, the patient's location coordinates will be used to locate the nearest health-care provider, retrieve their emergency contact and notify them along with the patient's stored emergency contacts, of the patient's emergency including the location of the patient. The emergency alert sent to the health-care provider will consist of a link which leads to a page on the GHS web application which summarizes the patient details, medical conditions, an overview of the vital signs monitored for the past one hour before the emergency occurred. This will help reduce the time it takes for a health-care provider to diagnose and identify the health condition of the patient.

3. System testing and results

The image below in Figure 2 shows the complete device prototype. For the device to detect emergencies, the following analysis algorithm is used by the device according to vital signs ranges defined in [17], to compare the data that is gotten from the sensors. Although this may vary with the age and gender of the patient in a clinical setting. However, this device can only be used by adults above the age of 18 for the results to be accurate.

The high-temperature alert is thrown if the patient body temperature is above 45 C.

The low-temperature alert is thrown if the patient body temperature is below 33 C.

High Pulse alert is thrown if the patient Breath per Minute is higher than 110 BPM.

Low Pulse alert is thrown if the patient Breath per Minute is lower than 50 BPM.

Fig. 3. Final prototype of vital sign monitoring device

4. Conclusion

In conclusion, this paper has discussed and reviewed the concept of health monitoring and how the process has evolved over the years due to technology advancement. The main aim of health monitoring is to help patients know and find the help they need their health is deteriorating. Various types of health monitoring such as in-patient and remote monitoring were discussed and compared to give the reader an insight on what each type does, with the focus point being the remote monitoring which this research aims to improve. The remote patient monitoring has been adopted by many people because it has proved to be useful and effective, as it allows monitoring outside the hospital. Due to this reason, more research has been carried out to continuously improve the process, helping people carry out their daily activities while their health is being monitored at the same time.

The developed system consists of two major prototypes; a wearable wireless monitoring device that records the temperature and pulse rate of the patient wearing it and a web application, that allows the patient and the emergency response unit (hospitals) to interact together among other features. This system allows health monitoring wherever a person might be around the world because the device uses a cellular module that provides mobile network, so when the person moves from one location to another, the connection is not lost and vital signs data are continuously logged on the server. It can also help registered patients request for emergency help anywhere, by using the person's current location to search for the nearest health-care provider that can offer an emergency response to the patient.

5. Recommendations for future work

Various ways or things that can be added to improve are as follows:

The monitoring device can be made to also store data off-line. Advanced maps can be created to get more detailed info about medical centers, in situations where the closest hospital is really far, pharmacy or even police emergency can be called. A mobile app can be developed and included in the system. More sensors that record vital signs such as blood pressure and respiratory rate, can be included within the wearable device. A medical consultation unit can be added to the system where the patient is able to communicate live with a doctor and receive a prescription.

References

[1] N. N. F. Ayu and C. Hamid, "Health care monitoring using wireless sensor network (H-Caring)," p. 66, Jun. 2012. http://umpir.ump.edu.my/6320/

[2] M. P. Agrawal, S. P. Hemingway, and B. P. Dharaskar, "Innovative approach for wireless health monitoring system using Client-Server architecture," IJETT, 2013.

[3] T. R. Prohaska, E. A. Leventhal, H. Leventhal, and M. L. Keller, "Health practices and illness cognition in young, middle-aged, and elderly adults," Journal of Gerontology, vol. 40, no. 5, pp. 569–578, Sep. 1985.

[4] K. Anudeep and S. Srinivas, "Health monitoring system of elderly using wireless sensor network," IJCAT, 2015.

[5] Y. Bai, L. Dai, and J. Li, "Issues and challenges in securing health systems," International Journal of E-Health and Medical Communications (IJEHMC), vol. 5, no. 1, pp. 1–19, 1 Jan. 2014.

[6] L. Gatzoulis and I. Iakovidis, "Wearable and portable health systems," IEEE engineering in medicine and biology magazine: the quarterly

magazine of the Engineering in Medicine & Biology Society, vol. 26, no. 5, pp. 51–56, 2007.
[7] X. Bellekens, K. Nieradzinska, A. Bellekens, P. Seeam, A. Hamilton, and A. Seeam, "A study on situational awareness security and privacy of wearable health monitoring devices," International Journal On Cyber Situational Awareness (IJCSA), vol. 1, no. 1, 2016.
[8] S. A. Manjushree and Y. M. Rajashri, "Remote health monitoring of elderly using GSM," IJIRTS, 2014.
[9] X. Bellekens, A. Hamilton, P. Seeam, K. Nieradzinska, Q. Franssen, and A. Seeam, "Pervasive health services a security and privacy risk awareness survey," in Cyber Situational Awareness, Data Analytics and Assessment (CyberSA), 2016 International Conference On. IEEE, 2016, pp. 1–4.
[10] X. Bellekens, A. Seeam, K. Nieradzinska, C. Tachtatzis, A. Cleary, R. Atkinson, and I. Andonovic, "Cyber-physical-security model for safety-critical IOT infrastructures," in Wireless World Research Forum (WWRF), 2015.
[11] C. Otto, "An implementation of a wireless body area network for ambulatory health monitoring," Ph.D. dissertation, The University of Alabama in Huntsville, 2006.