International Journal of Advanced Scientific Research and Management, Volume 4 Issue 6, June 2019
www.ijasrm.com
ISSN 2455-6378

A novel framework for patient health care monitoring system using IoT based cardiac disease management

R. Pragaladan [1] and A. Bama [2]

[1] Assistant Professor & Head,
Department of Computer Science, Sri Vasavi College, Erode - 638 316, Tamilnadu, India.

[2] Guest Lecturer, Department of Commerce, Government Arts and Science College, Komarapalayam – 638 183, Tamilnadu, India.

Abstract

In India, the cardiac disease management is not familiar with cardiac patients and most of the heart attack results in death due to patient's absence of mindfulness and improper management. Because the traditional healthcare model is inert, by which patients entitle the healthcare service by themselves. Consequently, they usually fail to call the service if they are unconscious when heart disease attacks. The Internet of Things (IoT) techniques have overwhelming superiority in solving the problem of heart disease patients care as they can change the service mode into a pervasive way, and trigger the healthcare service based on patients' physical status rather than their feelings. In order to realize the health protection, a remote monitoring system is essential. In this paper, we proposed a novel framework that can send patients' physical signs to remote medical management in real time. The framework is mainly composed the monitoring plan is the key point of the data acquisition part and discussion with Medical specialists. Various physical signs (Blood Glucose, Blood Pressure, SpO2, Pulse Rate, ECG and Treadmill Test) as well as an environmental indicator (patients' location) and emergency ambulance service are designed to be sampled at different rates continuously and checking one mode of medical analysis needs into consideration. Finally, a sample model is executed to present an overview of the framework.

Keywords: *Health Protection Model, IoT, Cardiac Patient Management System*

1. Introduction

Nowadays, heart diseases cause more than 2.1 million deaths in India each year and are now the leading cause of death in the country. Usually, patients with heart diseases live at home and ask for healthcare services when they feel sick. However, usually they won't feel sick until the very late stage of the disease and it is so late that the damages have already turned irreversible. And most of the patients die before they get any treatment. Therefore, the key to improve heart disease healthcare performance and reduce the death rate is turning the prevention healthcare mode into a digital way. That means the physical status of patients should be monitored by physicians, who will decide when to deliver healthcare service based on patients' real-time status. The essential part of this modern healthcare mode is the real-time monitoring system.

The Internet of Things (IoT) technique, it is feasible to monitor vital functions of human no matter where they are and what they are doing. Additionally, the data acquired can be sent to remote physicians with low cost, which ensures these experts be aware of patients' physical status continuously and in real-time. In this paper, we proposed an IoT-based healthcare monitoring system for cardiac patient's heart disease healthcare. This system monitors the patients' physical signs such as blood glucose, blood pressure, ECG, SpO2, pulse rate and treadmill test as well as relevant environmental indicators like ambulance services etc. The model provides three different data transmission modes that balance the healthcare need and demands for communication and computing resources. We also implemented a sample prototype to present an overview of the system. This monitoring system fulfills the basic needs of digital based cardiac healthcare for heart diseases, also takes the cost into consideration to ensure the constant mode as economical as possible. Furthermore, it can also be combined with real-time analysis algorithms to assess patients' health condition and give warnings to potential attacks in advance, which can make the digital healthcare more intelligent. But in this paper, we mainly focus on the monitoring, analyzing and management.

The remainder of this paper proceeds as follows. Related works will be discussed in Section 2, and Section 3 outlines the framework from three aspects: the system architecture, its proposed working principle and transmission parts. In Section 4, we explain the system's three operation modes, whereas as model of the framework is displayed in Section 5. Section 6 gives the conclusions.

2. Related works

As the number of elderly people and chronic diseases patients grow rapidly, the drawbacks of traditional healthcare service are increasingly prominent. The most critical one is that healthcare service is only available in hospitals, so it is inconvenient for elderly or disabled people cannot fulfill healthcare requires beneath under emergency conditions[1]. Therefore, a new concept, prevention healthcare was proposed to address the challenge and to deliver healthcare service to everyone, everywhere and all the time. A lot of prevention healthcare applications have been proposed in recent years. Uniyal[1] reviewed existing pervasive healthcare applications that aim at different living conditions like elderly people living alone[2] and disabled healthcare[3], or diseases such as Parkinson[4], heart diseases[5], diabetes[6], etc. The researches about pervasive healthcare can be divided into several aspects: real-time monitoring, incidence detection algorithms, emergency intervention and patient's self-management[7].

Among these aspects, health monitoring systems definitely represent a very hot research topic. Many research projects and prototypes have been developed with different aims, dealing with various diseases, users or different geographical scopes. For example, the monitoring projects proposed by Rofouei[8] and Bsoul[9] only focus on sleeping issues. Lin et al. developed a system aiming at monitoring people's brain bioelectrical activities[10]. And some systems are designed especially for elderly people, which can monitor their postures[11, 12] or detect falls[13]. Besides, researchers considered not only systems used in wide areas[14] but also ones used in a controlled area like a hospital[15]. Because of their different aims, their architectures and monitoring modes are diverse. As a leading cause of death, heart diseases also attract a lot of research interests[16]. Although they deal with the same illness, theses research is various from several aspects. First, the physical signs to be monitored are more or less different. Some only pay attention to one certain sign, such as heart rate, ECG[17], or blood pressure. While others, monitor other parameters which may not be limited to only physiological ones. These non-physiological parameters are considered as they can provide context information of patients which may assist the remote analysis or facilitate context-based services. Compared with the single-parameter monitoring systems, multiple ones can give more accurate and rich information to remote experts. For these systems with multiple parameters, different physical signs should be sampled at different frequencies to satisfy the medical requirements, while transmit them separately at their own sample frequencies will lead to huge amount of data and a great burden to the remote server. Therefore, most systems first resample all sensor data at a tradeoff frequency and transmit the resembled data all-together.

In summary, the health monitoring system is an essential part of prevention healthcare service. And multi-parameter monitoring systems are more useful than those only monitor one sign. However, data transmission for many parameters is an important problem. Although, the current re-sampling method can reduce the remote physician burden and improve the data accuracy. In health applications, data accuracy is crucial to the overall performance and may even affect patients' life. Therefore, we propose a multi-parameter monitoring system which keeps all sensor data, but uses a flexible transmission scheme to reduce communication and computing cost. Patients' risk level is used as the key to transmission control. Patients with higher level will send data more frequently, while ones with lower risk level only send data during important periods. Therefore, the burden of the remote server can be lightened without losing data accuracy.

3. The Cardiac Disease Management using IoT-Based Health Protection

3.1 System Architecture

The general architecture cardiac based health care management of IoT applications can be divided into three sections: the source layer, the transport layer and the designation layer. This type of architecture is evident and flexible enough for our monitoring system. Figure 1 demonstrates the architecture of the IoT-based monitoring system for the Cardiac Health Monitoring system.

IJASRM
International Journal of Advanced Scientific Research and Management, Volume 4 Issue 6, June 2019
www.ijasrm.com
ISSN 2455-6378

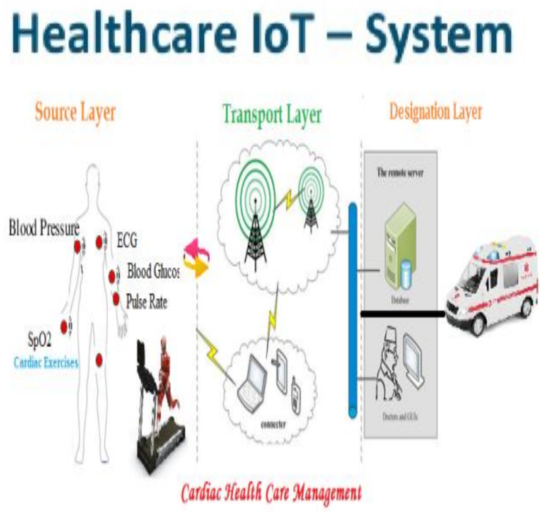

Figure1. Architecture of the Health Monitoring System

3.2 The Proposed Working Principle

Here the patients wear sensors and cardiac exercise details as shown in Fig. 1. And the selection of sensing devices should be based on parameters and the sampling frequency for every parameter.

The main aim of our system is to help the remote practitioners to be know about patient s' health status and to diagnose or forecast hazardous conditions, satisfying the requirement of medical diagnose of cardiac diseases and obeying rules in medical practice are essential for parameters selection and sampling frequencies. Accordingly, we conducted a series of interviews with specialists in nearby hospitals. In addition, the selection of parameters is also subjected to the requirement of moving conditions and convenience for common individuals. With the consideration of both medical and practical demands the monitoring scheme in our framework. The sampling frequency of ECG signals is set to be 128 Hz which is normally used for the ECG signals by ECG devices, Electrocardiography Holter Monitor Wireless Ambulatory ECG, Wearable ECG devices and Mobile ECG devices. The pulse rate and SpO2 can be computed from a pulse oximeter or sensor. In terms of calculating the blood glucose test Blood Glucose monitor or with the help of continuous glucose monitors (CGM) sensor. The cardiac exercise data gather from WIFI based treadmill system (It is done or monitored by qualified professionally or a doctor and it is not recommended all patients) Instead, these parameters are proposed to be tested for any time as random. The patient location information is selected considering the help of a body sensor network with that it is needed if the patient is in danger and resume services should be given to that patient.

Data Acquisition is the process of measuring and examining various electrical and physical entities comprises of Sensors acquired data measurement with the help of computing devices. Our framework covers all possible means of communication wireless for a wide variety of operations. It will be outfitted with WIFI and Bluetooth for medium range data transmission while GSM and Ethernet for long range transmission. The framework will be using thus various Internet of Things protocol options. We will also provide support for Android-based applications so that acquired data can be analysed by our application using different method of communication. The data transmission process takes responsibility of sending data from sensors to a connector in a short distance. As the smartphones, Personal Digital Assistant (PDA) or laptops which are capable of wireless communication in both short and long distances and have computing abilities are extremely popular and widely used nowadays, they are the most suitable devices to be taken as a connector. After the data is received by the connector, it will be sent to the remote side through another communication technology that is prudent for long distance communication.

4. Operation modes for the Health Monitoring System

In our monitoring system, we structured three distinct modes for the data transmission operation:

Mode 1 : High Risk – Immediate Action

In this mode, all data tested by sensors will be transmitted to the remote administration focus and be displayed to the practitioners in real time. This mode is the highest monitoring level. Here the patient considered high risk (ie.) the parameters results shows abnormality so that the emergency will be called with Ambulance and the nearby Physician attend the patient and after first aid sent to Specialist Cardiologist ready to wait for the patients to give treatment and management.

Mode 2 : Moderate Risk – Normal Action

In this mode, all data sampled by sensors will be transmitted to the remote service center and be displayed to the practitioners in real time. This mode is the moderate monitoring level. Here the patient considered moderate risk (ie.) the parameters results shows the little abnormality so that the patient send to nearby Physician attend the patient and after getting the opinion and management from the Specialist Cardiologist.

Mode 3 : Low Risk – Observing Action

In this mode, all data sampled by sensors will be transmitted to the remote service center and be displayed to the practitioners in real time. This mode is the low monitoring level. Here the patient considered low risk (ie.) the parameters results show the normal value so that the patient position observed by Specialist Cardiologist for the upcoming visit. It is useful to Specialist Cardiologist for patient diagnosis and management.

5. Model Implementation

There are various mature commercial wireless sensors for the parameters to be monitored in this system. Therefore, we chose appropriate devices to make up the sensing layer of the monitoring system. The connector plays an important role in the data transmission of the system. Here the system uses Android smart-phone as the connector due to the popularity of smart-phones and the openness of the Android platform. An application on a smart-phone was implemented in Java. This application is responsible for receiving and storing monitored data from the sensing devices through Bluetooth, and transmitting necessary data according to different operation modes. At the remote server side, a web-based application was realized for the doctors to query monitored data.

Figure 2. Sensor devices for Health Monitoring System

The above figures present some devices used in the system and an example of a monitoring GUI at the patient side and result shown in the doctor side. Figure 2 is a picture of the sensing device for Blood Glucose, Blood Pressure, SpO2 and Pulse Rate, ECG and Treadmill systems.

6. Conclusions

In this paper, we proposed an IoT-based cardiac healthcare monitoring framework for health assurance for cardiac patients. This framework monitors the patients' physical signs such as blood glucose, blood pressure, ECG, SpO2, pulse rate and treadmill as well as relevant environmental indicators and quick ambulance service and provides three data transmission modes that balance the healthcare require and demand for communication and computing resources.

References

[1] Uniyal D, Raychoudhury V. "Pervasive healthcare-a comprehensive survey of tools and techniques". Computing Research Repository, 1411(1821), (2014).

[2] Lin, Q., Zhang, D., Ni, H., Zhou, X., Yu, Z. "An integrated service platform for pervasive elderly care". Proceedings of the IEEE Asia-Pacific In Services Computing Conference (APSCC) , 165–172, (2012).

[3] Ganz, A., Schafer, J., Gandhi, S., Puleo, E., Wilson, C., Robertson, M. "PERCEPT indoor navigation system for the blind and visually impaired: architecture and experimentation". International Journal of Telemedicine and Applications, (2012).

[4] Hu, Y.X., Chen, Y., Li, L.M., Hao, H.W. "Wireless wrist-wearable wake/sleep identification device for closed-loop deep brain stimulation". Proceedngs of the Electronics Letters, 49(7): 452–453, (2013).

[5] Lee, J., Jung, J., Kim, Y.T. "Design and development of mobile cardiac marker monitoring system for prevention of acute cardiovascular disease". Proceedings of IEEE Sensors, 1724–1727, (2011).

[6] Poorejbari S, Vahdat-Nejad H, Mansoor W. "Diabetes patients monitoring by cloud computing. Cloud Computing Systems and Applications in Healthcare", (2016).

[7] Varshney U. "Pervasive healthcare and wireless health monitoring. Mobile Networks and Applications", 12(2-3): 113-127, (2007).

[8] Rofouei, M., Sinclair, M., Bittner, R., Blank, T., Heffron, J. "A non-invasive wearable neck-cuff system for real-time sleep monitoring". Proceedings of International Conference on Body Sensor Networks, Dallas, TXm USA, 23-25, (2011).

[9] Majdi Bsoul, Hlaing Minn, Lakshman Tamil. "Apnea MedAssist: real-time sleep apnea monitor using single-lead ECG". IEEE Transactions on Information Technology in Biomedicine, 15(3): 4 16-427, (2011).

[10] C.T. Lin et al. "Wireless and wearable EEG system for evaluating driver vigilance". IEEE Transactions on Biomedical Circuits and Systems, 8(2): 165-176, (2014).

[11] W.Y. Lin, M. Y. Lee and W. C. Chou. "The design and development of a wearable posture monitoring vest", IEEE International Conference

on Consumer Electronics (ICCE), Las Vegas: NV, 329-330, (2014).

[12] E.Sardini, M. Serpelloni and V. Pasqui. "Wireless wearable T-shirt for posture monitoring during rehabilitation exercises". IEEE Transactions on Instrumentation and Measurement, 64(2), 439-448, (2015).

[13] E.E. Stone and M. Skubic. "Fall detection in homes of older adults using the Microsoft Kinect". IEEE Journal of Biomedical and Health Informatics, 19(1), 290-301, (2015).

[14] Mitra, U., Emken, B. A., Lee, S., Li, M., Rozgic, V., Thatte, G., Vathsangam, H., Zois, D., Annavaram, M., Narayanan, S., et al. "KNOWME: A case study in Wireless Body Area Sensor Network design". IEEE Commun. Magt, 50: 116-125,(2012).

[15] G. Shanmugasundaram, P. Thiyagarajan, A. Janaki. "A survey of Cloud based healthcare monitoring system for hospital management". Proceedings of the International Conference on Data Engineering and Communication Technology, Springer Singapore, 549-557, (2017).

[16] Hu, S., Shao, Z., Tan, J. "A real-time cardiac arrhythmia classification system with wearable electrocardiogram". Proceedings of International Conference on Body Sensor Networks, Dallas, TX, USA, 23-25, (2011).

[17] B.A. Reyes et al. "Novel electrodes for underwater ECG monitoring". IEEE Transactions on Biomedical Engineering, 61(6), 1863-1876, (2014).

[18] Chao Lia, et al. "The IoT-based heart disease monitoring system for pervasive healthcare service", International Conference on Knowledge Based and Intelligent Information and Engineering Systems, KES2017, Procedia Computer Science 112, 2328–2334 (2012).