IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.6, Special Issue.10, Nov 2018 E-ISSN: 2347-2693

Cardiac Patient Remote Health Monitoring (CP-RHM) using Digital Monitoring

Kiran Waghmare[1*], Anuj Acodkar[2], Rohit Gavali[2], Rahul Tiwari[2], Prathamesh Pavnoji[2], Sidharth Naik[2]

[1]Computer Engineering Department, Don Bosco College of Engineering, Margao, Goa, India
[2]BE Students Computer Engineering Department, Don Bosco College of Engineering, Margao, Goa, India

*Corresponding Author: kiran.waghmare@dbcegoa.ac.in

Available online at: www.ijcseonline.org

***Abstract*—** Digital health is an application of digital and innovative technologies in health industry. It is a multi-disciplinary domain which involves Scientists, Researchers, Doctors and Technicians. Therefore, a new smart platform used by the Digital health is Internet of Things (IoT). An open, standards based framework enables innovators to create new ideas for e-healthcare. IoT allows innovators to design accessible, robust, affordable and secure healthcare i.e., Patient Remote Monitoring Systems which is used by Doctors, or Healthcare Practitioners to improve clinical care, research and public health. The main objective of this paper is to design remotely operated Patient Monitoring System for Cardiac patient at affordable cost.

***Keywords*—** Cardiac, Health Remote Monitoring, Classification, Internet of Technology

I. INTRODUCTION

Digital Health is the convergence of digital and high end technologies with health. It is a comprehensive platform of service offerings to digitization of health. Health experts are increasingly taking advantage of the benefits these technologies bring, thus generating a significant improvement in health care in clinical settings. Likewise, countless ordinary users are being served from the advantages of the M-Health (Mobile Health) applications and E-Health to improve, help and assist patients health.[8]

Internet of Things (IoT) is a smart, innovative technology and device in the area of health care that has caused great impact wider applications in the world.[2] The Healthcare industry remains among the fastest to adopt the Internet of Things. The reason for this trend is that integrating IoT features into medical devices greatly improves the quality, portability and effectiveness of service, bringing especially high value for the elderly, patients with chronic conditions, and those requiring constant supervision.[7]

II. RELATED WORK

Remote patient monitoring system brings a boom in the healthcare industry. It allows the healthcare provider to collect the medical & health data of an individual and transfers it to the clinical staff such as doctors, nurses etc. within no time. This system proves to be an asset for various stakeholders of the health care system for chronic disease management at remote locations. Remote patient monitoring technology have greatly changed the way of delivering and providing healthcare to the patients.[2] With the emerging technologies or connected tools, patients, elders or clinical study participants are not required to visit hospital premises for checkups. It helps in monitoring the patient's medical conditions and avoids the medical emergencies & hospital readmissions.[1]

III. METHODOLOGY

A. *Mathematical Model*

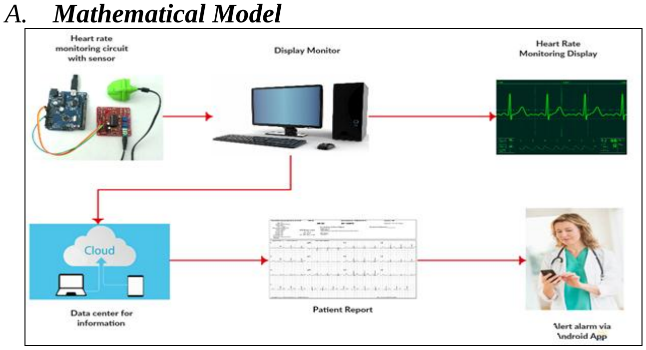

Figure 1.Architectural of System

Cardiac – Patient Remote Health Monitoring(CP-RHM) is consisting of 3-tier Client Server system. It can be divided into 4 sections: Patient Module, Desktop, Display Monitor Module, Data Center Connection Module and Remotely connected Doctor Module.

Server: The server consists of three basic components:

a) Heart Rate Monitoring Circuit with Sensor: It is the component responsible for obtaining information from Patient. The captured information is transferred through the IoT application that makes communication available between the server, the database, patients and doctors.

b) Display Monitor with Cardiac Reports: It is in charge of making inferences based on the contextual information provided by the detector context. It compares the previous patients database with current information and generates the status.

© 2018, IJCSE All Rights Reserved

c) The server (My SQL), gets connected to IoT devices i.e., the smartphone of the patient, which helps in diagnosing the patients and handle the emergency of cardiac patients.

Client: is a system developed on Android 4.4, which mainly consists of two main layers they are the Visual Interface, which makes regular web server invocations, the presents on the screen as the event that requires the interaction with the patient, namely, a reading of blood pressure, blood glucose meter among the others. In the event that is to take a reading from database or from recent reports of the patient readings and workout routines to be performed. Meanwhile the doctor can check the history of the patients. Given the circumstances of the patient readings are outside the normal range, the system sends alert notifications to the doctor where he reports on the readings obtained by the patient.

The patient monitoring based on Internet of things, is an alternative that can be used by doctors to help patients with chronic cardiac diseases as soon as possible . Likewise with the help of this system, the set of solutions is provided to improve the quality of patients health by not just monitoring them, but also to enable and direct them to improve their eating habits and workout routines constantly.

This system proved to be efficient when making inferences related to the critical condition of patients, emergency alerts messages with alarm are reported to the Doctor as well as the patient's caretaker it also provides real time health conditions of patients.

B. Classification of Cardiac Smart Health Remote Monitoring:

Classification aims to discover a small set of rules in a database to form an accurate classifier. Classification is a two steps process.

First step to implement classification functions is to build classification model to describe a predetermined set of classes or concepts.

Second step, Classification in classifier class. In this paper, to analyses the critical patient's condition a Support Vector Machine (SVM) classification is used. The patients database on server is as follows:

Patient	Gen	Age	Height	Weig	BMI	Hyperten	Diabetes	Dyslipidemia	Heart_	ECHO	Angiog	Stroke	Death	Dischar	Classifier
2015ASD	Male	90	156	65	26.7	No	No	No	123	Yes	Yes	No	NO	Yes	Healthy
2015APH	Fem	75	155	64	26.6	No	No	Yes	62	Yes	Yes	No	NO	Yes	Healthy
2015CHC	Male	0	178	57	18	Yes	Yes	Yes	70	Yes	Yes	No	NO	Yes	Healthy
2015ASD	Male	10	170	75	26	Yes	Yes	Yes	92	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Fem	45	173	65	21.7	No	No	Yes	86	No	Yes	No	NO	Yes	Healthy
2014HPS	Male	77	155	46	19.1	Yes	Yes	No	86	Yes	Yes	No	NO	Yes	Healthy
2015HPS	Male	60	999	999	10	Yes	Yes	Yes	66	No	No	No	Yes	NO	Critical
2015HPS	Male	85	140	64	32.7	No	Yes	No	88	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Male	90	169	85	29.8	No	No	No	70	Yes	No	No	NO	Yes	Healthy
2014HPS	Male	63	171	60	20.5	No	No	No	94	Yes	No	No	NO	Yes	Healthy
2014HPS	Male	88	168	45	15.9	Yes	No	Not Known	62	Yes	No	No	NO	Yes	Healthy
2014HPS	Fem	51	168	55	19.5	No	No	Yes	100	Yes	No	No	NO	Yes	Healthy
2014HPS	Male	61	179	82	25.6	No	No	No	74	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Male	40	160	60	23.4	No	No	No	90	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Male	66	165	60	22	No	No	No	62	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Male	48	158	47	18.8	Yes	No	No	101	Yes	No	No	NO	Yes	Healthy
2014HPS	Male	66	165	91	33.4	Yes	No	Yes	80	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Male	48	157	48	19.5	No	Yes	Yes	80	Yes	No	No	NO	Yes	Healthy
2014HPS	Male	66	170	68	23.5	No	No	Yes	86	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Male	68	172	80	27	No	No	No	80	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Male	74	170	75	26	No	No	No	64	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Male	52	145	44	20.9	No	No	No	85	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Male	80	145	66	31.4	Yes	No	Yes	62	Yes	Yes	No	NO	Yes	Healthy
2014HPS	Male	32	170	60	20.8	Yes	Yes	No	74	No	No	No	NO	Yes	Healthy

Figure 2. The patients Database on Server

C. Support Vector Machine

The Support Vector Machine (SVM) was invented by Vapnik and popularly used in Machine Learning Research application. Several studies have justifies that SVM delivers high performance in terms of accuracy specificity and Sensitivity over other classification algorithms.

SVM are learning systems that use a hypothesis space of linear functions in a high dimensional feature space using kernel functions. The system is trained with a learning algorithm from optimization theory using Lagrange. SVM also implements a learning bias derived from statistical learning theory using Generalization SVM is a classifier derived from statistical learning theory given by Vapnik and Chevthe onenkins.

SVM plays an advantageous role to be very effective, in high dimensional space . When a number of dimensions is greater than the number of dimension is greater than the number of samples in such cases also it is found to be very effective. SVM is Memory efficient because it uses subset of training points as decisive factors for classification.

IV. RESULTS AND DISCUSSION

The dataset consists of 83 male patients and 17 female patients. The heart rate ranges from minimum 56 beats per minute (bpm) to 180 bpm. The mean value for Heart Rate is 86.41 and standard deviation is 19.81. As specified in Fig 2. the classification of Normal and Abnormal Cardiac Patients are as follows:

In this paper, for the classification purpose, ECG data is used with various pathological tests. Based on these parameters, confusion matrix is designed as follows:

TABLE 1 CONFUSION MATRIX

(n=100)	Cardiac Patients with Normal ECG	Cardiac Patients with Ab-normal ECG
Cardiac Patients with Normal ECG	78	10
Cardiac Patients with Ab-normal ECG	9	3

Figure 3: Distribution of Classification of Cardiac and non-cardiac patients.

From the given data of Confusion matrix we can calculate the Accuracy, sensitivity and specificity of the system. As given in figure 3. The Cardiac Patients with Normal ECG are 78 and the Cardiac Patients with Ab-normal ECG is 10

True positive (TP) = the number of cases correctly identified as patient =78. The False positive (FP) = the number of cases incorrectly identified as patient =10, the True negative (TN) = the number of cases correctly identified as healthy =9 and

© 2018, IJCSE All Rights Reserved

the False negative (FN) = the number of cases incorrectly identified as healthy = 3.

Accuracy: The accuracy of a test is its ability to differentiate the patient and healthy cases correctly. To estimate the accuracy of a test, we should calculate the proportion of true positive and true negative in all evaluated cases. Mathematically, this can be stated as:

Accuracy= (TP+TN)/ (TP+TN+FP+FN)

Sensitivity: The sensitivity of a test is its ability to determine the patient cases correctly. To estimate it, we should calculate the proportion of true positive in patient cases. Mathematically, this can be stated as:

Sensitivity=TP/ (TP+FN)

Specificity: The specificity of a test is its ability to determine the healthy cases correctly. To estimate it, we should calculate the proportion of true negative in healthy cases. Mathematically, this can be stated as:

Specificity=TN/ (TN+FP)

TABLE 2 EVALUATION OF RECALL PRECISION AND ACCURACY OF SYSTEM

Sr No	**Distribution of Cardiac Remote Monitoring cases (n=100)**	
	Regular	**Result**
1	Specificity	25.%
2	Sensitivity	89.65%
3	Accuracy	88%
4	Precision	88.63%
5	Recall	89.65%
6	Prevalence	87%

As mention in Figure 3, classification of Cardiac Patients is 13 and the Non-Critical Patients are 87. Along with the classification the Precision Rate is 87% and Recall Rate is 89.65%.

The system shows the accuracy of 88% using SVM classification techniques. Also, the sensitivity for 89.65% and Specificity for 25%. The distribution of Normal and Ab-Normal ECG is given below:

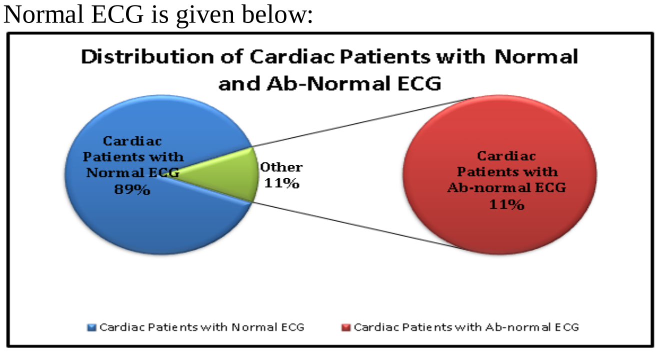

Figure 4. Distribution of Cardiac Patients

The snapshots of the designed Remote Monitoring System are as follows:

Figure 5 . Registration for Remote Monitoring.

In given snapshot, Patient has to be registered before availing the facility of Remote Monitoring. Whenever patient is admitted to hospital, he has to undergo various pathological test. The reports of the test uploaded on the database server, then the as a training database it can be used for the patients for prediction, in future.

Figure 6. Adding Patient to CP-RHM

From the records of database we can retrieve the previous history of patients, and proper diagnosis can be provided from Remote location. This type of preventive approach is defined in this Cardiac Remote Monitoring system. The system is working with the accuracy of 88 %.

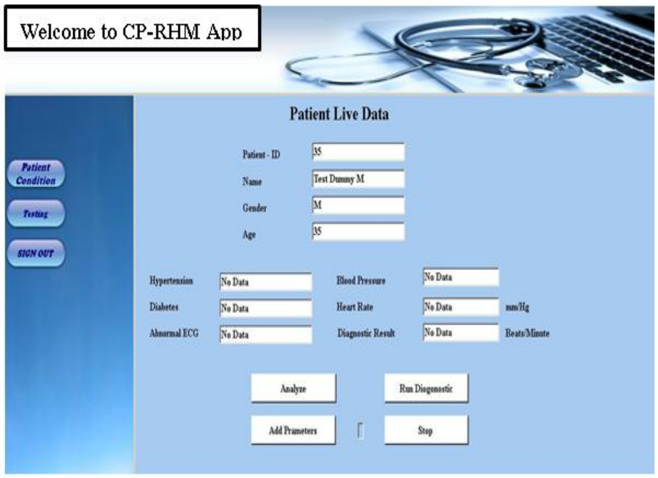

Figure 7. Analysing the Normal and Abnormal ECG

V. Conclusion and Future Scope

In the healthcare digital market, IoT plays an very important role for Patients Remote Monitoring. IoT has greatly decreased the financial burden of patients and delivered high quality of health care with lower risk of morbidity and mortality of patients. Beyond the patient interface, the technology platform is being enhanced in all aspects of medical related problem of the patient especially at remote locations.

Due to stressful lifestyle, prevalence of lifestyle related diseases especially cardiovascular diseases have increased. CP-RPM improves the quality of life by decreasing the mortality and reducing the duration of hospital stay in cardiovascular patients on pacemaker (arrhythmia), cardiomyopathy, myocardial infarction (heart attack)
Remote Patient Monitoring System improves quality health care to patients by timely and proper treatment. Multi-speciality doctors can evaluate the reports and diagnosis from the remote locations. The application moreover reduces travelling time and is useful from proximity of patients home and reduces waiting period in hospitals leading to rapid diagnosis and immediate emergency response services, thus saving the life of patients.

Due to IoT, doctors are also benefitted with Real-time visualization of patient health and medical parameters from remote locations, thus increasing operational efficiency, treatment planning and patients compliance.

References

[1] Bandana Mallick, Ajit Kumar Patro, "HEART RATE MONITORING SYSTEM USING FINGER TIP THROUGH ARDUINO AND PROCESSING SOFTWARE "- International Journal of Science, Engineering and Technology Research (IJSETR), Volume 5, Issue 1, January 2016

[2] Ramalatha Marimuthu, V. Deepak , S. Gowtham , V. Ram Prasad, " REMOTE HEART RATE MONITORING SYSTEM" - International Journal of Electronics & Communication Engineering Research (IJECER)Vol. 1 Issue 3, August – 2013

[3] Lovenish Sharma" PC BASED HEART RATE SENSOR"- Emerging trends in Engineering & Management for Sustainable Development 2016 International conference, Feb 2016

[4] Embedded Lab. Introducing Easy Pulse: A DIY photoplethysmographic sensor for measuring heart rate. http://embedded-lab.com/blog/?p=5508, 2012.

[5] Ufoaroh S.U , Oranugo C.O, Uchechukwu M.E "HEARTBEAT MONITORING AND ALERT SYSTEM USING GSM TECHNOLOGY" - International Journal of Engineering Research and General Science Volume 3, Issue 4, July-August, 2015

[6] Deepti Ameta, Kalpana Mudaliar and Palak Patel, "MEDICATION REMINDER AND HEALTHCARE – AN ANDROID APPLICATION " - International Journal of Managing Public Sector Information and Communication Technologies (IJMPICT) Vol. 6, No. 2, June 2015

[7] Rajalakhshmi.S S.Nikilla "Real Time Health Monitoring System using Arduino" -Department of ECE, Sri Krishna College of Engineering and Technology Coimbatore, Tamilnadu, India.- South Asian Journal of Engineering and Technology Vol.2, No.18 (2016) 52–60

[8] D.Senthil Kumar, G.Sathyadevi and S.Sivanesh," Decision Support System for Medical Diagnosis Using Data Mining" IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 3, No. 1, May 2011.

© 2018, IJCSE All Rights Reserved