Proceedings of the Second International Conference on Intelligent Computing and Control Systems (ICICCS 2018)
IEEE Xplore Compliant Part Number: CFP18K74-ART; ISBN:978-1-5386-2842-3

Study of Health Monitoring System

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Abstract— **Advancement in technology makes great efforts in health care system. Smart health monitoring will reduce effort of people by automating the patient monitoring task which improves patient work flow management. This study reviews enhancement in health care system. It focuses on portable, wearable and android technology based health monitoring system. This study reveals different approaches for health monitoring.**

Keywords—mobile health monitoring, wearable health monitoring, remote health monitoring

I. INTRODUCTION

With rapid increment in population, the number of patient and requirement of health monitoring is increasing. Currently, quality and affordability of health care system becoming major issue. Large amount of population facing problem with increasing cost of health care system. As per the world population data sheet, world population in 2017 is 7.5 billion and health monitoring of this huge population is challenging thing. According to 2016 Global Burden of Disease Report, heart disease is leading cause of death in India, killing 1.7millions Indians in 2016 nearly 53%. There is need to focus on health monitoring system. Recently health monitoring system playing crucial role in order to reduce cost of hospitalization, medical staff burden in addition with consultation time and waiting lists.

Basically the health monitoring system classified in three types. Classification of health monitoring is shown in figure1. Mobile health monitoring system (MHM) deals with smartphone, PC etc., Large number of smartphone based mobile devices are becoming popular day by day. In Mobile health monitoring , one can take care of their health any time without more efforts and this system is easy to use. Remote health monitoring systems (RHM) are important to monitor the patient and treatment is done by sending/receiving data from remote location. This type of system can measure variety of symptoms and can be implement at homes as well as hospitals. Wearable health monitoring systems (WHM) deals with wearable devices or biosensors that can use to measure vital parameters of human body consisting of WHM, RHM and/or MHM.

Smart health monitoring systems (SHM) is advanced technology and new approach to health monitoring.General health monitoring system includes measurement of heart rate (HR), blood pressure (BP), electrocardiography (ECG), oxygen saturation (SpO2), body temperature and respiratory rate.

II. OVERVIEW OF HEALTH MONITORING SYSTEM

During last few decades, advancement in health care system growing rapidly. Smart health monitoring plays crucial role in hospitals, residential and outdoor settings by different communication technologies like global positioning system (GPS), radio frequency identification(RFID).

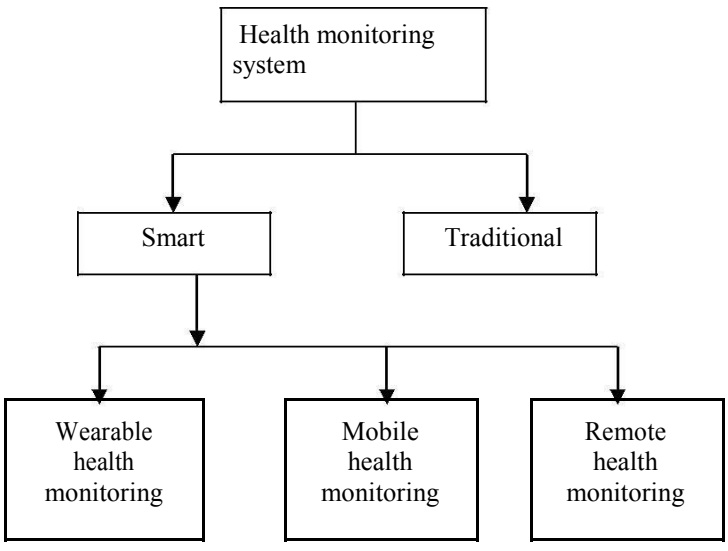

Fig.1 Classification of health monitoring systems (Source: Mirza Mansoor Baig et.al, 2012)

Increment in health care technology concern with medical data quality, security, stability and accuracy of system ,

acceptance by the medical staff as well as patients with the frequency of false alarms being generated.

In health monitoring system, data quality, security and privacy are major consideration. In wearable health monitoring user comfort, data transmission rate power consumption, context awareness needs to take into account. Secure data transmission, real-time availability, Middleware design with User-friendliness are major part of remote health monitoring whereas Power consumption, Energy required with efficiency, User-friendliness, Security and Privacy are important constraint in mobile health monitoring. Fig 2. Show basic architecture of smart health monitoring platform. In most system uses similar architecture with variation in software and technologies.

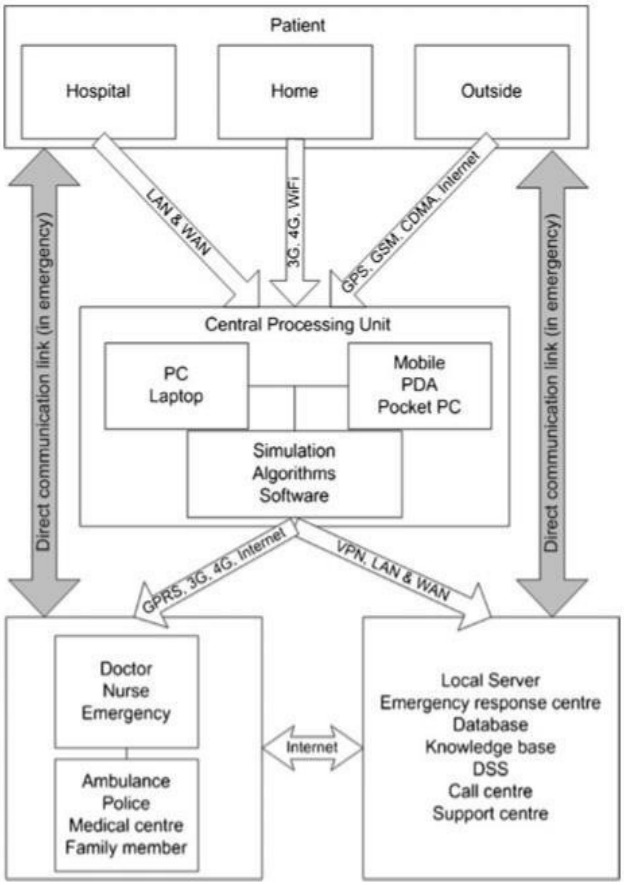

Fig. 2 Basic architecture of smart health monitoring system (Source: Mirza Mansoor Baig et.al, 2012).

III. SMART HEALTH MONITORING APPROACHES:

In this section we concentrate on different approaches used for health monitoring. Various techniques to enhance health care services with the consideration of various parameters mention in this section. Smart health monitoring systems have both advantages and disadvantages which need to taken into account. In the system describe below uses various communication protocol.

Dongdong Lou et al.(2013) describe mobile health monitoring consist of 3AHcare node and android application. 3AHcare is acquisition module with embedded Bluetooth for measurement of ECG, blood pressure blood oxygenation, respiration, temperature and motion. Android application will receive parameter, data is processed by special algorithm for obtaining steady waves and store on micro SD flash.

They have found that system is easy to use and gives high precision. This system is interchangeable.

A new approach of development of mobile health platform based on cloud computing which mainly focus on heart rate viability to access simultaneously the risk of vascular events and of falls by P.Melillo et al (2015).This platform provides proactive monitoring via data mining functionalities. Author describes designing of smart health monitoring system under UE-funded research project ”Smart health and artificial intelligence for risk estimation”. The architecture consist of three layers i.e. user base layer, function base layer and data base layer. While designing architecture user comfort, security and privacy and scalability are taken into consideration.

Amitabh Yadav et al.(2017) introduce a structure of embedded system that keeps track of position and health condition of patient all the time. This system makes use of active RFID card for tracking position of patient and WSN of xbee radio where data received in local database of PC. Use of xbee radio increases the cost of system.

Shintaro Izumi et al.[6] describe processor for electrocardiography in addition with a wearable healthcare system. In order to achieve better accuracy of detected heart rate instantaneous heart rate monitor with short term autocorrelation algorithm (STAC) is used .The ECG processor chipconsumes13.7 A for heart rate logging application.

Wearable noncontact arm band for mobile ECG monitoring system by Vega Pradana Rachim and Wan-Young Chung proposed system consist embedded armband with capacitive coupled electrode. In this system reliability is achieve through proper placement of sensors in arm band. To ignore distractions from body movements or noise and in order to achieve robustness, real-time heartbeat detection and a filter algorithm is used. Author use capacitive coupled electrode for measurement of bio-signals i.e. ECG signal. In addition to that, android application was created to show ECG signal in real time on graph which is useful for analysis. Proposed algorithm was tested on PC for validating system and they have analyze that error rate is less than 10% in comparison with standard system.

To enhance healthcare system Soumen Kanrar et al., has developed a prototype for monitors patient’s vital parameters with the help of android application. This E-health care system has capability to collect not only biological and personal information of patient but also vital parameters and stores this information into the health care database server. They make use of Gaussian mixture model (GMM).It is soft presentation of different feature classes.

In (Yunzhou Zhan et al., 2015), focus on remote health monitoring system with mobile phone and web service capabilities which provide pervasive and continuous health monitoring of patient. Multilayer architecture is designed for the work flow consists of portable terminal, smartphone and

remote server. Bluetooth protocol for communication purpose and Zephyr BioHarness sensor as a portable terminal is used. This system provides two modes i.e. normal status monitoring and emergent response. Indoor localization algorithm in smart phone is used in emergency situation. It gives stable performance but it is only for real time monitoring of patient's status and not for the professional analysis.

Priyanka Kakria et al. (2015) have developed real time heart rate monitoring system with the consideration of cost, simpicity of application with accuracy and data security.. It is having ability to extract cardiac parameters. These parameters are transmitted to android application using Bluetooth and provided to web application for further process.

Low power wearable ECG monitoring system by Elisa Spano et al.is based on IoT platform which integrate heterogeneous nodes and applications. This system is useful in monitoring multiple patients in large indoor area. ECG prototype sensor used low energy and architecture provides low marginal cost.

IV.VALIDATION

Different healthcare system describe in previous section are tested by various experimental study. In some system, monitoring platform validate by various clinical trial. To evaluate the performance, accuracy, system validation procedure is important. In this section different system with their experimental study are mentioned which tells about system efficiency.

Cloud based smart health monitoring platform developed by P.Melillo et al. [9] validate by two observational clinical trial .For cardiovascular risk assessment, a subject was labelled as high risk or low risk as per the vascular event occur during year follow up after recording, If at least one fall occurs in 3 month after recording, subject is labelled as faller for faller identification. Receiver Operating Curve (ROC) and standard measurement for binary classifiers using an appropriate cross validation approach are computed in order to evaluate data mining method. Performance measurements of the automatic system based on HRV for cardiovascular risk assessment and obtained sensitivity and specificity rate of 71.4 and 85.7 %, respectively(Ref. 9)For fall risk assessment, algorithm obtained overall accuracy of 72 % with an AUC of 67.6 %.

Yu Jin Hong et al. (2010) have collected data by using triaxial accelerometer, from 15 subjects. Data marks with time and name is assign to each activity. Mean, entropy, energy and correlation were extracted from acceleration data. Author uses three accelerometer for thigh, waist and hand movements. For recognition of hand movement they are classified in five categories. For better result author leave one subject out of validation process and repeat for 15 subject. In this process initially hand motion recognition is done, then confusion matrix for hand motion obtained after that verify motion of class and match up detection motion of class or not from iGrabber and accordingly I-ADL (activity of daily living) is determined. In order to show accuracy, result is compared with previous work which uses only motion sensor.

In E-health care system by Soumen Kanrer et al., have analyze the performance by two phases. In first phase information provided to central system which is not processed by GMM based algorithm and in second phase it is processed by GMM based algorithm and they have analyze that GMM based algorithm is more efficient in order to distribute the patient to proper doctor cluster.

In System developed by Yunzhou Zhang et.al, numbers of experiments are done to verify stability and precision of system is implemented and analyzed with different situation like walking, running, sleeping etc. experimental result obtained with accuracy of 96.73%, 94.85%, 98.15% and 99.8% for heart rate, skin temperature, respiration rate, posture respectively likewise reliability and accuracy of portable terminal is obtained.

Dongdong Lou et al., has tested system they connect all 3A Hcare node to body and open node power and Bluetooth switch. In order to get remote Bluetooth device and to establish connection they use user interface and result of physical parameter displayed on android device.

Real-time heart monitoring system developed for chronic disease management by Priyanka Kakria et al. (2015) have practically implemented on forty heart patient. Each patient with wearable sensor obtains medical information. Each subject testing was done with respect to conventional machine. System send alarm message when abnormalities (like arrhythmia, hypotension, fever, and hypothermia) detected.. For validation the system is tested using wireless protocols and obtained message sending time for protocols is under as per required medical standards.

V. SUMMERY

The comprehensive studies of different health care monitoring system with methodology with specification are enlisted in table I.

Concluding remark

This paper reviews advances in smart health monitoring system with their application especially in medical field.

Study of wireless, remote and mobile heath care systems emphasize effectiveness of system in hospital as well as home environment. Many researchers developed online or web based monitoring systems which plays crucial role to monitor patient by different approaches producing high quality data and accuracy.

Most monitoring system major vital signs and send it to remote station like local server, PC/Laptop for further processing. Different communication protocols like Zigbee, Wi-Fi, Bluetooth are used in smart health monitoring.Various health monitoring platform are validate by different experimental study and clinical trial. By validation procedure, one can easily understand accuracy, flexibility, precision rate etc. of various systems in depth

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Table I . Summary of smart health monitoring system.

Sr. No.	Author, Year	Specification	System description and Architecture	Communication Protocol used	Comment
1.	Amitabh Yadav et al.	automate the process of examining patients	Consist of subsystem: Patient Module, Data Receiver Unit, Central system module	Xbee, Wi-Fi, RFID	Simplified and cheap version of advanced patient monitoring system
2.	Soumen Kanrar &Prasenjit kumar mandal,2016	Used GMM based algorithm to enhance HMS.	System make use of Android, care database server, GSP system, Frontline SMS	Uses GPS system, Frontline SMS as SMS service.	To enhance healthcare system
3.	Dongdong Lou et. al,2013	health monitoring system capable of detecting, monitoring and transmitting subject's physiological parameters	3AHcare node, Data telemetry program on smart phone with android operating system.	Bluetooth low energy	System easy to use. High precision. Low cost. Small.
4.	Yu-Jin Hong et. al,2015	Activity of daily living based on human motion and object identification	For activity recognition triaxial accelerometer, RFID for tracking	Bluetooth, RFID	Robust High accurate recognition result. recognition accuracy is 80%
5.	Amin Boulemtafes and Nadjib Badache	To review synthesis the main implementation techniques and technologies used to design WHM Systems on the basis of WBAN three-tiers architecture	Typical three tiers BAN architecture: Intra BAN archi. Inter BAN archi. Beyond BAN archi.	BLE	Main goal to extract clinically relevant information of patient. Data fusion and analysis technique used to detect abnormal state.
6.	Shintaro Izumi et al.,2015	Concentrate on ECG processor for use, with wearable healthcare system	System consist of: proposed ECG processor, Near Field Communication (NFC) tag IC, and accelerometer IC	Near field communication (NFC) tag IC	Improves heart-rate detection accuracy despite its use in noisy conditions. ECG processor chip consumes 13.7μA for heart rate logging application
7.	Yunzhou Zhang et al,2015	System monitors physiological parameter and report users' position.	Architecture consist of 3parts: Portable terminal Smartphone Remote server Uses short term co	Bluetooth	1.System is user friendly 2.Easy information sharing between patient and doctor 3.Real time response for abnormal situation

8.	Vega Pradana Rachim and Wan-Young Chung ,	Real-time heart beat detection and a filter algorithm to ignore distractions from body movements or noise from the environment.	system consists of capacitive-coupled electrodes embedded in an armband	Bluetooth low energy	Error rate is less than 10% compared with standard system.
9.	P. Meillo et al.,2015	platform developed to collect and analyze biomedical signals for risk assessment of vascular events and falls in hypertensive patients	system architecture of the SHARE system consist of: User base layer Function base layer Data base layer	Bluetooth	Predict a future vascular event within the next12 months with an accuracy rate of 84 % and to identify fallers with an accuracy rate of 72 %. Platform developed to be flexible, extensible and transparent
10.	Priyanka Kakria et al,2015	Real time heart rate monitoring system providing interface between patient and doctor.	Architecture contain: (1) a patient interface, that is, wearable biosensors' tier, (2) Android handheld device ,that is ,a smartphone (3) a web portal	Bluetooth, Wi-Fi /3G	Experimental study shows system is reliable. System is convenient and ensures data security at low cost.
11.	Elisa Spano et al,2016	ECG remote monitoring system in residential environment integrated in IoT infrastructure.	Architecture consist of: 1. SAN 2. IoT server 3. User interface	Zigbee	Architecture provides low cost per sensor/user. It has long battery life. Provide high quality ECG signals.