International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 7 Issue 7 Ver II || July 2018 || PP 84-98

Iot Based Remote Health Care Monitoring System Using Wearable Sensor for Tracking Anomalous Situation

S. Shanmuga Priya
Senior Assistant Professor Department of Computer Science and Engineering New Horizon College of Engineering, Bangalore, Karnataka, India

Abstract:*Care of critically ill patient with chronological diseases and aging population need to be monitored regularly/periodically, especially if they are living alone. In such scenario, monitoring system plays an important role in aiding such needy people. It improves the living quality of the people, reduces the cost incurred and eliminates unnecessary travelling. The concept of ubiquitous healthcare system is a boon of the technology invention that helps in remote health care monitoring. An unobtrusive wireless sensor is placed on a person's (patient/aged/pregnant ladies) body to form a wireless network, which can communicate the person's health status with base station connected to the monitoring PC. In this paper, a ubiquitous healthcare prototype system for elderly people has been proposed that monitors the health of a person situated at a remote place and provide them required help in emergency situation. A Wearable Body Sensor (WBS) has been placed on the hand of the person; the vital parameters such as body temperature, breathing rate, blood pressure and pulse rate are measured periodically. The sensor sends the values through a smart phone and is stored in cloud in a secured manner. The information can be accessed from a remote location only by the authorized persons' like doctor and care taker. In case, if any anomaly situation is detected in the condition of the patient, the patient's location is traced and SMS alert will be send to the nearby hospital, ambulance service for further treatment and a notification to the care taker as well.*

Keywords – *Wireless Sensor Network, Elderly Person, Anomaly Situation, Vital Parameters, Blood Pressure, Body Temperature, Breathing Rate, Pulse Rate.*

Date of Submission: 21-06-2018 Date of acceptance: 09-07-2018

I. INTRODUCTION

The elderly persons or sick people may have some specific health issues that cannot be ignored. Not only the elderly people need a helping hand, also the people who are ill with chronic diseases, needs someone to take care of them. According to World Health Organization (WHO), the elderly population (people above the age of 60) of the world has drastically increased in the past decades and it has been predicted that it may reach 2 billion by 2050 [1]. For such elderly and sick people, remote health monitoring system proves to be a beneficial one. The traditional wired monitoring system may cause stress to the patient as it limits the patients' freedom. As the technology advances, the wireless monitoring system, enabled by sensors called as Wireless Sensor Networks (WSN), has become one of the major solutions for accomplishing an efficient healthcare system allowing elderly people and sick people to live independently [2][3]. Such wearable sensors are available in markets for commercial purpose [4] [5] [6]. This is a boon in technology that helps in remote health monitoring by recording the physiological information for a long term and managing it from remote location without human intervention [7-11]. These advanced networks include certain nodes, located on human body (either inside or outside), that can effectively communicate with one another for sending the data to a central station. The major advantage of such kind of wireless monitoring system is that it gives freedom and ease of movement of the patients. Installation is also easier as no wiring is needed between the communicating components and the data acquisition system [12-15].

There are two major categories available for wireless body-centric communications [16] are:

i) Inter-body Communication

Off-body, one device is located on the body and it can communicate with one or more devices that are located off-body. This communication covers propagation distances ranging from greater than 1 meter to less than 10 meters.

ii) Intra-body Communication

In-body, the devices are implanted on the body (e.g.,pace-makers). On-body, a number of devices that are located on the body can communicate with each other. This communication covers propagation distances ranging from less than 2 meters to less than 10 meters [17**].**

Recording the psychological along with physiological variables in daily life is very useful and helpful for managing the chronic disease or health related issues. Number of health related issue treatment has benefited from regular vital sign monitoring and measuring. The four vital signs that are prominent in the medical settings are temperature, pulse, respiration (breathing) and blood pressure that proves to be the best indicators of the body's ability to preserve homeostasis. These vital signs measure some of the body's functions and provide essential information about the patient's physical well-being [18].

Vital Sign	**Description**	**Prominent Spot for measuring**	**Normal Range**	**Below Normal Range and Symptom**	**Above Normal Range and Symptom**
Body Temperature	It is the typical temperature found in the body of human being. The normal body temperature of a person can vary based on the gender, fluid and food consumed, time, recent activity done.	Orally Rectally Armpit Ears Skin	97.8° F (36.5°C) to 99°F (37.2°C)	<95°F Hypothermia	>98.6°F Fever
Breathing Rate	Breathing or Respiration rate measures the number of breaths that a normal person takes per minute. This helps to ensure that the person is normally breathing and has no trouble. As people get aged, breathing rate will get decreased.	Throat Chest	12 to 20 breaths per minute	<12 breaths per minute Cardiac arrest [20][21][22]	>20 breaths per minute Dizziness, Spasm in muscle, Tingling in arms and legs
Blood Pressure	It is the force of blood pushed against the artery walls during relaxation and contraction of the heart. It may raise and fall. High blood pressure, or hypertension, directly increases the risk of heart attack, heart failure, and stroke.	Brachial Artery Wrist Fingers	<120 (Systolic) and <80 (Diastolic)	Systolic 120 to 129 and diastolic less than 80	Systolic is 140 or higher or the diastolic is 90 or higher
Pulse Rate	Pulse Rate is a measurement that measures the number of times a heart beats per minute. It also indicates the heart rhythm and strength of pulse. The pulse rate may fluctuate (either increase or decrease) with emotions, injury, illness and exercise. Pulse rate can vary from person to person and it can't be used solely for diagnosis. But it can act as a basic tool for primary diagnosis.	Wrist (Radial Artery) Neck (Carotid Artery) Inside of the elbow (Brachial Artery) Behind the knee (Popliteal Artery) Ankle Joint (Posterior Tibial Artery) [23]	60 to 100 beat per minute	<60 beats per minute Low heart beat	>100 beats per minute Heart related issues

These signs can be measured in a medical setup environment or at home or elsewhere whenever required for monitoring/detecting the medical related issues of a patient. Each of the vital sign is usually measured by using different specialized equipments. Few of these equipments are not handy and portability issues persist. The advantage of ubiquitous computing now made it simple to obtain the vital signs easily at the location where the person is available by using appropriate sensors and calculations/predictions can be made for analysing the present condition of the person. Table 1 shows the various vital signs and its ranges.

The major motivation behind this work is the significant increase in the aging population worldwide. Most patients or elderly persons' do not require any dedicated hospital treatment, but they may need special attention regularly with their doctors who have a detailed knowledge about the patient's history. To make it easier for the patients to gain attention, a patient information system is developed to support the health care system when they are at home. This system aims at giving a regular and timely health care routine support to the patient/elderly person, especially to those who need to be monitored regularly/periodically after being an inpatient like who underwent operations, or having chronic disorder who cannot be in-patient for quite long time. This system is helpful for patients and care takers to take medical assistance regularly and medical staff can also be updated with the timely information of their patients' for ensuring a constant support for their treatment.

The organization of the paper is as follows: Section II explains the related works, Section III highlights the designing and development of the proposed system, Section IV discusses the results of the proposed system and Section V concludes the work.

II. RELATED WORKS

Plenty of researches are available in literature that uses the monitoring technologies and still it's in growing stage due to the adverse need of human kind as well as invent of modern technologies. There are many IoT based healthcare application areas such as remote health monitoring, safety monitoring, personal fitness monitoring, chronic disease monitoring, medication monitoring, and real time location tracking. Out of these use cases, remote patient monitoring system along with location tracking is being quiet in existence and lot of works are being carried out. They are being designed and developed with a common idea to collect the physiological information such as, heartbeats, respiration rate, electrocardiogram (ECG), volume of oxygen in blood, blood pressure, temperature, blood glucose level, etc., from the patient/elderly person for predicting their present situation.

The literature study has been done on a broader spectrum that gives the existing system based on two-fold aspects: monitoring and measuring the required physiological parameters by using wearable wireless sensor and security related aspects while storing the sensitive data in cloud that has been designed and developed for serving the human communities.

a) Monitoring and measuring the required parameters by using wireless wearable sensor

Monitoring of vital sign proves to be a promising technique that helps in identifying the early symptoms of the patient and helps for giving on time treatment. Way back in 1961, Franklin et. al. [24] introduced the ultrasonic method for finding the velocity of blood by using Doppler shift of ultrasound response. This method helps a lot in the medical field for measuring the Blood Pressure (BP). Elseed et. al. [25] proposed an effective method for measuring the systolic blood pressure of the infants using Doppler technique. In literature, it is also found that Pulse Wave Transit Time (PTT) technique proposed by Gribbing et. al. [26] in 1976 is used for continuous BP monitoring. Electrocardiogram (ECG) sensor has been implemented along with Photo Plethy Smogram (PPG) sensor that demands a device to be placed on the patient finger or wrist to detect the pulse travelling from the heart to the peripheral point. This measures the rate at which the pulse travels, if it is fast, the pressure is high, else low. Poon et. al. [27] proposed a wrist watch-type device for monitoring the BP that integrates ECG and PPG sensor. The major disadvantage of Gribbin method and Poon method is, with respect to the reliability of the device is still a question.

Belani et. al. [28] has proposed a non-invasive a watch-type ambulatory blood pressure monitoring device. To estimate the artery location, a circular sensor, digital monitor and disposable adhesive plaster has been used. The data is collected by using the sensor, processed by a controller unit and the result is displayed on the digital screen. However, the limitation of the proposed system is, it is unsuitable for continuous monitoring. Bernacchia et al. [29] proposed a non-contact based method for measuring the vital parameters heartbeat and respiration rates based on kinect device. Tarassenko et al. [30] has proposed a video based method by utilizing a high definition camera for capturing and measuring the vital signs respiration rate and heart rate.

Ordóñez et al. [31] proposed an automated behavior analysis system for elderly people that capture the various daily activities who live alone at home. Various sensors have been used for measuring and monitoring the various day to day activities. By using the standard behavior pattern, the present measured health parameters were compared. Deviation in the parameter is used for predicting the anomalous situation by comparing against the standard patterns. Gjoreski et al. [32] proposed a system for detecting the heart-related issues by monitoring the daily activities of the user. They used ECG sensor and two accelerometers to detect the anomaly situation.

Hao and Foster [33] has given a design strategy for Wireless Body Sensor Networks (WBSNs) for health-care applications. Sardini and Serpelloni [34] developed a t-shirt with embedded sensors for measuring the vital parameters of patients. The t-shirt helps in continuously monitoring and analyzing the patient's situation. Sudden changes in the patient's health, is intimated to the healthcare experts for further treatment and to the caretaker for additional care. Lan et. al., [35] proposed a special medical based application, WANDA that is used for remote monitoring of patient and helps in predicting the risk of heart failure. Shiny and Mythili [36] has proposed a system to provide health care monitoring for rural pregnant women by measuring the vital signs of the maternal and the fetus. Ibrahim et. al. [37] proposed a system for monitoring patients by using a smart bracelet. It consists of set of integrated medical sensors that provides the medical experts with the real-time data with respect to the health condition of the patient.

Measuring of the parameters also includes checking for the patient weight, day to day activities carried out, posture details while sleeping and walking, and so on. Literature review founds works done for wound management, sleeping monitoring applications and so on.

b) Cloud-based monitoring and securing sensitive data

When it specifically comes for IoT based monitoring, security issues must be addressed for providing a safe and secured access of sensitive data. The important security based solutions such as integrity, data confidentiality and data authenticity must be integrated in the application. In the literature survey, it have been witnessed that many researchers doesn't pay enough attention to secure the data stored in the distributed system. Matsubara et. al. [38] designed and developed a seat belt for drivers that measure the respiration rate that is being applied on the gauge embedded in the seat belt. The proposed system implements certain algorithm for ensuring the safety and security aspects of the information being stored on cloud. Tudor et. al. [39] proposed a system for monitoring the health of patient by using body sensors and mobile devices but doesn't sufficiently address the security based issues.

At the same time, in literature it is also evident that, some research, such as [40] [41] [42] has paid specific attention to the security based issues for the healthcare applications they developed. Ben Othman et al. [43] proposed an efficient security model by combining compressed sensing with encryption strategy for transferring the sensitive medical data in hospitals.

Kalra and Sood [44] proposed a system for secure data communication involving embedded devices and cloud servers by using Elliptical Curve Cryptography based mutual authentication protocol. Lounis et. al. [45] developed a cloud-based architecture without doctors/patients intervention for medical wireless sensor networks that ensures the security of sensitive medical data. Jin-Xin Hu et. al. [46] has developed a safe monitoring scheme with IoT sensor based on cloud computing for elderly people. The proposed system involved digital certification based mechanism for securing the sensitive data.

III. Proposed System

The proposed work deals with a ubiquitous healthcare system especially targeted to assist elderly person, sick people and pregnant ladies who must be under constant monitoring as the health risk factor associated with them is huge. The Personal Healthcare Information (PHI) is developed for monitoring the patients at remote place without the direct doctor interaction. This system helps the patient in receiving a high-quality health care from the medical professionals anywhere at any time, which involves lesser cost. The person under monitoring is supposed to wear a wireless sensor device (Body Sensor Network – BSN) which can communicate the vital parameter information through smart phone's Bluetooth. A software interface has been designed to process the data received from the sensors, analyse the data and store it in the cloud-based database system. Only the interesting information is considered, encrypted by using AES algorithm, and transmitted to the healthcare centre for storage and analysis. This helps in reducing the communication loads, keeps the data secured, as well as minimizes the data storage requirements. The centralized health care database is designated to run on a cloud based service with a consideration that contains the complete patient history which can be accessed anywhere by the patient, doctors' and their care takers by using a secured network connectivity through an android application.

Based upon the minute-by-minute vital parameter readings of the patient, the developed intelligent system makes a comparison between the previous reading and the current reading. After processing the information, if any deviation is identified, the system envisages the patient is in emergency situation. The intelligent system helps in making a prediction on what kind of health issues has been identified (done based on the symptoms). This diagnosis helps the doctor's in giving immediate care to the patient without delay in treatment. The patients' location is traced by using latitude and longitude distance. The intelligent system also aids in sending alerts to the doctor who serves nearby the patients' residence and the location of patient to the ambulance service available nearby. It is done by retrieving the required information available in the database. Also it helps in sending an alert message to the care taker providing the hospital details where the patient has been taken to and the ambulance service number as well for tracking. The proposed system helps the patient to move freely anywhere they want and helps in measuring the vital parameters without disturbing them.

a) System Architecture

The figure 1 shows the architecture of the proposed system. The person is given with the wearable sensor whose condition must be monitored. The wearable device monitors the patient every single minute. It acquires and measures the essential signs like body temperature, breathing rate, blood pressure and pulse rate on continuous basis or on demand basis. The data is sent through the patient smart phone received through Bluetooth, and it will get stored in the phone's internal database (sqlite). Further, the collected information is sent to the centralized health care database through the web service. The received data are encrypted for securing the information and sent to the patient information system, where it is stored in the centralized health care storage. Maximum of 2GB data is collected every day from a patient and it demands a massive storage structure that is readily provided by the cloud storage. Once after receiving the data, it is analysed to check for the normal conditions. The collected information is compared with the data available in the existing information in the system, and checks for the standard values as shown in the table 1. A report is prepared based on the reading received against the standard value. In case, if any deviation in the parameter is identified, (any abnormal case is witnessed in case of emergency), the intelligent system predicts the diagnosis and an emergency alert service is also enabled in the form of Short Message Service (SMS) messaging and an alert call to the nearby medical authorities, nearby emergency ambulance service centre and patient's family/relatives/care taker via 3G network. The patients' GPS location is intimated to the ambulance via SMS.

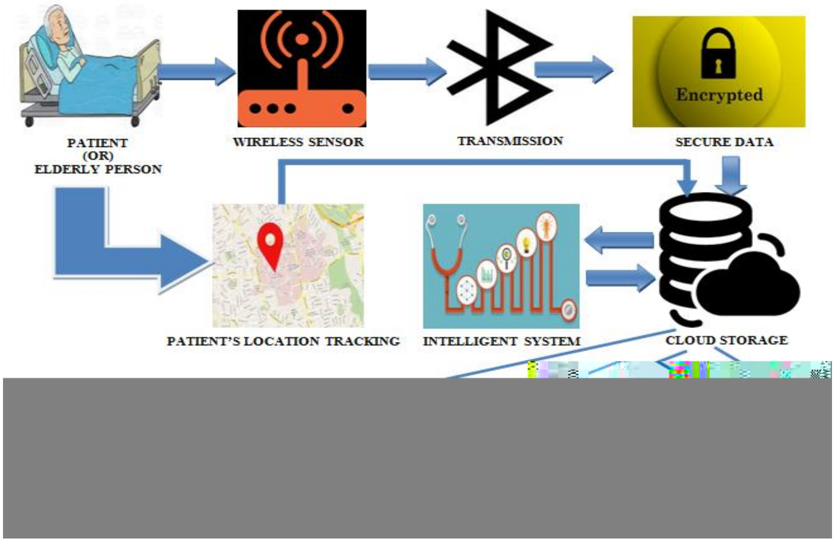

Fig. 1 Architecture diagram of the proposed system

The figure 2 describes the flow diagram of the proposed system:

i) The wearable device is designed in such a way, that it gives a quick snapshot of the patient's health history for continuous monitoring. It acquires the patient's vita data like blood pressure, body temperature, heartbeat, on frequent or continuous basis, depending upon the demand.

ii) It acquires data, encrypts it, stores, and compares the present data with the already existing information in the system and with the standard values. This helps the doctor to get connected with the system, empower them to take a quick and accurate decision in case of emergency for providing an on-time treatment to the patient.

iii) It provides alert from the data-produced system to remote locations like the medical authority, patient's family/relatives/care taker of the patient and nearby emergency ambulance service center via 3G network.

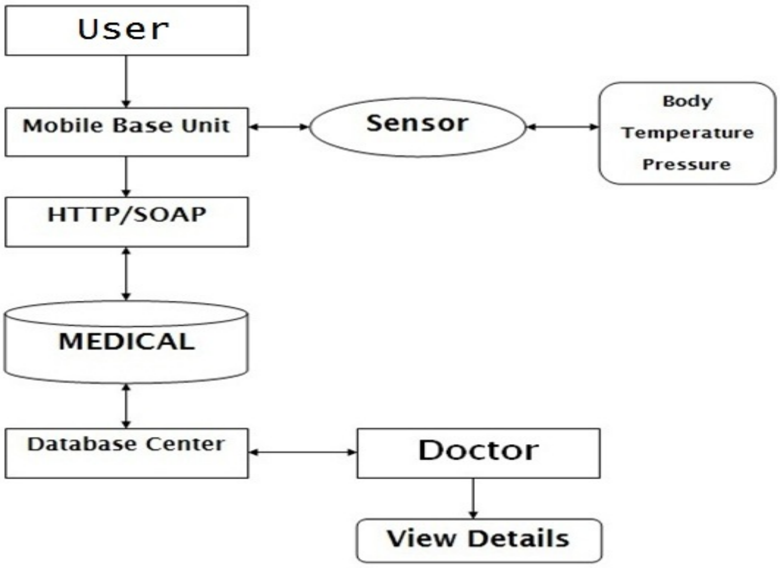

Fig. 2 Flow diagram of the proposed system

Figure 3 and 4 shows the data flow diagram of level 0 and level 2 of the proposed system respectively.

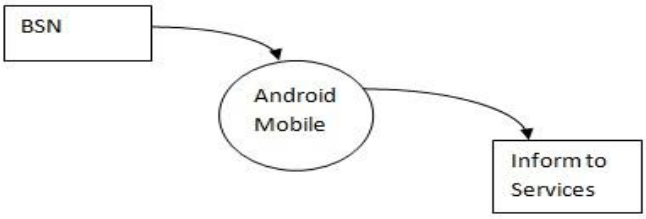

Fig. 3 DFD Diagram Level 0

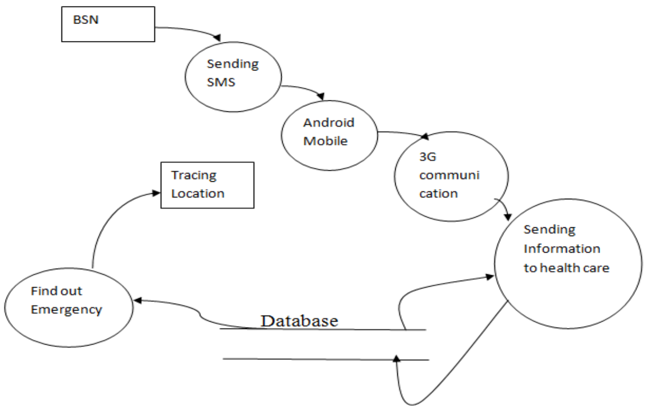

Fig. 4 DFD Diagram Level 2

b) Module Description

i) Designing of Wearable Sensor
ii) Medical Users Registration
iii) Data Acquisition
iv) Data Retrieval and Storage
v) Securing the Data
vi) Intelligence System
vii) Healthcare Database Centre

i) Designing of Wearable Sensor

The vital monitoring wearable device is light weight, portable and is an electronic device. It consists of three types of vital sign sensors: a pulse oximeter (for measuring heart beat rate), blood pressure sensor (for measuring the systolic and diastolic blood pressure), and a three-lead EKG.

- The wearable device is a hardware device that will have a direct contact with the individual to be monitored.
- It will be connected to the mobile application so that it can read the individual's vital signs and send the values to the mobile application.
- The mobile application can be used to either receive vital signs readings from a device and also send to the server, or monitor the readings from another device(s).
- The mobile application will provide a communication channel between the application and vital signs device.

The following figure 5 shows the design of the wearable sensor kit, figure 6 shows the pressure sensor, figure 7 shows the temperature sensor, and figure 8 shows the Bluetooth module device to transfer data signals from analog to digital from the device to smart phone.

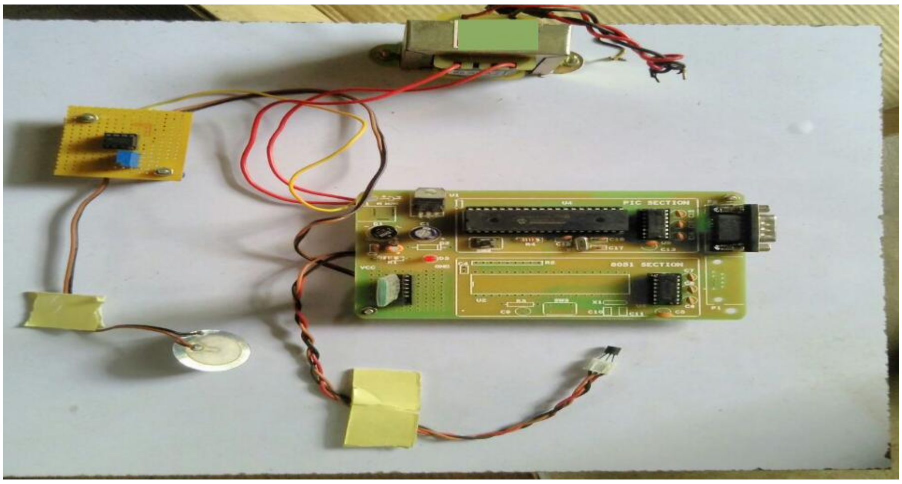

Fig. 5 Design of the wearable sensor

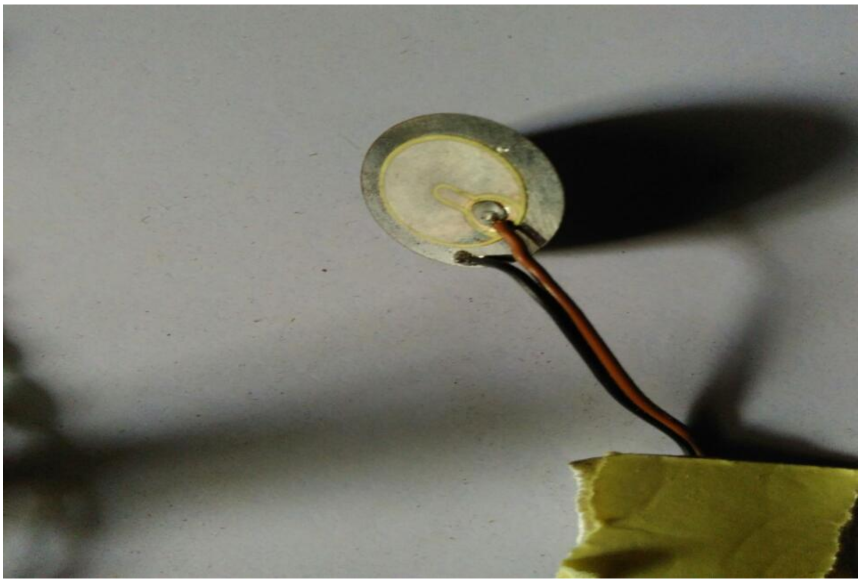

Fig. 6 Pressure Sensor

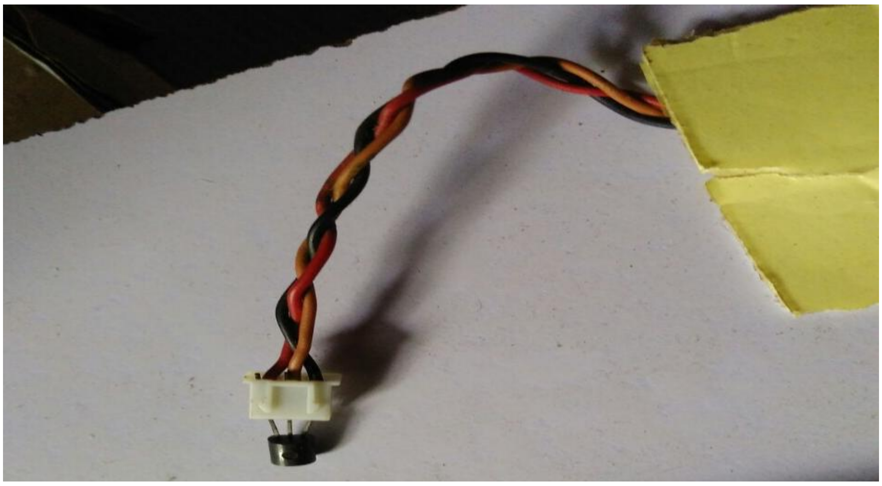

Fig.7 Temperature sensor

Fig.8 Bluetooth module device to transfer data signals from analog to digital from the device to smart phone

ii) Medical Users Registration

The medical user of the system must be a registered user, who can access the system easily by producing the username and password. If the user is new and using the system for the first time, he/she must register first, and then can continue using the system. This procedure has been implemented for providing a first layer of secured access and allows usage of the system for authorized user's only. The figure 9 shows the simple flow diagram for the medical user module.

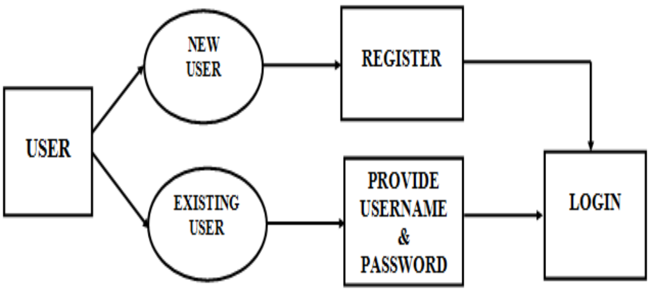

Fig. 9 Medical User Module Diagram

iii) Data Acquisition

The BSN helps in transmitting the vital parameters blood pressure, respiration, temperature and heart beat details for every time period. The details sent by the senor are captured and the range is calculated. The information is sent to the medical user smart phone. The figure 10 shows the simple way by which the BSN module transmits the vital sign data.

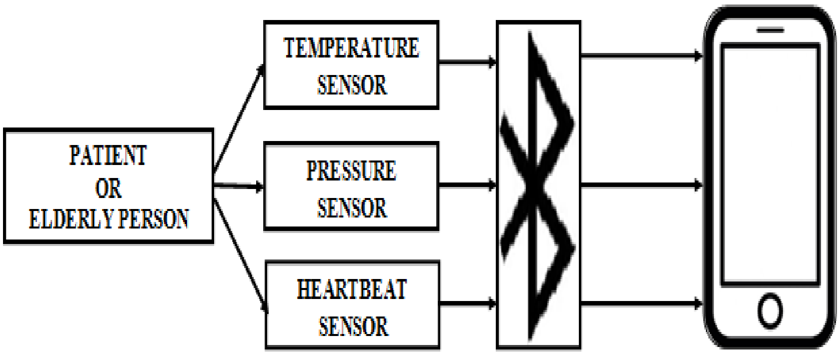

Fig. 10 BSN Module Diagram

The frequency and duration (time period) determines when the information must be transferred from the BSN to smart phone for logging the data. It is specified by using two methods (for logging the data) based on the condition of the patient. First method, is trigger-based logging, where the vital parameters are logged when it is identified it has reached a set threshold value. This method is used at the initial period of monitoring. Continuous logging, a high frequency monitoring technique, in which the vital parameters are collected throughout the sampling that can be taken multiple times per minute based on the patient's condition. Basically the first method helps in saving the battery life of the BSN by simplifying the on-chip storage of data and eases the analysis process. But when a sudden deviation is identified in the patient's vital parameter values when it reaches the threshold level as notified by the trigger-based logging method, then the emergency situation might demand continuous monitoring (minute wise monitoring). Hence, the second method helps in monitoring on continuous basis. It's a bit costly approach as it requires high data transmission rate, lot of data storage space, and consumes more power.

iv) Data Retrieval and Storage

The data stored in the sensor can be retrieved manually or remote method. Manual data storage promotes the data to be stored in the micro SD card that is incorporated in the sensor. Even though this approach is cheaper, considerably reduces the size of sensor that is being deployed, but the reliability and security of data are big issue. The manual method requires more user interaction for downloading the data that can be done through data cables. As this proves to be complicated, in the proposed system, remote method of data storage and retrieval technique has been used. This method uses telemetry, a long distance cellular network, Bluetooth communication aggregated by the smart phone for collecting the data over 3G network periodically. The collected data are transferred to a healthcare centre database, where they are stored and accessed via the internet, anywhere and anytime. This module also helps in retrieving current latitude and longitude of the patient/elderly person when anomaly situation is detected using GPS. This will convert the collected coordinates into street address by using the geocoding technology.

v) Securing the Data

The PHI information contains highly confidential information such as patient's medical history that includes disease diagnosed, treatment(s) undergoing/undergone, doctor(s) referring/referred, X-rays, scan reports, etc. This information could be stored in cloud and can be readily accessible where ever and whenever required. It requires a security model that ensures the privacy of patient by implementing some technical measures such as encrypting the information before storing in the cloud. As the records can be in the form of multimedia and text, different methods of encryption has been implemented for securing the information.

Advanced Encryption Standard (AES) encryption algorithm with a key size of 128 bits is used for encrypting and decrypting the information. It is a symmetric key based encryption algorithm that uses same key for encrypting as well as decrypting the text/image files. The images are converted in to pixels and those pixels are encrypted. After encrypting, the file is divided into 'n' different files and is stored in the healthcare database centre. For obtaining the original file, the 'n' number of files from the healthcare database centre is merged, and by using a private key decryption is done. This makes the information be accessible only by the authorized person(s). Figure 11 shows the steps involved in encryption and figure 12 shows the steps involved in decryption.

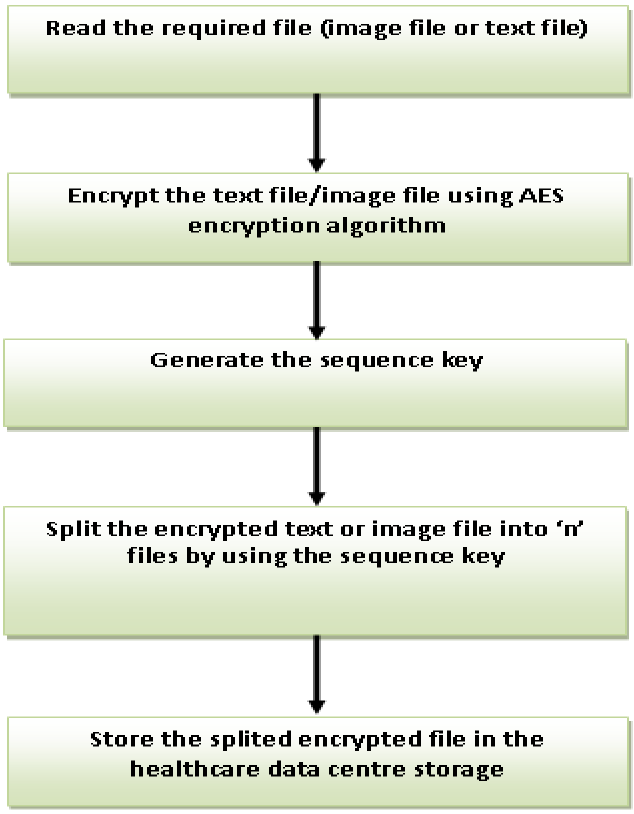

Fig. 11 Steps involved in AES Encryption

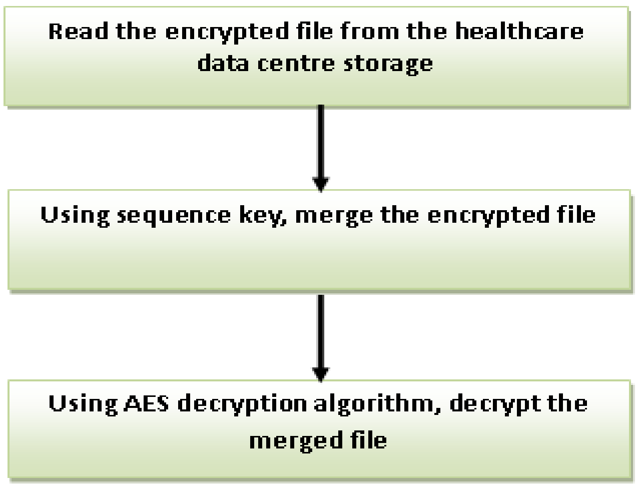

Fig. 12 Steps involved in AES Decryption

vi) Intelligence System

The intelligence system module utilizes the information stored in the health care database running on cloud for analysing the patient's present situation. The developed algorithm takes the vital sign information of the patient and it's compared against the normal value that is supposed to be. The algorithm designed uses the height, weight, and age of the patient to check for the thresholds. If any additional information is not available, a set of default values that is already provided in the algorithm is considered. If any deviation in the readings is identified, then the intelligent system predicts the health issues by taking the previous medical records of the patient along with the symptoms given in the database into account.

The intelligent system also aids in sending alerts to the doctor who serves nearby the patients' residence and the ambulance service available nearby. It is done by retrieving the details that are available in the database. The patients' location is traced by using latitude and longitude distance. The location of the patient is intimated to the ambulance service and doctor. Also it helps in sending an alert message to the care taker providing the hospital details where the patient has been taken for treatment and the ambulance service number as well for tracking.

This diagnosis helps the doctor's in giving immediate care to the patient without delay in treatment. The system has also been designed with one more option in mind that the patient might regularly take treatment with one doctor who might be at a distance place from the patients' residence. But when a life-threatening emergency situation is identified, for immediate treatment the patient must be taken to the nearby hospital. For proceeding with the treatment with a new doctor who does not know the patient's history, the new doctor can be given with the privilege to view the report of the patient from the centralized health care database at that instance of time.

vii) Healthcare Database Centre

The healthcare database centre keeps track of the previous treatment records of the patient. Whenever a patient is examined by a doctor or by a specialist, the examination report and treatment results are also updated in the database centre. In this module, a Secured and Privacy-preserving Opportunistic Computing (SPOC) framework has been designed for the healthcare emergency. With the help of SPOC, the information gathered by the BSN, which are shared to the smart phone through Bluetooth, is used for dealing with the computation (prediction) in the emergency situation. The data henceforth collected is stored in the health care centre database via 3G network. In order to secure the information, a user centric, two-phase privacy authentication and access control has been implemented. This privacy preservation, allows only the medical user to take part in the opportunistic computing having similar symptoms. Based upon the minute-by-minute vital readings of the patient, the intelligent system makes a comparison between the previous reading and the present reading. After processing the information, if any anomaly arises, the intelligent system, identifies the patient is in emergency situation, it sends alerts to three different devices stating the present condition and the location of the patient:

i) Sends a feedback to the medical authority, notifying the emergency situation of the patient, which is identified by the unique Patient ID.
ii) An alert message to the nearby the emergency service provider like ambulance service, stating the location and address of the patient who is in emergency condition and the address of the hospital to which he/she must be taken to. The required information is fetched from the healthcare centre database.
iii) A notification message stating the present condition of the patient, where they are taken to for the treatment and the doctor who is about to treat them to the corresponding care taker's smart phone as an alert, if the physical presence of care taker is not nearby the patient.

Figure 13 shows the diagram for medical database centre module.

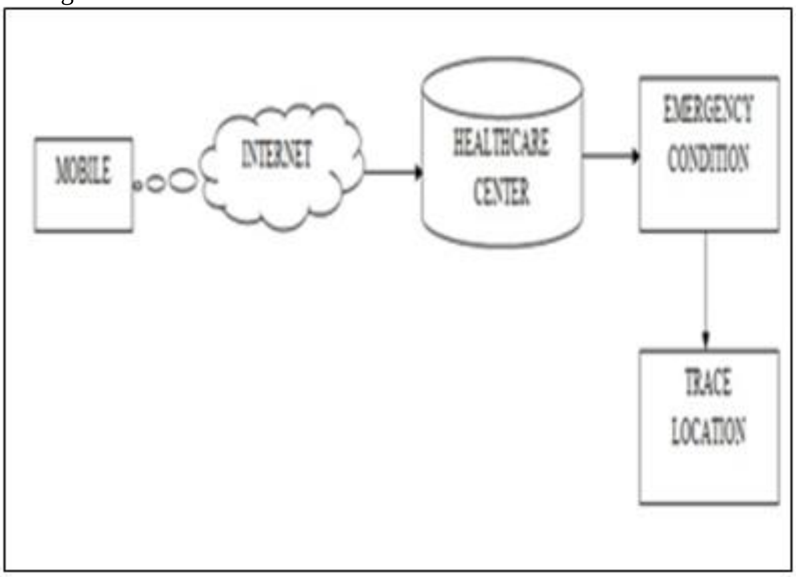

Fig. 13 Medical Database Centre Module Diagram

The following are some significant features of the proposed system:

i) It's fast and easy to install.
ii) Cheaper when compared with the wired monitoring system.

iii) Preserves the privacy of patient's data and also helps in localizing the patients' without disturbing the individual's privacy.
iv) Scalable, as the service can be extend to large number of patients in a wider domain for any kind of emergency treatment, anytime and anywhere.
v) Compatible to use with the existing telecommunication system such as cellular-phone networks, internet for sending, receiving and monitoring information 24/7 on all 365 days without interruption.
vi) The system has also been designed with one more option where a particular patient's information can be downloaded from the database by the authorized user and can be used as a local copy even when the internet is disconnected. This helps in increasing the availability of information 24X7.

IV. Results And Discussion

Remote health care monitoring system is helpful for the elderly person/patients to be continuously under monitoring without any difficulty, doctors' for knowing the patient details instantly and for care takers' to stay in touch with their loved ones' even though they are not nearby.

The figure 14 shows the home screen of the proposed system implementation. In this screen, the person's vital parameters that are measured are displayed when required after making a connection with the designed wearable sensor kit as shown in the figure 15.

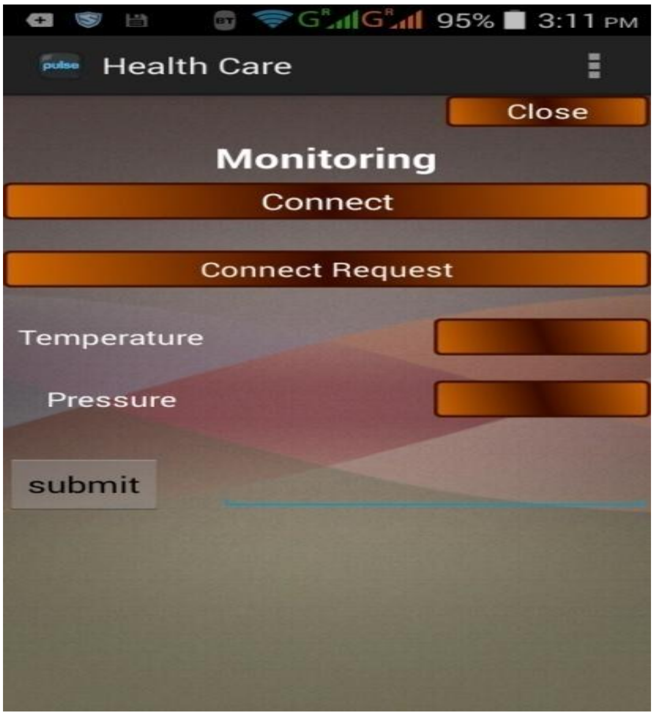

Fig. 14 Home Screen

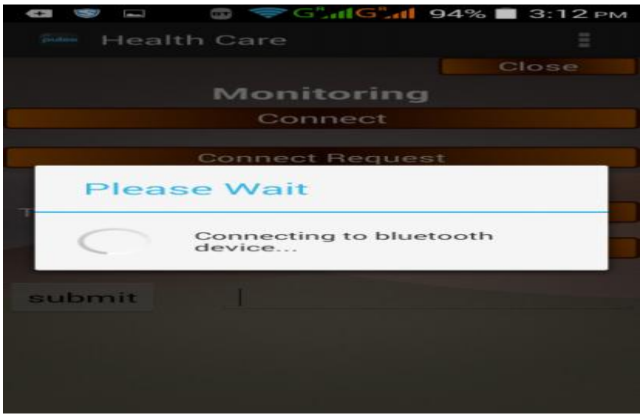

Fig. 15 Connecting the Application with Kit (BSN)

Figure 16 shows the patient information record that has been updated with the required vital parameters along with the latitude and longitude values of the person location. These values get updated in the database and are uploaded into database centre automatically.

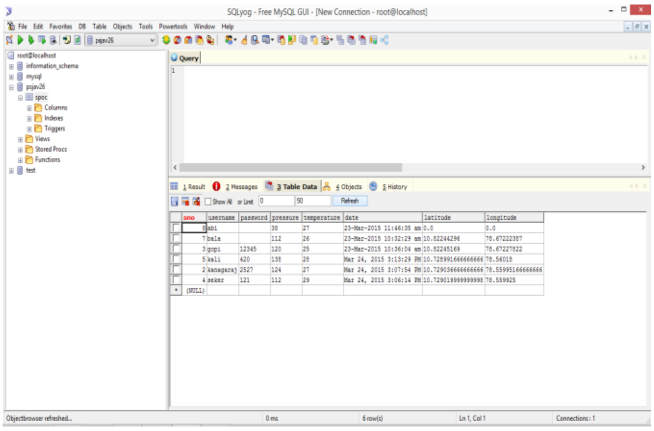

Fig. 16 Updating Recorded Data to PHI

Figure 17 shows the screen shot of throwing a message to the user once the patient health care record has been updated successfully.

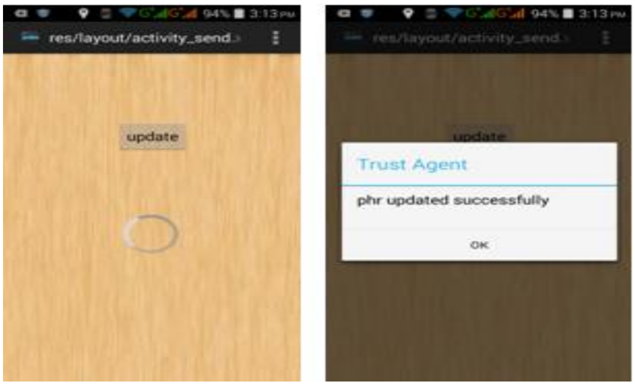

Fig. 17 Successfully updating Patient Health Record

Figure 18 shows the tracked location of the patient when emergency situation arises. This is done by using the latitude and longitude values obtained by using GPS and updated in the database.

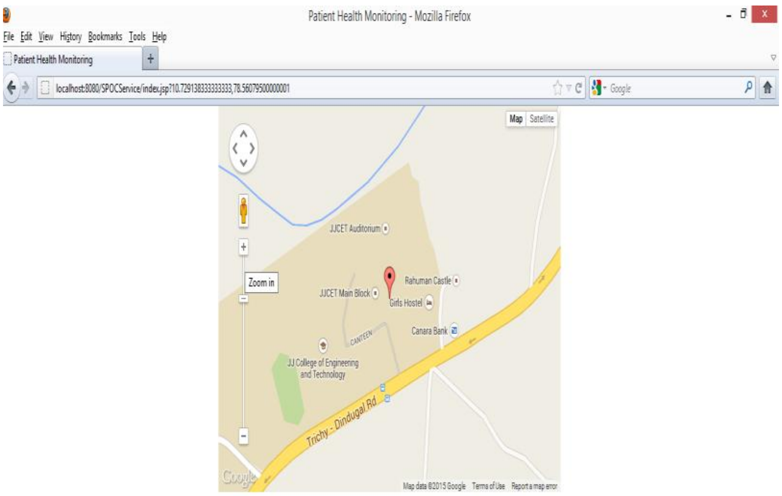

Fig.18 Tracked Location of the Patient

VI. CONCLUSION

In the modern era, technology is ruling the mankind. and the WSN is a great boon for monitoring the health of loved ones without physically being nearby them. In this paper, a ubiquitous healthcare prototype system for patient as well as hospitals and care takers has been designed. The concept of Ubiquitous healthcare system is to place unobtrusive wireless sensors on a person's body to form a wireless network which can communicate the patient's health status with base station connected to the monitoring PC. By using this system, the person health can be monitored from a remote place by professionals, help them in diagnosis during emergency situation and provide appropriate on time treatment. The proposed system takes less than one minute to predict the patient's anomalous situation, if any. This application could serve the mankind by saving a life and is quiet useful for medical emergency.

REFERENCES

[1]. 10 Facts on Ageing and the Life Course. Available online: http://www.who.int/features/factfiles/ ageing/en/ (accessed on 28 November 2014).
[2]. Alwan M, Dalal S, Kell S, "Impact of monitoring technology in assisted living: outcome pilot", IEEE Transaction on Information Technology Biomed, pp. 192–198, Vol. 6. 2006.
[3]. Ni Scanaill C, Carew S, Barralon P, "A review of approaches to mobility tele-monitoring of the elderly in their living environment", Ann Biomed Engineering, Vol. 34, pp. 547–563, 2006.
[4]. Jawbone Inc., "Jawbone fitness trackers," Accessed April 2015. [Online]. Available: https://jawbone.com/up/trackers
[5]. FitBit Inc., "Flex: Wireless activity + sleep wristband", Accessed April 2015. [Online]. Available: https://www.fitbit.com/flex.
[6]. Apple Inc., "Apple Watch", A4ccessed April 2015. [Online]. Available: https://www.apple.com/watch.
[7]. A. Pantelopoulos and N. Bourbakis, "A survey on wearable sensor-based systems for health monitoring and prognosis", IEEE Transaction System Man, and Cybernetics, Part C: Application and Reviews, Vol. 40, no. 1, pp. 1–12, Jan 2010.
[8]. D. Son, J. Lee, S. Qiao, R. Ghaffari, J. Kim, J. E. Lee, C. Song, S. J. Kim, D. J. Lee, S. W. Jun, S. Yang, M. Park, J. Shin, K. Do, M. Lee, K. Kang, C. S. Hwang, N. Lu, T. Hyeon, and D.-H. Kim, "Multifunctional wearable devices for diagnosis and therapy of movement disorders", Nature Nanotechnology, pp. 1–8, 2014.
[9]. A. Page, O. Kocabas, T. Soyata, M. Aktas, and J.-P. Couderc, "Cloud-Based Privacy-Preserving Remote ECG Monitoring and Surveillance", Annals of Noninvasive Electro cardiology (ANEC), 2014.
[10]. R. Paradiso, G. Loriga, and N. Taccini, "A wearable health care system based on knitted integrated sensors", IEEE Transaction Information Technology in Biomedicine, Vol. 9, No. 3, pp. 337–344, Sept 2005.
[11]. A. Milenkovi, C. Otto, and E. Jovanov, "Wireless sensor networks for personal health monitoring: Issues and an implementation", Computation Communication, vol. 29, no. 1314, pp. 2521 – 2533, 2006.
[12]. J. M. Rabaey, M. J. Ammer, J. L. Da Silva, D. Patel and S. Roundry, "PicoRadio supports ad hoc ultra-low power wireless networking", IEEE Computer Magazine, Vol. 33, pp. 42-48, 2000.
[13]. J. Agre, L. Clare, "An integrated architecture for cooperative sensing networks", IEEE Computer Magazine, May 2000.
[14]. Carlos de Morrais Codeiro, Dhrarma Prakash Agarwal, "Ad-hoc and Sensor Networks: Theory and Applications", 1st Edition, World Scientific Publishing Co. Private Ltd., Singapore, pp. 19-79, 2006.
[15]. RH. Katz, J.M. Kahn and K.S.J. Pister, "Mobile Networking for Smart Dust," Proceeding of the 5th Annual ACMIIEEE International Conference on Mobile Computing and Networking (MobiCom'99), Seattle, USA, pp. 350-355, 1999.
[16]. Hall, P.S.; Hao, Y, "Antennas and Propagation for Body-Centric Wireless Networks", 1st ed.; Artech House, Boston, MA, USA, 2006. ISBN 1-58053-493-7.
[17]. Alomainy, A., Hao, Y, Hu, X, Parini, C, Hall, P., "UWB on-body radio propagation and system modeling for wireless body-centric networks", IEEE Proceeding Communication, Vol. 153, pp. 107–114, 2006.
[18]. S. Babu, M. Chandini, P. Lavanya, K. Ganapathy, and V. Vaidehi, "Cloud-enabled remote health monitoring system", International Conference on Recent Trends in Information Technology (ICRTIT), pp. 702–707, July 2013.
[19]. T. Gerard and A. Nicholas, "Principles of Anatomy and Physiology", Harper-Collins, New York, Sixth Edition, 1990.
[20]. Fieselmann JF, Hendryx MS, Helms CM, "Respiratory rate predicts Cardio pulmonary arrest for internal medicine patients", Journal on General International Medicine, Vol. 8, pp. 354-360, 1993.
[21]. Subbe CP, Davies RG, Williams E, "Effect of introducing the Modified Early Warning score on clinical outcomes, cardiopulmonary arrests and intensive care utilization in acute medical admissions", Anaesthesia, Vol. 58, pp. 797-802, 2003.
[22]. Goldhill DR, McNarry AF, Manersloot G, "A physiologically-based early warning score for ward patients: the association between score and outcome", Anaesthesia, Vol. 60, pp. 547-553, 2005.
[23]. N. Abhijit, "Normal pulse rate", http://www.buzzle.com/articles/ normal-pulserate.html.
[24]. Franklin DL, Schlegel W, and Rushmer RF, "Blood flow measured by Doppler frequency shift of back-scattered ultrasound", 134(3478), pp. 564-5, Aug 25, 1961.
[25]. Elseed AM, Shinebourne EA, Joseph MC, "Assessment of techniques for measurement of blood pressure in infants and children", Arch Dis Child, Vol. 48(12): pp. 932-6, Dec 1973.
[26]. Gribbin B, Steptoe A, Sleight, "Pulse wave velocity as a measure of blood pressure change", Psychophysiology, 13(1):86-90, 1976.
[27]. Poon CC, Zhang YT, "Cuff-less and noninvasive measurements of arterial blood pressure by pulse transit time", Conference Proceedings IEEE Engineering Medicine Biol Soc., Vol. 6, pp. 5877-80, 2005.
[28]. Belani KG, Buckley JJ, Poliac MO, Can J Anaesth, "Accuracy of radial artery blood pressure determination with the Vasotrac", 46(5 Pt 1):488-96, May 1999.
[29]. Bernacchia N, "Non contact measurement of heart and respiration rates based on kinect", In: Medical Measurements and Applications (MeMeA), IEEE International Symposium, pp. 1–5, 2014.
[30]. Tarassenko L, Villarroel M, Guazzi A, Jorge J, Clifton DA, Pugh C, "Non-contact video-based vital sign monitoring using ambient light and auto-regressive models", 35(5):807, 2014.
[31]. Ordóñez, F.J.; de Toledo, P.; Sanchis, A., "Sensor-based Bayesian detection of anomalous living patterns in a home setting", Pervasive Ubiquitous Computing 2014, 19, 259–270.
[32]. Gjoreski, H.; Rashkovska, A.; Kozina, S.; Lustrek, M.; Gams, M. Telehealth using ECG sensor and accelerometer. In Proceedings of the 37th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), Opatija, Croatia, 26–30 May 2014; pp. 270–274.

[33]. Hao Y, Foster R, "Wireless body sensor networks for health-monitoring applications", Physiology Measure, Vol. 29(11), pp. R27-56, 2008.
[34]. Sardini, E.; Serpelloni, M. T-shirt for vital parameter monitoring. In Sensors; Springer: New York, NY, USA, Volume 162, pp. 201–205, 2014.
[35]. M. Lan, L. Samy, N. Alshurafa, M.-K. Suh, H. Ghasemzadeh, A. Macabasco-O'Connell, and M. Sarrafzadeh, "Wanda: An end-to-end remote health monitoring and analytics system for heart failure patients," in Proceedings of the Conference on Wireless Health, WH '12. USA, pp. 9:1–9:8, ACM, 2012.
[36]. S.Shiny Amala, S.Mythili, "IoT Based Health Care Monitoring System for Rural Pregnant Women", International Journal of Advanced Research in Electronics and Communication Engineering, Volume 6, Issue 11, November 2017
[37]. Ibrahim Almarashdeh, Mutasem K. Alsmadi, Tamer Farag, Abdullah S. Albahussain, Usama A Badawi, Njoud Altuwaijri, Hala Almaimoni, Fatima Asiry, Shahad Alowaid, Muneerah Alshabanah, Daniah Alrajhi, Amirah Al Fraihet, Ghaith Jaradat, "Real-Time Elderly Healthcare Monitoring Expert System Using Wireless Sensor Network", International Journal of Applied Engineering Research, Volume 13, Number 6, pp. 3517-3523, 2018.
[38]. Matsubara A, Tanaka S., "Unconstrained and Noninvasive Measurement of Heartbeat and Respiration for Drivers using a Strain Gauge", Proceedings of the 41st SICE Annual Conference; Osaka, Japan, pp. 1067–1068, August 2002.
[39]. P. Tudor, W. Martin, B. Natalia, P. Zeeshan, and B. Leon, "Ambient Health Monitoring: the smart phone as a body sensor network component," Innovation in Medicine and Healthcare Inmed, vol. 6, no. 1, pp. 62–65, 2013.
[40]. Z.-Y. Wu, Y.-C. Lee, F. Lai, H.-C. Lee, and Y. Chung, "A secure authentication scheme for telecare medicine information systems," Journal of Medical Systems, vol. 36, no. 3, pp. 1529–1535, 2012.
[41]. S. Sahaa and S. Kumar Tomar, "Issues in transmitting physical health information in m-healthcare," International Journal of Current Engineering and Technology, vol. 3, no. 2, pp. 411–413, 2013.
[42]. Q. Pu, J. Wang, and R.-Y. Zhao, "Strong authentication scheme for telecare medicine information systems," Journal of Medical Systems, vol. 36, no. 4, pp. 2609–2619, 2012.
[43]. S. Ben Othman, A. Trad, and H. Youssef, "Security architecture for at-home medical care using Wireless Sensor Network," in Proceedings of the 10th International Wireless Communications and Mobile Computing Conference (IWCMC '14), pp. 304–309, IEEE, Nicosia, Cyprus, August 2014.
[44]. S. Kalra and S. K. Sood, "Secure authentication scheme for IoT and cloud servers," Pervasive and Mobile Computing, vol. 24, pp. 210–223, 2015.
[45]. A. Lounis, A. Hadjidj, A. Bouabdallah, and Y. Challal, "Healing on the cloud: secure cloud architecture for medical wireless sensor networks," Future Generation Computer Systems, vol. 55, pp. 266–277, 2016.
[46]. Jin-Xin Hu, Chin-Ling Chen, Chun-Long Fan, and Kun-hao Wang, "An Intelligent and Secure Health Monitoring Scheme Using IoT Sensor Based on Cloud Computing", Journal of Sensors, pp. 1-11, 2017.

S. Shanmuga Priya "Iot Based Remote Health Care Monitoring System Using Wearable Sensor for Tracking Anomalous Situation "International Journal of Engineering Science Invention (IJESI), vol. 07, no. 07, 2018, pp 84-98