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Monitoring and Evaluation of Different Medical Parameters Using Android Smartphone Based Body Area Network

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Abstract: ***Android is the most popular operating system in the smartphone. The wireless body area network (BAN) combined with an Android based Smartphone offers a large functionality. Body area network (BAN) is a promising technology for real-time monitoring of physiological parameters of the patients. Particularly when the wireless technologies integrated with body area network provides the complete telemedical infrastructure. Different medical parameters can be analyzed, store and visualized using the graphical user interface of an Android Smartphone designed for the end user. The Bluetooth based sensor nodes acquire physiological parameters of patients, then perform signal processing and data analysis and send the results to the coordinator node. The data is transferred to an android based Smartphone via Bluetooth. The system will continuously monitor the physiological parameter of the patient and if any variation occurred, then it send alert messages to the medical professional. The alert is of two types, SMS alert and email alert. Using this alert system the emergency situation can be handled effectively and the patient will get the medical care as soon as possible.***

Keywords: android; body area network (BAN); electrocardiogram (ECG); smartphone; alert.

I. INTRODUCTION

Today the networking technologies are very much developed. So that the communication or connection between the people, multimedia and services have been greatly changed. Wireless communications technologies have greatly affected on the peoples lifestyle. IEEE 802 is an international standardization committee, which has developed various wireless technologies such as wireless local area networks (WLAN), wireless metropolitan area networks (WMAN), wireless personal area networks (WPAN), etc..

The population in the world is increasing day by day. This brings a need for more healthcare options. As the mortality rate reduced due to developed healthcare technologies and facilities the proportion of senior citizens is increased in the society. These senior citizens are easily vulnerable to chronic diseases, which require proper medical care than the rest of the population [1]. So, the monitoring and recording of physiological parameters of patients outside the clinical environment is becoming increasingly important in order to take care of senior citizens.

According to the report of the World Health Organization (WHO), about 17 million people die around the world due to cardiovascular diseases, particularly heart attack. Most of the deaths in them are due to untimely intervention. If proper medical care is provided to the patients at the right time, then their lives can be saved [2]. In these case the field of telemedicine becomes very useful. Telemedicine is the field of on-line monitoring and analysis of vital parameters of the patients and in the emergency situation, it helps to provide medical care as early as possible, so that the life of the patient can be saved. Different kinds of wireless technologies promise to ensure patient compliance. Especially Body Area Networks (BAN) combined with these

wireless technologies such as Bluetooth, Zigbee allow the setup of a comprehensive telemedical infrastructure [1]. This telemedical field becomes very useful for the cardiac patients. So the patient's physiological activity is continuously monitored by the system and if any variation found in the physiological activity of the patient, it informs the medical professional.

II. WIRELESS BODY AREA NETWORK

Body area network or body sensor network is the wireless network consist of several body sensor units connected to the central unit which perform the signal processing and data analysis. Basically body area network consists of the BAN architecture and the communication protocol such as Bluetooth or Zigbee.

A. BAN Architecture

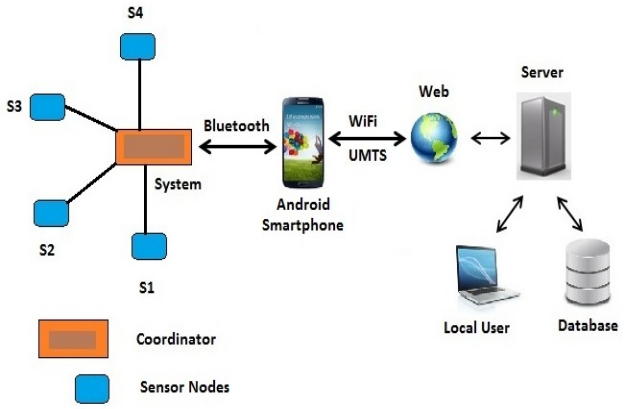

Fig. 1 BAN Architecture

Wireless BAN architecture is shown in figure 1. In this architecture the different sensor nodes performed the primary data processing, which includes the physiological signal processing in the microcontroller. The Android Smartphone performed the secondary data processing and shows the resulting output on the Graphical User Interface (GUI). This secondary data processing includes data filtering, data representation, graphical interface and data synchronization. Finally, the most important data processing is done together with database management in the server. This medical server allows the secure local and remote access for medical professional using Internet. In this design the Bluetooth is used as a communication protocol. Bluetooth is used to link the different sensors with the Android Smartphone. Also the power consumed by the Bluetooth is low.

B. BAN Architecture

The Bluetooth is standard IEEE 802.15 communication protocol for exchanging data over short distances from fixed and mobile devices. It works on the 2.45 GHz frequency band. Bluetooth operates on a very low power of 1.8 to 3.6 volts. It provides 3 Mbps data rate for distances of 20 meters, which is very good. The Bluetooth module is simple to use and fully certified, which provide the complete wireless embedded solution for short distances.

III. ATMEL BOARD

A. ATMEL Board

Atmel microcontroller is used for reliable communication with the Android Smartphone, as they are power efficient and provides an ideal platform for Telecare services [3]. The ATmega32 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. It has 32K bytes of In-System Programmable Flash, 1024 bytes of EEPROM, 2K byte of SRAM.

B. ECG Module

The interpretation of the electrical activity of the heart over a particular time captured by placing electrodes on the different parts of the body is known as the electrocardiogram (ECG). The recorded signal is graphically displayed in a two dimensional

graph, in which the height represents the measured electrical activity in millivolts and the width represents the interval of time in seconds. Figure 2 shows a typical ECG waveform [2].

The ECG records the electrical signal by detecting the electrical changes in the skin, which is caused due to the heart muscle depolarization. For this, pairs of electrodes are placed on the either side of the heart and the activity of the heart is recorded. This is done by placing pairs of electrodes on either side of the heart. There are different types of ECG's are differentiated according to the number of leads used to record the signal. Generally 3-lead ECG system is used to record the ECG signals. In this 3 lead ECG system, two electrodes are placed on both the arm and one is placed on the leg. Generally the ground lead is placed on the leg.

The jelly is used on the side of the electrode which comes in contact with the surface of the body. The other side of electrode has a conductive metal which is connected to the lead wire of ECG module. The jelly is used to place the electrode on the surface of the body which helps to get a noise free ECG signal. So the recorded signal is more correct. An ECG sensor collects the ECG signal from the different electrodes placed on the surface of the human body and transmits it to the Smartphone via Bluetooth. The Android Smartphone connected to this ECG module is used to generate the results.

Fig. 1 Typical ECG waveform

C. Sensor Platform

The flowchart of the overall operation is shown in the figure 3. As soon as the system starts, the different sensors such as the ECG sensor, temperature sensor and heart rate sensor start collecting the physiological data of the patient. After that the signal conditioning and analysis performs and then the data is stored in the microcontroller. This data is transmitted via the Bluetooth to the Android Smartphone and we can see the result on the Smartphone.

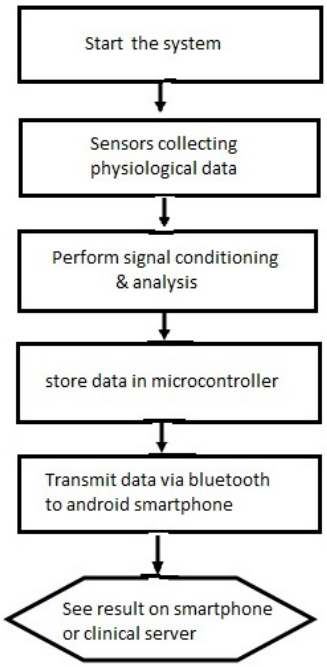

Fig. 3 Flowchart presenting overall system operation

IV. ANDROID BASED SMARTPHONE

A. Android OS

Android is the most popular operating system in the Smartphone. It is a software stack made for mobile devices which consist of an operating system, applications and middleware. The Android operating system is based on a Linux kernel designed primarily for touchscreen mobile devices such as Smartphones and tablets. Android is an open source operating system for touchscreen devices and Google releases the code under the Apache License. Android applications are written in the Java language and run on the Dalvik virtual machines. In Android operating system many applications can run at a time and user may switch between the running applications. Android OS has the several advantages as: simple and powerful, Java-based development kit, Android development tools, Its excellent documentation and library, including classes like Bluetooth Health, useful to develop on many platforms, like Windows, Linux and Mac operating system.

B. Android Application

Nowadays, Android is the very popular operating system in the Smartphones. It's popularity increasing day by day. It has simple and powerful Java based development kit and ability to develop on any platform such as Windows, Linux or Mac. So the user can develop an android application according to its requirements. Android software development kit (ADK) is used to develop Android applications. The officially supported integrated development environment (IDE) is Eclipse using the Android Development Tools (ADT) plugin.

As shown in the BAN Architecture the Smartphone should acquire data from wireless BAN and provide a Graphical User Interface (GUI), on which different physiological parameters are displayed. So to do this an Android application is required, this application should feature several functions such as data acquisition from wireless BAN, using Bluetooth communication, data analysis and representing this data using the GUI and transfer of data to a medical server via WiFi or cellular network. Also for future work internal Smartphone sensors can be used, e.g. GPS, accelerometer etc., provide additional opportunities, i.e. location of patient and possible detection of alert.

V. ALERT SYSTEM

Here the alert system is introduced in order to handle the emergency situation of the patient's. A particular threshold value of the sensors is set in the system settings. Whenever the sensor readings are above the particular threshold value, the system automatically initiates the alert system. So that the proper medical care can be provided to the patient as soon as possible. Here the alert system consists of the two types of alert such as SMS alert and email alert. Both alerts are initiated right after the threshold values of the sensors are broken.

C. SMS Alert

Whenever an alert is detected the android application will initiate an alert SMS to primary contact save in the setting activity. We have used shared preferences for saving the contact information than SQLite because we can easily retrieve the information than connecting to a database.

D. E-mail Alert

The E-mail alert is initiated right after the SMS send by the system. As the Android Smartphone is always connected to the internet, it is possible to send the email alert in real time. The email is sent to the primary contact person whose email id is filled in the setting of android application.

VI. RESULTS

Initially the reliability test runs with the wireless BAN prototype with the number of sensors connected to it. The three sensors are connected to the coordinator node or system i.e. ECG sensor, heart rate sensor and body temperature sensor. All

these three sensors worked correctly and got the respective readings of the patient's physiological condition. These sensors correctly monitor the patient's physiological condition and send the respective data to an Android Smartphone via Bluetooth connection. The android prototype application is shown in figure 4.

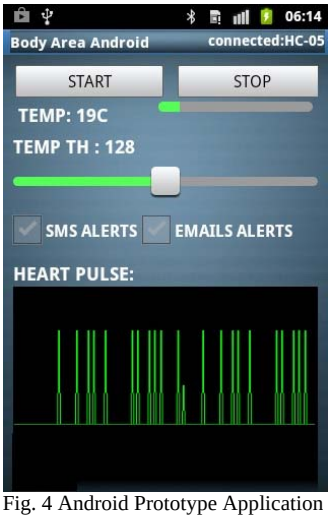

Fig. 4 Android Prototype Application

As we open the application in Android Smartphone, the setting activity logs opens, as shown in the figure 5. It consists of three parameters IP address, mobile number and email ID. The IP address is the address of the computer of the medical professional, who monitors the physiological parameters of the patients. The mobile number and email ID is required to send the alert messages to the concern person.

Fig. 5 Android Application setting activity screen

When the initial setting activity parameters are filled, it opens the main screen of the android application. On this main the screen of the android application, three physiological parameters can be monitored such as a temperature sensor, heart rate sensor and ECG sensor. All the physiological parameters can be continuously monitored by the medical professional. Just the IP address of the computer of medical professionals is to be filled with the initial setting activity of the android application.

As the alert system is introduced in the system, whenever the reading of the sensor crosses the threshold value the system will automatically activate the alert. The alert is of two types i.e. SMS alert and email alert. The figure 6 shows the SMS alert, which is enabled due to the variation found in the temperature of the patient's. This SMS alert is sent by the system to the primary contact person, whose number is filled in the application setting. The alert system is very useful from the patient's point of view. Due to this alert system emergency situation can be handled effectively and the patient will get the medical care as soon as possible.

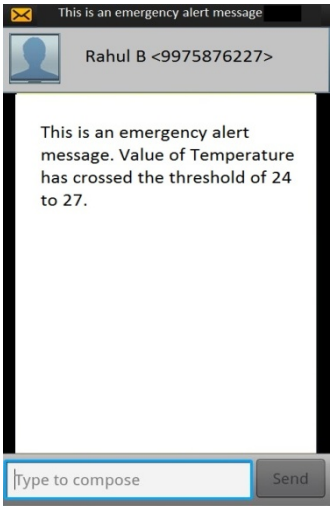

Fig.6 SMS Alert

VII. CONCLUSION

Body area network (BAN) will play an important role in supporting a wide range of applications with BAN devices being operated in the vicinity, on, or inside the body. The first design approach, a WBAN, fulfills the basic requirements. Reliability and range are sufficient. The system has implemented successfully on android platform and resulting output was verified. The alert system was also verified. The SMS alert and email alert were working correctly. The combination of the WBAN with an Android Smartphone offers a large functionality. Crucial parameters can be stored, analyzed and visualized with GUIs designed for the end-user. Security on all levels of the layered system must be further investigated. Certification according to medical safety standards is currently impossible due to the different components used, e.g. the Android operating system. The first version of the proposed system will therefore be used in different research applications of environmental physiology, i.e. heart rate, breathing rate, etc.

References

1. Kohno R., Hamaguchi K., Huan-Bang Li, Takizawa K., "R&D and standardization of body area network (BAN) for medical healthcare", ICUWB 2008, IEEE International Conference on, vol.3, pp.5-8, 10-12 Sept 2008.
2. R. Issac, M. Ajaynath, "CUEDETA: A real time heart monitoring system using android smartphone," 2012 IEEE, pp. 47-52, June 2012.
3. M. Wagner, B. Kuch, C. Cabrera, P. Enoksson, A. Sieber, "Android based body area network for the evaluation of medical parameters," International workshop on intelligent solutions in embedded system, pp. 33-38, May 2012.
4. Huan-Bang Li, K. Takizawa, and R. Kohno. Trends and standardization of body area network (ban) for medical healthcare. In Wireless Technology, 2008. EuWiT 2008. European Conference on, pages 1-4, 2008.
5. Bingchuan Yuan and J. Herbert. Web-based real-time remote monitoring for pervasive healthcare. In Pervasive Computing and Communications Workshops (PERCOM Workshops), 2011 IEEE International Conference on, pages 625-629, 2011.
6. D. Grimaldi, Y. Kurylyak, F. Lamonaca, and A. Nastro "Photoplethysmography detection by smartphone's videocamera," In Intelligent Data Acquisition and Advanced Computing Systems (IDAACS), IEEE 6th International Conference on, volume 1, pages 488-491, 2011.

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Baviskar Rahul received the B.E. degree in Electronics & Telecommunication Engineering from North Maharashtra University and also persuing M.E. in electronics & Telecommunication Engineering from D.Y. Patil College of Engineering, Pune affiliated to the Unicersity of Pune.

