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DEVELOPMENT OF A MOBILE APPLICATION BASED HEALTH TRACKING SYSTEM

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ABSTRACT

Nowadays, with the development of mobile technology, different perspectives have occurred in the system of health tracking. With the diseases requiring continuous follow-up, in the current situation, a patient had to stay in the hospital. Patients' physiological data are able to be monitored via the mobile technologies wherever the patients are (at home, at work, on road …etc.). With this study, the patients' ECG data can be monitored remotely by not only the patients themselves but also their companions and doctors. This kind of mobile health applications increases the quality and productivity of health services. The developed application with Android Studio takes the data from Arduino Card using e-Health sensor shield via Bluetooth technology. The taken data are recorded on the web environment utilizing this application. Then, these data can be accessed by patients' companions or doctors and the web-based monitoring of the patients is provided.

KEYWORDS: Health Tracking, Mobile Android Application, Arduino Card, ECG, e-Health Sensor Shield.

INTRODUCTION

People mostly spend their time on mobile phones; they read news, do shopping, play games, and use applications like facebook, whatsapp. Now mobile phone can replace a computer, radio, television and remote control [1]. It can make banking and e-mail operations easily. Its camera resolution increases so much that it also does camera's duty. Whenever wanted, it can take photo or shoot a video and share. In addition to these, without the need for extra time for using a smart phone, it can be used while eating, sightseeing, being on holiday, having rest, doing exercises etc. [2].

Nowadays the use of smart phones has increased both in our country and in the world. The ratio of using mobile phone is about 75% [3]. Over half of the world's population use smart phones. And this rate increases progressively [4].

21,7% of cause of death in Turkey arises from hearth diseases [5]. The tracking of chronic heart disease and other vital data are generally made at hospital with expensive devices. But it is hard to track essential data of patients that are looked after at home. Besides hearth–related deaths happen suddenly. There is no chance to follow up person's disease out of hospital. It is difficult to be able to recognize the prodrome in daily life. Due to the use of smart phone and the development of sensor technologies, patients' or normal people's vital data can be followed up at home, at work, and everywhere. Thus fulminant hearth diseases will be able to be prevented.

Until today, various studies have been performed for health tracking. Some of them are these: The study of measuring ECG signal using e-Health sensor platform and Raspberry Pi was realized by Yakut et al. [6]. They transferred ECG data that were taken by positioned electrode on body to Matlab environment and processed these data to obtain Heart Rate Variability (HRV) graph by using Pan-Tompkins QRS detection algorithm [6]. A web-based wireless ECG measuring and recording system was realized by the other study of Yakut et al. [7]. The ECG data were taken from patient via e-Health sensor shield and Raspberry Pi and recorded to the database for the purpose of access of clinicians when required [7]. With Ilhan's work called Mobile Device Controlled ECG Holter, data acquired via Arduino and e-Health sensor platform was viewed on mobile devices and was utilized as a recorder [1]. Mobile health applications on smart screen has been developed by Guler et al. [8]. Data belonging to patient-like ECG- have been monitorized on mobile phone by Lou et al.'s work of Health Monitoring System based on Android Operating System by using Huawei C8813 card [9]. ECG and body temperature have been measured by using microcontroller and they have been transferred to smart phone via Bluetooth thanks to Janye et al.'s work of Android Application for measuring ECG, temperature, heart rate and sending alerts to family doctor [10]. Signals that are acknowledged with electrodes by using microcontroller and amplifier have been transferred to mobile phone via Bluetooth on Kai et al.'s work themed A System of Portable ECG Monitoring Based on Bluetooth Mobile Phone [11]. With the work titled as A Telemedicine Application: ECG Data from Wireless Body Sensor on a Smartphone by Rashkovska et al.; data imported from body electrodes and processed via microcontrollers have been monitorized on smart phone by using C2500 wireless module [12]. With Balgacem's work of Bluetooth Portable Device for ECG and Patient Motion Monitoring; data which were

imported from patient via 12 electrodes by using dsPIC30F6010 microcontrollers have been processed, and has been transferred to mobile phone via bluetooth, ZigBee and WLAN IEEE 802.11 protocols and it has been monitorized [13].

In this study, Mobile Application Based Health Tracking System (MABHTS) was realized using e-Health sensor shield, Arduino and Bluetooth module. An Android application was developed for remote tracking the ECG signals of the patients by the patients, their companions or doctors. The ECG signal which was taken by the electrodes is transferred to the e-Health sensor shield for being processed. The processed data are sent to Arduino to be transmitted to the mobile smart phone via Bluetooth module. Then the ECG signal is plotted on the smart phone screen using the developed Android Application.

ELECTROCARDIOGRAPHY (ECG)

They are biological signals that happen as a result of recording electrical activities happening in heart during heart beat with the help of electrodes positioned on the body. The graph obtained via this record called electrocardiography (ECG) [14]. Doctors decide whether the patient has hearth-based diseases or not by examining this graph. These data are used to diagnose heart diseases.

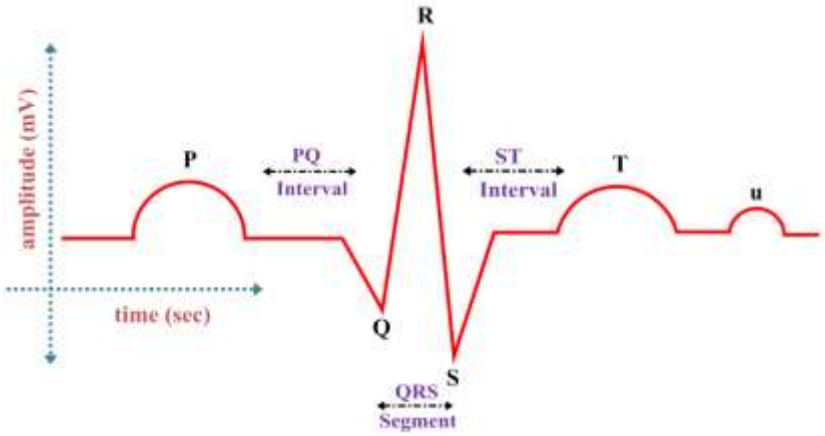

Figure 1: ECG Signal [6]

In Figure 1, the components of the ECG signal are shown. Wave P is the first signal recorded as ECG signal; it shows depolarization of atrium [14]. QRS Complex is the depolarization wave of ventricular, wave Q figures the first negative wave after wave P, wave R figures the first positive wave, wave S figures the first negative wave after R. Wave T images the repolarization of ventricular. Wave U is not always seen and is not known why it occurs [15].

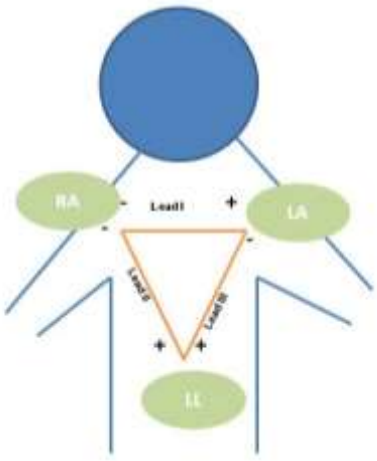

Figure 2: Einthoven Triangle

As seen in Figure 2, electrode is placed at least 3 specified locations on body to measure the electrical signal using Einthoven's triangle. Measurement can be made on where the hearth is at the point of RA, LA, LL. Lead I shows

potential difference between left and right shoulder, Lead II shows potential difference between right shoulder and left foot and Lead III shows potential difference between left shoulder and left foot [6].

$I = V_{LA} - V_{RA}$
$II = V_{LL} - V_{RA}$
$III = V_{LL} - V_{LA}$

THE TOOLS USED

In this work the devices such as, Android Studio, Arduino card, e-Health Sensor Shield, ASP and Access Database were used.

Android

Android is a mobile operating system which uses Linux Kernel. It has been developed by Google, Open Handset Alliance and free software communities. Designed primarily for touch screen mobile devices, Android is popular among devices which look for low-cost and customizable operating system and have high technology. At the beginning, this involves only tablets and smart phones, but now, it is commonly used for devices like televisions, cars, game consoles, digital cameras and watches. Android operating system has Bluetooth property to provide devices to exchange data with other devices wirelessly. Android Bluetooth Application Programming Interface (API) is used for accessing Bluetooth functionality. Thanks to this API it is available for applications to connect other Bluetooth devices [16].

Arduino

It is a flexible, easy-to-use hardware and software platform developed with open source code that everyone who wants can print their own printed circuit by downloading printed circuit and can take components placed [8,9]. The communication between smart phone and Arduino card can be made in a few different ways. Technologies like wireless, Bluetooth are examples of it. Bluetooth technology is a communication protocol using 2,4-2,48 GHz ISM band that is developed for short–distance communication. The communication distance among Bluetooth modules is about 20 meters if there is no obstacle among them [17]. In the works which Arduino is used, HC-05 or HC-06 Bluetooth modules are generally used.

e-Health Sensor Shield

e-Health Sensor Shield is used for measuring the physiologic signal on human body. There exist necessary inputs to read 9 different physiological data on human body via sensors. These can be sorted as accelerometer, blood pressure, pulse and oxygen in blood (SpO2), airflow, body temperature, ECG, galvanic skin response (GSR), electromyography (EMG), glucometer sensors. This card is designed for being used compatible with Arduino. It can also be adaptable to Raspberry Pi by using Connection bridge card. Data acquired from this card can be transferred to smart phone, computer or internet environment via Bluetooth or wireless connection devices [6,18].

Active Server Pages (ASP)

Active server pages increase the communication between user and web site. Codes which are written on the server are interpreted and monitoring as HTML on user's screen. Thus there is no possibility for user to see the codes processing in the backplane. On active server pages (ASP), JSP and ASP.NET are used. In this work programming device ASP has been used. ASP Windows operating system is a programming language on which IIS can be worked. ASP codes are compiled by the server and it shows the compiled data as HTML by interpreting photo, video and formatted writing via web browser on the screen [19].

Access Database Program

Database is an essential element for every business as computer systems come into our lives. For managing millions or billions recordings, advanced programmers are needed. Database becomes indispensable in the sector of banking, marketing and health. Wanted analysis can be made with devices that database servers or by accessing database via different applications [20]. Devices like ORACLE, SQL Server, MySQL and Access are generally used as Database. In this study, Access database program has been used for saving data recorded on the internet. Used database works compatibly with web server and ASP language.

EXPERIMANTAL WORK

In this study, the block diagram of developed MABHTS is seen in Figure 3. In this Figure, ECG data taken from patient to e-Health sensor shield via electrodes are transferred to Arduino card. During this process, the ECG signal is processed and converted to digital form by the ECG amplifier circuit on the e-Health sensor shield. Then, these data are transmitted to smart phone via Bluetooth module wirelessly. The taken ECG data are plotted on user's phone screen and at the same time they are recorded to the database found on the web. Later these data can be accessed by patient's doctor and can be commented when needed.

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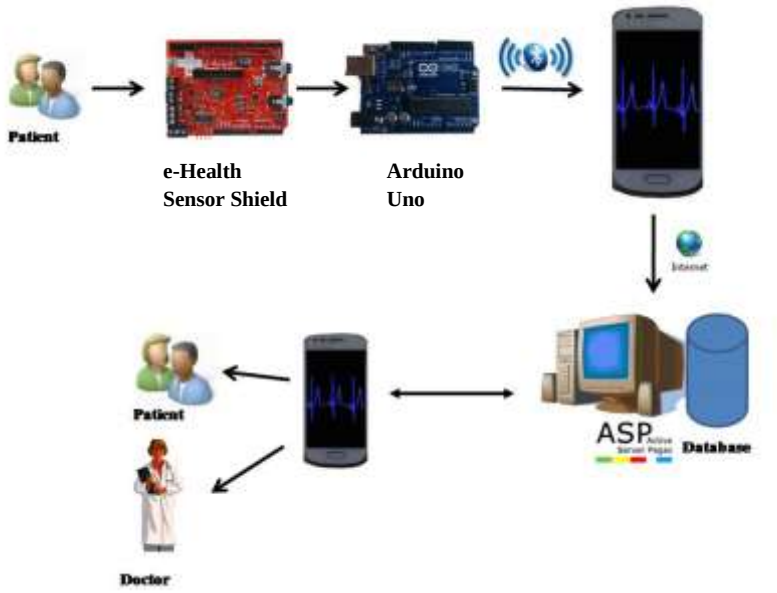

Figure 3: Block Diagram of Developed System

After downloading the developed Android Application to the smart phone, user needs to create an account for using the system. Once an account is created, the application will automatically identify the user whenever it is run. When the application is on, a confirmation is needed from user for making Bluetooth communication on if it is off. Then, the data flow starts by linking together with HC-05 module on Arduino card after "Read ECG" button is clicked. Data are read from patient during one minute and at the same time these data are recorded to the Access database on the web environment by using ASP programming language. The smart phone must have an internet connection for these processes being made. The photo of the ECG measuring system is shown in Figure 4.

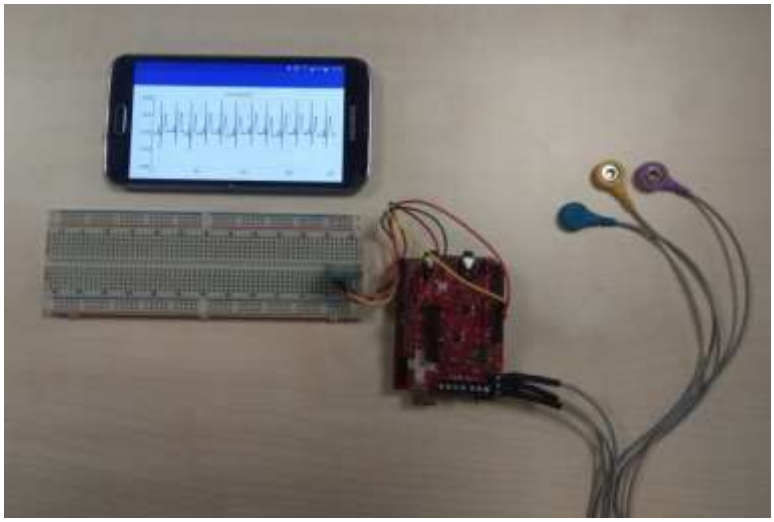

Figure 4: ECG Measurement System

After ECG data taken from the patient are recorded to the web environment, the ECG data are plotted transiently on the user's phone screen as seen in Figure 5. These data recorded to the database are read via JSON by the Android Application and its graph is drawn.

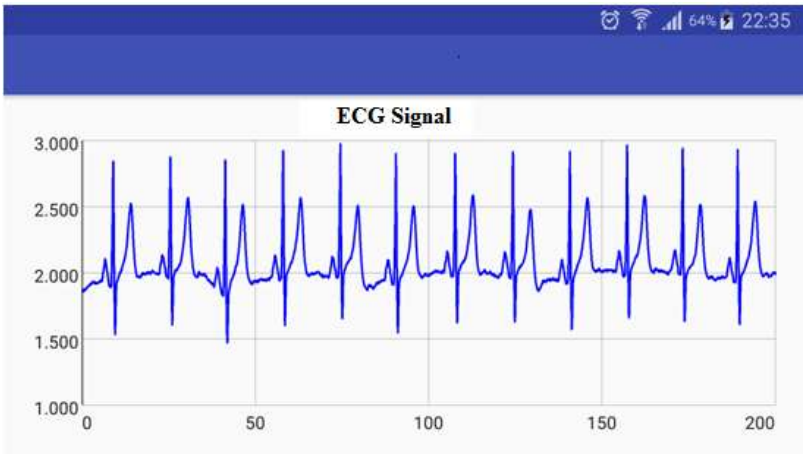

Figure 5: ECG Signal Monitorized in Mobile Application

In doctor's version of this program, after loading the program, doctor needs to sign up the system. Doctor chooses the patients who he/she wants to follow up and he/she can access all data of patients and can analyze.

CONCLUSION

With this work, it is shown that the ECG data belonging to a patient can be followed up wherever he/she is via electrodes by using the developed low-cost MABHTS. ECG data have been taken from patient via e-Health sensor shield connected to Arduino card. These data are transferred to a smart phone via Bluetooth technology which has an advantage of low-energy consumption. Taken data are stored in database on the internet and whenever required they are reached by patients, patients' companions and doctors. Moreover, patients can see their ECG data as a graph on their phone screen. Very practical, useful and low-cost mobile patient follow-up system (MABHTS) has been developed with this application which is developed for mobile phones that nowadays everybody has. This work can be improved by adding new data and processing, interpretting these obtained data.

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REFERENCES

[1] I. Ilhan, "Mobile Device Controlled ECG Holter", Dicle University Engineering Journal, 2017, vol.8, no.1, pp.101-110.
[2] S. Tuzunturk, "Understanding Consumer Behaviors of Y Generation Smart Phone Users by using Correspondence Analysis: The Case Of Bursa", Marmara University Faculty of Economics and Administrative Sciences Journal, 2017, vol. 39, no. 1, pp. 257-280
[3] http://www.dijitalajanslar.com/internet-ve-sosyal-medya-kullanici-istatistikleri-2017/, date of visit: 05.12.2017.
[4] https://www.emarketer.com/Article/Mobile-Phone-Smartphone-Usage-Varies-Globally/1014738, date of visit: 05.12.2017.
[5] A. Akduman, "Reported Causes of Death Burial Permits Application-Entered Examined within the Framework of ICD-10 and the Changing Comparison of Earlier Notices", Dissertation, Ege University, Department of Legal Medicine, 2012, Turkey.
[6] O. Yakut, S. Solak and E.D. Bolat, "Measuring ECG Signal Using e-Health Sensor Platform", International Conference on Chemistry, Biomedical and Environment Engineering, Antalya, 2014.
[7] O. Yakut, S. Solak and E.D. Bolat, "Implementation of a Web-Based Wireless ECG Measuring and Recording System", World Academy of Science, Engineering and Technology International Journal of Information and Communication Engineering, 2015, Vol:9, No:10.
[8] E. Guler, G. Eby, "Mobile Health Applications in Smart Screen", Journal of Research in Education and Teaching, 2015, vol. 4, no.3, pp.45-51.
[9] D. Lou, X. Chen, Z. Zhao, Y. Xuan, Z. Xu, H. Jin, X. Guo, Z. Fang, "A Wireless Health Monitoring System based on Android Operating System", International Conference on Electronic Engineering and Computer Science, 2013, pp. 208-2015.
[10] L. Janye, N. Kulkarni, A. Gawas, "Android Application for Measuring ECG, Temperature, Heart Rate and Sending Alerts to Family Doctor", International Journal for Research in Engineering Application & Management, 2016, vol. 01, issue. 11.

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Impact Factor 3.802

[11] L. Kai, Z. Xu, W. Yuan, H. Suibiao, G. Ning, P. Wangyong, L. Bin, C. Hongda, "A System of Portable ECG Monitoring Based on Bluetooth Mobile Phone", National High Technology Research and Development Program of China, 2011, 978-1-61284-704-7/11.
[12] A. Rashkovska, I. Tomasic, R. Trobec, "A Telemedicine Application: ECG Data from Wireless Body Sensors on a Smartphone", Mipro Opatija May 23-27, 2011.
[13] N. Belgacem, "Bluetooth Portable Device for ECG and Patient Motion Monitoring", Nature&Technology, 2010, pp. 19-23.
[14] U. Aksu, "Comparison of Standard and Lewis ECG in Detection of A-V Dissociation in Patients with Wide QRS Tachycardia", Dissertation, Ataturk University, Medical Faculty, Department of Cardiology, Erzurum, 2014, Turkey.
[15] N. Bascifci, "Zigbee-Based Mobile Health Monitoring System Design and Application ", Master of Science Thesis, Selcuk University, Graduate School of Natural and Applied Sciences, Electronic and Computer System Education, Konya, Turkey, 2011.
[16] M. Khtourm, "Android Based Hospital Application", Master of Science Thesis, Kirikkale University, Institute of Science and Technology, Computer Engineering, Kirikkale, 2015, Turkey.
[17] H. Dalkilic, "Applications of Sensors in Secure Embedded Systems", Master of Science Thesis, Dokuz Eylul University, Institute of Science and Technology, Computer Engineering, Izmir, 2016, Turkey.
[18] https://www.cooking-hacks.com/documentation/tutorials/ehealth-v1-biometric-sensor-platform-arduino-raspberry-pi-medical/, date of visit: 15.01.2018.
[19] R.N. Turğut, "Using web applications as an information technology tool on internet. Sample application: Emit Virtual Museum ", Master of Science Thesis, Suleyman Demirel University, Graduate School of Fine Arts, Graphic Design, Isparta, 2008, Turkey.
[20] Y.S. Kenanoglu, "An Application on Database and Library Automation", Master of Science Thesis, Ataturk University, Institute of Science and Technology, Computer Engineering, Erzurum, 1997, Turkey.