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DEVELOPMENT OF ECG MONITORING SYSTEM USING ANDROID APP

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ABSTRACT

Tele monitoring is a medical practice that involves remotely monitoring patients who are not at the same location as the healthcare provider. The purpose of the present study is to use handheld tele-electrocardiogram (ECG) to identify heart condition in the rural underserved population where the doctor-patient ratio is low and access to health care is difficult. The objective of the study was clinical validation of handheld ECG as a screening tool for evaluation of cardiac diseases in the rural population. The proposed system for the electrocardiogram (ECG) monitoring controlled by the Arduino UNO microcontroller and implemented in the form of android app application. This proposed system presents the implementation of patient ECG monitoring and real time feedback mechanism in Smartphone.

Keywords: Electrocardiogram (ECG), Arduino UNO, Android App, Wireless Health Monitoring

I. INTRODUCTION

Because of changes in technology, a continuous evolution is occurring in industries such as medical services, industrial manufacturing and comfort services. In medical services, researchers are developing tele operated robots and smart monitoring systems to benefit services such as medical interventions, medical studies and medical care [1]. Nurses play an important role in caring for the sick, because they are in direct contact with the patient when taking vital signs. Often, nurses and doctors record information about their patient's progress by filling out reports by hand. A smart monitoring system could measure the patient's progress in real time, providing continuous feedback on the improvement in the health of patients who have undergone treatment. Additionally, nurses and doctors could save valuable response time with real-time notifications. Integrating intelligent monitoring systems could improve care by providing the nurses with efficient documentation and timely access to information.

In this paper, a real-time smart monitoring tool for remote patient monitoring isproposed that integrates to take real time patients ECG readings and transmit data to support nurses and physicians. Wi-Fi technology is used to transmit data and reports to a nurse or mobile device in wireless mode. The brief introduction of ECG and hardware is introduced in the next sections with the subsequent implementation of both hardware and software.

II. ELECTROCARDIOGRAM

The ECG is an important tool used for the diagnosis and treatment of various cardiac and other related diseases. The recorded tracing of the ECG waveforms produced by the heart can tell a physician the basic information about a patient's condition. The heart is a muscle in the body with special morphologic and functional role. The electrical activity detected with the help of electrodes is amplified, displayed on an oscilloscope, recorded on ECG paper or stored in memory.

The ECG curve is made by a group of positive and negative amplitudes so-called Wavelets. These are marked as given by international convention with letters [P, Q, R, S, T, and U] just as were originally named by Einthoven the P wave represents the electric current obtained by atrial depolarization. In a similar way Q, R and S waves represents the electric current produced by the ventricular depolarization. The atrial T wave is obtained by atrial repolarisation and ventricular T wave is obtained by ventricular repolarisation. Atrial T wave is hidden in the QRS complex due to the occurrence of atrial repolarisation during ventricular depolarization [2]. Figure1.Shows the occurrence of P wave, QRS complex and T wave in a general cardiac cycle.

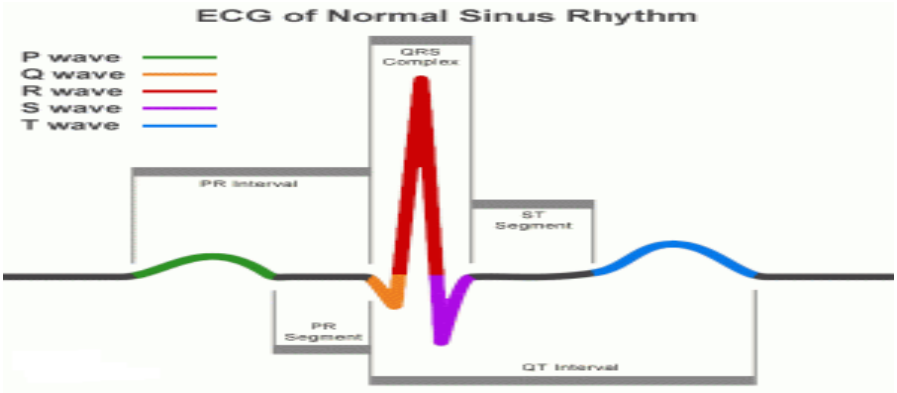

Figure1: ECG Wave Form

III. HARDWARE DEVELOPMENT

Based on the reviews of the available literature dealing with the EKG, and after comparative analysis of the options available to create an EKG device similar to a medical one, it was decided to utilize: Arduino UNO, e-health shield, electrodes designed for ECG shield. For signal processing is utilized Arduino IDE environment and own software solution was also created.

As already stated, the project consists of two principal parts, i.e. hardware and software. In the hardware part, Arduino UNO and e-health sensor board with ECG electrodes was combined. These three devices fit together very well. After their engagement in individual pins, Arduino was upgraded by the opportunity to capture the signals of the heart. Arduino was constantly connected to computer device and by this the need to use external battery was omitted, note that the energy was supplied through USB. It was proposed that the ECG data is to be plotted directly on the android layout using Arduino IDE & android studio environment and our application.

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The implementation of the ECG is by cascading several stages as shown in the figure2, which depicts the system block diagram at server side. At client side the doctor receives this ECG waveform by using android APP in Smartphone. The device hardware mainly consists of following parts.

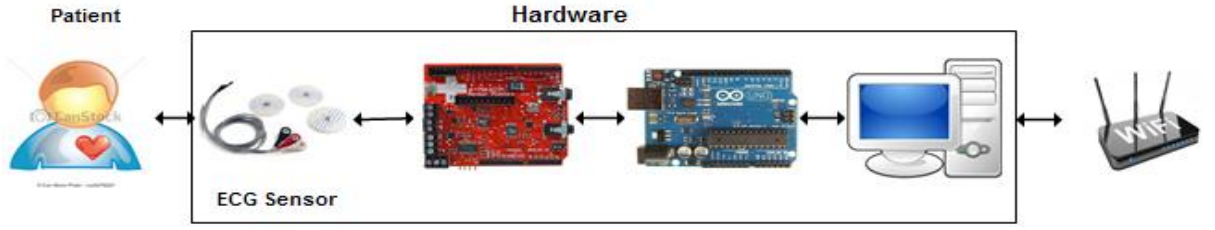

Figure2: Block diagram of Electrocardiogram

3.1 Arduino Microcontroller

Arduino is an open electronic platform, the principal reason of its success is user friendly hardware and software [3]. Arduino is able to perceive the environment by utilizing various sensors and shields that may be connected to it. Arduino is a massive development kit based on the microprocessor ATMEGA328 and contains 13 digital input-output pins, 6 of them with support of pulse-width modulation (PWM) and 6 analog inputs [4]. Arduino UNO due to specific aspects, i.e. in conjunction with ECG it overruns other projects. Other aspects are: clearly and easily usable API with a simple programming language, then so-called Arduino shields that actually represent enhancements of the Arduino board. The Arduino Uno board having hardware setup is shown in figure 3.

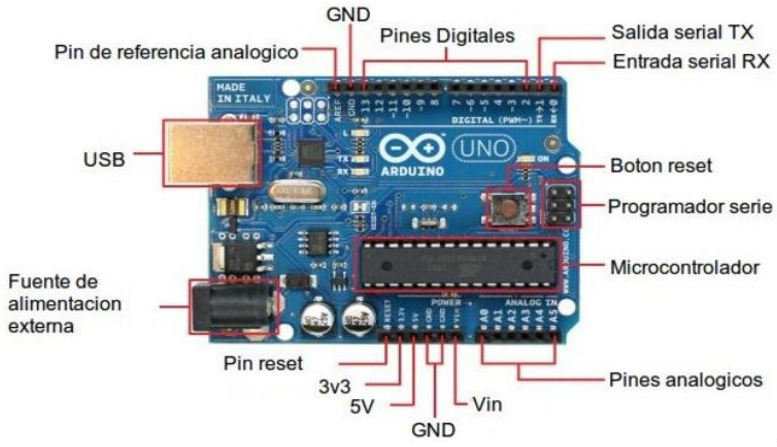

Figure3: ArduinoUno board

3.2 E-Health Shield

The e-Health Sensor Shield allows the Arduino UNO development board to perform biometric and medical applications where vital sign monitoring is needed by using different sensors like , Electrocardiogram (ECG), Blood Pressure, Pulse oxygen in the blood(SPO2), BodyTemperature, Glucometer, Airflow (breathing) and Electromyography sensor (EMG), etc. [5] Figure4shows E-health sensor shield.

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This information can be used to monitor the state of a patient in real time or to get sensitive data in order to be subsequently analysed for medical diagnosis Data can be sent to the Cloud in orderto perform permanent storage or visualized in real time by sending the data directly to alaptop or SmartphoneIPhones and Android applications have been designed in order to easily see the patient information.

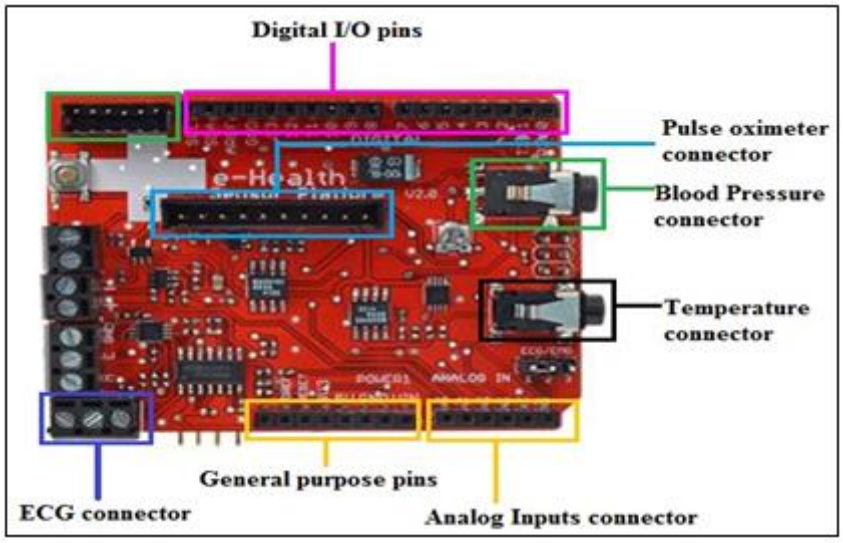

Figure4: E-health sensor Shield

3.3 ELECTRODES

THE original ECG devices used in medical practice in the art of cardiology use a combination of different electrodes. The 3 Lead electrodes are shown in figure3. In proposed systemutilized3-lead electrodes from e-health shield. These electrodes are created exactly for connection in the form of Einthoven triangle [6]. This type of connection includes three electrodes - one on the right hand, the second one on the left hand and the third one on the left leg. Three electrodes cross the notional heart. The right foot is taken as connection to the ground. Electrodes have also the option of renewable terminals. The electrodes are connected directly to the electrode jack.

Figure5: 3-lead ECG Electrodes

The system can be implemented by incorporating the following components. Figure.6 describes the schematic diagram of ECG.The ECG device hardware mainly consists of following parts namely

1) Instrumentation Amplifier

2) Offset (DC) cancellation Circuit

3) Low pass filter& Amplifier

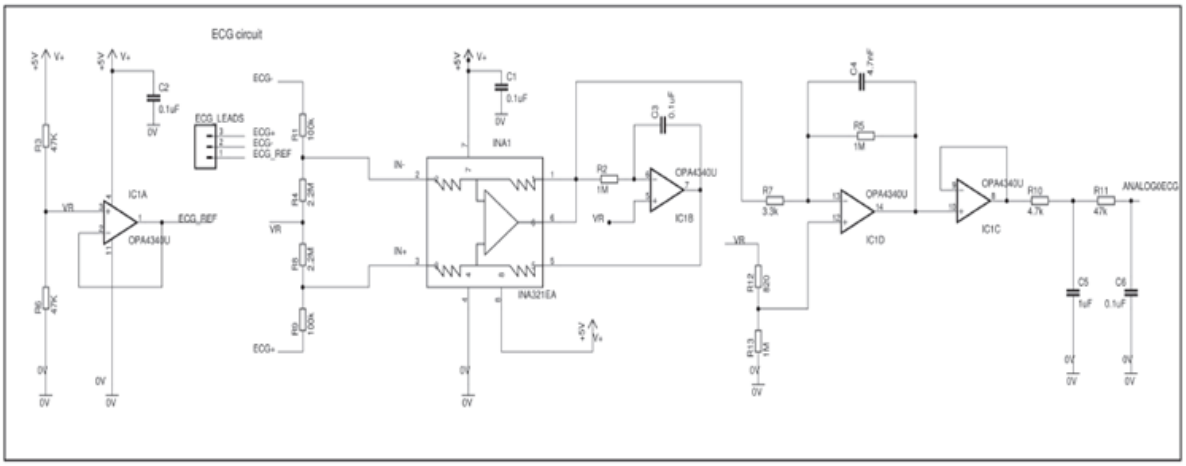

Figure.6: Schematic diagram of Electrocardiogram

IV. SOFTWARE IMPLEMENTATION

The software part in the present paper is used to determine the ECG values from sensor and with these vales draw ECG (PQRST) waveform. The microcontroller program controls the external devices and measures the input signals from the patient and displays the output.In the present work the C with Android GUI programming is used for the software development of ECG system.The ECG software mainly consists of following parts

4.1 Arduino IDE

In present work The Arduino integrated development environment (IDE) is used to interface biomedical parameter ECG sensor. It is a cross-platform application written in C, and derives from the IDE for the Processing programming language [7] and the Wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. Arduino programs are written in C or C++.

4.2 Android

An Android is a mobile operating system (OS) based on the Linux kernel and currently developed by Google. It is designed primarily for touch screen mobile devices such as smart phones and tablet computers, with specialized user interfaces for Home entertainments, Automobiles and wrist watches (Android Wear). The OS uses touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching and reverse pinching to manipulate on-screen objects, and a virtual keyboard. Despite being primarily designed for touch screen input, it also has been used in game consoles, digital cameras, regular PCs and other electronics. It is a powerful Operating System supporting a large number of applications in Smart Phones [8]. These applications make life more comfortable and advanced for the users. Hard ware's that support Android is mainly based on ARM architecture platform. Android architecture or Android software stack is categorized into five parts:

- Linux kernel
- Native libraries (middleware)
- Android Runtime
- Application Framework
- Application

➢ **Linux Kernel:** It is the heart of android architecture that exists at the root of android architecture. Linux kernel is responsible for device drivers, power management, memory management, device management and resource access.

➢ **Native Libraries**: On the top of Linux kernel, there are Native libraries such as Web Kit, OpenGL, Free Type, SQLite, Media, C runtime library (libc) etc. The Web Kit library is responsible for browser support, SQLite is for database, Free Type for font support, Media for playing and recording audio and video formats.

➢ **Android Runtime:** In android runtime, there are core libraries and DVM (Dalvik Virtual Machine) which is responsible to run android application. DVM is like JVM but it is optimized for mobile devices. It consumes less memory and provides fast performance.

➢ **Android Framework:** On the top of Native libraries and android runtime, there is android framework. Android framework includes Android API's such as UI (User Interface), telephony, resources, locations, Content Providers (data) and package managers. It provides a lot of classes and interfaces for android application development.

➢ **Applications:** On the top of android framework, there are applications. All applications such as home, contact, settings, games, browsers are using android framework that uses android runtime and libraries. Android runtime and native libraries are using Linux kernel.

The complete architecture of the Android Software stack is shown in figure 7.

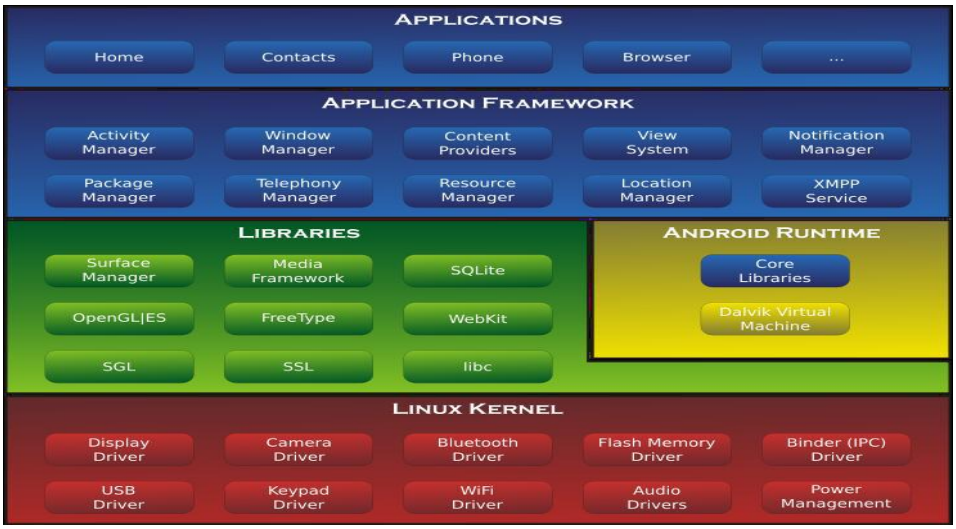

Figure 7: Android software stack.

4.3 Android Studio

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Android Studio is an integrated development environment (IDE) for developing on the Android platform with Android SDK tools. It is freely available and downloaded easily from internet. It is based on Jet Brains' IntelliJ IDEA software, the Studio is designed specifically for Android development. It is available for download on Windows, Mac OS X and Linux.

4.4 XAMPP

XAMPP is used in present work for development of Database storage and maintenance of server. XAMPP stands for Cross-Platform (X), Apache (A), MySQL (M), PHP (P) and Perl (P). It is a simple, lightweight Apache distribution that makes it extremely easy for developers to create a local web server for testing purposes. Everything you need to set up a web server – server application (Apache), database (MySQL), and scripting language (PHP) – is included in a simple extractable file [9]. XAMPP is also cross-platform, which means it works equally well on Linux, Mac and Windows.

4.5 Flowchart: The flow chart in Figure 8explains the operation of ECG signal processing.

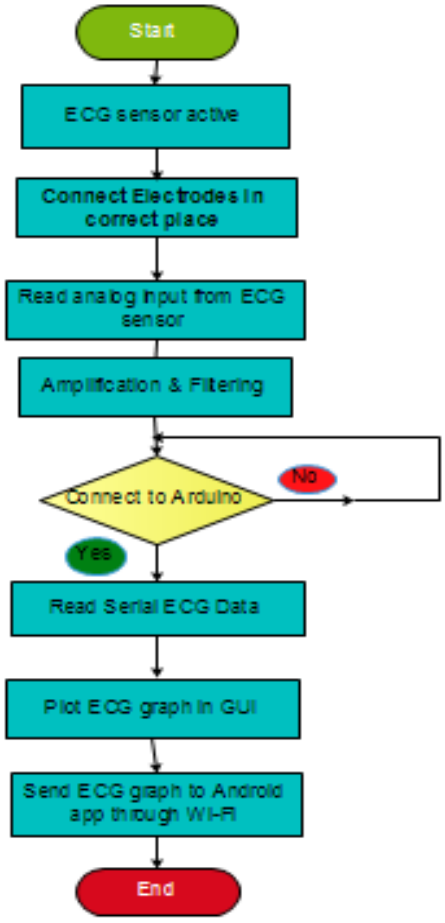

FIGURE8: FLOW CHART OF ECG

ALGORITHM

i. Initialize central processing unit
ii. Initialize Ports, Operational Amplifiers
iii. Initialize memory

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iv. Initialize ADC sampling rate using timer
v. Enable interrupts
vi. Connect 3-leads of electrode in correct place
vii. Read the signals from the sensor and transmit signals to the amplifier
viii. Convert analog signal to digital signal using inbuilt ADC
ix. Display the ECG values on serial monitor
x. Store ECG values in database
xi. From ECG values Plot ECG waveform in GUI using Android studio

V. RESULTS AND DISCUSSION

Results are obtained using Arduino, Android and a smartphone. The output of the ECG sensor is processed in Arduino Atmega328 controller and send to serial output in PC as shown in Figure 9.

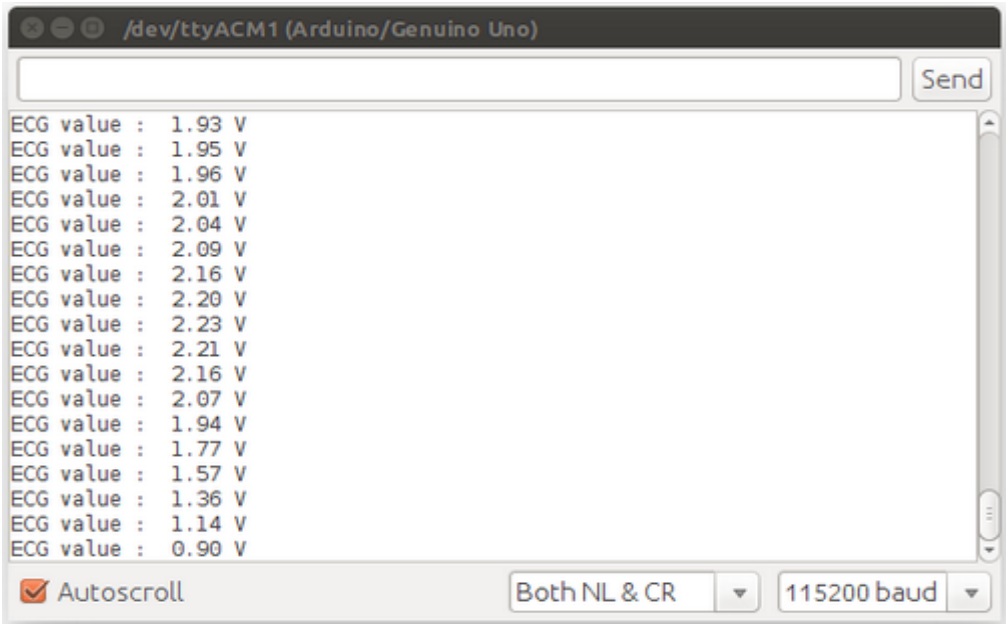

FIGURE9: ECG DATA IN ARDUINO SERIAL OUTPUT

Practical tests have been conducted to evaluate the real time performance of the wireless Medical Diagnosis platform. The main aim and objective of this work is to develop an Android based Patient Care Monitoring system with ECG measurement. Hence an attempt has been made by the author to develop an ECG system for the cardiac treatment using the advanced micro controller ATMEGA328 or Arduino UNO and Android development Tools.

The query processes handle the communication between the server and Android mobile device to display the biomedical signals graphically on a mobile screen in real time. The ECG signal obtained from ECG acquisition circuit isplotted and displayed on android mobile phone. The ECG waveform displayed on android smartphone app is shown in figure10.

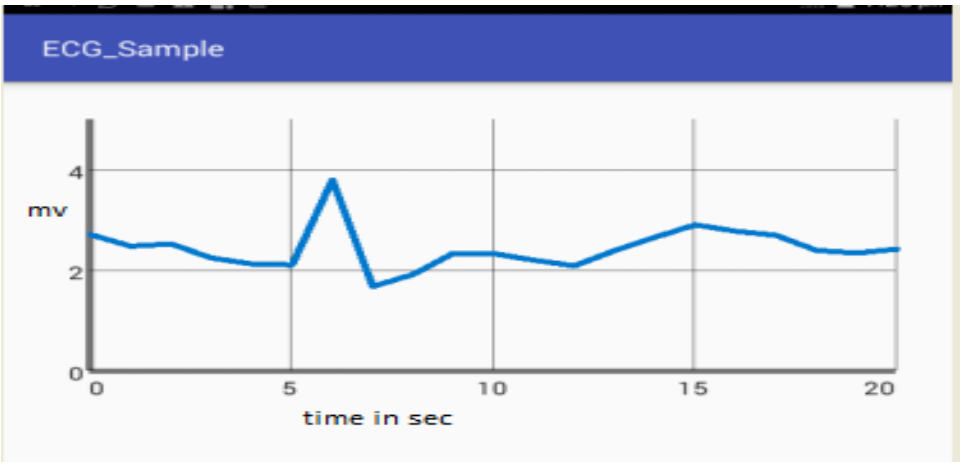

Figure10: ECG graph in Smartphone

VI. CONCLUSION

In this paper, remote patient monitoring system used android Smartphone is presented, which allows doctors to view his patient's vital parameter remotely and dynamically in real time. In present work the system is based on ECG sensor, microcontroller &Android technology used to transmit data wirelesslyinSmartphone, as great use in the field of medicine and helps theDoctor to keep a keen eye on the patient's health. So a systemis used to monitor the overall health status of cardiac patient, which needsconstant care, the data at receiver which can be used toanalyse the patients overall health condition. Thus the ECG signal is measuredfrom the sensor and respective diagnosis can bedone by doctors in Smartphone.

REFERENCES

[1] Surawicz B, Knilans TK. Chou's Electrocardiography in Clinical Practice. 6th Edition.Saunders Elsevier 2008.

[2] Gordan,Cornelia,ReizRomulus,"ECG Signal processing using wavelets"

[3] Arduino Uno official website https://www.arduino.cc/en/Main/ArduinoBoardUno

[4] ATMEGA328P datasheet http://pdf1.alldatasheet.com/datasheet-pdf/view/241077/ ATMEL/ATMEGA328P.html

[5] E-health shield https://www.cooking-hacks.com/documentation/tutorials/ehealth biometric-sensor-platform-arduino-raspberry-pi-medical

[6] http://medical-dictionary.thefreedictionary.com/Electro-Cardio+Gram.

[7] http://arduino.cc/en/Main/arduinoBoard

[8] "Download Android Studio". *Android Developers*. Retrieved June 13, 2016.

[9] http://www.oracle.com/us/products/mysql/overview/index.html