ECG And PPG Monitoring Using Machine-To-Machine Communication

Priyanka Amodkar, M.B. Limkar, Smita Kulkarni

***Abstract*— This paper provides a prototype which uses machine to machine communication to provide healthcare solution. ECG and PPG is an important tool to interpret a wide range of heart conditions. Early warning and patient awareness are critical in preventing permanent heart damage and saving much of the heart muscles. These critical conditions motivated us to develop a prototype that provides a long term ECG and PPG monitoring. Our approach is to provide healthcare solution which can process large amount of biomedical signals through the network that is a combination of internet and sensors.**

***Index Terms*— machine-to-machine, android app, ECG, healthcare, PPG.**

I. INTRODUCTION

The design of portable systems for remote monitoring of patients specifically those who are suffering from cardiac diseases are becoming one of the most important fields in telemedicine[2]. This system can be useful especially by patient like senior citizens or having physical disabilities or who are alone. Therefore, this system can be utilized for remote medical systems to assist the elderly patients, for selftesting diagnostics, or for physicians to diagnose diseases of the circulatory system. Also, in recent years mankind has witnessed a revolution in the smart phone industry and emerging growth in the usage of mobile applications that range from entertainment and educational apps to simple games, health care apps and more[2]. The purpose of this paper is to monitor the critical conditions with the help of machine-to-machine communication.

Machine to Machine (M2M) refers to technologies that allow both wireless and wired systems to communicate with other devices of the same type. M2M is a broad term as it does not pinpoint specific wireless or wired networking, information and communications technology.[11] The sensors at the patient's side monitor and record the readings, these readings can be accessed at the doctor's mobile phone on the android app. With advances in mobile communication, new opportunities have opened up for the development of healthcare systems that remotely monitor biomedical signals from patients. The availability of a new generation of mobile phones has had an important impact on the development of such healthcare systems, as they seamlessly integrate with a wide variety of networks (such as 3G, Bluetooth, wireless LAN, WCDMA and GSM), and thus enable the transmission of recorded biomedical signals to doctors or patients from a central server.

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II. SYSTEM ARCHITECTURE

The overall system block diagram of M2M healthcare solution is as shown in fig.1.

(A) ECG sensor:

It converts physical signals into electrical voltage. The voltage is in the range of 1 mV ~ 5 mV. The sensor pair is stuck on the right arm (RA), left arm (LA) and right leg (RL) of the subject as shown in fig.2. Obtain the sum of the voltages from all other electrodes and driving amplifier, the output of which is connected to the right leg of the patient. This arrangement is known as Wilson electrode system.[3]

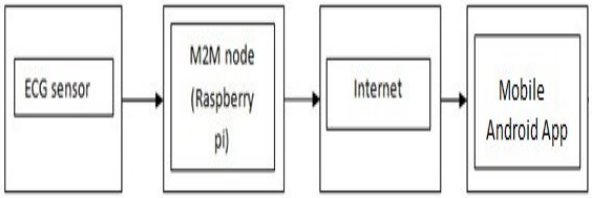

Fig1. Block diagram of the system

The effect of this arrangement is to force the reference connection at the right leg of the patient to assume a voltage level equal to the sum of the voltages at the other lead. This arrangement increases the common mode rejection ratio of the overall system and reduces noise interference. It also has the effect of reducing the current flow in to the right leg electrode.[3]

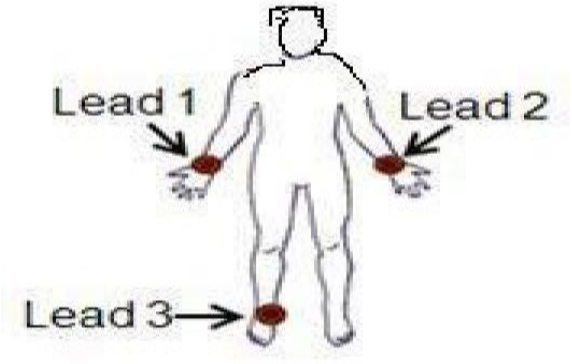

Fig2. 3 Electrode ECG sensor[3]

(B) Raspberry pi:

The Raspberry Pi is a series of credit card-sized single-board computers developed in the UK by the Raspberry Pi

Foundation with the intention of promoting the teaching of basic computer science in schools.

The original Raspberry Pi is based on the Broadcom BCM2835 system on a chip (SoC), which includes an ARM11 76JZF700 MHz processor, 256 megabytes of RAM, later upgraded Video Core IV GPU,[8] and was originally shipped with The [12]Model B+ is the final revision of the original

Raspberry Pi. It replaced the Model B in July 2014 and was superseded by the Raspberry Pi 2 Model B in February 2015. Compared to the Model B it has:

1) GPIO: The GPIO header has grown to 40 pins, while retaining the same pin out for the first as the model A and B.
2) More USB: There are 4 USB 2.0 ports, compared to 2 on the Model B, and better hot plug and over current behavior.
3) Micro SD: The old friction-fit SD card socket has been replaced with a much nicer push-push micro SD version
4) Low power consumption: By replacing linear regulators with switching has reduced power consumption by between 0.5W and 1W.
5) Better audio: The audio circuit incorporates a dedicated low- noise power supply.

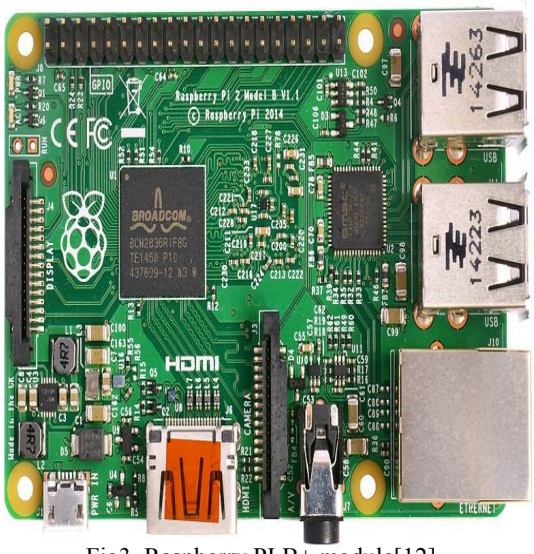

Fig3. Raspberry PI B+ module[12]

(C) M2M gate and Android Mobile Phone:

The measured biomedical signals are sent to the directly to the doctor's mobile through the internet by using the Raspberry pi for further processing. Once a data packet has been received through the M2M devices, the packet is processed, and useful data is extracted [1]. When the data is received, an IPv6 address is identified first to ensure that the received data is send from a correct M2M node. Then, the received data is scanned to ensure the data packet is a complete packet. This program continuously monitors not only biomedical signals, such as the PPG signals, ECG signals and oxygen saturation data acquired by wearable sensors, but also information related to M2M devices, such as communication settings and IPv6 addresses. Further, the recorded signals are send to the doctor's mobile, where this signals are plotted on the android app for the analysis of the health status of the patient. This signals are only send to the signals supported app on the android phone using JAVA.

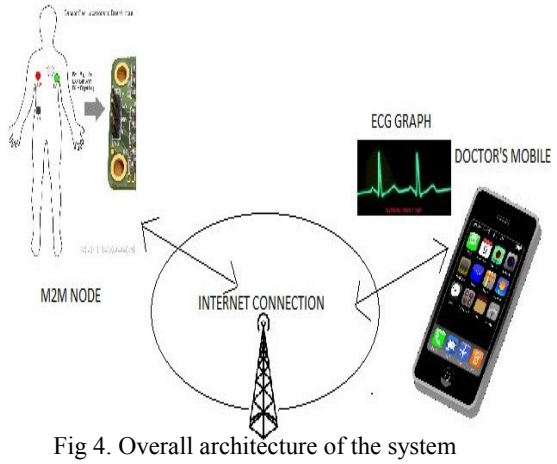

Fig 4. Overall architecture of the system

III. RESULTS

Practical tests have been conducted to evaluate the performance of the wireless Machine to Machine healthcare system, as shown in Fig. 4. In particular, an experiment was carried out in which one of the authors wore a wearable sensor on his wrist to perform real-time monitoring for 10 minutes[1].

The M2M node, which is connected to the wearable sensors placed on the patient's body to collect health parameters, further transfers the data to the M2M gateway. This program performs an accurate recognition even if the patient is unconscious [1]. The signals are recorded and by using various algorithms the signals are plotted and received on the Android mobile phone. This graph is compatible due to JAVA supported app.

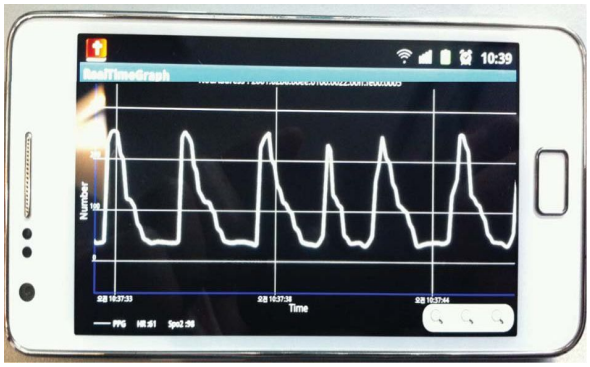

Fig 5. Display of ECG signal on the Android Mobile Phone

CONCLUSIONS

A wireless Machine-to-Machine healthcare solution using the Android mobile devices is successfully implemented in a global network [1]. The M2M devices are designed and used for the measurement of PPG signals and ECG signals, and their transmission to Android mobile device is used to provide a mobile healthcare service by means of an Android application running on a device with wireless internet access. With the implementation of this system the percentage of heart damage due to cardiovascular attack can be reduced and a efficient monitoring system can be implemented for a

preventive measure. The overall healthcare app is show in fig 6. Therefore, with the implementation of this project the patients can maintain their medical records safely for a long time as a soft copy in the memory. Based on the results, it is concluded that with the help of Machine-to-Machine communication, various wireless sensor and the management of this embedded system gives rise to a era of healthcare system.

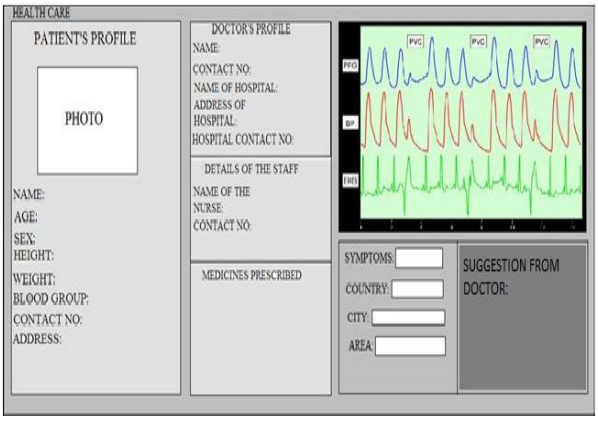

Fig6. Front view of Healthcare app

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