Healthcare based on IoT using Raspberry Pi

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***Abstract* - This paper explains a Raspberry pi controlled remote monitoring system. Raspberry Pi is a credit card sized single board computer with ARM11 microprocessor. In this study, a system is designed to continuously monitor the Electrocardiogram (ECG) and other vital parameters. This data is stored in a database and can be displayed in a website that can be accessed only by authorized personnel. This idea is familiar however; this paper presents a substantive and inexpensive method using Raspberry pi. The primary task of this system is to update the data to the database and alert the doctors for any aberrancy. The former is accomplished by using MySQLdb module to link Raspberry pi to the database whereas the latter is achieved by the combination of Raspberry Pi and GSM module. This system has much future scope as the data gathered by monitoring is so valuable and can be used for scientific research by the medical community. By determining the patterns in the parameters observed, the nature of disease can be predicted. The paper mainly emphasizes on the system design and the algorithm used to accomplish the task. The obtained results are presented.**

Keywords: Raspberry pi, ECG, Healthcare applications, Internet of things

I. INTRODUCTION

The advancement in the new innovative technology and Internet of Things (IoT) has had it substantial influence in the healthcare system. Moreover, the fusion of novel advances in technology with the healthcare systems provide us with a wide window for improvements in the areas of patient care and communications, support for decision making and reducing the inaccuracies. But the fragmented nature of the healthcare system, which is further worsened by the lack of tools for communication between the specialists, stimulates the need of functional interoperability to ameliorate this coordination. Currently, information technology is considered a necessity rather than a supporting tool.

A major aspect in the healthcare system is the monitoring of the patient's vital signs such as temperature, blood pressure and heart rate. Many monitoring devices that display the patient's vital signs are commonly present in the critical care units in operating rooms.

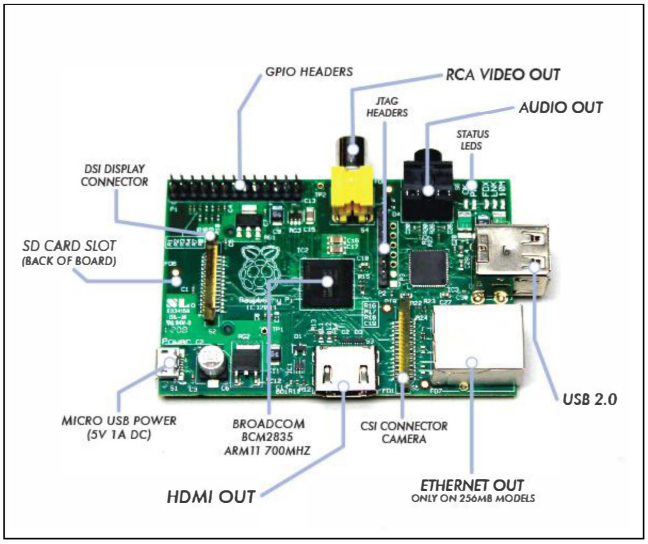

FIG1.1: RASPBERRY PI B+ BOARD

But there could be instances where the doctor couldn't be alerted in time when there is an emergency, despite of 24 hours of monitoring. Also the data couldn't be shared remotely with the other doctors who are specialists in that field and the family members. Technology that enables all these activities are available but aren't accessible and affordable by many people in developing nations. Hence the problem can be overcome by just a simple add-on to the current devices lacking these capabilities. A simple pragmatic solution to this problem can be made using Raspberry pi [1, 3], a credit card sized single board computer.

The functions of the various components are given below:

A. Raspberry Pi:

Raspberry Pi is a credit card sized single board computer weighs only 50g. It uses power rating of 5V, 700mA and cost effective than an actual computer. The board comes in different models A, B and a more advanced version B+. The B+ model has 512 MB RAM, runs on ARM11 processor and has an operating frequency around 700MHz. Many bootable

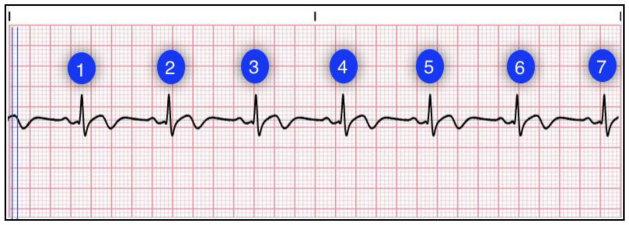

FIG1.2: ECG GRAPH

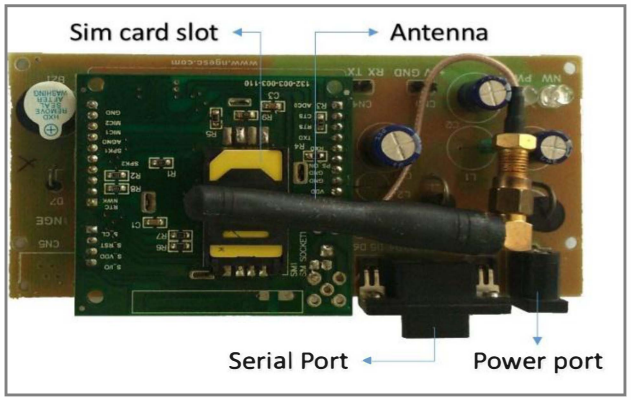

FIG1.3: GSM MODULE

Operating systems like Raspbian, Pidora, and Raspbmc can be installed using a SD card. Different peripherals like mouse, keyboard, Wi-Fi adapter can be connected using its four USB2.0 ports to make it a full size computer. Also the board consists of an Ethernet port to connect to network, GPIO pins to interface and control switches, sensors, LEDs and other devices. All kinds of monitors like projectors, LCD screens, Tvs can be connected using HDMI port. Some additional features include the audio jack and the camera connector to interface camera. These numerous features enable the users to use Raspberry pi in wide range of applications. Refer the fig 1.1.

B. *Electrocardiogram (ECG):*

The electrocardiogram (ECG or EKG) is the register of heart's electrical activity. Heart muscles contract by electrical stimulation, known as activation or excitation. These muscles are electrically charged at rest and get contracted by depolarizing the charge. ECG [10] is the graph of these electrical signals. It gives the information about heart rate and rhythm, and the mass or volume of the chambers of heart.

There are several methods for determining heart rate. In this paper we used the method of counting the number of QRS complexes over a 6 second interval. Multiply that counting number by 10. This method works well for both regular and irregular rhythms. In the fig 1.2, we can count 7 QRS complexes, so the heart rate is 70. Like this we can determine the Heart Rate from ECG graph.

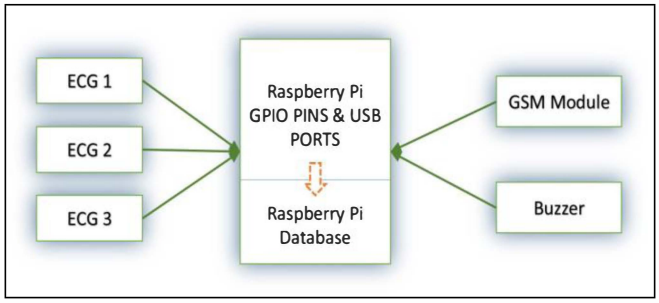

FIG2.1: SYSTEM DESIGN FOR HEALTH CARE SYSTEM

C. *GSM Module:*

GSM Modem [6] is a wireless modem that works with a GSM wireless network. The baud rate can be modified using AT commands from 9600 to 115200. It is operated on 12V supply and frequencies 900/1800 Mhz. It comprises of a SIM card slot and an antenna to receive signals. Using serial communication, RS232 interface, it can be connected to devices like Raspberry Pi, PC etc. Refer the fig 1.3. Several AT commands are used to perform various operations like sending and receiving SMS [5], voice calls. With a set of extended set of AT commands the strength of the signal, reading, writing and searching phone book entries is also possible. Functions such as receiving and sending messages, answering calls can be done using AT commands through serial port on Raspberry Pi.

The rest of the paper is structured as follows. Section II deals with the system design. Section III discusses the algorithm of the program and Section IV presents the results. Finally Section V and VI explains the scope for future research and conclusion respectively.

II. IMPLEMENTATION

System Design

The basic aim of system design is to monitor different ECG machines automatically, updating the database of website continuously and alerting the doctors by a message, if the health parameters are not in range of normal values. Different ECG machines are connected to Raspberry pi which is written a program to monitor the parameters continuously. If any abnormal values are obtained, a message is sent to doctors through the GSM module connected to RS232 serial port and alerting the people there through a buzzer connected to GPIO pins. Refer the fig 2.1.

MySQLdb module has been used to update the website database continuously. A display monitor can be connected to Raspberry pi through HDMI port and the website can be examined directly from the Raspberry pi. Several monitors can also be connected using HDMI extension switch.

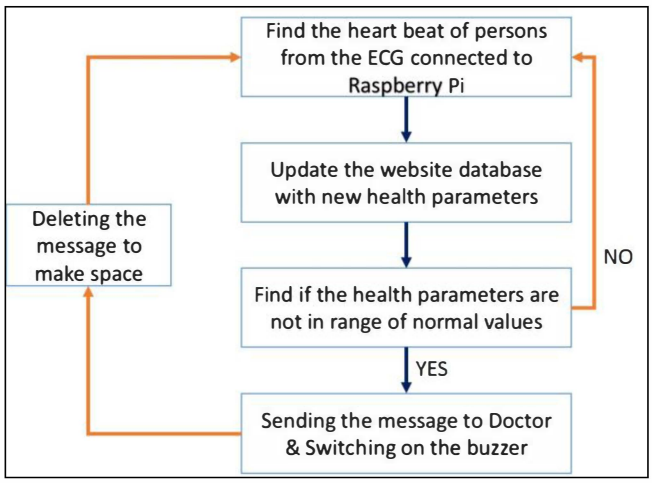

FIG3.1: CODING ALGORITHM FOR HEALTH CARE SYSTEM

III. ALGORITHM

Raspberry pi [4] is installed with a Linux based operating system, Raspbian, supports all programming languages like C, Python etc. For easy access, Python [8] programming language is used for the communication with ECG machines and updating website database using MySQLdb.

Altogether the function of the algorithm, written in Python, is to update the database and alert the authorized individuals for any aberrancy. Refer the fig 3.1.

.By following the below steps the system is implemented:

- Import all the modules required for Serial Communication, MySQLdb.
- Communicate with the ECG's connected to Raspberry Pi.
- Find the heart beat from the input data.
- Update the website database with new health parameters.
- Check if the heart beat is in the normal range.
- If heart beat is not in normal range alert the authorized person by sending SMS through GSM module and alert in the hospital through buzzer sound.
- Delete the message in SIM card to make space.
- If heart beat is in normal range monitoring continues.

IV. RESULTS

Health care system is practically implemented and the results are obtained.

Results of Health care system are as follows:

The health platform is show in fig 4.1. It is the website authorized person can view the patient health parameters online.

Fig 4.2 show the terminal diagram that finding the heart beat from the input sample files and updating the database of website.

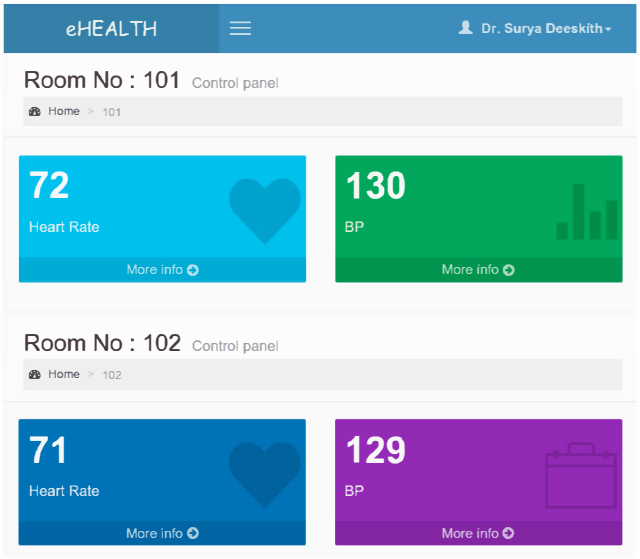

FIG4.1: WEBSITE SHOWING THE HEALTH PARAMETERS

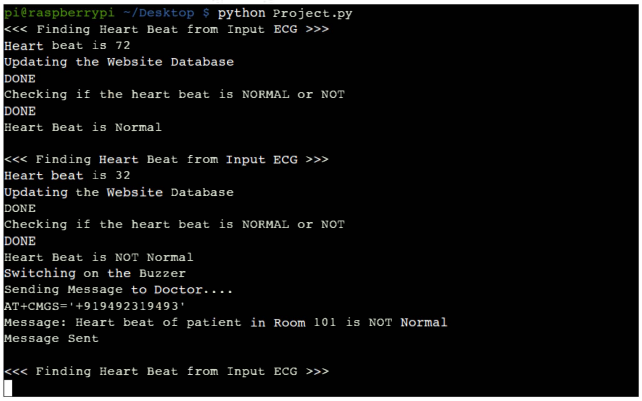

FIG4.2: SCREENSHOT OF TERMINAL IN RASPBERRY PI

V. SCOPE FOR FUTURE RESEARCH

A large amount of data can be collected using this system. This colossal amount of data, consisting medical history of many patients' parameters and corresponding results, can be explored using signal processing techniques and data mining, in search of consistent patterns and systematic relationships in the disease. This could a point of paramount significance for the medical research. Simply, the researchers provided with actual results which make their study easier. Additionally, they can also predict the nature of disease and take some preventive measures in advance. For instance, if a patient's health parameters are changing in the same pattern as those of a previous patient in the database, the consequences can also be estimated. If the same patterns are repeatedly confirmed, it would be easier for the medical personnel to find a remedy.

VI. CONCLUSION

In this study, a new approach is presented and proved, that works in an automatic way, guaranteeing a seamless

monitoring of ECG signals and other health parameters. Realized system can be a prototype for health care system to monitor patient's vital signals. Raspberry pi is used for this application because of its multi-tasking capability and low power consumption. Also this system can be installed easily in all the hospitals and huge data obtained can be stored in the database. Moreover this data is much valuable. Raspberry Pi, with its broad variety of features can be used for several purposes and have much scope in future. Even the results can be made to be accessed from mobile through an application. Any intelligent system can be added and can be further improvised to facilitate the clinicians and the patients.

REFERENCES

[1] Gareth Mitchell, The Raspberry Pi single-board computer will revolutionize computer science teaching [For & against], Vol.7, NO.3, pp. 26, 2012.

[2] Edwards, C., "Not-so-humble raspberry pi gets big ideas," in *Engineering & Technology* , vol.8, no.3, pp.30-33, April 2013

[3] Charles Severence, "Eben Upton: Raspberry Pi", vol.46, NO.10, pp. 14-16, 2013.

[4] "Content", 2015 IEEE International Conference on Electrical Computer and Communication Technologies (ICECCT), 2015.

[5] Vamsikrishna, Patchava; Sonti Dinesh Kumar; Shaik Riyaz Hussain; Rama Naidu, K., "Raspberry PI controlled SMS-Update-Notification (Sun) system," in *Electrical, Computer and Communication Technologies (ICECCT), 2015 IEEE International Conference on* , vol., no., pp.1-4, 5-7 March 2015

[6] SIM900 Manual_V1.03, Shanghai SIMCom Wireless Solutions Ltd.2010.

[7] Eben Upton, *Raspberry Pi Guide*. A John Wiley and Sons Ltd., 2012.

[8] Python Softwares, https://pypi.python.org/pypi

[9] Raspberry Pi Foundation, http://www.raspberry.org

[10]Heart Rate, http://www.practicalclinicalskills.com

[11]Helath, http://en.ecgpedia.org

[12]Health, www.heartlandmedical.com