Advances in Computer Science and Information Technology (ACSIT)
Print ISSN: 2393-9907; Online ISSN: 2393-9915; Volume 2, Number 11; April-June, 2015 pp. 111-114

http://www.krishisanskriti.org/acsit.html

e-MPHASYS-Monitoring Health Parameters using Android Operating System

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Abstract—*Today's health-care system demands helping hands of technology to become smart. Many developed and developing countries face the problems of regular health examinations. The load on the traditional healthcare centres can be minimized by observing health parameters by own, anywhere, anytime. For this purpose wireless health-care solutions are in race against traditional health solutions. Some concerns on their usability and applicability are being raised; they can be used to their fullest. We can incorporate advance embedded and micro-electronics, along with low powered wireless telephony and sensing devices into traditional health-care systems. We propose to develop a system "e-MPHASYS" Monitoring Health Parameters using Android Operating System. In this system, few biomedical signals are acquired on the node that includes biomedical sensors, controller and Bluetooth module. This node communicates to doctors smart phone via Bluetooth. Acquired data from the node helps care givers to have effective diagnosis.*

Index Terms*: Health-care, Heart-rate, Temperature sensors, Adruino-Board, Bluetooth, Android App;*

1. INTRODUCTION

Today's world is equipped with all the smart things in every walk of life. We have smart economy, smart people, smart living, smart environment, smart cities, smart phones, etc. To take this smartness to next level, a smart health-care monitoring system is proposed [1]. As far as India is concerned health care system needs a big transformation where we have a situation of increasing medical care cost and rapidly increasing demands which exceeds the health care supplies [3]. One way to put a step forward is to use ultra-integrated technology in sensors that can be wearable, communication protocols, WNS etc. The health-care monitoring should not only be the responsibility of hospitals, instead we can make this system very much portable for example, at homes, hostels, offices, travelling, etc [4]. The current trend gives an importance on monitoring of dynamic health parameters and to manage wellness of an individual. Both developed and developing countries faces the same situation and that the situation can be very well improved [2]. Many reasons can be considered like elderly aged population, stressful life at working place, hectic and busy life of house wives, delay in getting the medical services, etc. Hence both continuous or occasional recording and analysis of biomedical signals in diagnosis and treatment of various diseases with help of proposed system is a need of time [1]. The private health sector is the dominant health-care provider in both urban and rural sectors. A dependency on public and private health care sectors varies significantly between the states. More is relayed on private because of poor quality of care in public sector, distance of public sector facility, long wait times, load shadings, etc. But most of society people cannot afford the costly services given by private health sector and the conditions of public health sector leaves them in dilemma state [5]. Also the degree of malpractices being carried out in the Indian healthcare system that includes kickbacks for referrals, irrational drug prescribing, and exaggerated fee structures are common issues [10].

To overcome these limitations in Indian health-care system, an electronic wireless portable healthcare system can be implemented. We are monitoring few health parameters like body temperature, heart beat pulses, conductivity of skin, the level of saline. The admitted patients can also use this system, to help completely assist the patients and send the biomedical signals on the doctor's android phone. Few assisting voice commands can be played by the patients to get help. e-MPHASYS system includes pulse, temperature sensors, low powered Arduino-Nano, ATMega328 microcontroller, Bluetooth module for wireless communication, pulse sensor and an android app.

2. LITERATURE SURVEY

"Health is wealth". The health-care scenario in India when we compare across the countries in a cross section is surely not good [7]. Indian health-care system is paralyzed with numerous problems where investing the necessary wealth does not produces the required results [11]. This project work refers the solution to make health more accessible and affordable to the masses. The doctor population in India is 1:1500 as compared to a 1:1000 in China and 1:400 in USA. In urban India the ratio is around 1:500 while in rural its around 1:2500. India has approximately 13000 allopathic government

hospitals with capacity of around 6 lakh beds, however India has a ratio of 1 bed / 1000 population compared to 3 beds for China and 3.4 for USA [13]. This situation shows how drastically the health-care is affected. Lack of sanitation and improper hygiene is one of the root causes for spreading illness and health-care system falls short. We cannot become a developed country while continuing to fail in the improvement of this area. It is not only the public health that is in trouble, but equally depressing situation is being observed in urban areas. Although the private sectors have big specialized hospitals, heavy equipments and skilled doctors, we are failing to achieve patient's satisfaction [11]. This trust gap can filled by implementing a module that gives power for the patient to monitor health parameter by own.

3. SYSTEM DEVELOPMENT

The complete system can be divided into two parts: firstly data acquisition that includes all sensors and Arduino-Nano board based on ATmega328 microcontrollers, secondly the Android app which displays the biomedical signals. It also has few audio commands for assisting purpose. The parts are connected wirelessly via Bluetooth module.

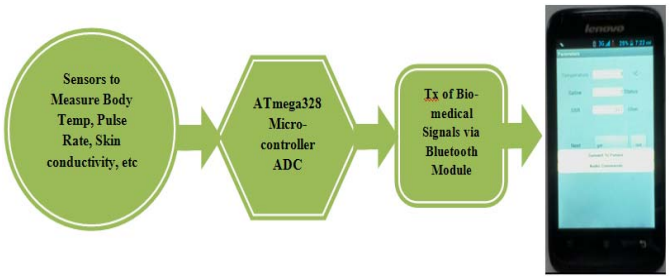

Fig. 1: Block Diagram

The overall goal of e-MPHSYS system is to develop a prototype and evaluate a new type of multi-sensor medical monitoring device that offers a small size, ability to put number of biomedical sensors according to the patients need which helps to maintain the electronic health record of patient.

1. Arduino Nano

Arduino is an open source electronics prototyping platform based on flexible easy to use hardware and software. Arduino Nano is a small, complete and breadboard friendly development board which is based on the ATmega328 or ATmega168. It works with a Mini-B USB cable [14].

Specifications:

Operating Voltage:	5V
Digital I/O Pins:	14 (6 PMW Output)
Analog Input Pins:	8
DC Current per I/O pin:	40mA.
Flash Memory: (ATmega328)	32Kb
EEPROM: (ATmega328)	1Kb
Clock Speed:	16MHz

Fig. 2: Arduino Nano

2. Sensors

Different parameters being monitored with this system are Body Temperature, pulse rate, skin conductivity, the level of saline.

a. Body Temperature Measurement

Normal body temperature can range from 97.8 degrees F to 99 degree F which is equivalent to 36.5 degrees C to 37.2 degree C for a healthy adult. For most people 98.6 F (37^o C) is baseline. If the temperature is103 F (39.4^o C) or greater the fever is too high, then the doctor need to pay attention towards patient.

In this module the body temperature is being measured with help of LM35, a temperature sensor. The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly-proportional to the Centigrade temperature scale. The LM35 has an advantage over linear temperature sensors calibrated in Kelvin, as it is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. LM35 independent of any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range.

b. Pulse Rate Measurement

The Easy Pulse sensor is based on the principle of photoplethysmography (PPG) which is a non-invasive method of measuring the variation in blood volume in tissues using a light source and a detector. Since the blood change volume is proportional or synchronous to the heart beat, we can use this technique to calculate the heart rate. Reflectance & Transmittance and are two basic types of photoplethysmography.

Fig. 3: Pulse Sensor

AVERAGE HEARTBEAT RATE

AGE	RANGE	AVERAGE RATE
0-1 Month	100-180	140
2-3 Month	110-180	145
4-12 Month	80-180	130
1-3 Years	80-160	120
4-5 Years	80-120	100
6-8 Years	70-115	92.5
9-11 Years	60-110	85
12-16 Years	60-110	85
>16 Years	60-100	80

The above table shows the average heartbeat rate for the persons of various ages.

c. Skin Conductivity

Sweating is controlled by sympathetic nervous system and skin conductance is an indication of psychological state. Skin conductivity is measured in resistance. A two-electrode system is used to measure the conductivity. One electrode is connected to 5V and the other is connected to the ground.

3. Bluetooth Module

HC-05 module is an easy to use Bluetooth SPP designed for transparent wireless serial connection setup. Serial port Bluetooth fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with 2.5 GHz radio transceiver and baseband.

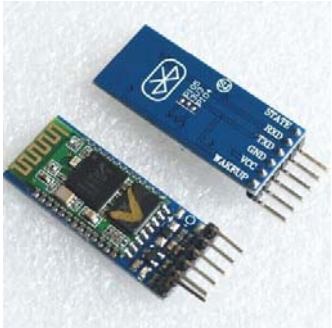

Fig. 4: Bluetooth Module (HC-05)

4. Android App

The measured signals are sent to the Android smart phone through Bluetooth for further monitoring. The monitoring code is written in Java programming language [8]. The mobile monitoring program was implemented and tested on Android mobile device Lenovo A369i running with Android OS version 4.2.2, 1.3GHz Dual-core Cortex-A7 processor. Arduino 1.5.8, MIT App inventor, Eclipse Helios IDE, etc are used.

4. EXPERIMENTAL RESULTS

Practical test have been conducted to evaluate the real-time performance of the system. An experiment was carried out in which few patients form hospital was tested. The temperature sensor was put under arm and also pinched in two fingers. To measure heart rate, index finger of right hand was put in the pulse sensor. To check the conductance of skin, the electrode connected to 5V was pinched in hand. Al these analog signals are converted to digital signals with in-built ADC of ATmea328. These biomedical signals are then transmitted to the Android phone via Bluetooth. 20-30 seconds is the transient time required to display the details on the respective fields of android app. The Bluetooth module gives a reliable communication to transmit a patient's biomedical signals to the smart phone.

All the biomedical signals measured thorough this module are verified with doctor's tools like digital thermometer, stethoscope, etc. This module gives approximately the same results with both systems.

5. CONCLUSION

Today's health-care system is growing very complex. The count of aged population and the persons in need for continuous care is increasing day-by-day. More and more challenges are being faced by medical intuitions, doctors, working staffs. To minimize this gap, this electronic health-care system can be used to record and analyse the biomedical signals. Pre diagnosis and post treatment can be efficiently carried out that will certainly reduce the burdens on health-care giving organisations.

To conclude from this point it can be asserted that electronic health (e-HEALTH) system seems highly promising.

6. ACKNOWLEDGMENT

Completion of this system is a great pleasure which would have not accomplished without cooperation and help from my guide. At the outset, a sincere thanks to guide Prof. S.R.Hirekhan, Head GEC, Aurangabad for his guidance and constant encouragement, without which it would have not been possible.

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