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Remote Patient Monitoring with Tele-Medicine based on Internet-of-Things

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ABSTRACT

Internet of Things (IoT) is a system in which connected physical objects can be accessed through the internet. Using IoT technology, various smart objects can be connected via the internet and can provide efficient data exchange methods for application purposes. Among the large range of applications that are based on IoT, smart healthcare services play a major role. Such a system consists of networked sensors placed on the human body that collects information regarding the patient's health status and alerts the physician immediately during an emergency. The privacy of each patient's data is also highly protected. In this paper a secured patient monitoring system is put forth which highlights the future of health care.

Keywords—*Remote patient monitoring; IoT healthcare; Authorized doctor; Tele-medicine; Cloud computing.*

I. INTRODUCTION

In today's modernized world, internet has become a prime factor in everyone's life. It has reformed the lifestyle of humans. Internet has transpired a massive development in the field of technology. The forthcoming version of internet is the Internet of things (IoT).

Envisioning a society where numerous smart devices are capable of sensing, sharing and reverting back the required data over a network via the internet is a path towards smart living. These smart devices gather the data, interpret it and trigger the necessary action. This is the uniqueness of IoT and it has been technically defined as an ever-growing network of physical devices that feature an IP address for internet connectivity and the communication between these Internet-enabled devices and systems. Since this technology is user-friendly it improves the way of living and it devises a secured healthcare system. Amidst various applications of IoT , its use in healthcare gives remarkable assurance of service. It is highly important to concentrate on utilizing the upcoming IoT technology towards betterment of healthcare. By outlining a framework in the perception of medical services where patient's health parameters are being sensed and then is sent to the cloud using Ethernet. The authorized doctors can view the patient's status via global server and when a critical condition arises medical assistance is provided immediately through GSM (Global System for Mobile) modem using the concept of Tele-Medicine.

II. PROBLEM DEFINITION

In the current scenario, it is not feasible for the patients to afford long-term stays due to economic restrictions, work etc even though their health status must be monitored consistently. To keep a check on the patients who are at home during post-operational days, a caretaker is also required. Persistent observance may not be attained using such a system. Currently there is no framework in place where constant time to time checking of the patient can be mastered along with encryption of patient's data. All the prevailing Patient Monitoring Systems are complex and also lacks emergency rescue mechanism.

III. EXISTING SYSTEM

The propounded systems in place for remote health care monitoring make use of IoT as the basic platform. As in the case of [1] the sensors that measure human health parameters are connected in the form of a network. The data from these sensors are recorded and stored on the cloud via Zigbee module. The recorded information is displayed in either phone or laptop which is placed near the patient but in this setup the data from the sensors is not encrypted and it uses low power communication protocols.

Another framework is explained in [2] in which the medicines are delivered to the patients by using GPS (Global Positioning System) and it is also connected to RFID (Radio Frequency Identification) to locate the patient immediately. Also the ambulance services use the GPS system, patients and physicians use ID card whereas bar codes are used to scan the medicines.

A similar setup to [2] is used in [3] wherein the feature of Tele-medicine is incorporated in an android application as well as the patients can take the doctor's appointment using the same App. Apart from this a warning message is also sent to the patient's guardian in case of an emergency.

A setup in [4] proposes a novel concept of monitoring the patients in a more efficient manner using IoT concept. This system collects the required parameters and evaluates the data from the obtained IoT devices. It also notifies the patient with possible precautionary measures to be practiced by them and suggests the patient with medical care and the preceding step to be followed in case of critical condition. The doctors, caretaker and the patients can view the details using the mobile application or through the web. But the data collected from the IoT devices to the system lasts only for three days in the mobile application.

IV. PROPOSED SYSTEM

The proposed system collects and transmits data from various sensors connected to the body of a patient that measure vital parameters of human body to a central network capable of comprehending, analyzing and processing the collected data. It comprises of a Microcontroller, Temperature sensor, Heart rate sensor GSM MODEM, Piezo-Electric buzzer, and Regulated Power Supply. A heart rate sensor which measures the blood volume in tissues will be used and temperature sensor will be utilized to read the body temperature of the patient. ECG sensor will also be incorporated to determine the electrical activity of the heart. The Microcontroller collects the data from the sensors and sends the data to the cloud. The data of vital parameters from the sensors is displayed on a web page and also on the LCD. The user interface html webpage is designed to automatically refresh for every fifteen seconds thereby ensuring constant monitoring of patient by the doctor.

The information stored on the cloud can be accessed anytime by the authorized doctor using any browser from end devices such as laptop/mobile. The doctors can login to the webpage using a unique IP address and password assigned to them. The doctors can also suggest medications to the patient which will be sent to the patient's phone achieving both remote patient monitoring and Tele-medicine integrated into a single system . When the vital parameters cross the safe threshold, to alert the doctor a message is sent to the doctor's cell phone through GSM modem and simultaneously the buzzer turns on to alert the caretaker. If there is no response reception from the prescribed doctor within a stipulated time frame, the message is sent to the mobile of another doctor, making the system more reliable.

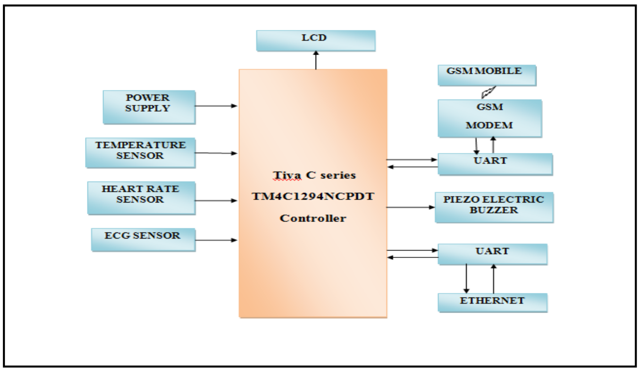

Fig. 1 Block Diagram

V. HARDWARE DESCRIPTION

A. TIVA C SERIES MICROCONTROLLER

The microcontroller used is a 32-bit controller and has on-chip 10/100 Ethernet MAC and PHY, USB 2.0 Connectivity with external high speed hibernation module and a multitude of simultaneous serial connectivity. The microcontroller is designed over a connected launch pad evaluation board. It has pre-loaded Internet-of-Things quick start application embedded on it and a 40- pin booster pack. The supply voltage that can be provided to the board ranges from 4.75-5.25 volts with a flash memory of 1024 kilobytes and 120 mega-hertz (MHz) frequency of operation.

B. TEMPERATURE SENSOR

The temperature sensor used is more precise than a Thermistor and it uses only 60micro-amps current from the supply. Output voltage is proportional to the Celsius temperature with a scaling factor of 0.01Volts/degree Celsius. The human body temperature depends upon the place at which the temperature is taken and also the surrounding environment. The normal body temperature is 37 in degree Celsius (98 .6 degree Fahrenheit).

C. HEART RATE SENSOR

Heart rate is defined as the number of heart beats recorded per minute measured in Beats per Minute (BPM). In this system the heart rate sensor uses Photoplethysmography (PPG) technique which is an optical technique used to analyze the blood volume variations in the tissues. The Heart Rate sensor is a reflective sensor that has an infrared light emitter and phototransistor. When the finger tip of the patient is placed over the sensor it will act as a reflector of incident light. The output waveform of the sensor is synchronous with heartbeat. The unwanted noise from the PPG signal is removed and the signal is amplified using combination of op-amps, capacitors and resistors. The circuit diagram is as shown below.

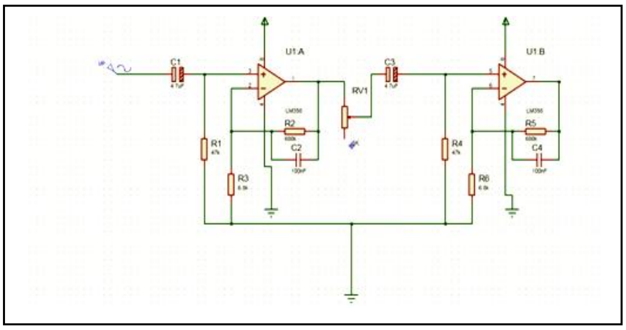

Fig. 2 Noise filtering circuit

In the circuit diagram shown in Figure 2, the first stage is a RC high pass filter to remove the DC component followed by an active low pass filter to remove high frequency noise. The combination of these filters amplifies the low amplitude pulse signal 101 times.

D. ECG SENSOR

This sensor measures the electrical activity of the heart. The ECG sensing device normally consists of three electrodes to measure the electrical activity. The electrodes can be fairly placed on the limbs and chest. The rhythmic activity of the heart is determined by examining the ECG waveform. This sensor will behave as an op-amp to acquire a clear signal from PR and QT intervals of the ECG signal effortlessly. Figure 3 shows the block diagram of ECG signal conditioning and amplification.

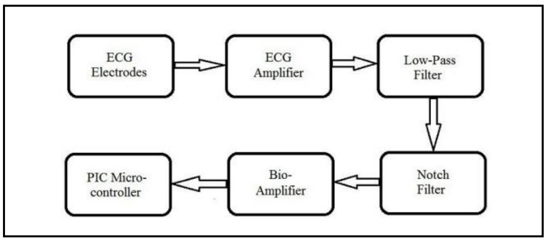

Fig. 3 Block diagram of ECG signal conditioning and amplification

The output from the sensor is very low up to 1.2 milli volts. This signal should be applied to the instrumentation amplifier for amplification. The amplified signal is then passed to the low pass filter followed by the notch filter. The signal then passes through the bio-amplifier for the detection of R wave. Once the R pulses are detected the signal is applied to a mono-stable multivibrator.

The sharp spikes generated from the multi-vibrator have low ON time when compared to OFF time. The duration between any two pulses is inversely proportional to the heart rate and the normal heart rate for human varies from 60 – 100bpm. (Beats Per Minute) The electrodes are placed based on Einthoven's triangle. This triangle is an imaginary formation of three limb leads in a triangle used in ECG. An inverted equilateral triangle is formed with the heart at the centre that produces zero potential when the voltages are added. Figure 4 shows one of the ways in which the electrodes can be placed on the human body. The electrode placed on the right leg is responsible for reducing the noise present in the ECG signal waveform.

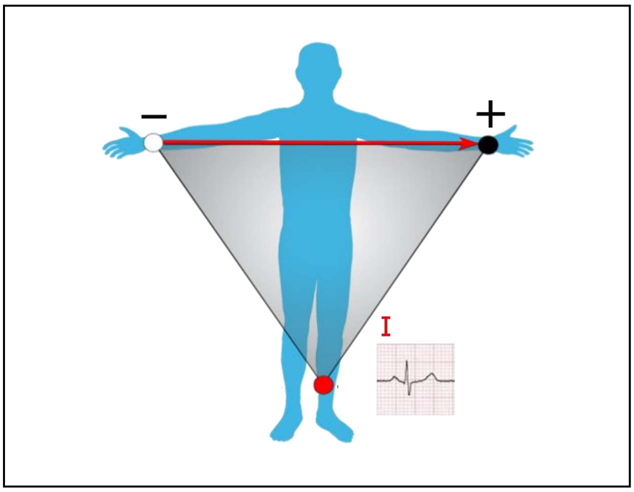

Fig. 4 Placement of electrodes onto the human body.

E. GSM MODULE

The GSM module is used to set up the interaction between a computer and GSM system. It uses a SIM (Subscriber Identity Module) card similar to mobile phones in order to actuate communication with the network. This modem requires AT (Attention) commands for establishing a connection with the controller.

F. LCD

It is an electronic display module which is favored over seven segments. LCDs are cost effective and comparatively easy to program. It has two registers specifically Command and Data. The function of the command register is to store command instructions assigned to the LCD whereas data register stores the data to be displayed and the data given is in ASCII (American Standard Code for Information Interchange) format.

G. ETHERNET

This is the most broadly used Local Area Network (LAN) technology. It is a link layer protocol in the TCP/IP (Transmission Control Protocol / Internet Protocol) stack. It includes both Layer one (physical layer) and Layer two (data link layer) of the OSI (Open System Interconnection) model.

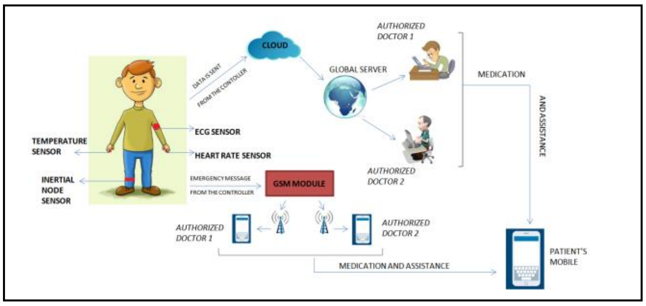

Fig.5 Schematic of proposed system

VI. SYSTEM ARCHITECTURE

Data acquisition is achieved by various sensors that measure vital human health parameters like body temperature, heart rate, ECG and movement of the patient. The data accumulator which is typically a microcontroller is used to connect the sensors to the network. The record of the patient from any remote location is transmitted to health-care centre or the doctor via data transmission components optimal in real-time. The data acquisition platform is designed without any range constraints. The data attained from each sensor can be accessed through the internet which form an internet of things (IoT) based architecture. In addition to providing temporary displaying of the health parameters on the LCD, the records of the patient is permanently stored in the cloud for future diagnosis purpose.

Cloud computing comprises of three main components namely storage, diagnostics, and visualization. Long-term storage of patient's biomedical data is made possible along with facilitating the doctor with diagnostic information. Storage of medical data using cloud-based computing is explained in [1]. Diagnostics deals with sensor data and e-health records which are important for the prognosis of various health conditions and ailments. Visualization is a prime necessity for any such system as it is inappropriate to depend on the physicians for data from the sensors.

VII. ALGORITHM FOR ENTIRE OPERATION

The initialization of the device indicating successful connection to the internet is performed. Thereafter the vital parameters such as temperature, heartbeat and ECG samples is taken for five seconds and sent to a global server which can be accessed from any browser. If the parameters cross the safe threshold value, a message is sent to the prescribed doctor's phone, else stored in the html data base segregated by dates for access to the doctor. The doctor then can prescribe medications to the patients accordingly.

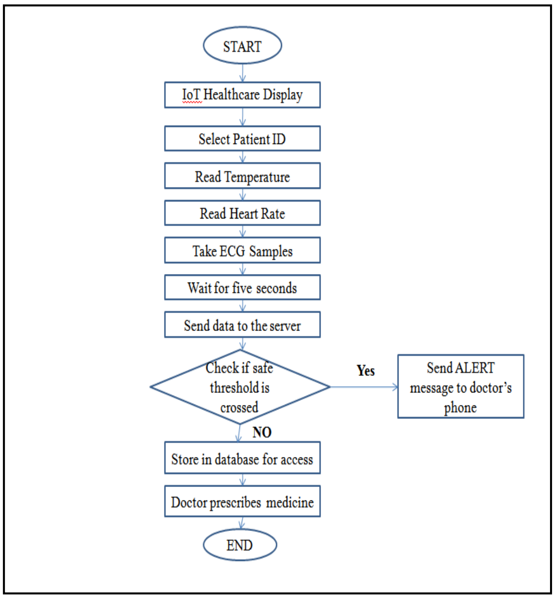

Fig. 6 Flowchart for the entire operation.

VII. RESULT ANALYSIS

The system takes the data from the IoT devices and updates in the database connected to the server. The doctor can view the patients' health condition from the web page by using a unique ID and password. In case of any abnormalities in the parameters the doctor can immediately provide medication by sending a message to the patient's phone. Figure 7 shows the display on the LCD at the patient's side.

Fig. 7 LCD display at patient's end

VIII CONCLUSION

In this paper the current problems in healthcare system has been analyzed and a productive remote patient monitoring system is put forward which communicates through the internet to provide more desirable healthcare facilities. The system is user friendly and in case of an emergency a warning message can be sent to the physician's phone. At the same instant the buzzer turns on to alert the caretaker. The doctors can view the patient's parameters by logging to the web page with a unique ID and password. The page refreshes every fifteen seconds in order to acquire ceaseless data reception. The encryption facility provided for the patient's data will be an added advantage. Thus such a system will indeed be a boon for both doctors as well as patients.

REFERENCES

[1] Moeen Hassanalieragh, Alex Page, Tolga Soyata, Gaurav Sharma, Mehmet Aktas, Gonzalo Mateos, Burak Kantarci, Silvana Andreescu On "Health Monitoring and Management Using Internet-of-Things(IoT) Sensing with Cloud-based Processing: Oppurtunities and Challenges," 2015 IEEE DOI 10.1109/SCC.2015.47.

[2] K.Natarajan, B.Prasath, P.Kokila On "Smart Health Care System Using Internet of Things," Journal of Network Communications and Emerging Technologies (JNCET) Volume 6, Issue 3, March (2016).

[3] Gipsa Alex, Benitta Varghese, Jezna G Jose, AlbyMol Abraham On "A Modern Health Care System Using IoT and Android," International Journal on Computer Science and Engineering (IJCSE) Vol.8 No.4 April 2016.

[4] Aruna Devi.S, Godfrey Winster.S, Sasikumar.S On "Patient health monitoring system (phms) using iot devices"-international journal of com sci & engg tech(IJCSET) Vol.7 No.03Mar2016.