IoT Based Smart Health Monitoring System

[1]Kinnera Supriya, [2] Rohith Kommineni
[1]M.tech student (ES), Department of ECE, VEMU Institute of Technology, P.Kothakota
[2] Assistant Professor, Department of ECE, VEMU Institute of Technology, P.Kothakota

Abstract-

Internet of Things is the new revolution that is going to impact every facet of our lives. Internet of Things (IoT) is the new technology which includes the collection of Sensors, Actuators, processors and other development boards (eg. Raspberry pi, Arduino etc) to collect the data from different sources depending upon domain of application, process the acquired data before sending to distant cloud or mobile application depending upon the requirement[7].The most promising application of IoT is in the field of health care sector.

In some countries, people still do not have access to quality health facilities owing to different barriers. The physical distance between patient and clinic is one of the foremost reasons. This paper studies the application of IoT in health care domain and a system is proposed to monitor the ECG of the patient. In the proposed system the Bio signals are collected from the Body of the patient using ECG sensor and after the required processing using development boards, sent to distant cloud named as Think speak, for further analysis by a physician or other authorized person and also measured temperature ,humidity , oxygen levels. Think Speak cloud uses Think speak (Message Queuing Telemetry Transport) protocol which is used to display ECG, temperature, humidity, oxygen levels values and corresponding graphs displayed.

Index terms -IoT, healthcare, ECG

I. INTRODUCTION

IoT (Internet of Things) is the next paradigm shift where sensors and actuators are connected with each other and exchange the data without human intervention. Nowadays the penetration of internet across each the corner of the globe has really opened the new spectrum of solutions to almost every problem which is being faced by society. Health monitoring of a patient distantly has become an easy and plausible task with the advent of this technology.The cardiovascular abnormality is one of the biggest causes of deaths among people of all races around the globe especially in the case of old age people.

According to one estimation, By 2050, it is expected that the world population of age 65 and older would exceed the population of the world with age of 15 years [3]. By 2030, one in every five US citizens would be 65 or older [3]. By 2060, the European Union population's share with 65 years or more will increase from 17% to 30% [3].Moreover, Economic advantages would come through reduced physician and emergency room visits, reduction in the hospitalization and nursing care at home. So to check the real-time functioning of the heart, distant patient ECG(Electrocardiogram) monitoring systems are designed by different researchers and designers in literature. Indoor ECG monitoring system [3] has been developed by some designers to use this system for nontechnical users but the main drawback of this system was its range of operation which was limited by the Bluetooth technology which has the range of around 10 meters. Furthermore, some systems were proposed by the researchers based on web implementation but the costly
hardware used by them made this system out of reach of those people who are financially not sound [1].Android mobile phone based system is also developed which receives the bio medical sensor data from the dedicated processor and store the data to SD card installed on the mobile phone[4]. But the main problem with this design was its incapability to visualize the data in real time.so the proposed system in this paper addresses all the requirements and provide state of art solution to the challenge of monitoring real time ECG of a distant patient.

This paper is organized in five sections. After this introduction, in Section II, motivation discussed of the paper, Section III about Implementation of the project explained, as well as the novel feature of the proposed method. Finally, Sections IV and V provide the experimental results and the conclusions, respectively.

II. MOTIVATION

The ECG monitoring system has been proposed in this paper to address the challenges associated with health care domain of IoT. With the advancement in the technology especially in the field of information technology and computing power of processors, it has become possible to utilize these advancements in the domain of health care to support senior citizens at homes, athletes, and people from all walks of life.

Furthermore, the real motivation to develop this system is to save the time which people spend in traveling to hospitals and waiting in long queues at hospitals. So with the development of this system the elder patients will have the facility to get them diagnosed from the comfort of their

home without traveling to hospitals. Moreover, any discrepancy in the monitored parameter may prompt the caregiver to take the required action.

III. LITERATURE REVIEW

OnderYakut et al [1] implementedthe wireless ECG monitoring system using e-health sensor platform and Raspberry pi as the development board. Moreover, a connection board developed by cooking hacks[11] was used as an interface between e-health sensor shield[13] and Raspberry pi as the sensor was designed originally for interfacing with Arduino.The information obtained by electrodes was sent to the database by using the software written in C++ language.

Junaid Mohammed et al [4] proposed the Android-based Heath monitoring system using IoT platform. This paper presents the information about required infrastructure viz.

IOIO microcontroller, communication protocols, data base management system and large file compression system.

Hristijan Gjoreski et al[8] implemented a health monitoring system consisting of ECG sensor and Accelerometer. The data supplied by this was analyzed to extract the useful physiological parameters from subject's body. Further, the data was analyzed to detect the abnormalities in patient's behavior and heart-related problems.

Stefano Di Pascoli et al[3] developed low-power ECG monitoring system with a wearable facility. The focus of this development was to design a system with attributes viz. low cost, wear ability, and low energy per bit. In this proposed system the ZigBee protocol was used for data transmission from a sensor. This system used low power ADC developed by Texas instrument (ADS1246).

IV.IMPLEMENTATION OF PROJECT

The complete flow of information in proposed system is explained below. The block diagram of the proposed system is shown in figure 1. Components used in the system can be divided into 2 parts: Hardware components and software component. We will briefly give the information about each component of the system and subsequently the working of all components as a whole system.

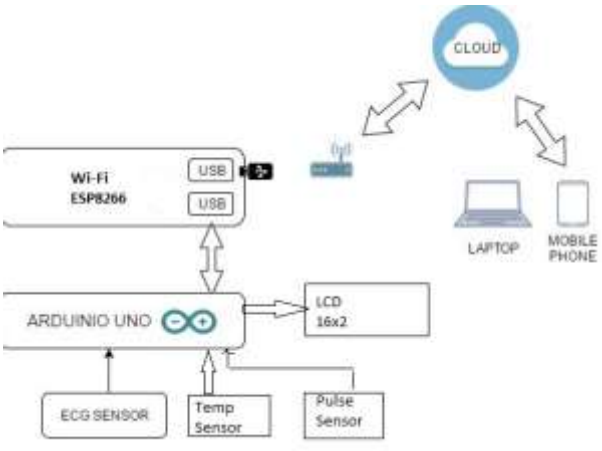

Fig. 1.Architecture of the proposed system

A. Hardware Components

1) Arduino

Arduino is an open-source microcontroller board based on ATmega 328P.It has 16 MHZ clock, 14 pins for an inputoutput purpose, USB connection, reset button and power jack. It contains everything which is required to implement or design the microcontroller based embedded system applications. In order to process the analog data given by analog sensors it also contains 10 bit ADC (Analog to Digital converter). Moreover, Arduino has inbuilt libraries for almost every application.

2) ECG (AD8232) Sensor

Fig 2. ECG Sensor

This sensor is a cost-effective board used to measure the electrical activity of the heart. This electrical activity can be

charted as an ECG or Electrocardiogram and output as an analog reading. ECGs can be extremely noisy, the AD8232 Single Lead Heart Rate Monitor acts as an op amp to help obtain a clear signal from the PR and QT Intervals easily.

The AD8232 is an integrated signal conditioning block for ECG and other biopotential measurement applications. It is designed to extract, amplify, and filter small biopotential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement.

The AD8232 module breaks out nine connections from the IC that you can solder pins, wires, or other connectors to. SDN, LO+, LO-, OUTPUT, 3.3V, GND provide essential pins for operating this monitor with an Arduino or other development board. Also provided on this board are RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins to attach and use your own custom sensors. Additionally, there is an LED indicator light that will pulsate to the rhythm of a heart beat.

3) Temp Sensor & Skin Humidity Sensor

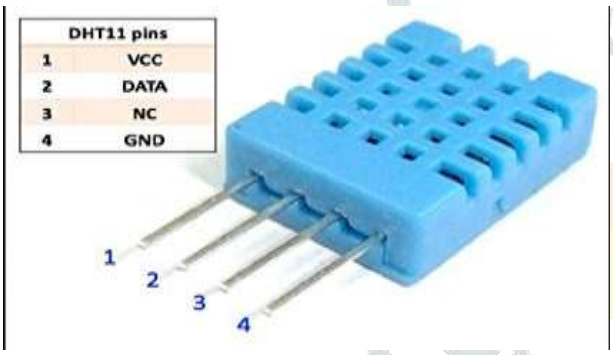

Fig 3. Temp &Skin Humidity Sensor

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

4) Pulse Oximeter and Heart-Rate Sensor

Fig 4. Pulse oximeter

The MAX30100 is an integrated pulse oximetry and heart rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

5) Wi-fi ESP8266

Fig 5. ***Wi-Fi ESP8266***

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

B.SOFTWARE COMPONENTS

Think Speak Cloud

Fig 6. Think speak cloud

According to its developers, "**Thing Speak** is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. Thing Speak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates

IV. EXPERIMENTAL RESULTS

Fig 7.Experimental setup

The figure 7 shows the total setup for the smart health monitoring system. The total setup size was small.

Fig 8. Initializing Wi-Fi

The figure 8 shows the connecting to Wi-Fi when switched on the power supply of setup.

Fig 9.Initializing Sensors

The figure 9 shows the initializing the Sensors when switched on the power supply.

Fig 10. Showing heart beat in bpm & Oxygen content

The figure 10 shows the sending measured ECG, Temperature, humidity, oxygen and Heart beat from the body displayed on the LCD display.

Fig 11. Measured values sending to the IoT

Similarly the figure 11 shows the sending measured ECG, Temperature, humidity, oxygen and Heart beat from the body to IoT through Wi-Fi ESP8266.

Fig. 12Think speak cloud

The figure 12 shows the think speak cloud HTML page which was Smart health monitoring system.

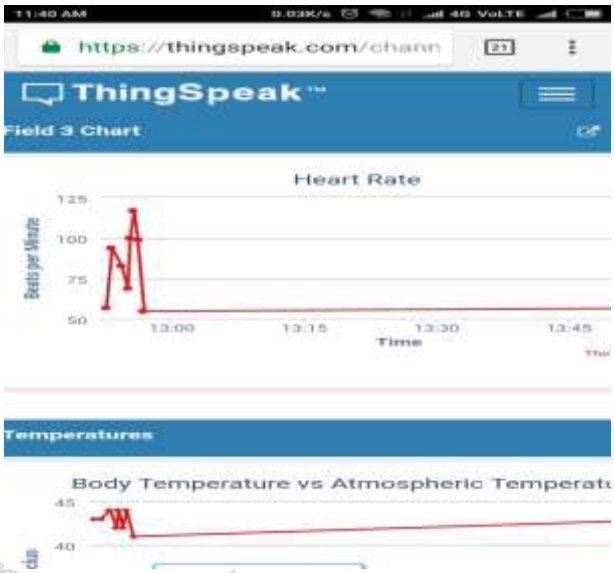

Fig 13. Heart rate and temperature charts displayed in Think speak Cloud

The figure 13 shows the heart rate and body temperature chart in the cloud.

Fig 14. Heart rate measured in bpm & temperature charts displayed in Think speak Cloud

The figure 14 shows the heart rate measured bpm and oxygen contents in blood in the think speak cloud.

V. CONCLUSION

In order to monitor the ECG of the patient, the ECG electrodes were placed at the appropriate place and the Acquired signals were sent to think speak cloud. The real time ECG graphs were plotted on think speak dashboard for the specified time period. The instantaneous value of ECG signal was also shown in the form of Gauge. Here we can

see that the instantaneous value of ECG signal is shown in the form of the graph as well as the value of the signal is also shown in the form of Gauge for better visualization. And also monitoring the Temperature, heartbeat, oxygen and humidity, corresponding sensors at the appropriate place and the Acquired signals were sent to think speak cloud Here the numbers shown are the instantaneous value of the signal in micro volt. The think speak cloud also has provision to store the value on cloud itself for later analysis by the doctor or any authorized person.

. Hence in this paper, a low-cost health monitoring (ECG, Temperature, Humidity, oxygen and
Heart rate) system has been implemented and its cost is compared with other proposed systems in literature to prove its cost efficiency.

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ABOUT AUTHORS

1. Ms Kinnera Supriya received B.Tech degree from ECE in Annamacharya Institute of technology and sciences in 2014, Tirupathi Chittoor District, A.P. Currently she is pursuing M.Tech in ES Specialization in VEMU Institute of Technology P.Kothakota, Chittoor Dist, A.P, India.

Her interested areas are ES, WSN etc.

2. Mr Rohith Kommineni received B.Tech degree from Department of Electronics & Control Engineering from JNTU, Hyderabad in 2006 and M.Tech degree in Embedded Systems from JNTUH, Hyderabad in 2014. He is Currently working as an Assistant professor in Department of ECE in VEMU Institute of Technology, P.Kothakota Chittoor Dist, A.P, India .

He has membership in Institution of Engineers (India) and Indian society of technical Education. His area of research is development of MEMS sensors, intelligent controllers in biological applications.