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REMOTE WEB BASED ECG MONITORING USING MQTT PROTOCOL FOR IOT IN HEALTHCARE

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Abstract - *General public healthcare is very important issue given the exponential rise in growth of population and medical expenses these days. People living far off city and away from good medical help often suffer due to lack of medical resources at their . It is now necessary that an effective health monitoring system, which can detect deterioration of health conditions in time helps in acting quickly by taking necessary steps according to the obtained data. This paper has proposed a new method for ECG monitoring based on light weight MQTT keeping Internet-of-Things (IoT) in mind. ECG data is gathered using a ECG monitoring sensor (AD8232) by Texas Instruments and are transmitted through ADS1115 16-bit ADC interfaced with Raspberry Pi using I2C protocol. The digital ECG sensor data received from ADC is published to a CloudMQTT broker using MQTT mosquitto client using IEEE 802.11 (WLAN) in-buit in Raspberry Pi 3. MQTT subscribe is used to visualize the ECG using a GUI at any remote healthcare center, hospital or treating doctor.*

Keywords- *ECG, IoT, AD8232, MQTT, Raspberry Pi, healthcare, CloudMQTT, mosquitto*

I. INTRODUCTION

IoT or Internet of Things is based on a general concept of being able to control and analyze any non-living object from anywhere. The network devices are used to connect any physical object through sensors and receive data from the real world objects around us, and then use this data with help of the Internet for processing and utilizing it for a better future [1]. The medical industry, which is though now very advanced but still, is not able to provide help to everyone. This is purely down to two reasons, one of which is that not everyone can afford expensive medical treatment. The other reason is such advanced medical aid is not available everywhere.

One such medical problem which is very common and requires regular monitoring is heart rate. Heart rate means the number of heart beats per minute (BPM). A heart rate monitor will measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram [2][3]. Fig.1 shows the proposed system for remote ECG monitoring system using light weight MQTT protocol for sending AD8232 sensor data in real-time.

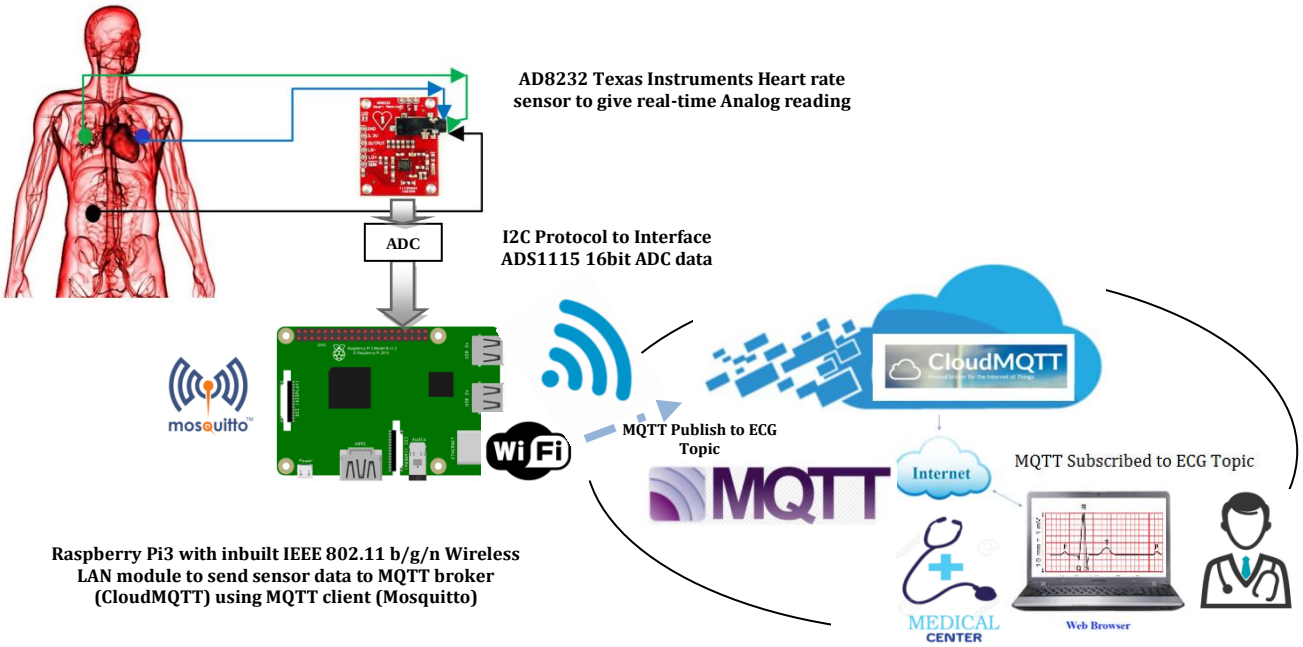

Fig.1: Proposed System for a real-time web based ECG Monitoring using MQTT Protocol

Our proposed system uses ECG sensor that allows detecting the heart rate of a person using heartbeat sensing even if the person is at home. The sensor is then interfaced to Raspberry pi 3 that allows checking heart rate readings and transmitting them over internet.

The remote heart rate monitoring system gives information of heart rate and sends results to the web server. This web server is MQTT Cloud. From this cloud, anyone can monitor the physical status of the patient. Thus in this system the condition of the body can be monitored from remote places. For example a person living in a village miles away from proper medical attention can use this system and data is sent over MQTT cloud, which contains his medical records data from bio-medical sensor. A doctor living somewhere far off in a city can look into the data and then send the necessary feedback required for the patient. In no time a medical diagnosis of a patient living in rural parts would be done and necessary feedback was also provided [4].

II. PROPOSED SYSTEM ARCHITECHTURE

We were handling a system where communication was very important and to generate and receive data we used MQTT protocol. The advantages of such an system are many but the most important being that the data generated can be stored in database and looked into anytime from anywhere. Basic outlay of our proposed system is given in the figure below.

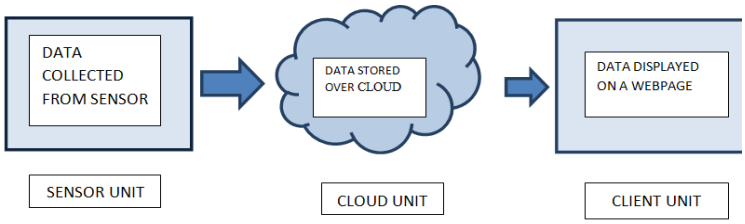

Fig.2: Flow diagram of data transfer using the system

We preferred MQTT protocol over HTTP protocol as it used less payload data ,has a simple publish subscribe architecture and its message size is small thus making it ideal for memory constrained devices . Fig.2 shows the data flow for the proposed system.

2.1. AD8232 Sensor interfacing with ADS115 and Raspberry Pi

The communication starts at the sensor which is AD8232 which collects the data from the patient and pass it on to analog to digital convertor ADS1115. It converts the analog data received by sensor AD8232 and passes it to Raspberry Pi3 because Raspberry Pi3 only processes digital data.

Raspberry Pi was loaded with the Raspbian software. This was used because it is a also a part of Linux software which helped in implementing the MQTT protocol onto the system easier as open source versions were easily available. Mosquito software was thus installed in raspberry pi so as to implement MQTT protocol. First raspberry pi is connected to an OS and is configured and using software like WinSCP and Putty we managed to go inside raspberry pi and then downloaded NOOBS software which was written onto SD card and was later mounted and installed on raspberry pi. Then MQTT was installed on Raspberry pi using python commands. Then a profile was created on MQTT cloud along with the topic /*hearbeat_monitor* and then we were able to access it using raspberry pi. As soon as the topic was created one could communicate by publishing and subscribing to the same topic using python commands [5]. Fig.3 shows the schematic diagram form all the connection done for prototyping of the proposed system.

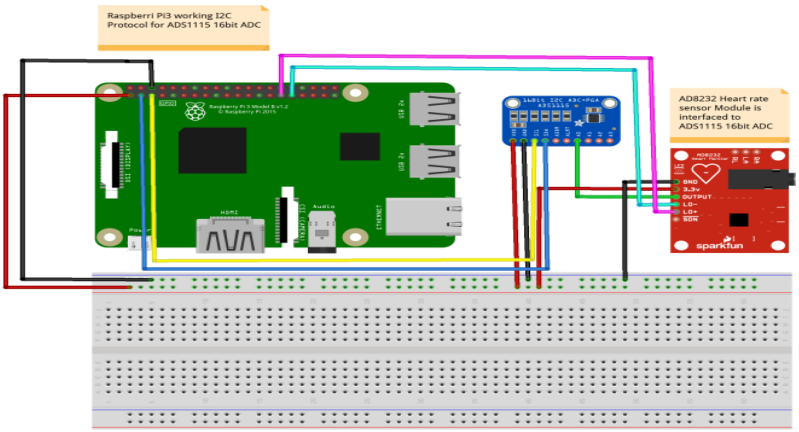

Fig.3: Prototype connection diagram using Fritzing

Table.1: Interfacing pin connection for proto-typing

Sno	RaspberryPi3	Sensor(AD8232)	ADC(ADS1115)
1	Pin31 GPIO6	LO-	-
2	Pin29 GPIO5	LO+	-
3	-	OUTPUT	A0
4	17(3.3V)	3.3V	-
5	25(GND)	GND	-
6	09(GND)	-	GND
7	01(3.3V)	-	VDD
8	03(SDA)	-	SDA
9	05(SCL)	-	SCL

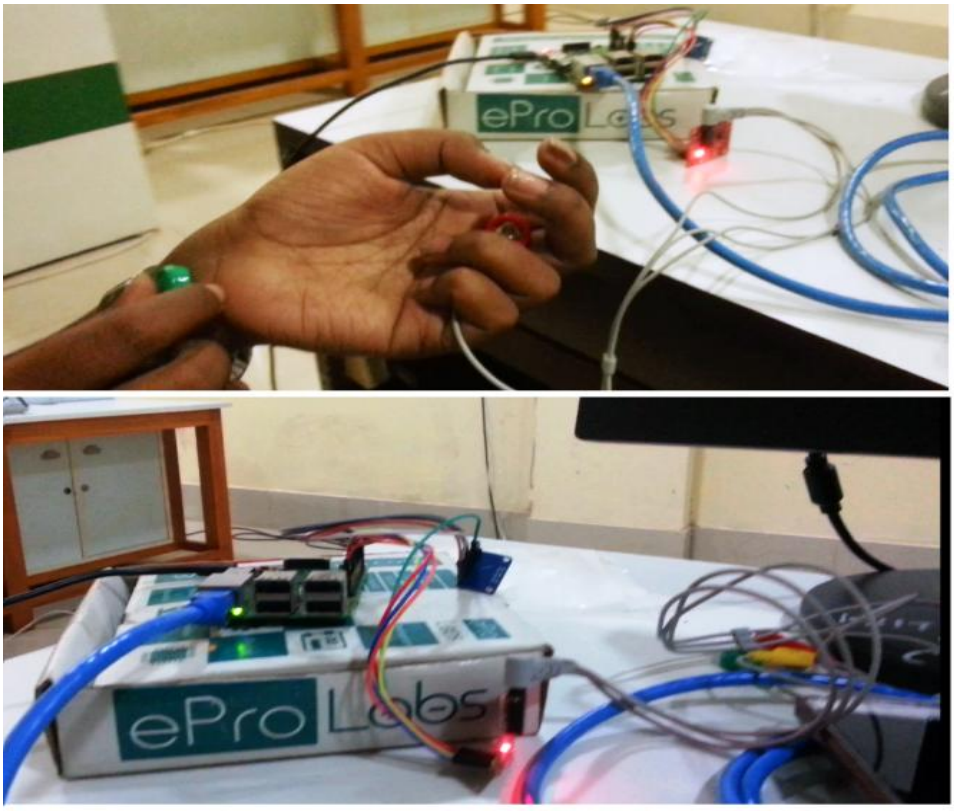

Fig.4: Implemented prototype of remote ECG monitoring

The sensor (AD8232) was connected to A to D converter (ADS115) which was connected to the raspberry pi. We used an A to D converter because raspberry pi is capable of accepting analog input only. Fig. 4 shows the prototype in working as per the proposed system architecture. The Table.1 shows the pin level interfacing for development of prototype.

2.2. Sending data to Cloud using MQTT Protocol

The second stage of communication starts as Raspberry Pi3 processes the data from the sensor using a python code and sends it to the cloud account which was created on an open source platform as Raspberry Pi3 has built in Wi-Fi module[6][7].

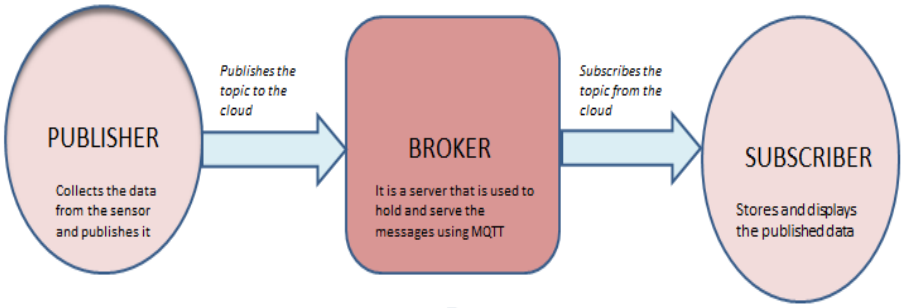

Fig.5: MQTT subscribe and publish flow diagram

Fig.5 shows the MQTT publish and subscribe methodology for getting data remotely. The third stage of communication starts and now the doctors receives the data from the cloud and diagnose the data details and thus provides the necessary feedback back to patient required for its well-being.

2.3 MQTT PUBLISH and SUBSCRIBE using CloudMQTT broker

After communication over MQTT cloud was done, the task of publishing data on the topic and receiving it using other device by subscribing to it was targeted. For that sensor AD8232 along with three electrical patches and AD1115 had been connected to Raspberry pi and the data was published on the topic */heartbeat_monitor* using python command. The program name was sent as the payload. The python program calculates the data received from the sensor and converts it into numerical values [8].

Publish command
mosquitto_pub -d -h m11.cloudmqtt.com -p 14710 -u iezbkepe -P I60oummAghys -q 1 –t heartbeat_monitor

Subscribe command
mosquitto_sub -d -h m11.cloudmqtt.com -p 14710 -u iezbkepe -P I60oummAghys -q 1 –t heartbeat_monitor

The data was sent to the cloud server using the subscriber command which was included in the python code [9][10].

III. RESULTS

The sensor was connected on the body and the data was published to the cloudMQTT server/ broker. Fig.6 shows the python script publishing data to CloudMQTT broker through the above mentioned mosquitoo MQTT script for publish.

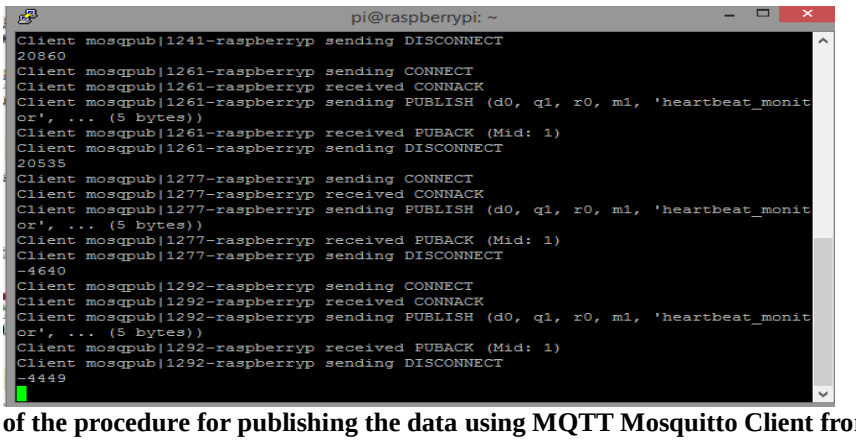

Fig.6: Screenshot of the procedure for publishing the data using MQTT Mosquitto Client from Raspberry Pi

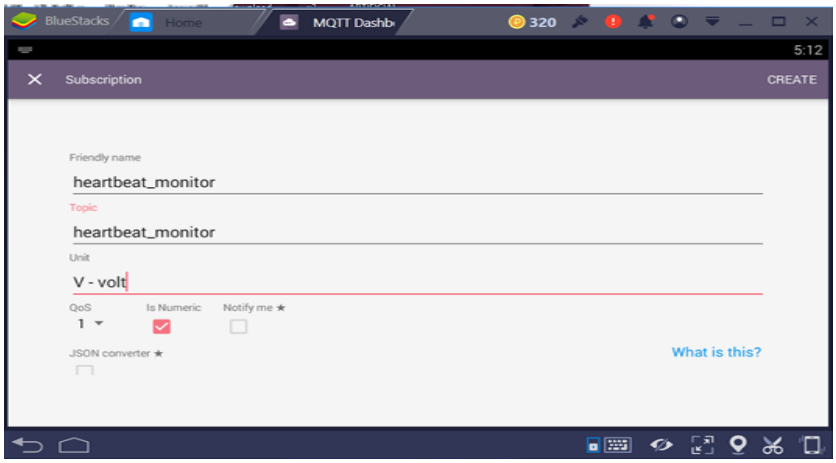

Fig.7: Screenshot of the MQTT dashboard page for subscribing the data

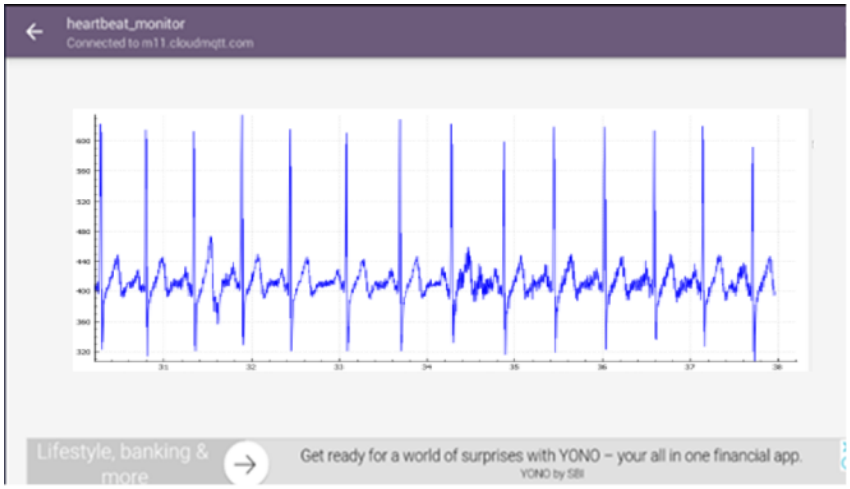

Fig.8: ECG using MQTT Subscribe to heartbeat_monitor topic of CloudMQTT

Fig.7 shows the subscribe screenshot for the topic /*heartbeat_monitor* for getting the data remotely .Fig.8 shows that the system is able to get data from the sensor by subscribing to the topic. We then went on to use this data and display it in a graphical form much like an ECG. For that we used an android app MQTT Dashboard which is easily available on Google Play. We installed the app on smart phones; we also installed it on laptops using blue stacks emulator, which helps run android apps on winds. Necessary information like topic name, username, password, port number, client id, etc. was provided and the data published was then displayed in a graphical manner as soon as it was subscribed from the app [11].

IV. CONCLUSION

This paper has proposed a MQTT based remote ECG monitoring system. The deployment of the proposed system is done using a prototype developed using Raspberry Pi. The mosquitto MQTT client program is used to capture the heart-rate sensor data from AD8232 module through 16-bits ADC ADS1115 and publish the data to the CloudMQTT broker and the results & outputs are shown and discussed in the results section of this paper. The End-user in this case a doctor or any medical technician can visualize the data from any internet enabled device using MQTT subscribe to the same MQTT topic to which the raspberry pi equipped with AD8232 to publishing data.

V. FUTURE WORK

This work can be extended by developing software modules to detect any ECG pattern and in case of any heath condition should be able to send E-mail or SMS notification or any web based notification to the doctor to make the system automated and for time critical early detection of critical patents.

VI. ACKNOWLEDGEMENT

The prototypes were developed in the Wireless Communication and Networking Lab at KIIT Deemed University. The schematic diagram of the whole circuit using raspberry pi, AD8232 and ADS115 was designed using Fritzing software.

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