IOT BASED ECG MONITORING SYSTEM (Iot Health)

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Abstract— *Smart and cost effective healthcare has been in increasing demand to meet the needs of growing human population and medical expenses. ECG monitoring is a widely studied and applied approach to diagnose heart diseases. However, existing portable wireless ECG monitoring systems cannot work without a mobile application, which is responsible for data collection and passing on the messages to doctors. In this project, we propose a new method for ECG monitoring based on Cypress Wireless Internet Connectivity for Embedded Devices (WICED) Internet of Things (IoT) platform*

Keywords— Electro Cardio Gram (ECG); Internet of Things(IOT); Electro Encephalo Gram (EMG); WIFI; Bluetooth; Zigbee Communication

1. INTRODUCTION

The Internet of things (stylized Internet of Things or IoT) is the internetworking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data.

In 2013 the Global Standards Initiative on Internet of Things (IoT- GSI) defined the IoT as "the infrastructure of the information society. The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.

Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine (M2M) communications and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices (including smart objects), is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid and expanding to the areas such as smart cities.

"Things," in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring or field operation devices that assist firefighters in search and rescue operations. Legal scholars suggest to look at "Things" as an "inextricable mixture of hardware, software, data and service". These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. Current market examples include home automation (also known as smart home devices) such as the control and automation of lighting, heating (like smart thermostat), ventilation, air conditioning (HVAC) systems, and appliances such as washer/dryers, robotic vacuums, air purifiers, ovens or refrigerators/freezers that use Wi-Fi for remote monitoring.

As well as the expansion of Internet-connected automation into a plethora of new application areas, IoT is also expected to generate large amounts of data from diverse locations, with the consequent necessity for quick aggregation of the data, and an increase in the need to index, store, and process such data more effectively. IoT is one of the platforms of today's Smart City, and Smart Energy Management Systems.

The concept of the Internet of Things was invented by and term coined by Peter T. Lewis in September 1985 in a speech he delivered at a U.S. Federal Communications Commission (FCC) supported session at the Congressional Black Caucus 15th Legislative Weekend Conference.

2. RELATED WORKS AND EXISTING SCHEMES

A novel signal quality aware IOT enabled ECG telemetry system for continuous cardiac health monitoring applications. The proposed quality-aware ECG monitoring system consists of three modules: ECG signal sensing module; automated signal quality assessment module; and signal-quality aware ECG analysis and transmission module.

The main objectives of this paper are: design and development of a light-weight ECG signal quality assessment method for automatically classifying the acquired ECG signal into acceptable or unacceptable class and real-time implementation of proposed IoT-enabled ECG monitoring framework using ECG sensors, Arduino, Android phone, Bluetooth and cloud server. The proposed framework is tested and validated using the ECG signals taken from the MIT-BIH arrhythmia and Physio net

Challenge databases and the real-time recorded ECG signals under different physical activities. Experimental results show that the proposed SQA method achieves promising results in identifying the unacceptable quality of ECG signals and outperforms existing methods based on the morphological and RR interval features and machine learning approaches.

This study further shows that the transmission of acceptable quality of ECG signals can significantly improve the battery lifetime of IoT-enabled devices. The proposed quality-aware IoT paradigm has great potential for assessing clinical acceptability of ECG signals in improvement of accuracy and reliability of unsupervised diagnosis system.

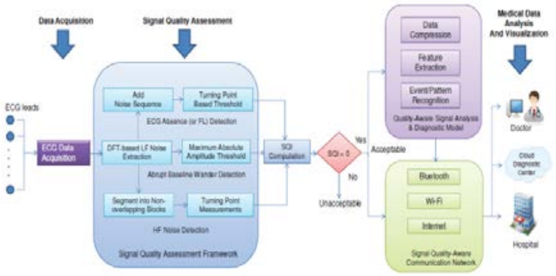

Fig 1 The main modules of our signal quality-aware (SQA)-IOT framework are illustrated

It consists of three modules: (i) ECG signal sensing module, (ii) automated signal quality assessment module, and (iii) signal-quality aware ECG analysis and transmission module. In this paper, we mainly focus on design and real-time implementation of automated ECG signal quality assessment method and validation of the effectiveness of the proposed SQA-IoT framework under resting, ambulatory and physical activity conditions.

The proposed automated ECG signal quality assessment (ECG-SQA) method consists of three steps such as flat-line (or ECG signal absence) detection, abrupt baseline wander extraction, and high-frequency noise detection and extraction to compute the signal quality index (SQI) for assessing the clinical acceptability of ECG signals. In this work, the ECGSQA is implemented based on the discrete Fourier transform (DFT)-based filtering, turning points and decision rules.

X[k] denotes the kth DFT coefficient. The baseline component is extracted from the DFT coefficients having the frequency values below 1 Hz.

The DFT coefficient index k for the component of F Hz is computed as

$$k = bFN/Fs\ c.$$

The baseline wander signal is obtained as

$$b[n] = x[n] - \tilde{x}[n]$$

From the results, it can be noted that the baseline wander exhibits high amplitude variation for short duration. Thus, the extracted signal is further processed to discriminate the abrupt baseline drift from slowly varying baseline wanders.

ECG Signal Absence Detection.

Due to the disconnection of electrodes with skin and the electronic component saturation, sensing device exhibits the absence of ECG signal information in the acquired signal. In practice, we observe that the recording shows the presence of zero amplitude flat line (ZFL), only baseline wander (OBW), and the long pause with physiological and external noises. Existing approaches were developed for detection of ZFL event. In this work, we present a novel approach for detecting aforementioned noise events. Our approach is based on turning points (TP) which can be computed as mentioned in Algorithm.

Step 1: For turning point calculation, we first compute both positive and negative slopes which can be computed as,

$$SL = \begin{cases} 1: & \text{if } (x(n) - x(n-1) > 0) \\ 0: & \text{if } (x(n) - x(n-1) = 0) \\ -1: & \text{if } (x(n) - x(n-1) < 0) \end{cases}$$

Step 2: Then, for computing the local maxima and minima count all the positive and negative slopes respectively. That is,

```
N_SL = 0; I = [ ];
for(i = 1 : length(SL))
  if((SL(i) − SL(i − 1) < 0)||(SL(i) − SL(i − 1) > 0))
    N_SL = N_SL + 1; I = [I, i]
  end
end
```

Here, N_{SL} is total number of turning points and I contains indices of turning points.

Step 3: Now, compute the turning points (which are greater than γ_H) and their locations as,

```
z = []; z[1] = 0;
for(j = 2 : length(I))
z[j] = x(I(j)) − x(I(j − 1));
end
tp = 0; tp_loc = [ ]; //tp → turning points; tp_loc = location of turning points
for(i = 1 : length(I) − 1)
  if(|z(i)| > |Thr|)
    tp_loc = [tp_loc, I(i)];
    tp = tp + 1;
  end
end
```

Fig 2 Turning point computation algorithm

The turning point with zero threshold can provide estimates of local maximum and local minimum points in the ECG signal. The acquired signal may be considered as random if number of turning points exceeds the (2=3)th of length of a signal. This is the basis for ECG signal absence detection (or flat line detection). To compute the turning points, the value of H is set to zero. In absence of ECG signal, the recorded segment is classified as an “unacceptable”. The flat line detection (or ECG signal absence detection) algorithm is as follows:

- Add uniformly distributed random noise of very small amplitude into the ~x[n], i.e., s[n] = ~x[n] + aw[n]. The random noise is added into the signal to increase a number of turning points The amplitude scaling a is set to 0:01 mV. In the absence of ECG signal, the noisy signal s(n) results in a large number of turning points.
- Compute the number of turning points (tp) for the noisy signal s(n) with a threshold.
- Apply decision rule for detecting the absence of ECG signal (or flat line segment),

$$\mathrm{SQI_{FL}} = \begin{cases} 1 & t_p > 0.65M \\ 0 & \text{otherwise} \end{cases}$$

If SQIFL = 1 then the segment is classified as a flat line or ECG signal absence segment. Otherwise the segment is further processed for detecting the presence of high frequency noises. In practice, a presence of sudden long pause event may be seen in the real-time ECG recordings due to the abnormal health condition of subjects. Therefore, the signal quality index information is stored/transmitted to the diagnostic server for each processed ECG segment. Furthermore, subject is immediately altered when an absence of ECG signal is detected, like in the conventional ECG monitoring systems.

3. PROPOSED SYSTEM

In this system, some vital parameters like temperature and heart rate is measured. Sensors are attached in this system thus it helps to take reading and display on your mobile or system. The Internet of things is increasingly allowing to integrate devices capable of connecting to the Internet and provide information on the state of health of patients and provide information in real time to doctors who assists it.

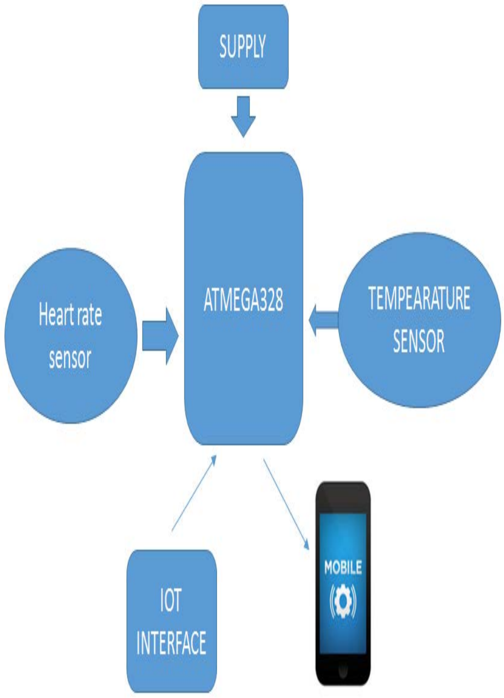

Fig 3 Proposed Block

i. ARDUINO

Arduino is an open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control objects in the physical world.

The project is based on microcontroller board designs, manufactured by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on the Processing project, which includes support for the C and C++ programming languages.

The first Arduino was introduced in 2005, aiming to provide an inexpensive and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Arduino boards are available commercially in preassembled form, or as do-it-yourself kits. The hardware design specifications are openly available, allowing the Arduino boards to be manufactured by anyone. Adafruit Industries estimated in mid-2011 that over 300,000 official Arduinos had been commercially produced, and in 2013 that 700,000 official boards were in users' hands.

*ii. Temperature Sensor **(LM35)***

LM35 is a precision IC **temperature sensor** with its output proportional to the temperature (in ^{o}C). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With **LM35**, temperature can be measured more accurately than with a thermistor. It also possess low self-heating and does not cause more than 0.1 ^{o}C temperature rise in still air.

The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every ^{o}C rise/fall in ambient temperature, *i.e.*, its scale factor is 0.01V/ ^{o}C.

iii. Heartbeat / Heartrate sensor

A person’s heartbeat is the sound of the valves in his/her’s heart contracting or expanding as they force blood from one region to another. The number of times the heart beats per minute (BPM), is the heart beat rate and the beat of the heart that can be felt in any artery that lies close to the skin is the pulse.

1) Two Ways to Measure a Heartbeat

A. Manual Way:

Heart beat can be checked manually by checking one’s pulses at two locations- wrist (the **radial pulse**) and the neck (**carotid pulse**). The procedure is to place the two fingers (index and middle finger) on the wrist (or neck below the windpipe) and count the number of pulses for 30 seconds and then multiplying that number by 2 to get the heart beat rate. However pressure should be applied minimum and also fingers should be moved up and down till the pulse is felt.

B. Using a sensor:

Heart Beat can be measured based on optical power variation as light is scattered or absorbed during its path through the blood as the heart beat changes.

iv. Principle of Heartbeat Sensor

Intensity through that organ (a vascular region). In case of applications where heart pulse rate is to be monitored, the timing of the pulses is more important. The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses.

4. SIMULATION DESIGN AND RESULTS

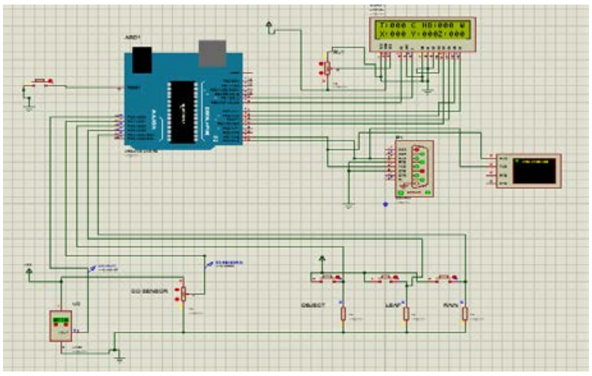
Fig 4 Proteus Design

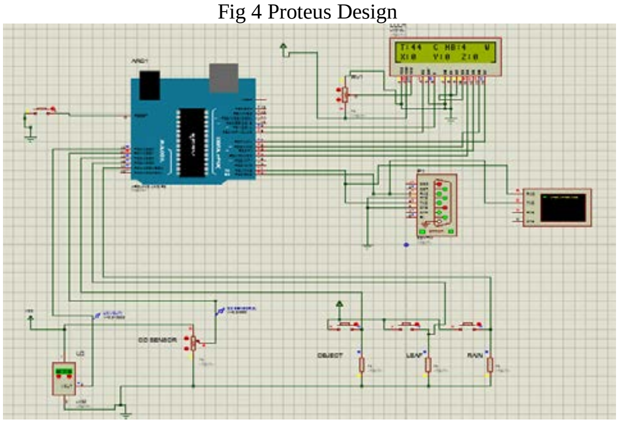
Fig 5 Monitoring System.

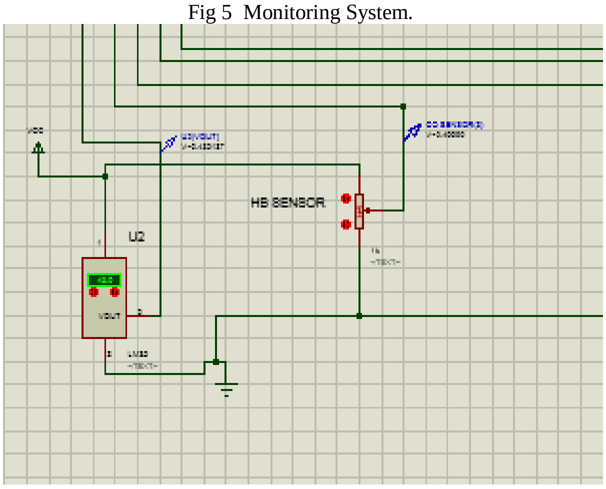

Fig 6 Sensor Unit.

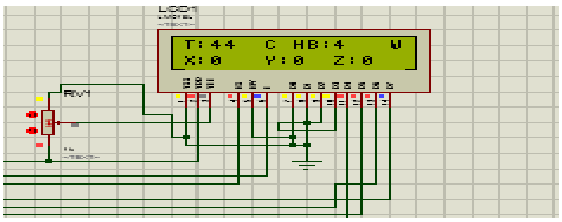

Fig 7 Display Unit.

5. CONCLUSION

As per this project, health monitoring system design is based on researcher idea that meets to the patients need. As per consideration of conventional system, this system still in use from their manufacturing but it is very bulky to handle individually and size and cost are also more compared to the advance system and also it take more than 1minute for getting the exact result. As per consideration of advance system, each system has its own advantage. Each health monitoring system has different specification as per patient's requirement. This system provides more medical instrument facility on single system on-chip compare to conventional system. This system takes less than 1 minute to calculate result related to health condition. Size also reduces compared to the conventional system because of integration of number of medical instrument on single chip. So, size, cost and complexity also reduce.

Researchers designed health monitoring system as per patient's requirement. Because of wireless data transmission over internet (i.e) IOT, health related data will be send to doctor's personal computer or on his mobile. So, that the patient can get an immediate remedy related to their health condition.

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