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Application of IOT using fuzzy logic controller-Pacemaker

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Abstract: All over the world, people severing from heart diseases are increasing dayafter day, now it's more important tofocus on this destructive problem and provide a good health care and remote patient monitoring.An effective monitoring system has been discovered to monitor patients by implanting an IOT based pacemaker which monitors and gives complete diagnosis of the patient.
In this we will develop a method of ECG monitoring for patients that can provide a detailed information, it senses the magnetic field variation due to current pulses. The device will start collecting ECG information and send it directly via Wi-Fi to the IOT cloud. Reviewing ECG data through the cloud has led to the alleviation of the problem of the inability of the doctor to monitor the patient from the home, the device also helps to discover the magnetic field that confuses the pacemaker by giving the patient a warning.

Keywords: Pacemaker, IoT, Cloud, Sensor, Thinkspeak, Fuzzy controller

I. INTRODUCTION

Internet of Thing (IOT) is the most trending in all the sector these days. IoT helps the devices to monitor the safety and health of the patients. These also helps the health professional to give the superlative care providing the way to increase patient engagement, satisfaction and also provides more interaction with doctors. By this the outcome of the treatment is improving and also it reduces the healthcare costs.

1.1 Pacemaker:

Among the applications that Internet of Things (IoT) facilitated to the world, Healthcare applications are most important. One such IOT device is Cardiac Pacemaker or also called as artificial pacemaker. It is a device which maintains an adequate heartbeat by sending electric pulses to the heart. They are indicated when the natural pulses are absent or too slow. Most recent ones are controlled externally, and some include an inbuilt defibrillator. Some pacemakers are used during emergency lifesaving procedures, such as the external defibrillator.

Figure 1: Pacemaker

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Pacemakers work by sensing the best of the heart and stimulating the atrial/ventricular chambers when a beat is sensed as missed. Fitting a pacemaker is a simple 1-2 hour operation carried out under general or local anaesthetic under antibiotic cover.

1.2 IOT:

A formal definition of the IoT is the following: “The Internet of Things is an integrated part of the Future Internet and could be defined as a dynamic global network infrastructure with self- configuring capabilities based on standard and interoperable communication protocols where physical and virtual things have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network.”

Figure 2: IOT in Healthcare

For the communication domain for Pacemaker using IOT, two requirements are needed. The first one is how to make possible the communication of the equipment in hospital using Wi-Fi. The second one is to connect the Pacemaker to the internet world. Internet of Things refers to medical devices using network, where all things are uniquely and universally addressable, identified and managed by
Computers. It is a collection of technologies that makes it possible to connect things like sensors and actuators to the Internet.

1.3 Pacemaker using IOT:

Even while using a Pacemaker a patient needs to be monitored periodically by the doctor after implanting the device So when the doctor is in another place or cannot reach the patient for some reason or the high cost of hospital for the patient to stay. This device can make a solution. Based on this wireless IOT connected device, a surveillance system is designed that enables the patient to wear and transfer information directly to IOT using Wi-Fi, compared to other ways such as Bluetooth, Zigbee, wi-fi can send more data and can be connected to cloud and can be moved anywhere in the world.

II. METHODOLOGY:

Portable monitoring system of Pacemaker using IOT:

The system is that is responsible for collecting data from human body through various sensors and the data is stored in the cloud through Wi-Fi and the data has to be visualized and further analysis can be done easily. It can record the data for hours that may reach the day. This data is processed through several stages of amplification and filtering, as well as using a specific wireless protocol that consumed a medium energy. The components used in this monitoring system is ECG, HR controller.

Figure 3: Smart monitoring system.

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2.1. ECG Sensor:

The wireless ECG sensor based on the differential lead and which has optical heart rate monitoring inside them.An ECG sensors records the tiny electrical signals that are generated by the beating of your heart under your skin, which it presents as a trace. This then allows trained professionals, machines or wearables to understand more about how your heart is functioning – and determine if there are any abnormalities.

2.2. HR Controller:

This HR controller is considered for designing the cardiac pacemaker.This controller is designed using two controllers, PID and fuzzy controller.
We have used fuzzy logic to analyze the data collected from the sensors. We have also generated the graphs based on the inferences made using fuzzy logic. The advantage of using fuzzy logic is that we do not require many data sets to analyze the newly data collected. Another advantage of Fuzzy logic is its power of interpretability and simplicity Here we have used the most commonly used Fuzzy methodology called the Mamdani Inference Method. Mamdani method is the simplest method because of its structure using min-max operations. We have also chosen the Mamdani fuzzy inference method because of its wide spread acceptance and it is well suited for human inputs. The output from the Mamdani method can also be efficiently transferred to a linguistic form.

The fuzzy logic-based controller (FLC) system can be used. This FLC controller does both manipulation of data and storing the data in the cloud. We can program this with help of MATLAB software.

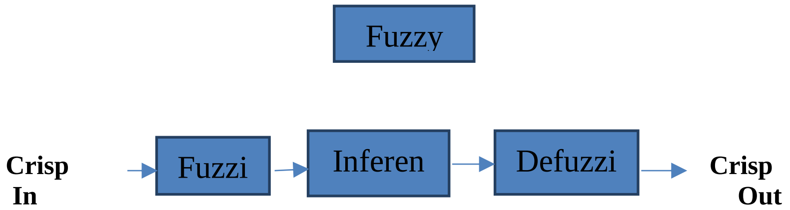

Figure 4: Block diagram of Fizzy Controller.

The block diagram of a FLC shown in Figure 2 is consisting of the following main units:
a) Fuzzifier: The observed data is in crisp form so fuzzifier at input stage is required to convert the data in fuzzy form for manipulation of data using fuzzy theory.
b) Fuzzy inference engine: Fuzzy inference engine employs the fuzzy decision-making based on knowledge base to simulate control actions
c) Knowledge base: The knowledge base of the FLC consists of database and rule base. The rule base provides the required information for proper fuzzification and defuzzification
d) Defuzzifier: Finally, the defuzzification is used to convert the output of FLC into the crisp data for real world applications.

2.3. Data saving to the cloud:

The IOT provides access to embedded systems and also to the web services.The heartbeats are sensed and read as data signals. The read data are processed by the microcontroller and transmitted to the WiFi module for uploading to the internet server platform (www.thingspeak.com) for further analytics and visualization. The data are processed and stored in real-time with the date and time stamp when the data was captured.

III. PROCESS OF DATA SAVING IN CLOUD

3.1: WIFI

Wi-Fi is a wireless networking technology that allows computers and other devices tocommunicate over a wireless signal. Wi-Fi is the standard way computers connect to wireless networks. Nearly all modern computers have built-in Wi-Fi chips that allow users to find and connect to wireless routers. When a device establishes a Wi-Fi connection with a router, it can communicate with the router and other devices on the network. However, the router must beconnected to the

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Internet (via a DSL or cable modem) in order to provide Internet access to connected devices. Therefore, it is possible to have a Wi-Fi connection, but no Internet access.

3.2: Thingspeak:

One of the application platform of IOT Thingspeak is utilized for data communication. Thingspeak is open source platform used to store and retrieve the data from the cloud which supports MATLAB where we can analyze and visualize the data.Data can be sent from Arduino, Raspberry Pi. Thinkspeak used as a data collector which is used as a bridge between sensors and software. ThingSpeak will contain a Channel which is a primary element which contains location field, data field, and also status field. Channels are used to write the data, process and view with the help of MATLAB, and also respond to data by alerts.

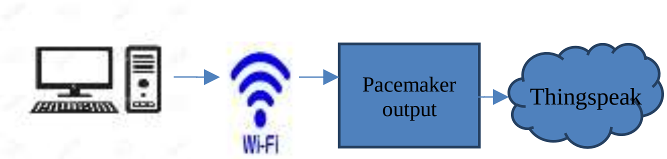

Figure 5: Saving the processed data to the cloud

IV. RESULT AND ANALYSIS

4.1. Receiving the signal:

The appearance of the ECG in a paced patient is dependent on the pacing mode used, placement of pacing leads, device pacing thresholds, and the presence of native electrical activity. The electrodes placed on the surface of body of patient to capture the signal of ECG. The electrodes deliver the electrical impulses(electron flow) by contracting the heart muscles, to regulate the beating of the heart. For the best ECG detection place the electrode 3-5 inches away from the pace generated area to avoid electrical interference.

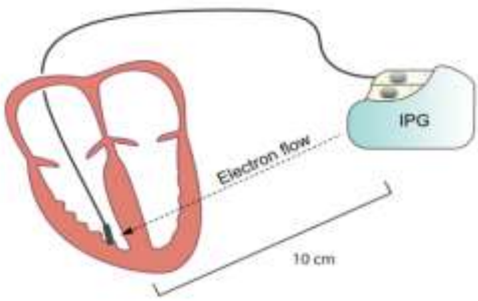

Figure 6: Electrons travel from anode to the tip of electrode(cathode).

4.2. Analysis:

Usually the heart rate depends on the intervals of these waves. This Cardiac Pacemaker can record intrinsic cardiac activity and responds appropriately.The device delivers an electrical impulse of sufficient strength to result in depolarization and the waveform immediately follows the pacing spike and that data is stored in the cloud.
The data collected from the regular volunteer to take the heart rate where the patient in place 1and the doctor in place 2, the doctor must know if the rhythms is regular or irregular.

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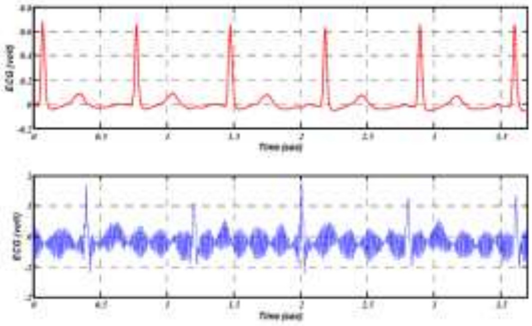

Figure 7: ECG signal of a normal person(above); ECG signal of patient who has pacemaker(below)

V. ADVANTAGES OF PACEMAKERS USING IOT:

The IOT monitoring of the patient's with pacemaker can be monitored and recorded and can keep the track of the changes in the ECG signals over the period of time. Doctor can refer the data and suggest the treatment or medicines to the patient. Normal routine and hospital stays can be reduced by this procedure where the data is stored over the cloud and the records can be maintained in the proper way which minimizes the corruption of data while using Pen drives or PCs.

VI. CONCLUSION:

There are many emerging technologies to realize the usage of IOT. This is an alternative that can help patients with chronic disease and with this set of solutions the main aim is to improve the quality of life of the patients by easy data analysis using cloud technology. The collected ECG signal was sent to the Internet of things by Wi-Fi, which uploading data for the wanted coverage areas. The implementation of this IOT based ECG monitoring system reduces the time to receive treatment, if the physician detects a problem with the pacemaker based on the transmitted data, less time spent at a doctor's office or clinic for regular checks of the pacemaker and, ideally, increased survival rates and decreased lengths of stay if a physician is able to more quickly treat a medical problem.

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