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IoT-ASSISTED WIRELESS PATIENT HEALTH MONITORING SYSTEM SECURE DATA TRANSMISSION

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Abstract:

The Embedded technology has entered almost in all aspects of day-to-day life, and the healthcare field is no exception for that the requirement for fully-equipped hospitals and diagnostic centers growing day by day as people are becoming more unaware of their health problems. An ECG signal can trace various physiological and abnormal conditions of the heart. This heart monitoring system also helps to inform the person whether he/she has any heart diseases or not. This is done by checking the heart beat level. In this system ATmega controller is used to scan ECG signal and search for pattern in common range, if the pattern will be in common range then it gives the report of being normal if it is found that the is not in common range then the person is suffering from some kind of heart disease. The following result is sent as message on IOT.

Abstract: ***ECG, IoT, Embedded technology***

1. INTRODUCTION

Medical expert systems are increasing day by day where one part is transferrable and smart healthcare nursing devices which can be used in everyday life. Medical applications have greater importance in this fast moving and competitive world. Any change in heart rate or rhythm, or variation in the morphological ECG signal pattern, is a symptom of an arrhythmia, which could be identified by the analysis of stored data of ECG [1]. ECG monitoring system plays an important role in determining cardiac diseases. There are number researchers working on to archive long term ECG monitoring system. Various types of ECG measuring systems have been introduced. The ECG monitoring system that are used currently in hospitals are big and heavy so it is less portable and also the measuring system have 12 electrodes where 2 on anklet 2 on wrist and other electrodes upon chest of the body.

These electrodes are gel electrodes which causes allergy and infection in case of regular use so it is difficult to do long term measurement. These devices are very expensive and home monitoring is not possible so the aged people who need to be tested their heart rate frequently is very difficult in this high population, and it is a main problem in hospitals to check the ECG of all the patients. To provide home monitoring system smart technology place an important role where the result of ECG data collected is analyzed and shared with doctor and the family members. There are various applications which provide multiple health related data such as ECG, finger photoplethysmography, and blood pressure plethysmography [2].

There are several signal amplification filter methods used in order to get the proper waveform. The delayed signal error is normalized using LMS in order to achieve high speed and low latency and SVM classifier method is used to remove noise [3]. The analysis of signal depends on the P, Q, R and S point in the ECG signal waveform the detection of this point has various algorithm and these points are implemented on IOS based smart phone to serve for remote area people [4]. The doctors are able to axis the data from the cloud and provide the detail analysis of various data collected [5]. The removing of noise is so performed by using FIR and FFT filters [6]. The ECG monitoring system can also be designed as the remoteness as a part of their private home network moderately than being more dependable home control system [7].

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There are so many devices which detect the ECG signal and these electrodes are used in textiles, seat belts, wrist watch and mobile case [8]. The signal is controlled by controller and sent to the cloud in this survey they have used MSP430 single chip to control the signal [9]. The original ECG signal is compared with the various filter output and also, they have calculated the power spectral density and signal to noise ratio before and after filtering [10]. There are many sensors available in the market to detect the ECG signal like wireless sensors, MEMS and Nano technology is developing different type of portable wireless sensors for the better life [11]. The command used helps in sending and receiving the data from cloud this process is obtained by HTTP and MQTT protocols [12]. Since the smart phone are limited in power consumption and are very easily portable the heart beat data is transmitted to the smart phone, but it requires great.

1.1 Architecture of IoT-Based ECG Monitoring System

The ECG detecting network is the establishment of the whole framework, which is liable for gathering physiological information from the body surface and communicating these information to the IoT cloud through a remote channel. Wearable ECG sensors are generally embraced in this framework, which littly affect the client's everyday life. Through this implies, ECG information can be recorded over extended periods or even days. Then, at that point, the ECG signals are handled through a progression of methodology, like intensification, sifting, and so on, to work on the sign quality and to meet the prerequisites of remote transmission. The ECG information accumulated from sensors are communicated to the IoT cloud through a particular remote convention, e.g., Wi-Fi, Bluetooth, Zigbee, and so on [23].

Every one of the three conventions can give sufficient information rates to communicating ECG signals with fulfilling energy utilization. Notwithstanding, because of the restricted interchanges scopes of Bluetooth and Zigbee, a keen terminal (like a cell phone) is normally expected to get the ECG information and afterward send the information to the IoT cloud through the remote conventions of the General Packet Radio Service (GPRS) or Long Term Evolution (LTE). Correlations among different kinds of ECG detecting networks are given in Table.

Table: Comparisons among typical ECG sensing networks

	WiFi-based ECG sensing network	Bluetooth-based ECG sensing network	Zigbee-based ECG sensing network
Protocol	IEEE 802.11	IEEE 802.15.1	IEEE 802.15.4
Coverage	20-200 m	20-30 m	2-20 m
Data rates	11-54 Mbps	1-24 Mbps	10-250 kbps
Power consumption	Medium	Low	Low
Terminal dependency	Data collection is independent of smart terminals	Smart terminals are needed for receiving and forwarding sensed data.	Smart terminals are needed for receiving and forwarding sensed data.
Popularization	High, nearly all houses and public places provide Wi-Fi access points.	Medium, often supported by smartphones.	Low, only supported by specific devices

1.2 IoT Cloud

The high level IoT methods, ECG information can be put away and broke down adequately and proficiently. With the guide of an IoT cloud, calculation serious information cycle and examination undertakings can be completed in powerful a worker, which significantly facilitates the weight of keen gadgets [26]. As a rule, an IoT cloud for ECG observing generally comprises of four utilitarian modules, i.e., information cleaning, information stockpiling, information investigation, and sickness cautioning.

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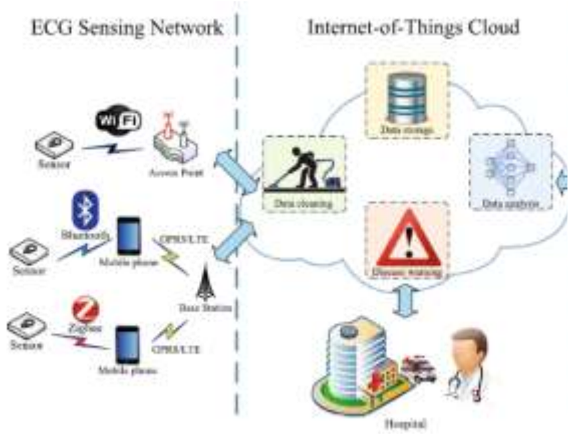

Figure: Architecture of the IoT-based ECG monitoring systems

Critical provisions can be removed from ECG flags to identify potential heart illnesses. Nonetheless, during the cycles of information assortment and transmission, commotion might be brought into the ECG signal, which would antagonistically influence the finding exactness. Hence, the ECG signal should be cleaned at first [11]. Regularly, an appropriately planned channel is utilized to eliminate the commotion outside the band of the ECG signal. Moreover, the system of information reviewing is typically utilized to recognize information irregularities and logical inconsistencies.

2. EXISTING SYSTEM

ECG signals are analyzed by a microcontroller to determine heart rate in the present system. The ECG signal is obtained by measuring the wrist's electrical activity. In the proposed system, the heart rate is monitored using ECG leads and a microprocessor. Moreover, the ECG is collected straight from the chest area of the body. When using the existing sensor fusion technique, sensors can detect body temperature and water level in a person's system. According to the proposed system, the alarm system and LCD display will be able to monitor the heart rate and ECG through the county monitoring system. Mobile, versatile, accurate, and efficient - these are the characteristics of this technology.

3. PROPOSED SYSTEM

The design of the researchers' health monitoring system is a hot topic. Health monitoring systems are utilized in a variety of settings, including hospitals, home health care units, and sports teams. For chronic disease patients undergoing daily check-ups, this health monitoring system is used. As a result, researchers created a system that could be carried around. Researchers developed a variety of health monitoring systems based on the needs of the participants. To develop the system based on this performance, different platforms such as Microcontroller, ASIC, FPGA, and PIC microcontroller are employed.

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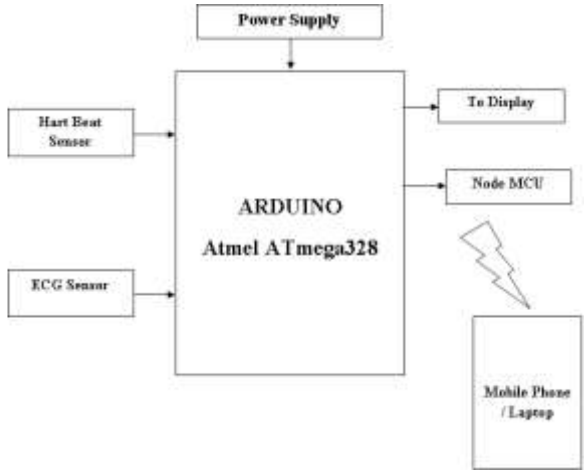

Figure: Proposed system Block diagram

Proposed system consists of two blocks as shown above figure

1. Patient monitoring location
2. Implementation Of The IoT-Based ECG Monitoring System

3.1 Patient Monitoring System

It comprises of ECG sensor AD8232 which procure Electrocardiograph (ECG) signals. AD8232 is liked over another chips, HM301D is three channels, while we just need single channel ECG and ADS1191 doesn't give sufficiently high addition to get great goal. AD8232 has the best yield impedance and gain [2]. ECG is the most common way of recording the electrical action of the heart throughout some stretch of time utilizing terminals set on the body.

These cathodes distinguish the minuscule electrical changes on the skin that emerge from the heart muscle's electro physiologic example of depolarizing a lot during every heartbeat. The AD8232 is a slick little chip used to quantify the electrical action of the heart. The AD8232 Single Lead Heart Rate Monitor is a savvy board used to gauge the electrical action of the heart. This electrical movement can be graphed as an ECG or Electrocardiogram and yield as a simple perusing. ECGs can be incredibly boisterous; the AD8232 Single Lead Heart Rate Monitor has as an operation amp to assist with getting an unmistakable sign from the PR and QT Intervals without any problem.

The AD8232 has a coordinated sign molding block for ECG and other bio potential estimation applications. It is intended to extricate, intensify, and channel little biopotential signals within the sight of boisterous conditions, for example, those made by movement or far off cathode arrangement. The AD8232 Heart Rate Monitor comprises of 9 pins+, LO-, OUTPUT, 3.3V, GND give fundamental pins to working this screen with an Arduino or other improvement board. Likewise gave on this board are RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins through which ECG cathodes are associated with as displayed in outline underneath figure.

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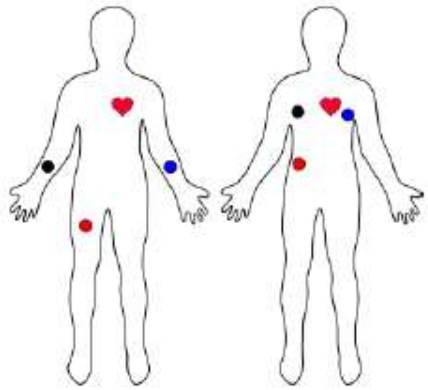

Figure: AD8232 electrodes placement

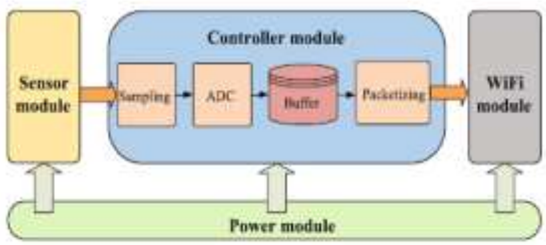

Figure: Main components of the ECG monitoring node

3.2 Implementation of the IoT-Based ECG Monitoring System

In light of the design proposed in Section "Engineering of IoT-based ECG Monitoring System", an IoT-based ECG checking framework is executed utilizing the high level strategies of portable detecting, distributed computing and Web. Insights concerning the checking hub, IoT cloud are presented as follows.

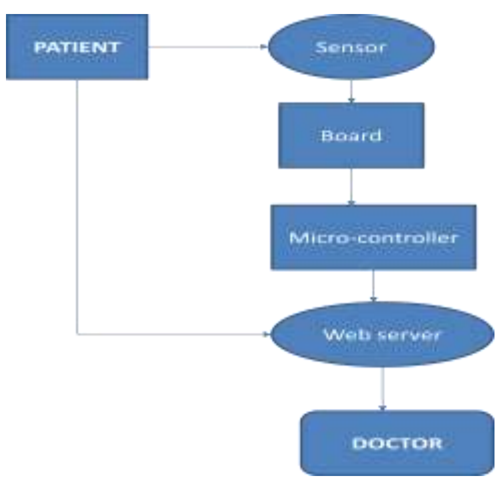

Figure: Working flow

Step 1-Request: The client sends a solicitation to the HTTP worker to get to the page.

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Step 2-Response: The HTTP worker sends a HTML document back to the client, which can be changed over to a page by the internet browser.
Step3-Subscribe: Using the Application Programming Interface (API) of the IoT cloud, the page can buy in specific subjects identified with the ECG observing hub.
Step 4-Publish: The ECG observing hub distributes information to the MQTT worker on a specific point. This information is sent to every one of the WebPages that have bought in a similar point.
Step 5-Storing: ECG information is put away into the data set oversaw by the capacity worker.

4. HARDWARE COMPONENTS

4.1 Arduino

The Arduino UNO is the greatest electronic and coding board to get started. Arduino is a platform for open source construction of electronics devices. The Arduino is a physically programmable circuit board and a software package that is either used on your computer to create and upload computer codes to the physical board or IDE. A physical programmable system (also referred to as microcontroller) is used.

Figure: Arduino

4.2 Node MCU

It is an open sources firmware and advancement packs to fabricate IoT items. It incorporates firmware that sudden spike in demand for ESP8266 Wi-Fi SoC and equipment that has an ESP-12 module. The unit has simple (A0). It additionally has computerized (D0-D8) pins on the board. It even helps sequential ports correspondences, for example, SPI, UART, I2C and so forth.

Figure: Node MCU

4.3 ECG monitoring node

The ECG observing hub is liable for gathering ECG information from the human skin and afterward sending these information to the passageway by means of a remote channel. As portrayed in Fig. 2, the ECG observing hub in our framework mostly incorporates: 1) Sensor module; 2) Controller module; 3) Wi-Fi module; and 4) Power module. A photograph of the ECG observing hub is beneath figure.

Sensor module: The sensor module is the establishment of the checking hub, which is answerable for gathering ECG information from the human body. With the guide of the AD8232 ECG sensor and certain fringe circuit, feeble ECG signs can be distinguished with good exactness [15]. Since the normal recurrence of the ECG signal lies between 0.5 Hz and 100 Hz [16], a band-pass channel is utilized in AD8283 to eliminate the commotion outside this recurrence band. From that point onward, the sifted signal is enhanced utilizing a functional enhancer. At last, with the assistance of the sensor module, ECG signals from 0 v to 3.3 v are assembled.

Figure: Photo of the ECG monitoring node

4.4 Heartbeat Sensor

This heart beat sensor is designed to give digital output of heat beat when a finger is placed inside it .When the heart detector is working, the top-most LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

Figure: Hart beat Sensor

4.5 Thing Speak Cloud

It is an IoT stage that is intended to empower significant associations among individuals and things. It includes constant information assortment, information investigation, information preparing, and information perception utilizing an associated Social Networking Service (SNS) by means of an open source API to help different stages. It serves to handily move information from installed gadgets like Arduino, Raspberry PI, Node MCU, and so forth additionally, it upholds different dialects and conditions. Our proposed framework peruses and sends sensor information utilizing Thing Speak. The primary target is to plan and execute a robotized framework and to picture detected data as graphs. The information acquired can be seen all around the world anyplace, whenever.

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5. RESULTS

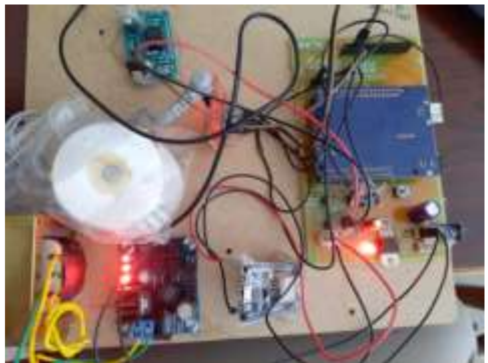
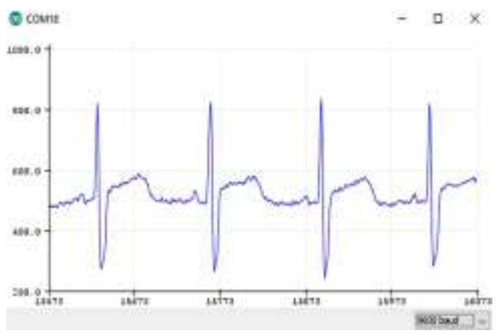


Figure: Hardware Prototype



Check the presence of the P or T waves, nor will it measure your pulse. Henceforth, we will attempt to gauge heartbeat and pulse inconstancy (HRV) utilizing AD8232 ECG sensor. As talked about before, HR = No. of R tops in 1 moment. In any case, this would imply that it would require 1 whole moment for a solitary HR worth to show up. Consequently, many individuals will in general gauge the time span between two continuous R pinnacles and gauge HR utilizing the accompanying recipe

$$HR = \frac{60}{RR\ interval}$$

This may be extremely quick, however therapeutically this is mistaken. Why? Since this situation expects that every R-R stretch all through the whole 1 moment is something very similar. Notwithstanding, this isn't the situation. For a normal solid human, the time taken by 1 whole heartbeat is around 800-850 ms (65-75 thumps each moment). This may change contingent upon whether the individual is resting or working. Regardless, the heartbeat spans don't differ much for the individual. However, for an individual experiencing atrial fibrillation or Arrhythmia changes fundamentally all through the ECG, notwithstanding the normal heartbeat having all the earmarks of being typical. The boundary to recognize this is called Heart Rate Variability.

The default threshold is 100, but please set it as per your own sensor. The code is pretty simple and intuitive and just implements simple timers to measure the ECG values and RR intervals to calculate the hr and HRV variables according to the formula explained earlier.

Figure: Data uploaded to server

CONCLUSION

We built and installed a cutting-edge IoT-based ECG monitoring system. In the beginning, the architecture of the ECG monitoring system was described. ECG sensing networks, including Wi-Fi, have been described and compared. An IoT-based ECG monitoring system was created based on the proposed architecture. It is possible to capture real-time ECG readings using a wearable monitoring node with three electrodes. Wi-Fi was used to transport the collected data to the IoT cloud, which has high data rates and a wide coverage area. Users can view the ECG data in the IoT cloud, which is comprised of three servers, including HTTP server, MQTT server, and storage server. The web-based GUI eliminates the requirement for mobile applications and provides a versatile mechanism for users to get ECG data that is independent of any mobile OS platform. We still need to do more research on ECG monitoring in the future. ECG-based diagnostic results, for example, need to be improved to provide a more accurate diagnosis.

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