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SMART ECG MONITORING SYSTEM DRIVEN BY IOT

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ABSTRACT
With the exponential rise in the human population and medical costs, public healthcare has received more and more attention. It is commonly recognized that a proficient health monitoring system has the ability to promptly identify irregularities in medical conditions and provide diagnoses based on the collected data. ECG monitoring is a key diagnostic tool that is extensively researched and used. But almost all of the portable ECG monitoring devices on the market today require a mobile application to function; this application handles data collecting and display. In this work, we suggest a novel approach to ECG monitoring that makes use of Internet-of-Things (IoT) technologies. Wearable monitoring nodes are used to collect ECG data, which are then wirelessly transferred to the Internet of Things cloud. The Internet of Things cloud uses both the HTTP and MQTT protocols to give consumers access to real-time and visually represented ECG data. The cross-platform problem has been significantly mitigated by the ease with which ECG data may be obtained by almost any smart terminal equipped with a web browser. To ensure that the system as a whole is reliable, experiments are conducted on healthy volunteers. Experimental results reveal that the proposed system is reliable in collecting and displaying real-time ECG data, The suggested system can help with the primary diagnosis of several heart disorders since it is dependable in gathering and presenting real-time ECG data, according to experimental results.

INTRODUCTION

Over the past few decades, heart disorders have become more common, and many individuals pass away from related illnesses. Heart illness should therefore not be taken lightly. Over the past ten years, chronic and cardiovascular diseases (CVDs) have been the leading cause of death in every nation. Heart and blood vessel diseases are known as CVDs. Blood vessel diseases are referred to as cardiovascular diseases (CVDs) and include coronary artery diseases. Heart failure, rheumatic heart disease, cardiomyopathy, stroke, and heartattack. Among the disorders affecting the heart are arrhythmias. With 17.9 million deaths annually, cardiovascular diseases (CVDs) are the world's leading cause of mortality. With more than 8,40,000 deaths in 2016, it remains the greatest cause of death in the US. Additionally, based on the European Health Network European Report 2017

Cardiovascular Disease Statics, or CVDs, account for roughly 1.8 million deaths annually in the European Union (EU) and 3.9 million fatalities in Europe. This represents 37% of all deaths in the European Union and 45% of all deaths in Europe. In today's healthcare, continuous heart rate monitoring and rapid heartbeat identification are crucial priorities. Therefore, keeping an eye on physiological signs such as electrocardiogram (ECG) signalsIndications offers a fresh, comprehensive framework for evaluating CVD and supporting illness prevention and control. Thanks to advancements in sensor technology, communication infrastructure, data processing, modelling, and analytics algorithms, the risk of impairments can now be more effectively addressed than in the past. Thus, a new era of astute, proactive healthcare would eventually become available, especially in light of the major challenge of scarce medical resources. The Internet of Things is expected . A mobile ECG monitoring solution based on the cloud was showcased. These can use a sensor to detect ECG signals and wireless transmission technologies like Bluetooth, Wi-Fi, and Low-power wireless to send those signals on a screen. An ECG tracking apparatus that is wearable and uses Wi-Fi to send data wirelessly to the Internet of Things cloud, eliminating the need for a mobile terminal. Wi-Fi has greater coverage regions and better data speeds than Bluetooth or Zigbee.

Using smartphones running different operating systems, a web-based graphical user interface is designed to make it easy for physicians and patients to access data services provided by the IoT cloud. IoT works on electrocardiograms are numerous. In An Arduino and GSM module were used to construct a framework for an old patient living alone at home, which is intended to detect heart problems or declines in the patient's state. The framework was developed using Arduino and GSM modules, and it sends data to the specialist via SMS on a cell phone. If the body vibration signals and echocardiography are abnormal, the framework notifies the pre-specified expected individuals or a medical facility. Their approach uses the cloud as a means of sending ECG data to a display device and a Raspberry Pi microcontroller. There are still issues with this system, like the need for a strong internet connection in order for doctors to use it whenever they want. proposed a system that, in the event that an abnormality is found after an ECG analysis, can notify users and medical professionals.

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IOT-BASED ECG MONITORING SYSTEM ARCHITECTURE

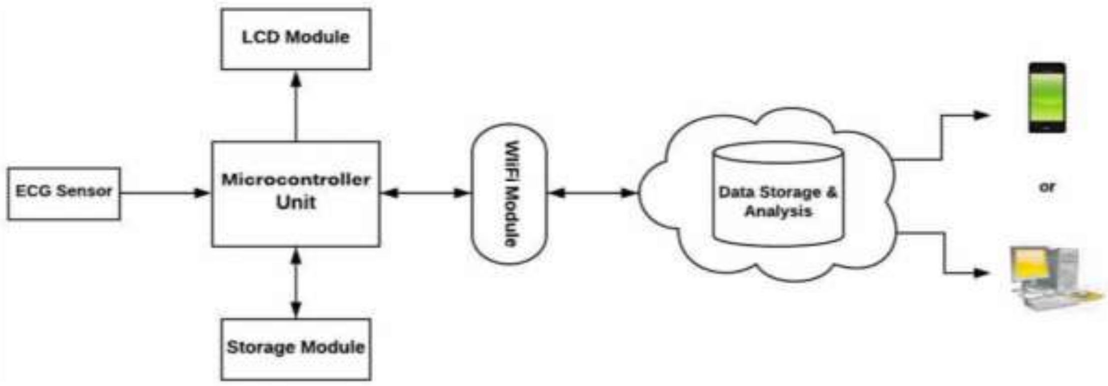

Fig.1.IoT based ecg Monitoring System Architecture

Network For Data Collection
The foundation of the entire framework, which is dedicated to collecting anatomical data from the body's surface, is the data gathering structure. The Wi-Fi convention is used to transmit the ECG data collected from the sensors to the Internet of Things cloud since Wi-Fi protocol may provide greater data esteems and more expansive inclusion zones.

Data Display and Storage
Since an SD card's design operates at a low voltage and its communication is based on an advanced nine-pin interface , it is a highly suited device for storing ECG data offline. The Real Time ECG Wave is shown via an interfaced thin-film transistor (TFT) LCD.

Server in the Cloud
With the advancement of sophisticated Internet-of-Things systems, the ECG data may be successfully stored and inspected in sufficient quantities. An Internet-of-Things cloud allows information activities and inspections to be conducted on high-power servers, significantly reducing the amount of smart devices that are needed.

Interface for Graphical Users (GUI)
Perception and administration of information fall under the purview of the Graphical User Interface. It provides a module that is simple to understand; a module for communication; and a module for offline storage. . Three components make up the architecture of the Internet of Things-based ECG Monitoring System: Ubidots, NodeMCU ESP8266, and AD8232 ECG Sensor.

ECG Sensor AD8232
The procedure known as electrocardiography, or ECG, is used to collect electrical impulses produced by the heart. The ECG sensor helps us identify the degree of physiological arousal in individuals, but it also helps us c omprehend their psychological states. In order to determine the heart's electrical activity, an AD8232 sensor is employed. This little chip's electrical activity may be graphed similarly to an electrocardiogram (ECG). Electrocardiography is a useful tool for identifying a variety of cardiac diseases.

A commercial board called the AD8232 ECG sensor is used to measure the electrical activity of the human heart. The result of this activity is an analogue readout, which may be plotted like an ECG. The AD8232 chip can be used to lessen the noise produced by electrocardiograms, which can be highly loud. The ECG sensor functions similarly to an operational amplifier in order to facilitate the simple extraction of a clear signal from the intervals. The AD8232 sensor is employed in several biopotential measuring applications, including signal conditioning in electrocardiograms. This chip's primary function is to capture, filter, and amplify tiny biopotential signals in noisy environments, such as those created when a distant electrode is replaced.

The pins SDN, LO+, LO-, OUTPUT, 3.3V, and GND are included in the heart rate monitoring sensor, such as the AD8232. in order to solder pins on this IC and attach it to development boards like Arduino. In addition, this board has pins for connecting custom sensors, such as the left arm (LA), right leg (RL), and right arm (RA). This board has an LED indication that shows the rhythm of a human pulse. The AD8232 sensor has a rapid restoration capability that is utilised to shorten the HPFs' long resolving tails. This sensor comes in a 20-lead LFCSP package and is available in a 4 mm x 4 mm dimension.
It functions between -40°C and +85°C, although the performance

Fig.2ECG Sensor

MCU Node ESP8266

Node MCU is an open-source development board and firmware with Lua programming specifically designed for Internet of Things applications. It consists of hardware based on the ESP-12 module and firmware running on Espressif Systems' ESP8266 Wi-Fi SoC. This board has a Wi-Fi module and a microprocessor. 3.3 V is the voltage at which the ESP8266 operates. This board's single-board microcontroller has 12 GPIO and D0 on it . It is a 32-bit microcontroller that lacks reinforced open drain, interrupt , PWM, and 1-Wire functionality. It has a 128-byte memory and a 4-million-byte storage capacity. ESP8266 is a commonly used Wi-Fi module in Internet of Things applications that is combined with the TENSILICA XTENSA LX106 core.

Fig3.MCU Node

Ubidots

With the use of Ubidots, System Integrators (SIs) and small and medium-sized businesses (SMBs) may quickly develop and implement IoT applications. The building components of Ubidots include alarms, device-friendly APIs, analytics, reports, and drag-and-drop dashboards.

Table I: According to [7], comparison among typical ECG Sensing Networks such as Wi-Fi, Bluetooth, and ZigBee.

Standards	Wi-Fi based 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	100 m	10 m	10-100 m
Data Rates	54 Mbps	1 Mbps	250 Kbps
Power Consumption	Medium	Low	Low
Terminal Dependency	Data collection in dependent of smart terminals	Smart terminals are needed for receiving and forwarding sensed data	Smart terminals needed for receiving and forwarding sensed data

Circuit Diagram: Connecting NodeMCU ESP8266 to AD8232 ECG Sensor

This is the circuit schematic for connecting the NodeMCU ESP8266 to the AD8232 ECG sensor. The AD8232 Breakout Board has six pins. SDN is not linked

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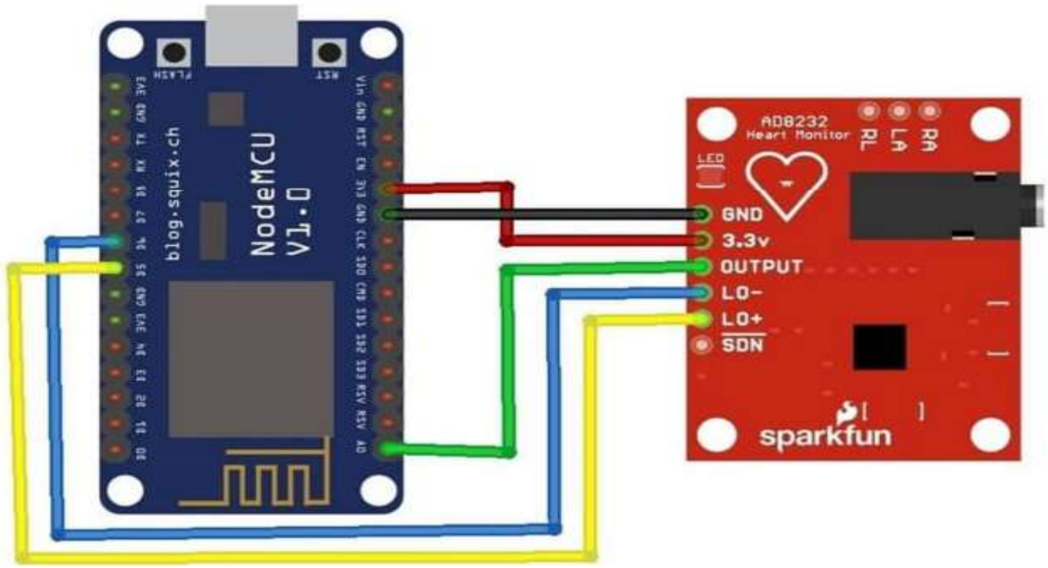

Fig.4.Circuit Diagram

Attach the output to Node MCU's analogue A0 port. Attach the LO+ and LO-to NodeMCU's D5 and D6, respectively. Connect the GND of the AD8232 kit to GND and provide it with 3.3V VCC.

C. Positioning ECG Leads and Electrodes
Prior to applying to the body, it is advised to snap the sensor pads onto the leads. The pads provide better measurements the closer they are to the heart. To assist in determining correct placement, the cables are color-coded.

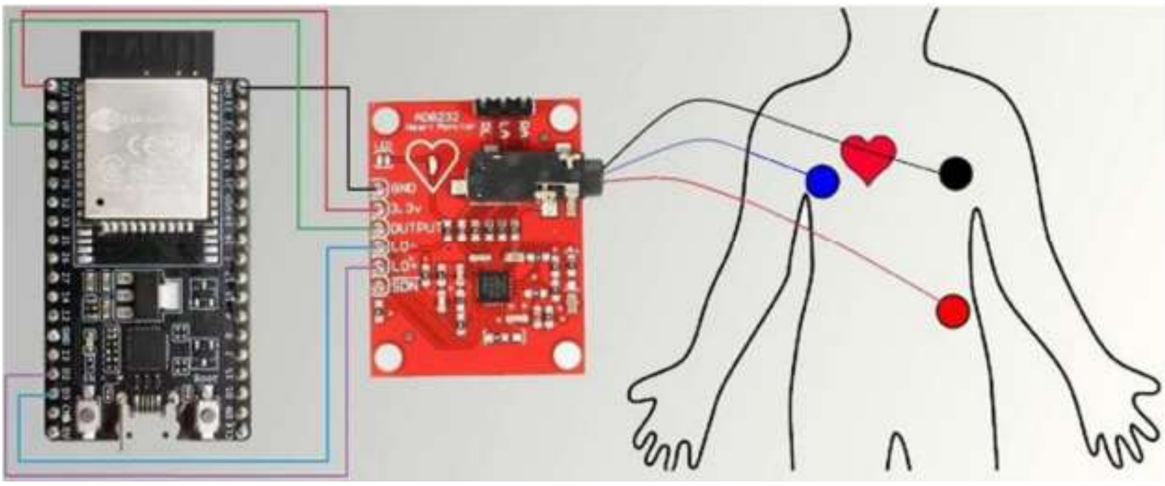

Fig5..Connection with Heart

ACADEMIC OUTCOME AND ANALYSIS

Comparing a 3-lead placement to a traditional 12-lead ECG monitoring equipment used in hospitals, it is sufficient to analyse the key aspects of the ECG signal. The electrodes must be positioned in a triangle around the heart in order to get the greatest possible ECG data. We have tested our technology on a number of patients in order to validate its functionality. The five primary wave types found in typical ECG readings are the P, T, Q, R, and S waves.

1)RR Interval: The R wave is one of the most noticeable features and is frequently used to determine the ECG signal's period. The time gap between two consecutive R waves is known as the RR interval, and it can become abnormal in certain cardiac conditions, such as arrhythmia.

2) PR Interval: This quantifies the amount of time that passes between the start of the P wave and the QRS complex. It shows how long it takes for an impulse to get from the sinus node to the ventricles.

3) QT Interval: This term, which is associated with ventricular depolarization and repolarization, denotes the period of time between the beginning of the Q wave and the conclusion of the T wave. If the QT interval is longer than usual , there is a higher chance of ventricular fibrillation or perhaps sudden cardiac death.

4) QRS Complex: The three major waves that make up the Ventricular Depolarization— the Q, R, and S waves— are primarily l inked to the QRS complex. Certain disorders including medication toxicity and electrolyte imbalance are likely to be identified by QRS complex analysis.

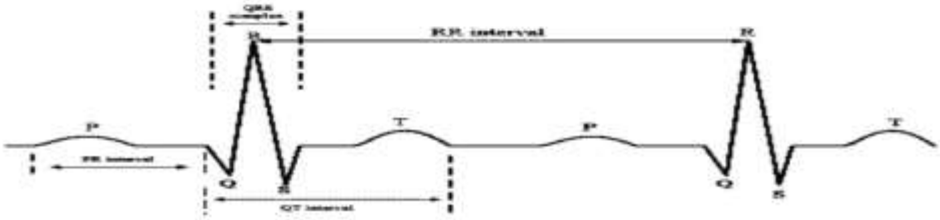

Fig.6.Key ECG parameter values at normal levels

TABLE-II-ECG WAVE INDICATION

Features	Characteristics
PR Interval	0.12-0.20 sec
QRS Interval	0.06-0.10 sec
QT Interval	Less than half of the R-R interval
ST Segment	0.08 sec

When both of the criteria are false, abnormalities are discovered. Lastly, in the case that any illnesses are discovered, an emergency email has been forwarded to the physicians or users, enabling them to take immediate action to save the patients from suffering grave consequences. This can lower the death rate as well as any harm that heart failure may produce.

CONCLUSION

The Internet of Things' integration with healthcare has created a huge new development field. In addition to making healthcare easier, data processing and worldwide trend analysis can help discover novel ways to avoid illnesses. Furthermore, a bright future is fully dependent on the automation of medical facilities and therapeutic methods that use IoT and artificial intelligence to assist doctors better comprehend illness.

But since this subject deals with human health, safety, and security, we need proceed cautiously and not rush into it. This has to be the primary priority. Largely speaking, this may also result in less expensive patient care and therapies. If technology and health work together, we can accomplish the objective.

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