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# INTERNET OF THINGS BASED ON CARDIAC ARRHYTHMIA DETECTION USING ESP32

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**Abstract**

Cardiac arrhythmias are a major cause of morbidity and mortality worldwide. Early detection and treatment of cardiac arrhythmias can significantly improve patient outcomes. However, current monitoring and detection systems are limited by the poor signal quality, limited spatial resolution, and high costs. In this paper, we propose a smart biomedical sensor network for multi-patient cardiac arrhythmia detection. The system consists of wearable sensors that collect electrocardiogram (ECG) and other physiological data, a wireless network that transmits the data to a central monitoring hub, and a cloud-based algorithm that analyzes the data to detect cardiac arrhythmias. The system is designed to be scalable and can monitor multiple patients simultaneously. We evaluate the system's performance using simulated ECG signals and demonstrate its efficacy in detecting various types of cardiac arrhythmias. The proposed smart biomedical sensor network has the potential to revolutionize cardiac arrhythmia detection by providing real-time monitoring, improving patient outcomes, and reducing healthcare costs. The system can alert healthcare professionals to potential cardiac arrhythmias before they become life-threatening, allowing for early intervention and prevention. The use of wearable sensors can also improve patient comfort and mobility, allowing for continuous monitoring in a non-invasive manner. Overall, the proposed system offers a cost-effective and efficient solution for multi-patient cardiac arrhythmia detection, which has the potential to improve patient outcomes and reduce healthcare costs significantly. Further research and development are needed to optimize the system's design and performance, but the proposed smart biomedical sensor network is an exciting development in the field of cardiac arrhythmia detection.

**Keyword-** Internet of Things (IoT), Health monitoring, Wearable devices, Data analytics, Real-time monitoring, Remote monitoring, Mobile applications.

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# I. INTRODUCTION:

Heart disease is one of the leading causes of death worldwide. Cardiac arrhythmia is a common cardiac disorder that is characterized by the irregular beating of the heart's electrical impulses, leading to abnormal heart rhythms. Early detection and timely intervention of cardiac arrhythmia can significantly reduce the risk of debilitating consequences such as heart failure or stroke. Smart biomedical sensor networks have emerged as an innovative approach for monitoring and detecting cardiac arrhythmia in real time. This technology employs wearable sensors that collect physiological data and transmit it wirelessly to a central monitoring unit for analysis. In this context, this paper proposes a robust and reliable smart biomedical sensor network that can monitor multiple patients simultaneously for the detection of cardiac arrhythmia. The proposed system integrates advanced signal processing algorithms with machine learning techniques to enable accurate and efficient detection of abnormal heart conditions. The proposed network is expected to provide an effective and convenient solution for real-time cardiac arrhythmia diagnosis, thereby improving patient outcomes and reducing healthcare costs.

# II. SYSTEM DESIGN:

## ESP32:

The ESP32 is a powerful microcontroller designed by Espressif Systems, which includes integrated Wi-Fi and Bluetooth connectivity, making it ideal for building Internet of Things (IoT) applications, including health monitoring devices. Health monitoring involves the continuous measurement and analysis of various physiological parameters, such as heart rate, blood

pressure, body temperature, oxygen saturation, and more. The ESP32 can be used to build various types of health monitoring devices that can be used in homes, hospitals, clinics, and other healthcare settings. Sensor Data Acquisition: The ESP32 can be connected to various sensors that can measure different physiological parameters. For example, a pulse oximeter sensor can be used to measure oxygen saturation levels, a blood pressure sensor can be used to measure blood pressure, and a temperature sensor can be used to measure body temperature. The ESP32 can interface with these sensors using various protocols such as I2C, SPI, or UART. Data Processing and Analysis: Once the data is acquired from the sensors, the ESP32 can process and analyse it in real time. It can perform various signal-processing techniques to extract meaningful information from the raw sensor data. For example, it can filter out noise, detect anomalies, and calculate statistical values. Communication and Visualization: The ESP32 can communicate the processed data to a smartphone app, a cloud server, or a local display. It can use Wi-Fi, Bluetooth, or other communication protocols to send data wirelessly. The data can be visualized using charts, graphs, or other graphical interfaces, allowing users to monitor their health status and detect any abnormalities. Alerting and Notifications: The ESP32 can be programmed to send alerts and notifications in case of any abnormal readings or critical health situations. For example, it can send a notification to a caregiver's smartphone if a patient's blood pressure or heart rate is outside of the normal range.

## LCD display:

LCD stands for Liquid Crystal Display. It is a type of flat-panel display technology used in various electronic devices such as televisions, computer monitors, smartphones, and more. LCDs use a liquid crystal substance, which is located between two transparent electrodes, to control the amount of light passing through them. The liquid crystal molecules align themselves in a specific way, either parallel or perpendicular to the electrodes, which allows them to control the polarization of the light passing through them. The liquid crystals are sandwiched between two polarizing filters that are perpendicular to each other. The first polarizing filter allows only light waves vibrating in one plane to pass through it. The liquid crystal layer then twists these waves to align them with the second filter, which blocks all light except for those vibrating in the same plane as the second filter. There are two main types of LCDs: passive matrix and active matrix. Passive matrix LCDs are simpler and cheaper, but they are not suitable for displaying moving images as they have a slow refresh rate. Active-matrix LCDs, on the other hand, use a thin-film transistor (TFT) for each pixel, making them faster and more reliable. In an active-matrix LCD, each pixel is controlled by a transistor, which allows for faster switching and greater control over the display. Each transistor is connected to a row and column electrode, which allows the controller to turn on and off individual pixels by selectively charging the electrodes. The controller can then change the voltage at each electrode, which changes the orientation of the liquid crystal molecules and hence the amount of light that passes through the polarizing filters. The colour of an LCD screen is determined by the filters used in front of the light source, and these filters can either be separated or integrated into the LCD. Older LCDs used separate white backlight and colour filters, which led to a loss of colour accuracy and lower contrast. However, newer LCDs use a technique called "in-plane switching" (IPS), which allows the colour filters to be integrated into the LCD, resulting in better colour accuracy and contrast. Overall, LCDs are a versatile and widely-used display technology that is found in many electronic devices. They are energy-efficient, lightweight, and can display high-quality images and videos.

**Arduino IDE:**

Arduino The official Arduino Integrated Development Environment (IDE) can be used to program and upload code to Arduino boards. It is a user-friendly and versatile tool that supports a wide range of Arduino boards and shields. Pulse-Sensor is an Arduino-compatible sensor that can be used to detect heart rate. It is a low-cost and easy-to-use sensor that can be attached to a fingertip or earlobe to measure heart rate.AD8232: The AD8232 is a single-lead heart rate monitor analog front end (AFE) for use in fitness and health monitoring. It is a low-cost and easy-to-use sensor that can be integrated into a variety of health monitoring devices.

Open BCI is an open-source platform for bio-signal acquisition and processing. It includes a range of sensors and amplifiers that can be used to measure EEG, ECG, EMG, and other bio-signals. Open BCI can be used with Arduino boards to create custom health monitoring devices. The ESP32 is a powerful and versatile microcontroller that can be used to build a variety of projects, including health monitoring devices. The first step in programming the microcontroller is to define the pins to which the sensors and display module are connected. This is done using the pinMode() function, which sets the pin to either input or output mode.

Next, the code can be written to read the data from the sensors using the analogRead() function, which returns a value between 0 and 1023 representing the voltage level on the sensor pin. This value can be converted into a meaningful health parameter value using a mathematical formula. Finally, the data can be displayed on the display module using functions such as print() and println(). These functions allow for the data to be displayed in a user-friendly format, such as a numerical value or a graphical representation. In addition to displaying data on the display module, the Arduino IDE can also be used to transmit the data to a computer or mobile device for further analysis and storage. This can be achieved using wireless communication protocols such as Bluetooth or Wi-Fi.

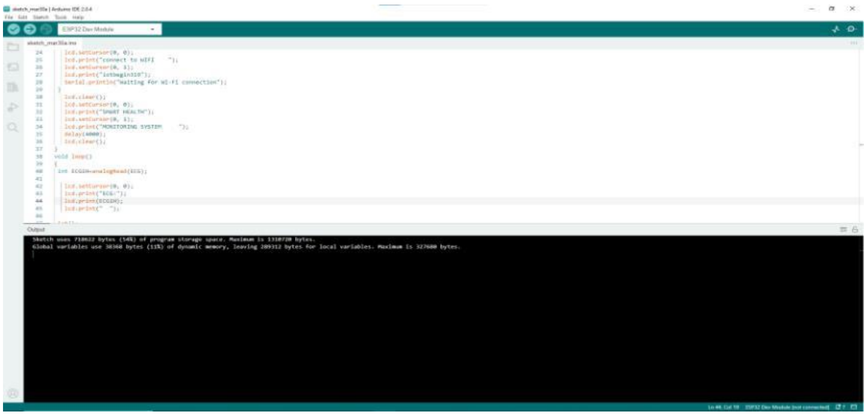

**Fig 1. Shows the Arduino Execution.**

## III.METHODOLOGY

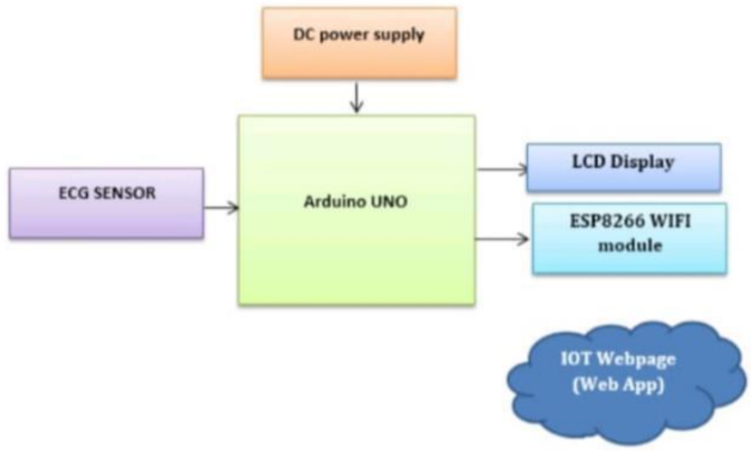


Fig 2. Shows the system architecture of proposed hardware module

## METHODOLOGY:

Biomedical Sensor Placement: The first step is to attach the biomedical sensors to the patients in appropriate locations. The sensors should be placed in locations that provide good signal quality and minimize artifacts. Typically, the sensors are placed on the chest, arms, and legs.

Signal Acquisition: Once the sensors are placed, they acquire ECG signals from the patients. The sensors are designed to record the electrical activity of the heart and transmit this data wirelessly to a central processing unit. Data Pre-processing: The ECG signals received from the sensors may contain noise and artifacts. To remove the noise and artifacts from the signal, the data undergoes pre-processing. The pre-processing techniques can include filtering, amplification, and signal conditioning. Real-Time Notification System: If an abnormal cardiac rhythm is detected, the system sends a real-time notification to the medical personnel, alerting them of the abnormality. This notification can be sent through a mobile app, email, or SMS. Patient Follow-Up: Once the notification is sent, medical personnel can review the data and take appropriate action. This can include administering medication, performing diagnostic tests, or referring the patient to a specialist.

**Implementation summary:**

The first step in implementing a smart biomedical sensor network is to select the appropriate sensors. In this case, sensors that can detect and monitor cardiac arrhythmias are needed. Some of the sensors that can be used include ECG sensors, pulse sensors, and blood pressure sensors. Network Design: The next step is to design the network architecture. The network should be able to collect data from multiple sensors and transmit it to a central processing unit for analysis. The network can be wireless, using protocols such as ZigBee or Bluetooth, or wired, using Ethernet or USB. Data Acquisition and Transmission: Once the network is designed, the next step is to acquire and transmit data from the sensors to the central processing unit. This can be done using analog-to-digital converters, which convert the analog signals from the sensors into digital signals that can be processed by a computer. Data Processing: The data collected from the sensors is then processed using algorithms to detect cardiac arrhythmias. Machine learning algorithms such as artificial neural networks or support vector machines can be used for this purpose. The algorithms are trained using datasets of known cardiac arrhythmias to detect abnormalities in the collected data. Alert Generation: Once the data is analysed, the system should generate alerts if any cardiac arrhythmias are detected. The alerts can be in the form of text messages or emails sent to healthcare providers or family members of the patients. A user interface can be created to display the data collected from the sensors and the alerts generated by the system. This can be in the form of a mobile application or a web-based dashboard. Finally, the system should be tested to ensure that it is accurate and reliable in detecting cardiac arrhythmias. Once the system is tested and validated, it can be deployed in hospitals or other healthcare settings to monitor multiple patients simultaneously. A smart biomedical sensor network is a system of sensors and data communication devices that can be used to monitor and collect data from multiple patients simultaneously. These sensors can be wearable devices or implanted devices that can continuously monitor vital signs, such as heart rate and rhythm, blood pressure, and oxygen saturation. Cardiac arrhythmias are abnormal heart rhythms that can be life-threatening. Designing the hardware components, which include sensors to gauge vital indicators like the ECG, pulse, blood pressure, etc., is the initial phase. The sensors are managed by a microcontroller, which also sends the data to a cloud server. To ensure that the sensors can run for an extended amount of time without battery change, the hardware should be created to be low-power. Making a programme that can interpret and analyse the data gathered from the sensors is part of the software development phase. The software must be able to recognise aberrant heart rhythms and immediately alert medical personnel. To guarantee that patient data is safe and readily available, the software should also have data storage capabilities.

## IV.RESULTS AND DISCUSSIONS

A Smart Biomedical Sensor Network for Multi-Patient Cardiac Arrhythmia Detection is a system that uses advanced technology to monitor the heart rates of multiple patients simultaneously in real time. The system is designed to detect any abnormalities in the cardiac rhythm of patients and alert medical personnel in real time. The system consists of a network of biomedical sensors that are attached to the patients. These sensors are capable of recording the electrical activity of the heart and transmitting this data wirelessly to a central processing unit. The central processing unit is responsible for analyzing the data and detecting any cardiac arrhythmias. The system uses machine learning algorithms to analyze the data from the sensors and identify abnormal cardiac rhythms. The machine learning algorithms are trained on large datasets of ECG signals to detect a wide range of cardiac arrhythmias, including atrial fibrillation, ventricular tachycardia, and bradycardia. Once an abnormal cardiac rhythm is detected, the system immediately alerts medical personnel through a real-time notification system. This allows medical personnel to quickly intervene and provide appropriate treatment to the patient. The Smart Biomedical Sensor Network for Multi-Patient Cardiac Arrhythmia Detection has several advantages over

traditional methods of cardiac monitoring. First, it allows for the simultaneous monitoring of multiple patients in real time, which can improve the efficiency of medical staff and reduce the need for costly hospital stays. Second, the system can detect cardiac arrhythmias that may be missed by traditional monitoring methods, such as Holter monitors or event recorders. Finally, the system can provide continuous monitoring of patients, which can help detect arrhythmias that occur infrequently or intermittently. Overall, the Smart Biomedical Sensor Network for Multi-Patient Cardiac Arrhythmia Detection is an innovative and effective system for detecting and monitoring cardiac arrhythmias in multiple patients simultaneously. It has the potential to improve patient outcomes and reduce healthcare costs by providing early detection and intervention for cardiac arrhythmias.

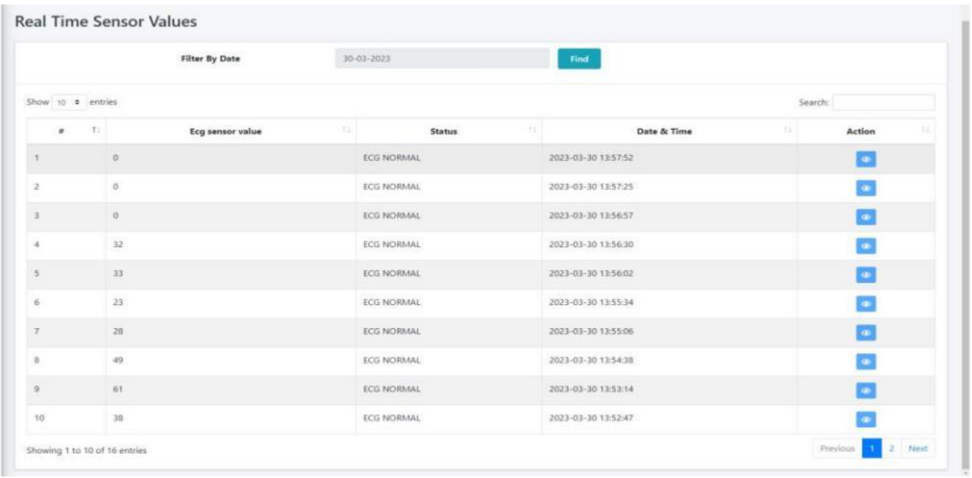


**Fig 3. Shows the output in the website.**

## V.CONCLUSION

This initiative is focused on using internet technology to set up a system that would interact via the internet to improve health because of how pervasive the internet is. One of the most notable instances of how the Internet of Things is changing the world is the healthcare sector. As a result, the current effort is concentrated on creating a smart patient health tracking system based on microcontrollers for usage with the Internet of Things. In the event of a medical emergency, it is feasible to alert a doctor using IoT. The proposed system utilizes wireless sensor nodes that are strategically placed on the patient's body to continuously monitor cardiac activity and transmit data to a central monitoring station. The data is processed using machine learning algorithms, which are trained to detect abnormal heart rhythms and provide real-time alerts to medical personnel. The system's ability to monitor multiple patients simultaneously provides an efficient solution for hospitals and clinics that have limited resources and staff. It also allows for early detection of cardiac arrhythmias, which can lead to early intervention and prevent complications such as stroke and heart failure. Moreover, the system's wireless design eliminates the need for invasive procedures, such as implantable cardiac monitors, and provides a non-intrusive and comfortable monitoring experience for patients. This can improve patient compliance and reduce the risk of infections and other complications associated with invasive procedures. The necessity to address issues like data privacy and security is one of the ongoing difficulties. Overall, the advantages of IoT-based smart biomedical sensors for cardiac arrhythmia monitoring are encouraging, and it is expected that future developments in this area will continue. Real-time heart health monitoring is now possible thanks to technology, which can significantly speed up and enhance the precision of identifying and treating cardiac arrhythmias.

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