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IoT-Assisted ECG and Multi Sensor Data Monitoring System for Health Care Applications

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Abstract— **The new IoT architecture paves the way for the development of tiny devices with perception, processing, and communication capabilities, which in turn paves the way for the development of sensors, embedded systems, and other "services" that can help us better understand our surroundings. An electrocardiogram (ECG) system for continuous monitoring of cardiovascular health via encrypted data transmission is presented, with the support of the Internet of Things (IoT). The current paradigm of the Internet of Things makes feasible the development of tiny sensors, embedded devices, and other "things" with sensing, processing, and communication capabilities. As a result of advancements in connected medical technology and the Internet of Things (IoT), patients' health can now be monitored in real-time, from afar. There would be a substantial rise in the number of people requiring medical attention during a corona-virus pandemic, therefore constant monitoring of patients would be necessary. The transfer of the massive amounts of confidential health information created by patients who do not wish to disclose their own medical information demonstrates the continuing significance of concerns over the privacy of IoT data. As a result of recent advancements in IoT technology, "smart objects" (things) can now communicate via the Internet in real-time. Internet of Things healthcare applications can benefit from sensors, a centralised processing unit, and a database platform. This thesis includes an Internet of Things (IoT)-enhanced electrocardiogram (ECG) monitoring system that can either send data to a server in real time or create an ECG graph that can be seen on a Smartphone with an accompanying app. The patient's current temperature, humidity, and heart rate are all shown in the app. As part of this effort, we present a lightweight method for rapidly updating data at a distance.**

Keywords— ***Internet of Things (IoT), Smart Health Care System, ECG monitoring system, IoT Based ECG system***

I. Introduction

The age-old proverb "Health is Wealth" holds true today as much as it did in antiquity. Humans have a wide variety of health problems while being able to launch rockets to distant worlds. Due to advancements in technology, medical professionals can now effectively treat a wider variety of illnesses. Health regulation, however, is now beyond the financial means of the vast majority of people. It would appear that the average person is unable to cover the high cost of medical care. Thanks to technological progress, those who otherwise could not afford the latest medical advances now have access to them. Those who live in major cities have convenient access to medical care, provided they have the resources to pay for it or are covered by health insurance. Can we aid those in outlying places who don't have easy access to reasonably priced medical care? By implementing systems driven by technology, we can find the solution to this issue. If it doesn't aid the underprivileged, technology is pointless. Scholars and academics who study recent developments in the computer industry can draw inspiration from this idea. The focus here is on people who live in more isolated areas (remote places). The introduction of remote health monitoring is one possible use of this concept. This was unthinkable until now. This paves the way for the implementation of remote monitoring systems utilizing distributed computing technologies like cloud computing and the Internet of Things (IoT). Because of IoT, it is now possible to combine the online and offline worlds. There are fundamental differences between the physical and digital composition of humans and mobile devices. Thanks to the IoT, we can easily merge these two infrastructures. The "Internet of Things" (IoT) refers to a wide range of interconnected technologies, including but not limited to those involving wearables, telephony, the Internet, and other connected gadgets. Cloud computing is an alternative because it allows data to be stored and processed on demand using a distributed system of remote computers that is highly available, scalable, and resilient to failure. When it comes to remote health monitoring, cloud computing and the IoT are must-haves. Data storage and management frameworks like Hadoop are made available via cloud computing's use of distributed programming frameworks. We can show that the existing state of IoT and cloud integration in healthcare institutions has a low empirical value. A complete framework for remote health monitoring is essential in cases where a primary health care centre (PHC) is accessible to a rural community. This thesis lays out a strategy for remote patient monitoring in a PHC by leveraging a smart bed coupled with the Internet of Things and the cloud. The patient's vitals and other data are saved in the cloud, where analytics analyze the data before making it available to the doctor and other stakeholders via a mobile app. This chapter will continue with a brief summary of the study's findings, and subsequent chapters will offer more in-depth discussion of those findings.

II. Literature Review

Guangyu Xu et. All (2020) Remote monitoring of cardiac health is now feasible with the use of an Internet of Things-assisted signal analysis framework for ECG quality. Based on these findings, the ECG-SSA technique was developed, which can instantly assess the quality of an electrocardiogram (ECG) recorded during exercise. Findings from the tests show that the proposed ECGSQA, which is based on machine learning approaches, performs similarly to the existing methods. The results reveal that when physical activity increases, ECG signals drop. The suggested lightweight ECG Signal Strength Analysis (SSA) in this study significantly reduces battery energy usage while still providing sufficient ECG signals in IoT devices with inadequate ECG signals, as demonstrated by real-time evaluation findings. Transmission security for electrocardiogram (ECG) data is supported by the Lightweight Secure IoT (LS-IoT) and the Lightweight Access Control System (LAC-S) (LAC). The study's findings suggest that implementing SSA with an IoT device enabled for cardiac health control could significantly impact the resource efficiency, security, and reliability of uncontrolled signal analyses and diagnostic systems by reducing the number of false alarms for recordings with significant ECG noise. Modern machine learning algorithms will soon be included into ECG health monitoring systems. [1]

Ata Ullah et. All (2021) Connectivity between various technologies, smart devices, and apps is critical for the improvement of human existence through the Internet of Things (IoT). Medical buildings and their surrounding contexts are considered while formulating health care policies. Smart medical equipment collects patient data and sends it to servers for analysis. It is crucial that information be transferred to a Fog/cloud server in a secure and efficient manner. In order to ensure that healthcare data is collected, aggregated, and sent securely, we have done a systematic evaluation of existing procedures. We've offered a thorough breakdown of the most typical literary devices. Our primary areas of interest up to this point have been healthcare systems, data security, and fog computing. By using fog computing instead of the cloud exclusively, sensitive healthcare data can be transferred more quickly. There is no room for delay in emergency medical situations, thus this method could be helpful. The time and resources needed to transmit information can be reduced by using compressed data collection methods. In addition, research questions that have not yet been answered are formulated and assessed to see if the systems described in the literature are up to the task. For the first time, academics have a chance to propose legitimate new approaches to these problems. Software-defined networking allows us to verify data before delivering it, reducing the amount of data transferred and the associated costs. [2]

Li-Ren Yeh et. All (2021) Electrocardiograms are helpful in detecting heart rhythm problems. There are two possible signs that can indicate heart abnormality. Damage to the tissues responsible for electrical conduction in the heart is an early warning sign. The second kind occurs when an electrolyte imbalance brings about a shift in rhythm. As part of a diagnostic procedure, it can pinpoint the exact site of a heart attack. Classification results from this work demonstrate that ECG images can be classified into four disease types using the suggested DNN model. Anesthesia risks could be estimated by categorizing ECG signals as normal or abnormal.

A prototype monitoring system for the Internet of Things was developed as part of the research. Analyzing ECG images helps doctors better understand heart conditions. Resting heart rates between 60 and 100 beats per minute are within the device's target range. As part of this proposal, a protocol and theoretical apparatus for identifying arrhythmias are provided. Results and findings will be more generalizable the larger the sample size. Meanwhile, we'll be tinkering with a variety of arrhythmias, each with its own distinctive pulse rate and rhythmic pattern. It is possible that a gadget still in the prototype stage may detect and categorize different types of rhythms as they occur. It could be useful for long-term surveillance or in case of an emergency. Additional investigation may be required. In the long run, it is intended to construct a comprehensive system on the foundation of the afore mentioned progress. With this set up, doctors may see the patient's ECG on their phones or tablets in real time. Having access to this kind of timely and precise information can greatly improve the quality of care given to patients. Health data collected by IoT devices can also be useful for home health care (HHC) and long-term care (LTC) providers (LTC). Those who are chronically ill can receive a wide range of services through long-term care (LTC). An entire medical team may keep tabs on a patient's condition in real time and offer advice as it's needed. [3]

Omar Chelkhrouhou et. All (2021) To accomplish inference and training, we employed a dispersed DL model that leveraged both fog and cloud computing environments. The DL model employs a 1D-CNN architecture and has undergone thorough testing on the MIT-BIH Arrhythmia dataset. The DL model is supplemented by a proof-of-concept system for distant cardiac patient monitoring. By streamlining the process of analyzing ECG data collected by IoT devices, the suggested technology expedites the diagnosis of cardiac crises (around 99.46 percent). Complex DL models will be used in future versions of the remote patient monitoring system to keep tabs on things like blood volume. This new approach will be used in a variety of urgent care facilities in the future. [4]

Xiaowei Tanga et. All (2021) A key feature of the proposed framework is the use of cloud based IoT technology to deliver patient health reports directly to the end user. To improve the health monitoring system gateway and cut down on patient wait times, the IoT-HCMS framework was put into place in this study. In addition, we used the IoT-HCMS framework to classify the patient's health state as healthy or unhealthy while reducing the amount of data transmitted to the cloud. In the face of complex numerical problems, data is tracked in real time in the cloud. To prevent the loss of potentially lifesaving patient signals during an emergency, an incident-initiating system has been put in place. Indices of patient health (PHIs) are computed in the cloud and used to gauge the severity of the problem. There are connections to be made between individual instances and the nuggets of information that underpin good judgement. In the event of a medical emergency, it is essential that data be uploaded to the cloud as quickly as possible. Finally, the proposed method is improved by the timely production of warnings and an estimated event's severity. [5]

Lakshmi Sudha et. All (2021) Here, we'll take a look at some of the latest medical breakthroughs enabled by cloud computing and the Internet of Things. iCAIDL, or intensive cloud-assisted deep learning, is a novel paradigm that combines two effective tools in a single, streamlined framework. Our first strategy makes use of the Internet of Things in conjunction with the cloud computing paradigm to facilitate communication and interaction between our proposed smart device and remote servers and to provide adequate storage space according to data needs and the number of patients or elderly people. On the other hand, the Cloud IoT paradigm coupled with machine learning technologies may foresee problematic circumstances for patients, warning doctors or caretakers so they can act accordingly. Both patients and caregivers can benefit from the proposed iCAIDL logic, which makes it easier for the end user to identify patient or elderly people's health information in a more thorough manner without adding human error and makes the whole metrics totally transparent. The proposed approach protects patients' personal information in the face of the widespread problem of data loss or corruption in medical records. Our research has shown that when a remote server is utilized in place of a local workstation for all operations and storage, the simulation is accurate to within a 30% margin of error. To make this even better, a multi-cloud server component can be added to the current Single Cloud design that is based on the Internet of Things. Processing and searching data in a multi-cloud scenario is quicker and more accurate than maintaining everything in a single cloud architecture. [6]

Gia Nhu Nguyen et. All (2021) Using the CPS classification model and block chain-based data transmission, this work proposes a safe healthcare intrusion detection system. Implementing the model requires a number of steps, including data collection, intrusion detection using DBN, encryption using MSC, data transport using block chain, and classification using Resent 101. Data from NSL-KDD 2015, CIDDS-001, and ISIC are used to evaluate the model's efficacy. The presented DBN model achieved a 98.95% detection rate in the NSL-KDD 2015 competition and a 98.94% detection rate in the CIDDS-001 competition using only simulated data. Resent

101's model provided in the study on classification performance had a sensitivity of at least 96.12%, a specificity of at least 96.13%, and an accuracy of at least 96.13%. The effectiveness of the method for CPS in clinical settings was experimentally proven. A future application of hyper parameter tuning algorithms and learning rate schedulers can further improve the performance of the proposed models. [7]

Aiman Jan et. All (2021) Safeguarding sensitive information is essential for the widespread adoption of IoT services and gadgets. In this study, we describe a simple image steganographic method that can be utilized for secure data transmission in low-bandwidth settings as those seen in smart industrial, smart healthcare, and smart residential applications. If implemented, the proposed method would allow for more information to be hidden in an image's edge area than in a smooth area, with little to no loss in quality. In this paper, we introduce a steganographic framework that makes use of a canny/LoG edge detector hybrid that we have created. Red, green, and blue are the host image's primary colors, and they are utilized to hide information (B). We employ a (k, n) embedding technique to mask data in the green and blue channels of both edge and nonedged pixels. The host pixels in the green and blue channels are copied to the red channels for blind detection at the receiver. Several subjective and objective quality indicators have been used to validate the notion. PSNR, NCC, and NAE are used to assess the quality of the proposed method. In comparison to the average values given by the NCC and the NAE, the PSNR values achieved by the suggested method are 48.12 dB, an increase of 14.32%. (0.99 and 0.0047 dB, respectively). Even with a sizable payload, our method can produce high-quality steno-images with near-unity NCC values and very small NAE values. We demonstrate the statistical validity of the suggested approach using a histogram analysis. We also ran a computational time analysis to see how long it would take to do the task using the recommended strategy. The new technology can perform both embedding and extraction in less than a second, significantly reducing processing time. When compared to similar state-of-the-art systems, the suggested system excels in many areas, including PSNR, payload, NCC, NAE, computing time, etc. The suggested technique is applicable for IoT-driven infrastructure in a CPS setting due to its properties, such as geographic domain embedding and a high embedding capacity. There is potential for this strategy to be improved by the application of frequency domain techniques in the future. [8]

Jafar et. All (2021) From the results of this research, a new authentication method for IoT medical devices has been proposed. By integrating a blockchain-based IoT cloud network with patient and hospital health records, the LMDS system does away with the need for a third party. This method streamlines the processes of deploying apps, creating signatures, and verifying them. Sensitive medical information was protected while transmission over the IoT network with the use of authentication techniques like LMDSG and LMDSV. Using a Lamport Signature, we can reduce CT and CO emissions using this technique. To avoid having to generate and store the signature in each every IoT device, this method can be used instead. The use of lengthy hash values is a further safeguard against imposter users. There is no effect of sample size on the stability of CT and CO. Experimental results demonstrate that LMDS reduces CT and CO by 25% while enhancing security by 7%. With LMDS's ability to keep track of a wide range of crucial factors, we can accommodate a larger number of users without significantly increasing the CT and CO. [9]

Krithika P J et. All (2021) During the epidemic, patients pushed for this development because they desperately needed medical care. In that case, a wearable Internet of Things gadget could be incredibly helpful. The authors built a prototype device using an ARM microprocessor and Wi-Fi module (LPC2148) and connecting it to the sensors that would be most useful in this situation: thermometers, electrocardiographs, and pulse oximeters. With the help of the ubidots IoT data and the Bluetooth serial controller app, medical professionals may be updated on the patient's condition. There were many challenges, but we succeeded in reaching our destination. [10]

Hassan Ali et. All (2021) It is suggested that patients use a wearable heart rate monitor connected via the Internet of Things (IoT). There is an ECG monitor with three leads. Wearable’s that make use of Bluetooth Low Energy can communicate with the user's smartphone (BLE). The user's ECG readings are shown on a companion Android app, which can also sound an alarm in the event of arrhythmia. The user and their doctor can either utilize cloud storage to access and exchange their data, or the user can use an Android app to transmit their data directly to their doctor's phone. In real-time, the doctor can watch the selected user's ECG trace and heart rate on his or her smartphone and utilize this information to diagnose a variety of arrhythmias (bradycardia or tachycardia). The CMRR of the system can be increased to 121 dB by incorporating an RLD circuit into the AFE to mitigate interference from the 50 Hz power line frequency lines. Thanks to digitally inserted notch filters, the interference from the 50 Hz power line can be suppressed or even completely removed. A PSoC

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microcontroller can be included into the design of a wearable device to increase its flexibility and reduce its size, weight, and cost. The cloud allows several users to contribute data at once, allowing multiple clinicians to examine the same patient record. Users' locations can be tracked in real-time for up to 25 hours with this method. In testing, it was found that the device could generate clean ECG signals meeting all the specifications, with no 50 Hz residual noise. It was proven that the device's built-in QRS detection algorithm had excellent sensitivity and produced no false negatives. It was also demonstrated that the device's accuracy and reliability in detecting cardiac abnormalities were on par with that of a commercial heart rate application. Indeed, both the latency and response time of the system are quite low. For the foreseeable future, Android smartphones will outsell Apple iPhones due to their cheaper prices and higher durability. The suggested system is a low-latency and high-performance real-time ECG monitoring system with great potential for use in rural areas and in the case of a COVID-19 pandemic. [11]

Guangyu Xu et. All (2020) In order to better monitor cardiac health, we introduce a novel Internet-of-Things-assisted signal processing framework for ECG quality. This study demonstrates methods for the automated evaluation of the quality of ECG signals gathered in relation to the patient's physical activity. After extensive testing, it was determined that the proposed ECG-SQA holds its own against established methods involving morphology, the RR interval, and machine learning algorithms. The results reveal that when physical activity increases, ECG signals drop. Lightweight ECG Signal Strength Analysis (SSA) is proposed to drastically cut down on battery energy consumption by sending acceptable ECG signals in IoT devices disguised as unwanted ECG signals. Transmission security for electrocardiogram (ECG) data is supported by the Lightweight Secure IoT (LS-IoT) and the Lightweight Access Control System (LAC-S) (LAC). By reducing the number of false alarms for recordings with significant ECG noise, this study suggests that incorporating ECG Signal Strength Analysis (SSA) with a cardiac health control enabled IoT device could have significant implications for the resource efficiency, security, and reliability of uncontrolled signal analyses and diagnostic systems. Modern machine learning algorithms will soon be included into ECG health monitoring systems. [12]

Ben Othman Soufiene et. All (2021) Significant progress has been made in the areas of the Internet of Things, medical sensors, Internet apps, and online medical services, among others, in recent years. However, ongoing security issues will slow the expansion of the IoT. Healthcare applications are afraid of compromising patients' privacy or the veracity of their medical records due to this direct interaction. We suggest LSDA as an IoT-enabled approach to healthcare data aggregation. Based on the results of the performance studies, LSDA is the best choice for healthcare facilities using an IoT system and constrained devices. [13]

M.G. Sharavana Kumar et. All (2020) The biggest issues with real-time monitoring with IoT-enabled wearable sensor networks are their slow response time, lack of dependability, and excessive power consumption. When it comes to MAC, it's better to employ a dynamic method of time slot allocation rather than a static one. Via the healthcare industry, IoT devices generate massive volumes of data that enable the delivery of end-user services in a cloud based IoT architecture. For mission critical IoT applications, the latency of standard cloud services is unacceptable. Patients can be monitored constantly with the use of wearable sensor platforms and fog technologies. To speed up responses and lessen transmission errors, networks often employ a fog layer (or central coordinator) at their periphery. [14]

Chun-Li Zhong et. All (2020) Numerous research over the past two decades have looked at the PARM's potential for helping treat chronic diseases, rehabilitate musculoskeletal systems, and keep people of all ages and walks of life living healthy, active lives. Internet of Things methods can differentiate between two distinct types of healthy human physical activity: (1) commonplace activities like walking, and (2) people who partake in regular, structured exercise programs (e.g., free weightlifting). By employing PARM technologies, which have been proven to guarantee the wellbeing of the IoT ecosystem at a 98 percent performance ratio, the challenges have been surmounted. [15]

III. Methodology

3.1 Proposed Model Communication Method

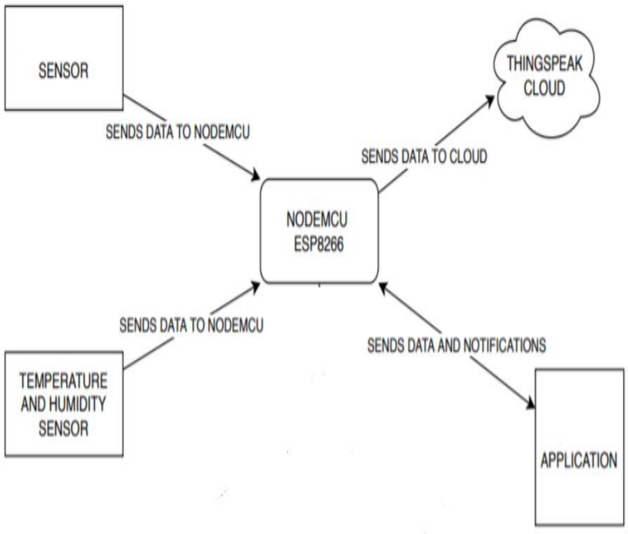

Figure: 3.1 Proposed Model Communication Method

The process is automated with the help of our suggested solution. The node MCU's ESP8266 microcontroller collects data from a number of sensors, including those that measure temperature, humidity, and vital signs. Read both temperature and humidity with the DHT11 Temperature and Humidity Sensor. Accurate environmental monitoring is possible thanks to the use of a capacitive humidity sensor and a thermistor-based temperature sensor. Data (I/O) - Digital serial Data Output, Ground (VCC), and Power (GND) are its three pins.

Microcontroller: As the microcontroller for the node, the ESP8266 is used. A platform for creating Internet of Things applications that use the free and open-source Lua programming language. The Wi-Fi SOC it uses is the ESP8266, and it comes preloaded with firmware that communicates with the ThingSpeak cloud and makes data accessible via mobile app. The "Power" pins are the first of various varieties. A USB port, a 3.3V power input pin, a ground pin, and an external power input pin labelled Vin are all included on the Micro-USB Node MCU. Second, pressing this button will reset the microcontroller (control pins EN, RST). The pulse sensor, to round things off, makes use of Analog pin A0's capacity to measure Analog voltage.

Sensor data is continuously collected by a microcontroller and then transmitted to the cloud and various mobile applications. When the data is collected, the Node MCU microcontroller with built-in WIFI will send it to the ThingSpeak cloud. Users using Android and iOS devices can use the Mobile App that provides this data.

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3.2 Connection Block Diagram

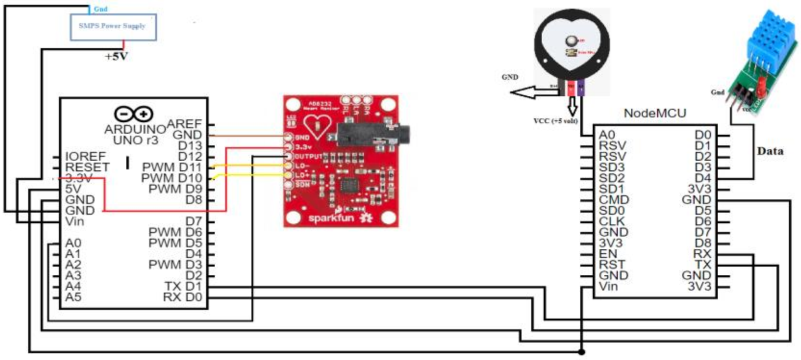

Figure: 3.2 Main Connection Diagram

The above figure is a connection diagram for the proposed work, and it displays the sensor connections developed for this project. A DHT11 temperature and humidity sensor and a pulse rate sensor are connected to the node MCU, while the ECG sensor is connected to the Arduino microcontroller board. The dht11's data pin was connected to the node MCU board's fourth GPIO (General purpose input output) port, and the pulse rate sensor's output pin was connected to the analogue input. Sensor for recording electrocardiogram (ECG) readings connected to an Arduino The ECG sensor's Lo- and Lo+ pins are wired to the Arduino board's analogue input pin. The dc leads off detection mode is engaged and LO is high when the IN electrode is disconnected, and the situation is reversed when the electrode is reconnected. One of a comparator's first outputs, LO+, is a logic one. When the +IN electrode is disconnected (high) and connected (low) in dc leads off detecting mode, LOD+ is active. Since all the boards and sensors need to be powered by a regulated 5V supply, we opted for a 5V SMPS (Switch Mode Power Supply).

3.3 ECG Code Flow Chart

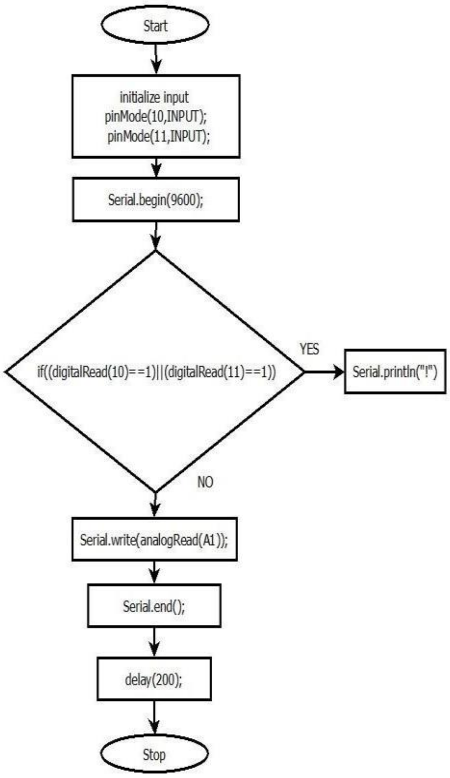

Figure: 3.3 ECG Code Flow Chart

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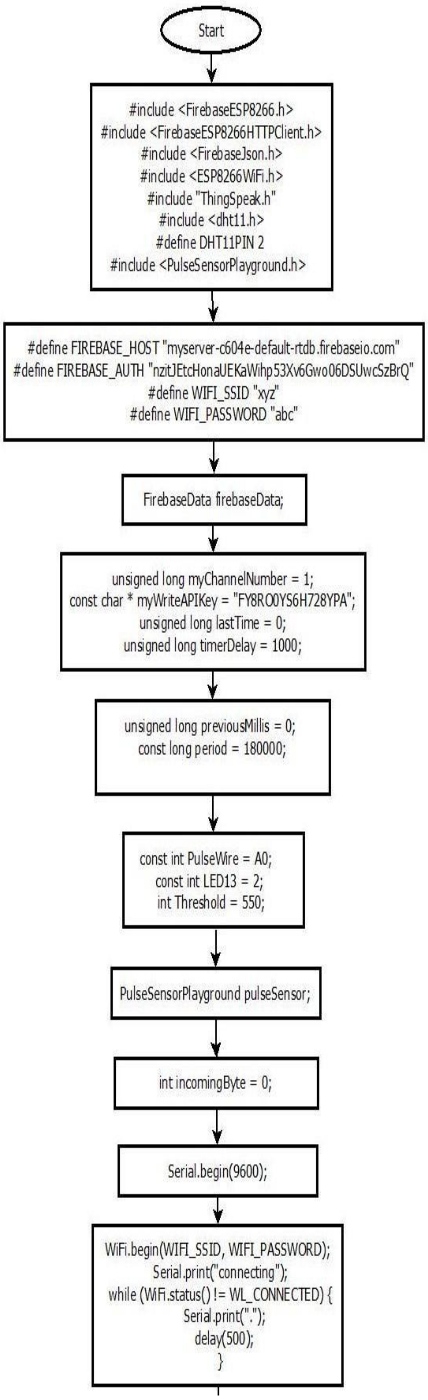
In the above figure, we can see the ECG algorithm for captured ECG data, this program is uploaded into the Arduino board because our ECG sensor is directly connected to the Arduino board, so this data is processed in Arduino after capture reading, these readings transferred to the node MCU via serial communication for update data on thingspeak web server. In this algorithm we can see, 1st the algorithm is started then the input is initialized we use pin number 10 and pin number 11 as input so these pins are initialized as input after this serial communication starts with the baud rate of 9600, after this, a condition will be applied that is if pin 10 and pin 11 found high then something will print on serial monitor if this condition is not true then transfer received reading to node MCU via serial communication with serial write function that is read by analog pin number 1 this pin is directly connected to ECG Sensor output data pin after this serial communication stop with serial end function then after 200 milliseconds algorithm will be stop and this loop is repeat till then Arduino connected with the power source.

3.4 NodeMcu (Esp8266) Code Flow Chart



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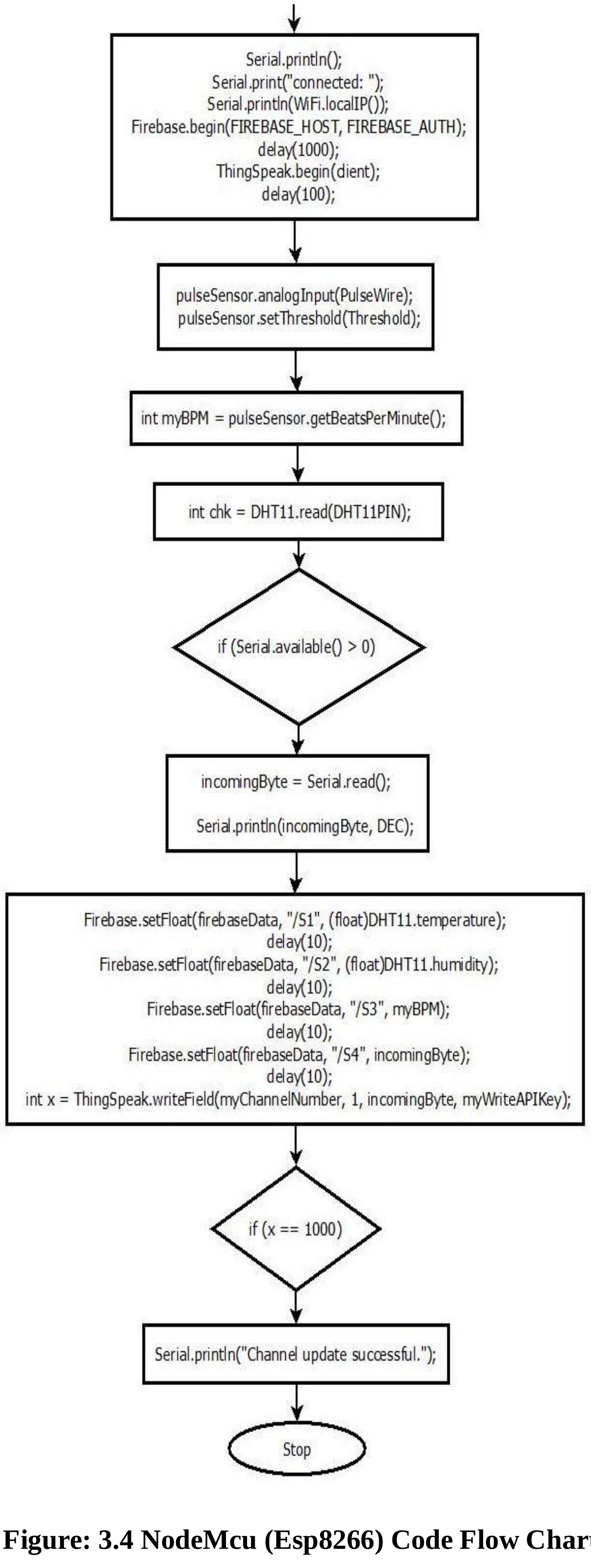

Figure: 3.4 NodeMcu (Esp8266) Code Flow Chart

The preceding flowchart illustrates the process by which the nodemcu application gathers sensor data, processes it, and then uploads the results to the proper locations on the firebase server and the thingspeak web server.

The algorithm is executed first, then the libraries for firebase, wifi, thingspeak, dht11, and the pulse sensor are initialized, and lastly the firebase host, key, and URL are displayed. Finally, the wifi SSID and password that have been stored are shown; these are used to establish a reliable connection between the router and the nodemcu. The next step is to set up a Thingspeak channel's API key, number, and URL after firebase data has been initialized. Once the timers have started, we will setup the pulse wire at analogue pin 0 to start taking pulse readings and set the maximum ignore value to 550. Once the byte has arrived, it is considered to be a 0. This variable is where Arduino stores information received via the serial port. The nodemcu wifi then begins scanning for networks according to a set SSID and password, connecting to them if successful and making the internet accessible. This process is repeated every 500 ms until the nodemcu is no longer online. To establish a connection between firebase and thigspeak, the nodemcu's serial print port must be linked to its local IP address through WiFi. The data from the pulses will be read via Nodemcu's analogue pin 0. In order to analyze the heart rate, beats per minute must be calculated. Then, check the nodemcu's digital pin 4 for the dht11 sensor's output, which details the ambient temperature and humidity. After that, we'll check the nodemcu's serial RX pin to see if any data has arrived. This would mean that data has been transferred between the arduino and the nodemcu, with the latter receiving it on its RX pin after it was transmitted from the former. If the criteria is met, the data is stored in the incoming byte variable. After this is finished, the firebase server receives the byte variable containing the processed data from the nodemcu and parses it into the strings S1 through S4 depending on the data type (temperature, humidity, pulse data, and electrocardiogram). A graph can be constructed from the ECG data that is transmitted to the thingspeak server. As a last step, we'll use the condition (x==1000) to verify that the graph was properly refreshed. After this algorithm exits, the serial print channel update is complete, and the loop resumes until the nodemcu is powered.

3.5 Firebase to Android Application Communication Flow Chart

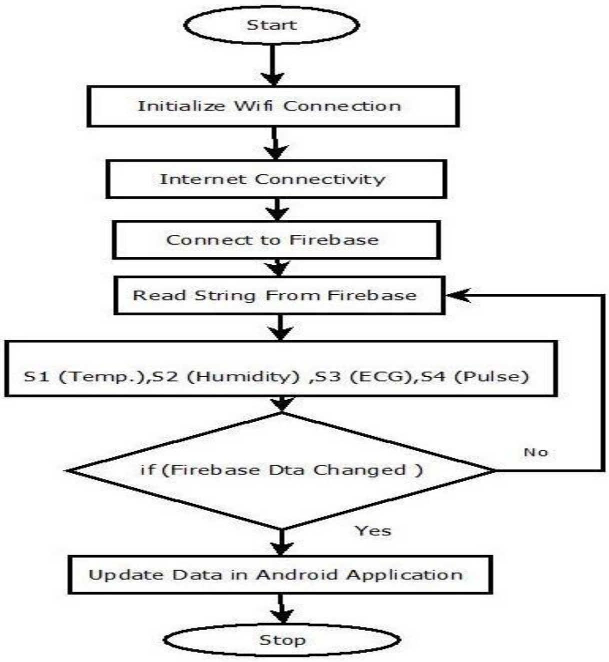

Figure: 3.5 Firebase to Device Communication Flow Chart

Whether you need hosting, authentication, storage, or anything else for your web project, Firebase has you covered. The infrastructure utilized by this work includes both a real-time database and a hosting service. Use Firebase's hosting service instead of operating a server and arranging deployment and networking. It doesn't cost anything (but has severe limitations) and it's easy to use. Firebase is a platform created by Google that can be used to build apps for both mobile and online platforms. All input/output devices are turned on and a Wi-Fi connection is made once the first line of code is executed, as shown in the preceding figure, which also details the rest of the steps that take place during a conversation between an Android app and the Firebase server. Sensor values are read from firebase after the system establishes a connection to the server when online. When string data in firebase is changed, for example when additional information is added, the relevant data in the mobile application is also updated.

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IV. Results

4.1 Serial Results

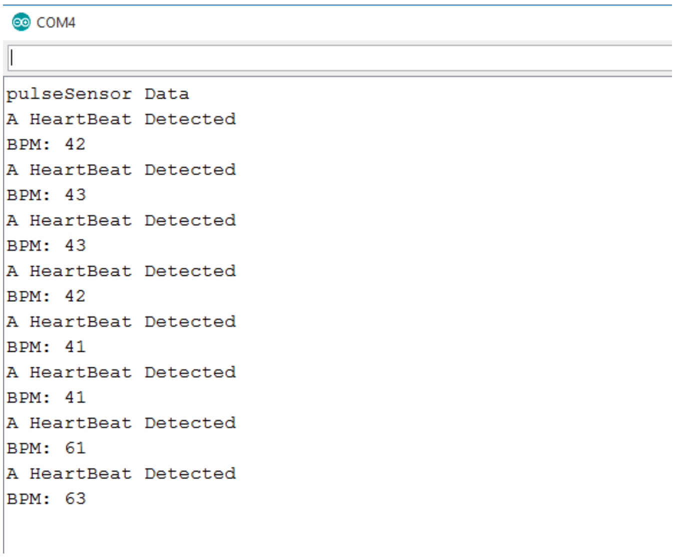

Figure: 4.1 Heartbeat Detection

In this above figure we can see pulse sensor data read by nodemcu and print on serial monitor of the arduino IDE.

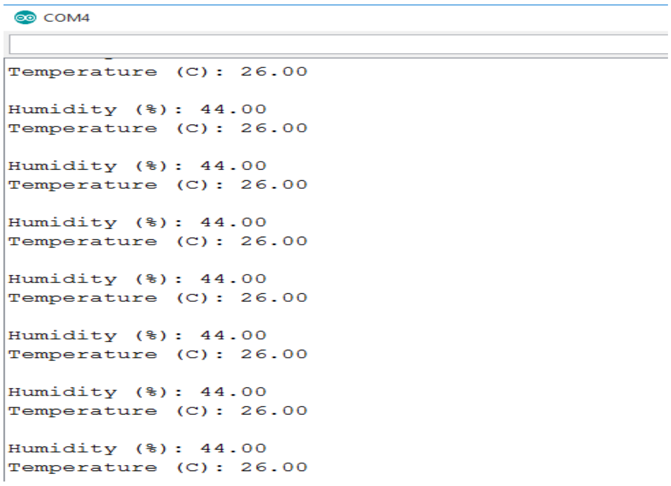

Figure: 4.2 Temperature and Humidity Detection

In this above figure we can see temperature and Humidity data sensor data read by nodemcu and print on serial monitor of the arduino IDE.

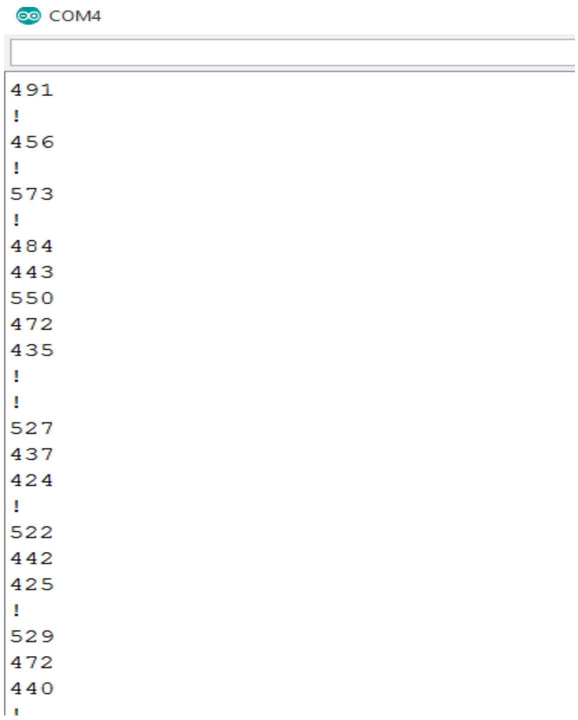

Figure: 4.3 ECG Readings

In this above figure we can see ECG sensor data read by nodemcu and print on serial monitor of the arduino IDE.

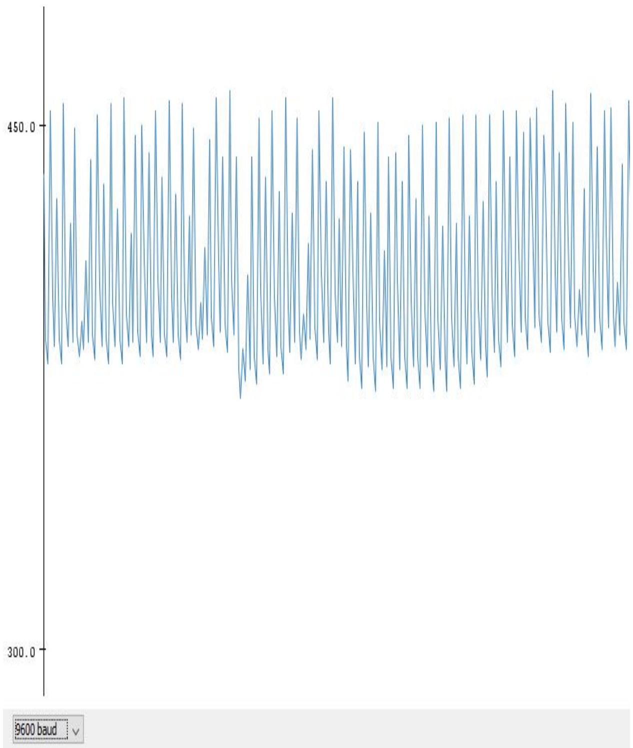

Figure: 4.4 ECG Graph

In this above figure we can see ECG Graph on serial monitor of the arduino IDE.

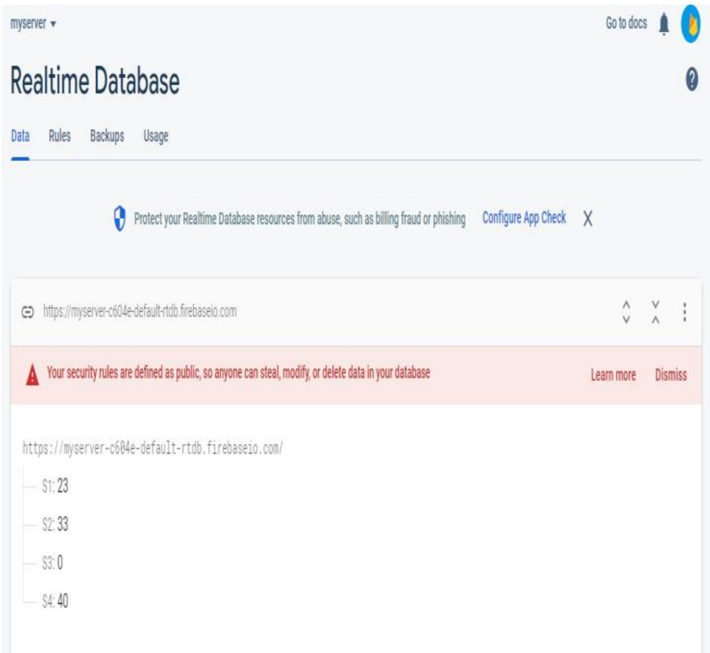

Figure: 4.5 Real-time FireBase DataBase

In the above figure we can see our real time firebase database for store data in S1,S2,S3,S4 string in real time and this data is used for communication between nodemcu and android application.

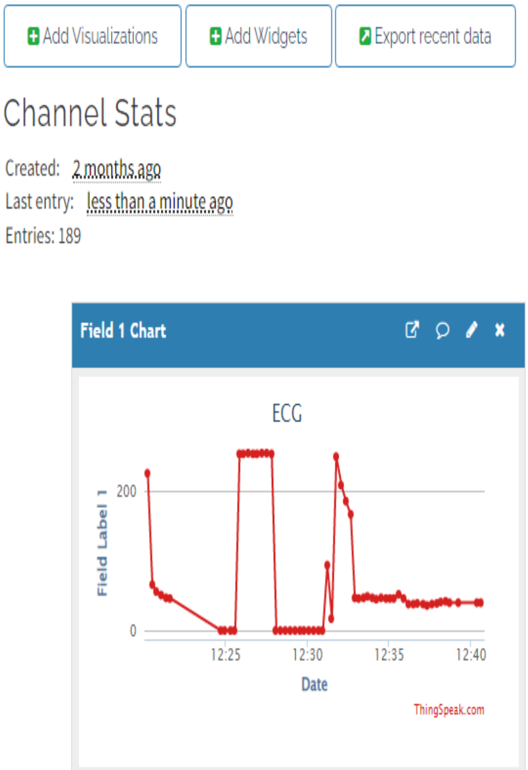

Figure: 4.6 ECG Graph On Thingspeak Server

In the above figure we can see graph plot of ECG data on the thingspeak website.

4.2 Android Application Results

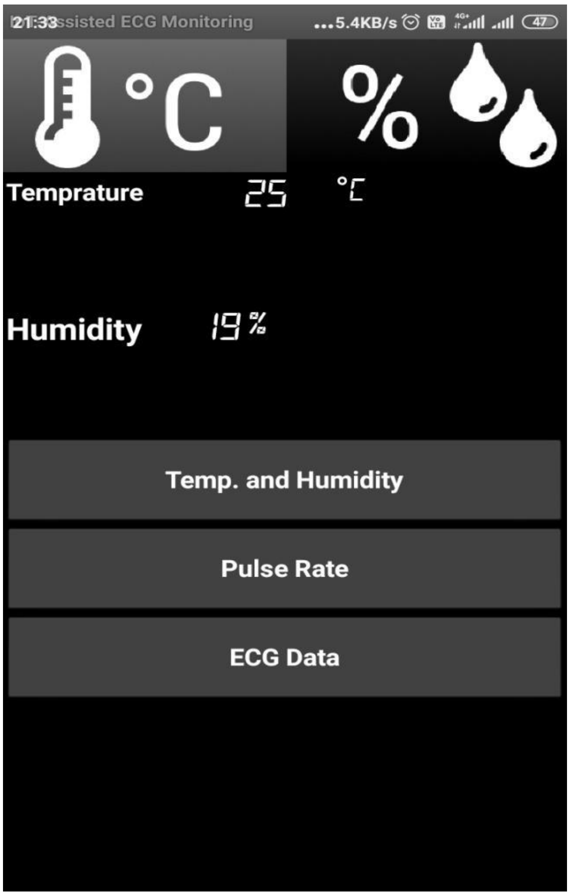

Figure: 4.7 Temperature and Humidity on Android Application

In the above figure we can see temperature and humidity on the our developed android application, this data is captured from our firebase database.

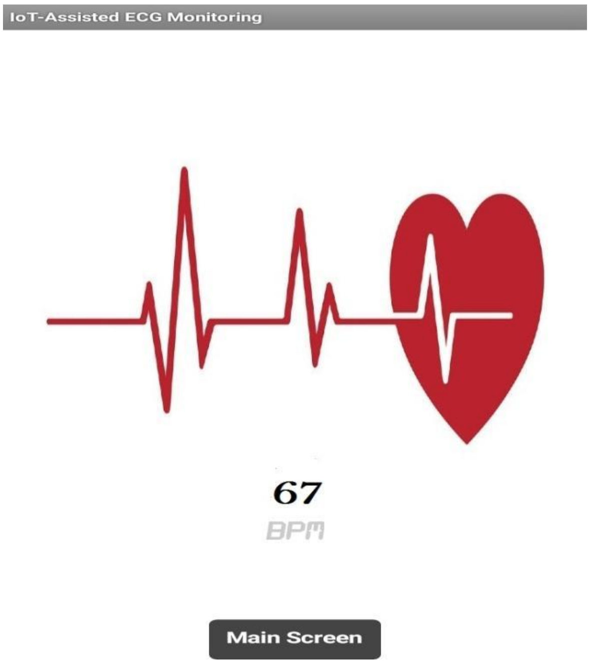

Figure: 4.8 Beats Per Minute On android Application

In the above figure we can see heat beat reading in real time in the form of beats per minute on the our developed android application, this data is captured from our firebase database.

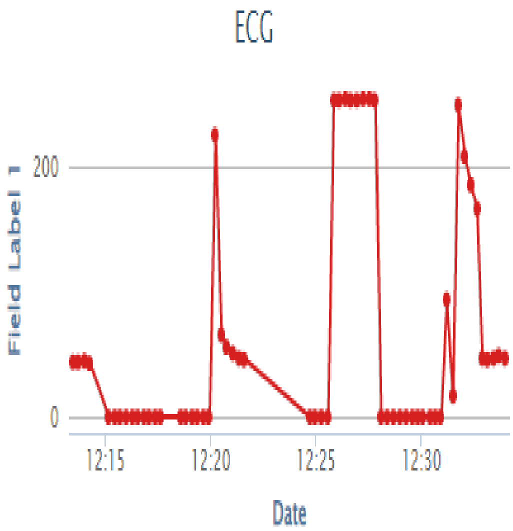

Figure: 4.9 ECG Graph On Android Application

In the above figure we can see ECG graph in real time on the our developed android application, this data is captured from our thingspeak web server.

V. CONCLUSION

For both individuals and governments, the rising cost of providing adequate medical treatment has emerged as one of the most pressing issues in recent years, especially in light of the global population boom and the rising need for health insurance. However, a recent WHO report highlights how serious issues associated with an ageing population. The health of the elderly must be monitored more frequently, providing a more visible test of existing medical frameworks. Human disease diagnosis needs careful thought so that it can be done easily, accurately, and cheaply. Sensors, embedding devices, and other 'things' can now be designed with the detecting, processing, and communicating capabilities made possible by the growing Internet of Things (IoT) framework. In order to keep tabs on a patient's heart health round-the-clock, a system for IoT-assisted electrocardiogram (ECG) monitoring has been developed. This research presents a novel Internet-of-Things-assisted methodology for ECG quality, with potential applications in heart health surveillance. Sensors, a centralized processing unit, and a database platform are all useful tools for Internet of Things healthcare applications. The electrocardiogram (ECG) monitoring system described in this thesis takes advantage of IoT technology to either upload real-time data to a server or generate an ECG graph viewable on a smartphone. The android application developed in this proposed work displays the patient's current temperature, humidity, and heart rate also ECG graph plot in real time. We provide a lightweight way for remotely updating data quickly with long distance.

VI. Future scope

Blood pressure, glucose levels, and respiration rate are just a few of the additional health indicators that may be tracked without intrusive procedures. As a result of its potential to improve the speed and accuracy with which medical diagnoses are made, machine learning technology is also a potentially crucial component of any healthcare monitoring system. Furthermore, other strategies can be introduced to this project in the event of an emergency, when there is an abnormal signal produced by the patient's body. First, by integrating a SIM800L GSM Module into the system, this project will be able to make and receive phone calls, as well as send and receive SMS messages, to hospitals, homes, and emergency medical service hubs. Automatic life-saving emails can be sent from NodeMCU to particular email addresses. Second, a DC defibrillator can be worn by the patient and coupled to the body to deliver DC shocks automatically in the event of a VF (Ventricular Fibrillation). Last but not least, an automatic ventilation system can be added to this setup to supply oxygen in the event that the SPO2% drops below 90%.

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