“Real Time Cardiac Monitoring Device Using IoT”

A PROJECT REPORT

Submitted By

DHARITRI. H. TOSHIKHANE (190303107085)
KRATIKA KADAM (190303107030)
JYOTHI PRAKASH VUTI (190303107090)
MILTON PONDECA (190303107068)

IN FULLFILLMENT FOR THE AWARD OF THE DEGREE

Of

BACHELOR OF TECHNOLOGY

In

Department of Electronics & Communication Engineering,

UNDER THE GUIDANCE OF

Dr. Arvind Yadav

PARUL INSTITUTE OF ENGINNERING AND TECNNOLOGY

ELECTRONICS AND COMMUNICATION ENGINNERING DEPARTMENT
PARUL INSTITUTE OF ENGINNERING AND TECNNOLOGY
FACULTY OF ENGINEERING AND TECHNOLOGY
PARUL UNIVERSITY

March, 2023

CERTIFICATE

This is to certify that the project work entitled **"Real Time Cardiac Monitoring Device using IoT"** for subject Project-II of 8th semester, group number PUECE01 has been successfully completed by **Dharitri Hemant Toshikhane-190303107085** in fulfilment of final year of the Bachelor of Technology (B. Tech) in Electronics & Communication Parul University in Academic Year 2022-2023 is a record of the group of the student's own work carried out by them under my supervision and guidance. Information derived from the published work of other has been acknowledge in the text and a list of reference is given.

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PARUL UNIVERSITY

Dr. Arvind Yadav
(Project Supervisor)

Prof. Anuradha Gharge
(Project Co-ordinator)

External Examiner

Dr. Kalpesh Jadhav
(HOD)

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This is to certify that the project work entitled **"Real Time Cardiac Monitoring Device using IoT"** for subject Project-II of 8th semester, group number PUECE01 has been successfully completed by **Kratika Kadam- 190303107030** in fulfilment of final year of the Bachelor of Technology (B. Tech) in Electronics & Communication Parul University in Academic Year 2022-2023 is a record of the group of the student's own work carried out by them under my supervision and guidance. Information derived from the published work of other has been acknowledge in the text and a list of reference is given.

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Prof. Anuradha Gharge (Project Co-ordinator)

External Examiner

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This is to certify that the project work entitled **"Real Time Cardiac Monitoring Device using IoT"** for subject Project-II of 8th semester, group number PUECE01 has been successfully completed by **JYOTHI PRAKASH VUTI- 190303107090** in fulfilment of final year of the Bachelor of Technology (B. Tech) in Electronics & Communication Parul University in Academic Year 2022-2023 is a record of the group of the student's own work carried out by them under my supervision and guidance. Information derived from the published work of other has been acknowledge in the text and a list of reference is given.

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Dr. Kalpesh Jadhav
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CERTIFICATE

This is to certify that the project work entitled **"Real Time Cardiac Monitoring Device using IoT"** for subject Project-II of 8th semester, group number PUECE01 has been successfully completed by **Milton Pondeca- 190303107068** in fulfilment of final year of the Bachelor of Technology (B. Tech) in Electronics & Communication Parul University in Academic Year 2022-2023 is a record of the group of the student's own work carried out by them under my supervision and guidance. Information derived from the published work of other has been acknowledge in the text and a list of reference is given.

Year: - 2022-2023

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PARUL UNIVERSITY

Dr. Arvind Yadav	**Prof. Anuradha Gharge**
(Project Supervisor)	(Project Co-ordinator)
External Examiner	**Dr. Kalpesh Jadhav**
	(HOD)

ABSTRACT

The main aim of this project is to develop a Real-Time Cardiac Monitoring Device. To be able to detect basic Cardiac related ailments. People susceptible to cardiac ailments, their cardiac functions can be regularly monitored by using this low cost sensor network by detecting such diseases at an early period in golden time. Therefore many lives can be saved by early intimation to the experts. The device is capable of detection of the heart related conditions for Example: Cardiac Arrest, Tachycardia, etc. The device is constructed at a reasonable price and is easy to use. It will help the concerned person or specialist at a distance to monitor and act on the patient's condition within golden period.

Wearable bias using electrode detectors for health monitoring can prop the timely discovery of varied symptoms, and hence prompt remedial conduct can be carried out. In particular, the monitoring of heart affiliated events by using similar wearable detector integrated devices can give real- time and more applicable opinion of cardiac arrhythmias than classical results.

ECG monitors with features such as portable/wearable, wireless, user-friendly, low-cost and convenient at home, are more and more necessary. Electrocardiogram (ECG) signals monitoring, a process in which battery-operated wearable sensors collect long-term recording of ECG signals.

Healthcare Internet of Things (HIoT) can link mobile and wearable devices in the medical field, making ailment monitoring and diagnosis possible anytime and anywhere. Utmost of these movable and wearable bias can accumulate bodily signals in real time. This design stresses on designing and developing a device for prognosticating arrhythmia (atrial fibrillation) in conjunction with covering the ECG signals. To produce an arrhythmia vaticination model and an IoT grounded real- time ECG surveillance system.

KEYWORDS: AD8232, Wi-Fi module, Health Internet of things (IOT), ESP32, Remote Monitoring system, golden period.

ACKNOWLEDGEMENT

We are deeply indebted to our Internal Guide Dr. Arvind Yadav and Prof. Aslam Durvesh for their constant guidance, motivation, suggestion and encouragement through project work and for being helpful in making our hardware more effective. They have devoted significant amount of their valuable time to plan and discuss the project with us. Without their experience and insights, it would have been very difficult to do this distinctive work.

We are thankful to our project Coordinator Prof. Anuradha Gharge of Electronics & Communication Engineering Department, Parul Institute of Engineering and Technology, Parul University for directing us to carry out this project at given time and by discussing about reading, searching and writing of literature review and guiding us about the project aspects and for generous assistance and cooperation.

We would like to express our sincere gratitude to Dr. Kalpesh Jadhav of E & C, HOD, PIET, Parul University for supervising us in this project work.

Last but not the least, we would like to thank our college, faculties of ECE department, friends for helping out in difficult situations during our project work and also our parents for supporting us throughout completion of the hardware development and literature review.

Above all we would like to thank almighty for giving us strength to build the hardware and complete the project work with success.

DHARITRI. H. TOSHIKHANE (190303107085)

KRATIKA KADAM (190303107030)

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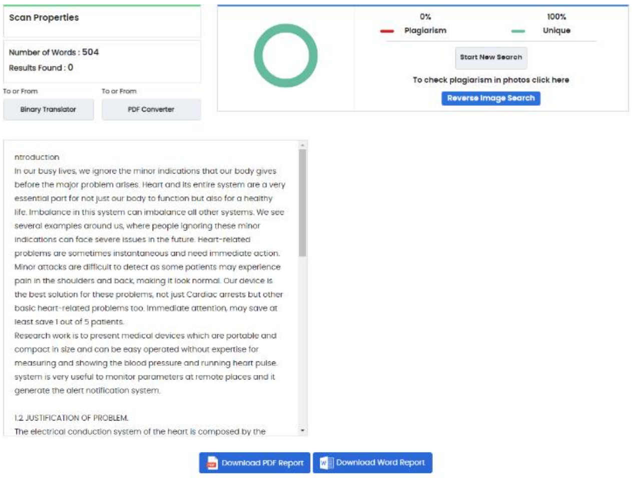

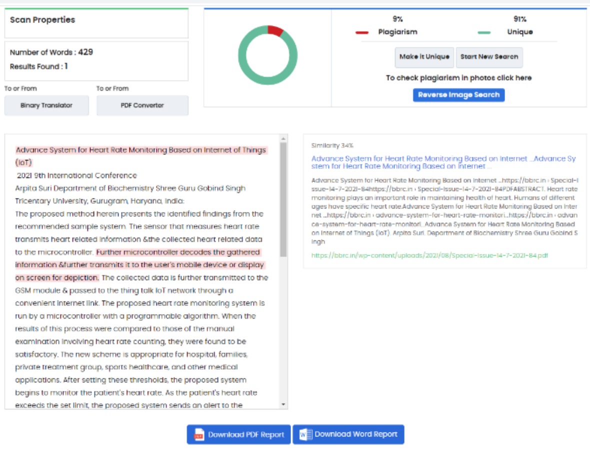

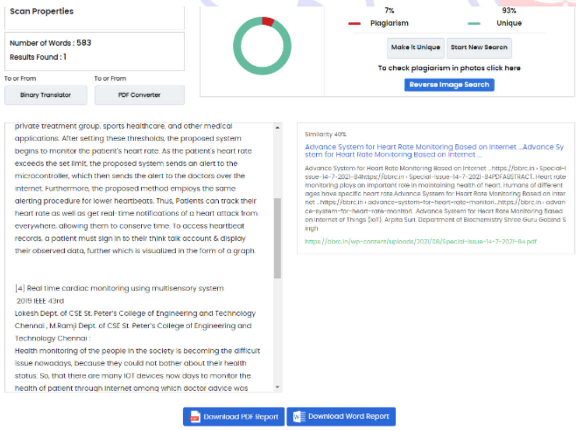

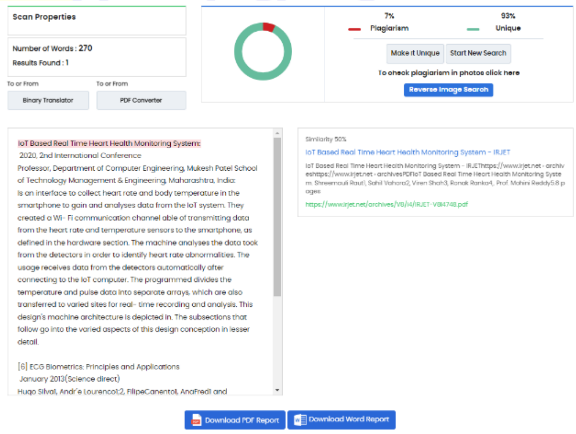

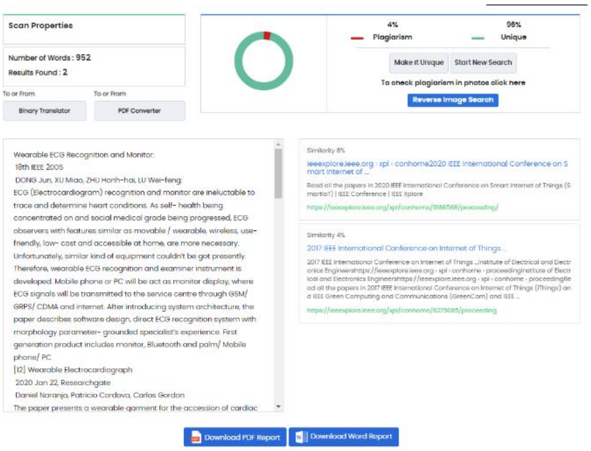
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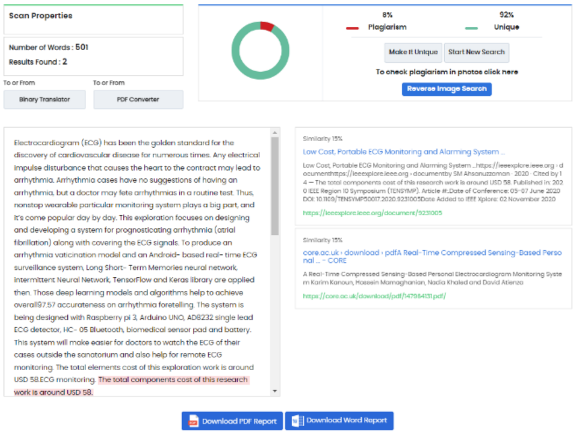
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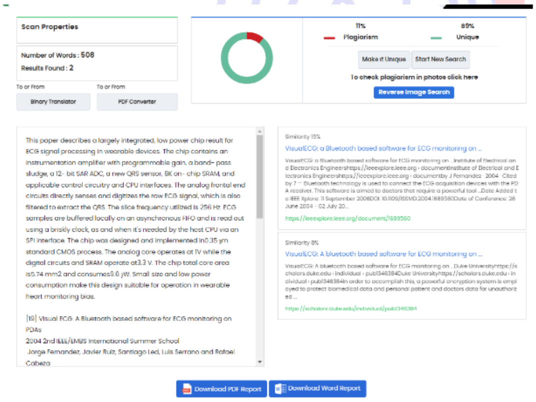
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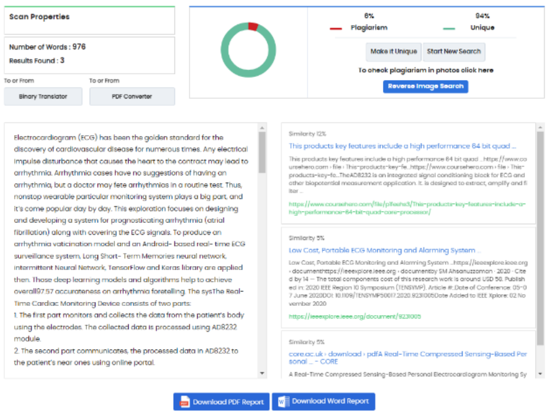
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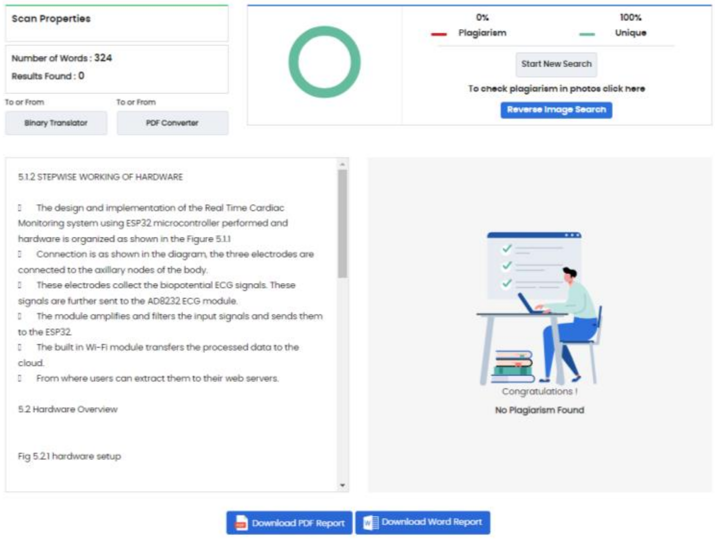
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5.1.2 STEPWISE WORKING OF HARDWARE
The design and implementation of the Real Time Cardiac Monitoring system using ESP32 microcontroller performed and hardware is organized as shown in the Figure 5.1.1
Connection is as shown in the diagram, the three electrodes are connected to the axillary nodes of the body.
These electrodes collect the biopotential ECG signals. These signals are further sent to the AD8232 ECG module.
The module amplifies and filters the input signals and sends them to the ESP32.
The built in Wi-Fi module transfers the processed data to the cloud.
From where users can extract them to their web servers.
5.2 Hardware Overview
Fig 5.2.1 hardware setup
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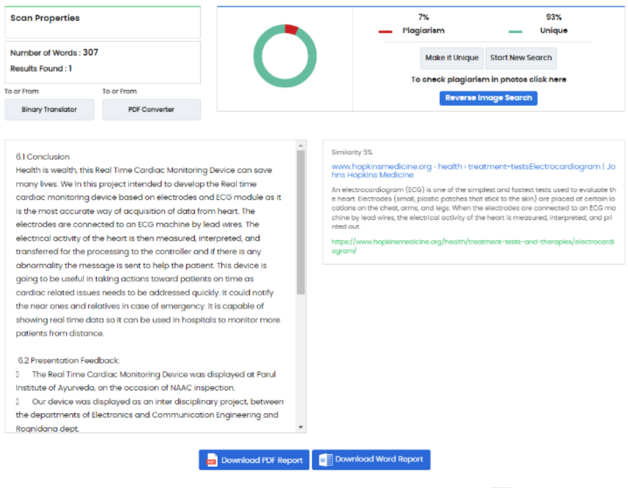
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6.1 Conclusion
Health is wealth, this Real Time Cardiac Monitoring Device can save many lives. We in this project intended to develop the Real time cardiac monitoring device based on electrodes and ECG module as it is the most accurate way of acquisition of data from heart. The electrodes are connected to an ECG machine by lead wires. The electrical activity of the heart is then measured, interpreted, and transferred for the processing to the controller and if there is any abnormality the message is sent to help the patient. This device is going to be useful in taking actions toward patients on time as cardiac related issues needs to be addressed quickly. It could notify the near ones and relatives in case of emergency. It is capable of showing real time data so it can be used in hospitals to monitor more patients from distance.
6.2 Presentation Feedback:
The Real Time Cardiac Monitoring Device was displayed at Parul Institute of Ayurveda, on the occasion of NAAC inspection.
Our device was displayed as an inter disciplinary project, between the departments of Electronics and Communication Engineering and Rognidana dept.
Similarity 5%
www.hopkinsmedicine.org › health › treatment-testsElectrocardiogram | Johns Hopkins Medicine
An electrocardiogram (ECG) is one of the simplest and fastest tests used to evaluate the heart. Electrodes (small, plastic patches that stick to the skin) are placed at certain locations on the chest, arms, and legs. When the electrodes are connected to an ECG machine by lead wires, the electrical activity of the heart is measured, interpreted, and printed out.
https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/electrocardiogram/
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CHAPTER 1

1.1 Introduction

In our busy lives, we ignore the minor indications that our body gives before the major problem arises. Heart and its entire system are a very essential part for not just our body to function but also for a healthy life. Imbalance in this system can imbalance all other systems. We see several examples around us, where people ignoring these minor indications can face severe issues in the future. Heart-related problems are sometimes instantaneous and need immediate action.

Minor attacks are difficult to detect as some patients may experience pain in the shoulders and back, making it look normal. Our device is the best solution for these problems, not just Cardiac arrests but other basic heart-related problems too. Immediate attention, may save at least save 1 out of 5 patients.

Research work is to present medical devices which are portable and compact in size and can be easy operated without expertise for measuring and showing the blood pressure and running heart pulse. system is very useful to monitor parameters at remote places and it generate the alert notification system.

1.2 JUSTIFICATION OF PROBLEM.

The electrical conduction system of the heart is composed by the sinoatrial node (SA node) that normally initiates the cardiac cycle, the atrioventricular node (AV node), the internodal atrial pathways, which connect the two and regulate the passage of the cardiac impulse from the atria to the ventricles. This system enables the electrical triggering impulses generated at the SA node, to be propagated from the wall of the right atrium. When measured non-invasively, the ECG records the combined contribution of each component of the electrical conduction system, as propagated to the body surface. The current device can detect a heart attack only within 20 mins after the attack is started. Due to which the patient remains untreated for a sufficient amount of time, to create complications. Fig1.1 depicts different types of methods to detect cardiac signals, out of which we are using the ECG.

1.3 Scope

The concerned patient needs to wear this device on their chest which is integrated in a jacket. The device will be sending real time data collected from the sensors to the cloud by the use of IoT technology, whenever worn by patient. Due to the advancement in Medical Science, the system is getting cheaper to monitor and treat the patients. Therefore, this implies that in the future more Doctors and Health workers are going to adopt our device.

1.4 Aim and Objective

1.4.1 Aim

To provide real time heart parameters through IoT and give alert notifications to the nearby hospitals and acquaintances in the case of emergency.

1.4.2 Objective

- To be able to detect basic Cardiac related diseases.
- It will help the concerned person or specialist at a distance to monitor and act on the patient's condition and alert the nearby hospitals and people for help in emergency.
- To construct this system at a reasonable price and easy to use.
- To make a device portable, accurate and fast in action.

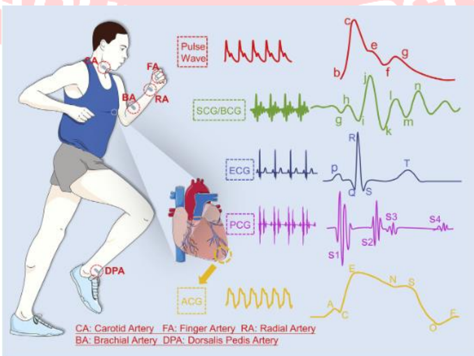

Fig 1.1 Illustrating different heart parameters and signals [i]

CHAPTER 2

2.1 LITERATURE REVIEW:

This device is a real time cardiac monitoring system which will constantly monitor the patient's heart parameters such as heart rate, oxygen levels, respiratory levels, pulse rate etc. and will send the data to the internet by using the Internet of Things. In case of the abnormal threshold values, it considers it as cardiac arrest and sends notification to the nearby hospitals in case of emergency detected. It is very comfortable to wear and compatible. Allows mobility to patients and can be monitored and operated easily.

[1] <u>Real Time Health Monitoring System Through IoT Using Sensors</u>

2020 2nd International Conference

Professor, Department of Computer Engineering, Mukesh Patel School of Technology Management & Engineering, Maharashtra, India:

The healthcare observing system requires the three-stage architectural features: Sensor Module, Data Processing Module, Web User Interface. The process starts when power is supplied to the Arduino UNO R3. As it boots up its operating system, it triggers the sensors to start. All the sensors are triggered at the same time approximately, thus the delay in the sensors is very low. Sensor Module is the part where the sensors come in contact with the human body and check for the signal, from which they gather the information. The temperature sensor senses the heat waves and stores the temperature. The SpO2 sensor senses the O2 content in blood and stores the O2 level of the individual. The heart beat sensor senses the beats per minute and the ECG sensor senses the pathway of electrical impulses through the heart muscle and stores the values. Data Processing Module is a part where the data collected by the sensors are transferred to the web application through the Wi-Fi Module. The Arduino UNO R3 not only acts as a power supply but also collects the data output from the above sensors and then processes them into an output that gets displayed on the LCD display. All four sensors are connected to the Arduino from which it gets its input, and turn those into an output, which gets displayed on the LCD screen.

[2] IoT based real time cardiac monitoring system using body sensor network

2021 9th International Conference

Ajay Joel Abraham 1, Allan Thomas 2, Dr. Jayarama Pradeep 3 Department of Electrical and Electronics Engineering St. Joseph's College of Engineering Chennai:

It is a high-performance board that uses an open-source platform for prototyping of Wearable IoT devices. It combines MediaTek Aster which is the world's leading SoC for Wearables with high performance Wireless-Fidelity and Global Positioning System chipsets. It provides pin-out features similar to Arduino boards and this helps to connect various sensors, peripherals, and Arduino shields easily.

This system is mainly used to monitor the pulse automatically. The collected data will be stored in the cloud and will be continuously monitored automatically for irregularities. When the pulse rate goes above or below normal values, the chances of heart rates are maximum and such a situation will be notified to both the user and a primary contact through IoT.

[3] Advance System for Heart Rate Monitoring Based on Internet of Things (IoT)

2021 9th International Conference

Arpita Suri Department of Biochemistry Shree Guru Gobind Singh Tricentary University, Gurugram, Haryana, India:

The proposed method herein presents the identified findings from the recommended sample system. The sensor that measures heart rate transmits heart related information &the collected heart related data to the microcontroller. Further microcontroller decodes the gathered information &further transmits it to the user's mobile device or display on screen for depiction. The collected data is further transmitted to the GSM module & passed to the thing talk IoT network through a convenient internet link. The proposed heart rate monitoring system is run by a microcontroller with a programmable algorithm. When the results of this process were compared to those of the manual examination involving heart rate counting, they were found to be satisfactory. The new scheme is appropriate for hospital, families, private treatment group, sports healthcare, and other medical applications. After setting these thresholds, the proposed system begins to monitor the patient's heart rate. As the patient's heart rate exceeds the set limit, the proposed system sends an alert to the microcontroller, which then sends the alert to the doctors over the internet. Furthermore, the proposed method employs the same alerting procedure for lower heartbeats. Thus, Patients can track their heart rate as well as get real-time notifications of a heart attack from everywhere, allowing them to conserve time. To access heartbeat records, a patient must sign in to their think talk account & display their observed data, further which is visualized in the form of a graph.

[4] <u>Real time cardiac monitoring using multisensory system</u>

2019 IEEE 43rd

Lokesh Dept. of CSE St. Peter's College of Engineering and Technology Chennai , M.Ramji Dept. of CSE St. Peter's College of Engineering and Technology Chennai :

Health monitoring of the people in the society is becoming the difficult issue nowadays, because they could not bother about their health status. So, that there are many IOT devices now days to monitor the health of patient through internet among which doctor advice was been held more convent tool to make jobs of doctors to patients. The request delivers modified advice of doctors with various sickness methods, and after patients will choose one of the doctors for meeting to their favourite. Besides representing the value of rule or routine in order of lament bound, doctor will also provide various numerical examples to show the same rule routine among various prize sessions and display matching with algorithms in the writing among allocated prize scenarios.

[5] <u>IoT Based Real Time Heart Health Monitoring System:</u>

2020, 2nd International Conference

Professor, Department of Computer Engineering, Mukesh Patel School of Technology Management & Engineering, Maharashtra, India:

Is an interface to collect heart rate and body temperature in the smartphone to gain and analyses data from the IoT system. They created a Wi- Fi communication channel able of transmitting data from the heart rate and temperature sensors to the smartphone, as defined in the hardware section. The machine analyses the data took from the detectors in order to identify heart rate abnormalities. The usage receives data from the detectors automatically after connecting to the IoT computer. The programmed divides the temperature and pulse data into separate arrays, which are also transferred to varied sites for real- time recording and analysis. This design's machine architecture is depicted in. The subsections that follow go into the varied aspects of this design conception in lesser detail.

[6] ECG Biometrics: Principles and Applications

January 2013(Science direct)

Hugo Silva1, Andr´e Lourenco1;2, FilipeCanento1, AnaFred1 and NunoRaposo3

This system enables the electrical driving impulses generated at the SA node, to be propagated from the wall of the right atrium. When scaled on-invasively, the ECG records the combined co the authors reported 100 accurateness in identification for a population of 20 subjects. Standard clinical- grade ECGs are acquired using 12 or further leads mounted on the chest and limbs, using conductive paste or gel to lower the electrode/ skin impedance. A fake V1 bipolar detector with virtual ground and dry electrodes was created. Contribution of each element of the electrical conduction system, as propagated to the body surface

[7] Classification of heart disease from ECG signals using Machine Learning

2021 International Conference

V.G.Rajendran, Dr.S.Jayalalitha, M.Thalaimalaichamy, T.Nirmal Raj :

An electrocardiogram (ECG) is a simple test that can be used to check your heart's rhythm and electrical activity. The most bold properties of ECG is that the signals can be constantly acquired using minimally nosy setups Sensors attached to the skin are used to determine the electrical signals produced by your heart each time it beats. It can be used to probe symptoms of a possible heart problem, similar as chest pain, beatings, dizziness and breath. The heart generates electrical current, by the compression of its muscle cells. Doctors must take an ECG within 10 minutes of a person presenting with heart attack symptoms.

[8] Design and Optimization of an Autonomous, Ambulatory Cardiac Event Monitor

2018 IEEE 20th International Conference

Thomas S. Metkus, MD, Assistant Professor of Medicine and Surgery, Johns Hopkins University School of Medicine, Baltimore, MD. Also reviewed by David Zieve, MD, MHA, Medical Director, Brenda Conaway, Editorial Director, and the A.D.A.M. Editorial team: In subjective, the monitoring of cardiac occurrences by using similar wearable sensors can give real- time and more applicable opinion of cardiac arrhythmias than classical results. Designed and estimated a connected sensor for the ranging monitoring of cardiac events, which can be used as an independent device without the need of a battery. Suitable to reduce the energy consumption of the entire system to below0.4 mW while measuring and storing the ECG on anon-volatile memory.

[9] Wearable cardioverter defibrillator: A life vest till the life-boat (ICD) arrives

8th January 2014 (science direct)

Johnson Francis, SvenReek:

Implantable cardioverter defibrillator (ICD) is a life saving device assuring protection against life hanging ventricular arrhythmias. The wearable cardioverter defibrillator (WCD) is a device which can be used to bridge the situation when a case is staying for an ICD. The WCD had four detecting electrodes and three defibrillation pads stitched into cloth to be worn by the case. The defibrillator device had a maximum capacity of 285 Joules (J) monophasic shock. The WCD tested was a vest with ECG monitoring and defibrillator electrodes along with a monitor and an alarm system. User had to transfer the data to the monitoring medical centre generally once a week using the modem. Median quotidian use has been22.5 h per day. Cases awaiting cardiac transplantation, as an alternative to ICD implantation. The average application was 20 h a day for about three months, Temporary skin rash was the only major side effect

[10] <u>Health at hand: A systematic review of smart watch uses for health and wellness</u>

2016 Sep 6 (Science direct)

Blaine Reeder PhD, Alexandria David BS:

Smart watches have the potential to support health in everyday living by enabling self-monitoring of personal activity; obtaining feedback based on activity measures; allowing surveys to identify patterns of behavior etc. A smart watch is a wrist-worn "general-purpose, networked computer with an array of sensors". Enable near-real time continuous monitoring of physical activity and physiological measures. The use of smart watches as a personal health information device is consistent with the fundamental theorem of biomedical informatics, which states: "A person working in partnership with an information resource is 'better' than that same person unassisted." Two-week field study with a single participant to test the real-time in-home location identification functionality of the Texas Instruments Chronos smart watch in conjunction with wireless sensor motes. The system performed with 91% accuracy for location identification as compared to the participant's journal location.

[11] <u>Wearable ECG Recognition and Monitor:</u>

18th IEEE 2005

DONG Jun, XU Miao, ZHU Honh-hai, LU Wei-feng:

ECG (Electrocardiogram) recognition and monitor are ineluctable to trace and determine heart conditions. As self- health being concentrated on and social medical grade being progressed, ECG observers with features similar as movable / wearable, wireless, use-friendly, low- cost and accessible at home, are more necessary. Unfortunately, similar kind of equipment couldn't be got presently. Therefore, wearable ECG recognition and examiner instrument is developed. Mobile phone or PC will be act as monitor display, where ECG signals will be transmitted to the service centre through GSM/ GRPS/ CDMA and internet. After introducing system architecture, the paper describes software design, direct ECG recognition system with morphology parameter- grounded specialist's experience. First generation product includes monitor, Bluetooth and palm/ Mobile phone/ PC.

[12] Wearable Electrocardiograph

2020 Jan 22, Researchgate

Daniel Naranjo, Patricio Cordova, Carlos Gordon

The paper presents a wearable garment for the accession of cardiac signs in real- time by means of the use of amplifiers of instrumentation, the overhead mentioned obtained signs can be transmitted of wireless form by means of the technology WI- FI that provides the module NODEMCU. The process of treatment and visualization of the cardiac signs is realized in a head office of monitoring installed in a Raspberry Pi3, allowing to observe easily the waves P, Q, R, S, T Y U that shape the sign of an examination of Electrocardiography (EKG), this way serviceableness happens at the moment of the examination both for the case and for the doctor. The novel of this new design is to be suitable to offer utility and mobility to the cases and doctors at the moment of realizing an electrocardiogram inside the hospitals, also it's possible to have a nonstop monitoring for cases with habitual cardiac ails. The use of hardware and free software allows that to be suitable to be modified and ameliorated this device constantly, achieving this way that the maintenance of this device is much easier and represents big money saving for all the beneficiaries.

[13] A Novel Diagnostic Algorithm for Heart Disease in ECG Monitoring System

2020 IEEE International Conference on Smart Internet of Things

Zhengyang Gu, Kehua Jiang, Qi Zhou

Healthcare is one of the most appealing and promising operations for the Internet of things (IoT). The IoT could incubate numerous medical operations, similar as telemedicine health monitoring, fitness programs, habitual ailment monitoring and care for the senior. Healthcare Internet of Things (HIoT) can connect mobile and wearable devices in the medical field, making condition monitoring and diagnosis possible anytime and anywhere. Utmost of these mobile and wearable devices can collect physiological signals of the mortal body in real time. Among them, ECG signal as anon-invasively collected signal that can effectively reflect the physiological changes of the heart plays a vital part in clinical and HIoT. They originally propose a practical ECG monitoring system grounded on Humeds Portable ECG Monitor. Secondly, based on wavelet transform (WT) and deep convolutional neural network (DCNN), the paper propose a new algorithm suitable for the opinion of atrial fibrillation (AF) and arrhythmia. The ECG monitoring system designed in this paper can be used as a complete and effective operation of HIoT. The algorithm designed in this paper isn't only applicable to the ECG monitoring system proposed but also can be integrated as a implicit algorithm in other ECG mobile and wearable devices.

[14] <u>Ambient Cardiac Expert: A Cardiac Patient Monitoring System using Genetic and Clinical Knowledge Fusion</u>

6th IEEE 2007

Iqbal Gondal, Shoaib Sehgal, Mudasser Iqbal, Joarder KamruzzamanResearch paper represented by Yanping Wang, Zongtao Chi:

Cardiac cases can be regularly monitored using low cast sensor networks which can save numerous lives and precious time of experts. This monitoring can be more effective if in addition to standard clinical parameters inheritable information is used because of its capability to prognosticate heritable diseases like cardiac problems. Current clinical practices, still, only stress on physiological observation to prognosticate heart failure rate which could miss the important information which could lead to fatal consequences. This paper presents Ambient Cardiac Expert (ACE) which combines physiological parameters observed using sensor networks with gene expression data to prognosticate the heart failure rate. The system uses well established Support Vector Machines (SVM) for class vaticination and uses Wrapper Evolutionary Algorithm grounded on Gaussian Estimation of Distribution Algorithm (EDA) to determine cardiac case's criticality. Results suggest that ACE can be successfully applied for cardiac case monitoring and has capability to integrate the information from both clinical and inheritable sources.

[15] <u>IoT based Compressive Sensing for ECG Monitoring</u>

2017 IEEE International Conference on Internet of Things

Zhengyang Gu, Kehua Jiang, Qi Zhou

The continuous monitoring of heart patient is very important which can be done from anywhere latest IoT technologies. The data from the patients when taken goes to the cloud and is very large compression scheme for ECG signal. Difficult to handle. The purpose of this paper is two-folded, first, to propose an effective CS-based. It has been shown the proposed system can achieve a high reconstruction quality by taking a compressed data with only 20% of the number of samples in the original ECG signal. The second purpose of his paper is to validate the reconstructed data in terms of heart beat class identification. Therefore, the concept of committee machine has been proposed to exploit different classifiers to further improve the classification accuracy. The use of compressive sensing (CS) will definitely help to be efficiently compress the data and the use of subspace pursuit (SP) algorithm which used provides a good reconstruction quality for the data collected. As future work, the proposed scheme will be implemented on a multicore system on chip (SoC).

[16] <u>Low Cost, Portable ECG Monitoring and Alarming System Based on Deep Learning</u>

2020 IEEE

S.M Ahsanuzzaman, Toufiq Ahmed, Md. Atiqur Rahman

Electrocardiogram (ECG) has been the golden standard for the discovery of cardiovascular disease for numerous times. Any electrical impulse disturbance that causes the heart to the contract may lead to arrhythmia. Arrhythmia cases have no suggestions of having an arrhythmia, but a doctor may fete arrhythmias in a routine test. Thus, nonstop wearable particular monitoring system plays a big part, and it’s come popular day by day. This exploration focuses on designing and developing a system for prognosticating arrhythmia (atrial fibrillation) along with covering the ECG signals. To produce an arrhythmia vaticination model and an Android- based real- time ECG surveillance system, Long Short-Term Memories neural network, intermittent Neural Network, TensorFlow and Keras library are applied then. Those deep learning models and algorithms help to achieve overall97.57 accurateness on arrhythmia foretelling. The system is being designed with Raspberry pi 3, Arduino UNO, AD8232 single lead ECG detector, HC- 05 Bluetooth, biomedical sensor pad and battery. This system will make easier for doctors to watch the ECG of their cases outside the sanatorium and also help for remote ECG monitoring. The total elements cost of this exploration work is around USD 58.ECG monitoring. The total components cost of this research work is around USD 58.

[17] A Real-Time Compressed Sensing-Based Personal Electrocardiogram Monitoring System

2011 Design, Automation & Test in Europe

Karim Kanoun, Hossein Mamaghanian, Nadia Khaled and David Atienza

Wireless body sensor networks (WBSN) hold the pledge to enable coming- generation patient- centric mobile cardiology systems. A WBSN- enabled electrocardiogram (ECG) monitor consists of wearable, miniaturized and wireless sensors suitable to measure and wirelessly report cardiac signals to a WBSN coordinator, which is responsible for reporting them to the tele- health provider. Nevertheless, state- of- the- art WBSN- enabled ECG observers still fall abruptly of the needed functionality, miniaturization and energy effectiveness. Among others, energy effectiveness can be significantly ameliorated through embedded ECG contraction, which reduces airtime over energy-empty wireless links. In this paper, they propose a new real- time energy- apprehensive ECG monitoring system grounded on the arising compressed sensing (CS) signal accession/ contraction paradigm for WBSN operations. For the first time, CS is demonstrated as a profitable real-time and energy-effective ECG contraction fashion, with a computationally light ECG encoder on the state- of- the- art Shimmer TM wearable sensor node and a real time decoder running on an iPhone (acting as a WBSN coordinator). Interestingly, our results show an average CPU operation of lower than 5.

[18] An ECG-on-Chip for Wearable Cardiac Monitoring Devices

5th IEEE International Symposium on Electronic Design, Test & Applications, 2010

C.J. Deepu, X.Y. Xu, X.D. Zou, L.B. Yao, and Y. Lian

This paper describes a largely integrated, low power chip result for ECG signal processing in wearable devices. The chip contains an instrumentation amplifier with programmable gain, a band- pass sludge, a 12- bit SAR ADC, a new QRS sensor, 8K on- chip SRAM, and applicable control circuitry and CPU interfaces. The analog frontal end circuits directly senses and digitizes the raw ECG signal, which is also filtered to extract the QRS. The slice frequency utilized is 256 Hz. ECG samples are buffered locally on an asynchronous FIFO and is read out using a briskly clock, as and when it's needed by the host CPU via an SPI interface. The chip was designed and implemented in0.35 ʒm standard CMOS process. The analog core operates at 1V while the digital circuits and SRAM operate at3.3 V. The chip total core area is5.74 mm2 and consumes9.6 ʒW. Small size and low power consumption make this design suitable for operation in wearable heart monitoring bias.

[19] <u>Visual ECG: A Bluetooth based software for ECG monitoring on PDAs</u>

2004 2nd IEEE/EMBS International Summer School

Jorge Fernandez, Javier Ruiz, Santiago Led, Luis Serrano and Rafael Cabeza

Visual ECG is a software application developed for ECG monitoring on Personal Digital Assistants (PDA's). Bluetooth technology is used to connect the ECG acquisition devices with the PDA receiver. This software is intended to specialists who need a tool capable to perform ECG monitoring using wireless technologies. Visual ECG uses hierarchical databases and files in order to store all of the ECG registers and all data related to authorized doctors and patients. Data storage is made keeping in mind the international laws related to privacy and data protection. In order to accomplish this, a powerful encryption system is employed to protect biomedical data and personal patient and doctor's data for unauthorized accesses. Visual ECG is a software application developed to improve health monitoring adding Bluetooth to the existing monitoring software.

[20] <u>A Wearable ECG Monitoring System Using Adaptive EMD Filter based on Activity Status</u>

2015 IEEE 29th International Conference

Byeong-Hoon Kim, Yun-Hong Noh, Do-Un Jeong

ECG, pulse and body temperature are essential bio signal measurement which reflects various health information. A belt -type wearable ECG measurement system and a 3-axismspeedometer has been added to adjust the level of the EMD filter depending on the activities of the user. Activity status is classified by using the Fuzzy Classification, and then we use EMD filter to remove motion artifacts from the ECG signal. A real-time experiment has been conducted to evaluate the performance EMD-based filter. As a result, the proposed EMD-based filter has improved accuracy of heart rate detection. Thus we can finally increase the accuracy of the heart rate results by just removing the distortion that can be caused due to the body movements and motion of the patient and also making the whole wearable belt very comfortable and compact. The wireless concept makes is very easy to use unauthorized accesses. Visual ECG is a software application developed to improve health monitoring adding Bluetooth to the existing monitoring software

From the above research papers, we came to know that lots of work has been done in this area and so many researches are still going on.

CHAPTER 3

3.1 Experimental Setup

The Real-Time Cardiac Monitoring Device consists of two parts:

1. The first part monitors and collects the data from the patient's body using the electrodes. The collected data is processed using AD8232 module.
2. The second part communicates, the processed data in AD8232 to the patient's near ones using online portal.

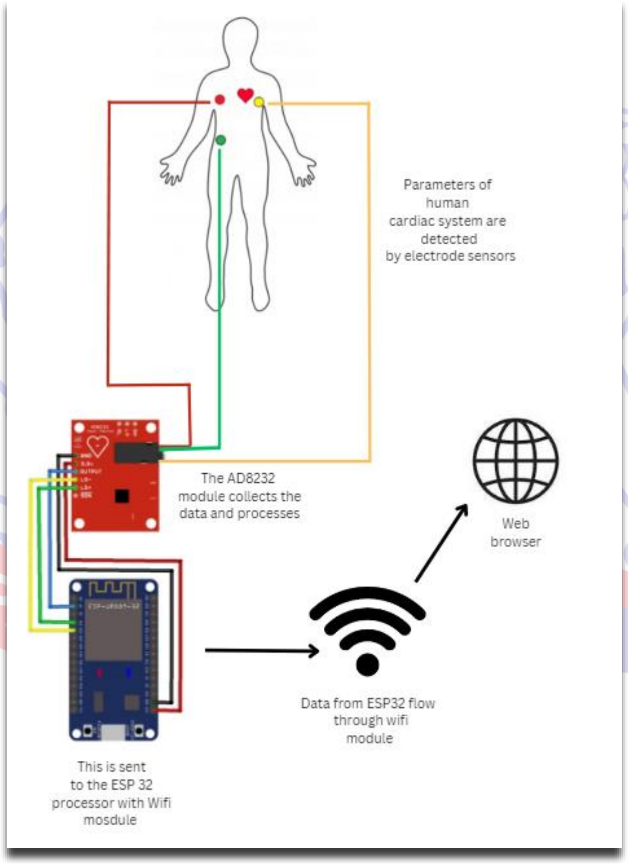

Fig 3.1.1. Architecture of Real-Time Cardiac Monitoring Device

3.2 System Overview

- Figure 3.1.1 shows the architecture of the system which consists of three Electrodes connected to the AD8232 module and ESP32 board.
- Out of the three electrodes provided on the board are RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins to attach, where the ECG signals can be captured.
- These Three electrodes collectively transmit the signals to the AD8232 ECG module.
- Ad8232 is an integrated signal conditioning block for ECG and other biopotential measurement application. It acts like an op-amp which help in obtaining a clear signal. Additionally, there is an LED indicator light that will pulsate to the rhythm of a heartbeat.
- The ESP 32 board is embedded with a Wi-Fi module.
- ESP32 acts as master, who receives data from AD8232 module and forwards the data to user's server.
- The system mechanism is follows; the detection of the ECG signals emitted from the heart, which are processed and the data is transferred to the cloud. The users can access this data from cloud to any mobile device.
- The ESP32 receives these voltages from the sensors and compares it with the threshold value and makes a decision based on that input. Based on this input the decision is made by the microcontroller whether to send alert notification to the users.

3.3 Methodology

- The use of electrode sensors to take inputs from the patient's Cardiac systems.
- Analysis and interfacing of the output from the sensor using AD8232 ECG module.
- With the help of inbuilt Wi-Fi module in ESP 32, the data is stored in cloud.
- Transferring the data to the user and his/her near one's phone or any other electronic device through cloud.
- If the input signals from the patient's body cross the threshold value, the user's near one's and health workers will be informed with an alert notification.

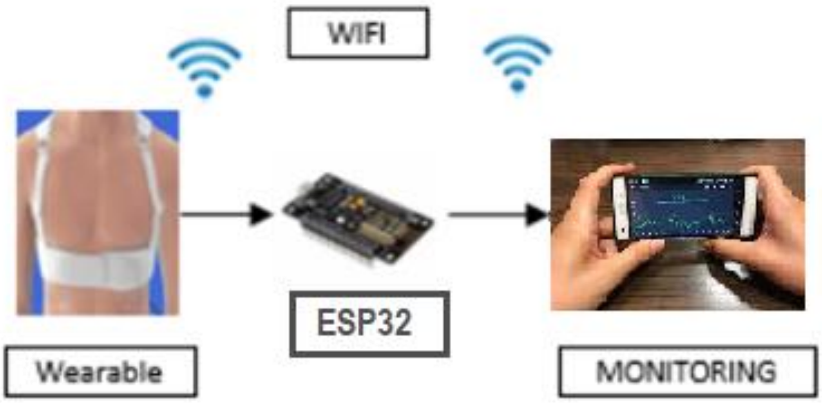

Fig 3.3.1 llustration of methodology

3.4 Block Diagram and description

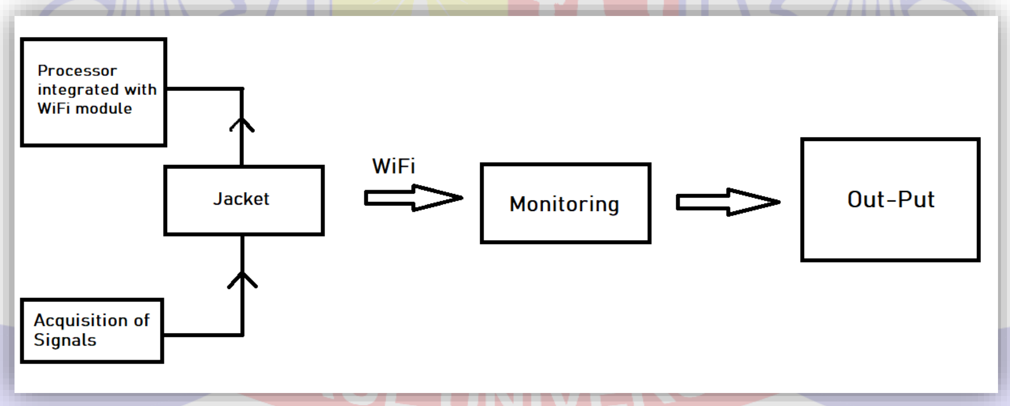

Fig 3.3.2 Proposed Block Diagram

- The above block diagram is a detail description of the device we have designed.
- The mentioned Jacket is inbuilt with electrode sensors, these acquest the ECG signals from the user's body.
- These signals after being processed by the ECG module are sent to the ESP32 board.
- From ESP 32 this data is sent to cloud using the inbuilt Wi-Fi module, where the data is stored.
- Users can acquire this data from cloud on any electronic monitor, using the web application.

CHAPTER 4

4.1 Hardware Description

S.N.	COMPONENTS NAME	QUANTITY	Price (Rupees)
1	ESP32 Board	1	400
2	AD8232 ECG Sensor	1	580
3	Micro-USB Cable	1	50
5	Connecting Wires	1 pack	40
6	Breadboard	3	50
		Total	1100

- **ESP32 Devkit V1:**

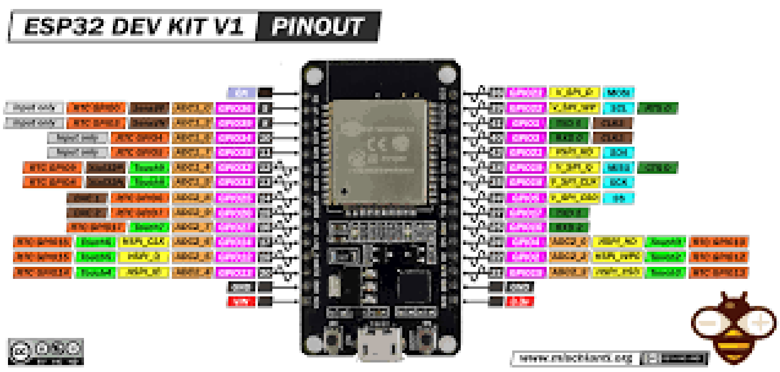

Fig 4.1.1 ESP32 Devkit V1

ESP32 can perform as a complete standalone system or as a slave device to a host MCU, reducing communication heap overhead on the main operation processor. ESP32 can associate with other systems to deliver Wi- Fi and Bluetooth functionality through its SPI/ SDIO or I2C/ UART interfaces.

In RTCMD, ESP 32 acts as a slave which is used to communicate with the host server. The inbuilt Wi-Fi module provides the opportunity to transmit the data wireless to cloud. ESP32 Devkit V1 has inbuilt Bluetooth module too.

- **AD8232 – ECG module**

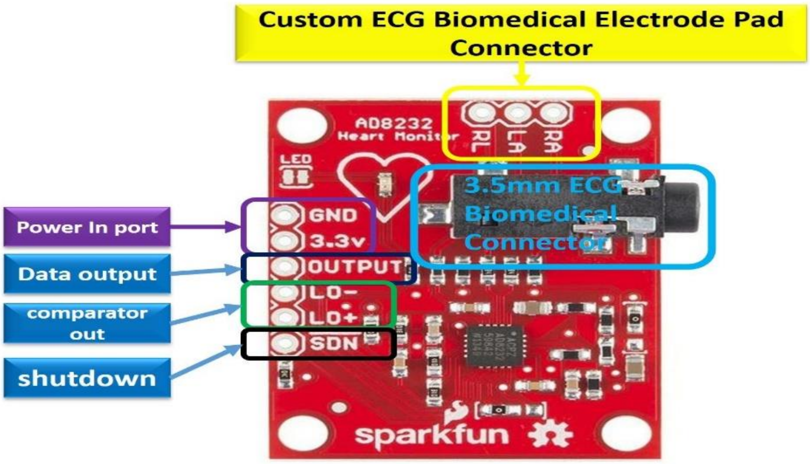

Fig 4.1.2 AD8232 Module [iii]

The AD8232 is an intertwined signal conditioning block for ECG and other bio potential measurement operations. It's designed to extract, amplify, and filter small bio potential signals in the presence of noisy conditions, similar as those created by movement or remote electrode placement. This sensor is a cost-effective board used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram and affair as an analog reading. ECGs can be extremely noisy, the AD8232 Single Lead Heart Rate Monitor acts as an op amp to help gain a clear signal from the PR and QT Intervals fluently.

AD8232 plays the part of a processing unit in our design. It collects the input signals from all the three electrodes. This signal is modulated, amplified and conditioned. Further, it's transferred to ESP32 for transferring of the data.

- **ELECTRODES**

Fig 4.1.3 Electrodes [iv]

The ECG machine uses a series of bias called Electrodes to record the electrical activity of the heart. The Electrocardiogram Electrodes are placed in contact with the case's skin on the arms, legs and in the thoracic region. The position of electrodes is a vital parameter for the accurate ECG discovery.

4.2 Working of the Project

- The system uses ESP 32 which are programmed using the Arduino IDE
- ESP 32 which is running on local server to enable remote monitoring of the system.
- The device also notifies the user if values of the parameters drift out of the bounds abnormally.
- Ubidots has a web interface that allows the user to visualize the data that is received.
- The main source of monitoring comes through the web interface; however, Ubidots also offers a web server that allows for more accessibility.
- Through the web server users can monitor the same parameters

4.3 Software Description

Software application is the heart of any system. In this system we will use the software's that are required by component i.e.;

Arduino IDE

Arduino IDE is an open- source software program that allows users to write and upload code within a real- time work terrain. Arduino Software used to write code for Arduino series board in multiple languages from c and c. Also, it responsible for rate of data transfer. It connects to the Arduino and Genuino hardware to upload programs and communicate with them effectively.

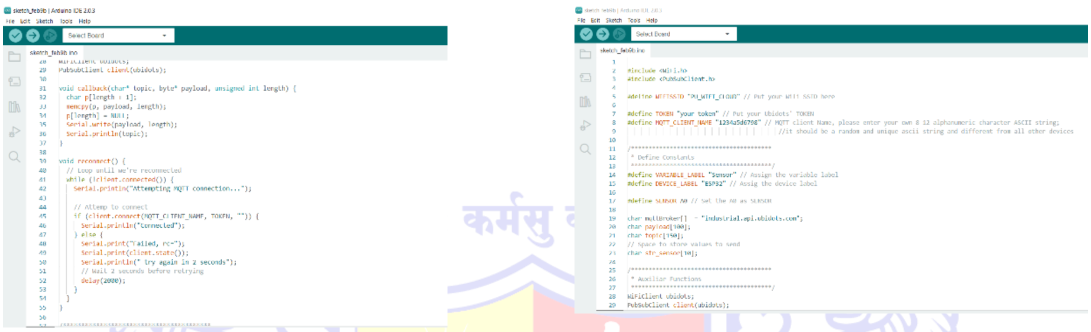

Fig 4.3.1 Program Module

- The code links the Sensor with the Web Server where the data is stored. Also, in the code value of heart rate is taken as threshold and once unusual changes occurs above the threshold the users are sent an alert. This is the main aim of the project to improve monitoring of the patients with cardiac problems.

4.4 Flowchart of program

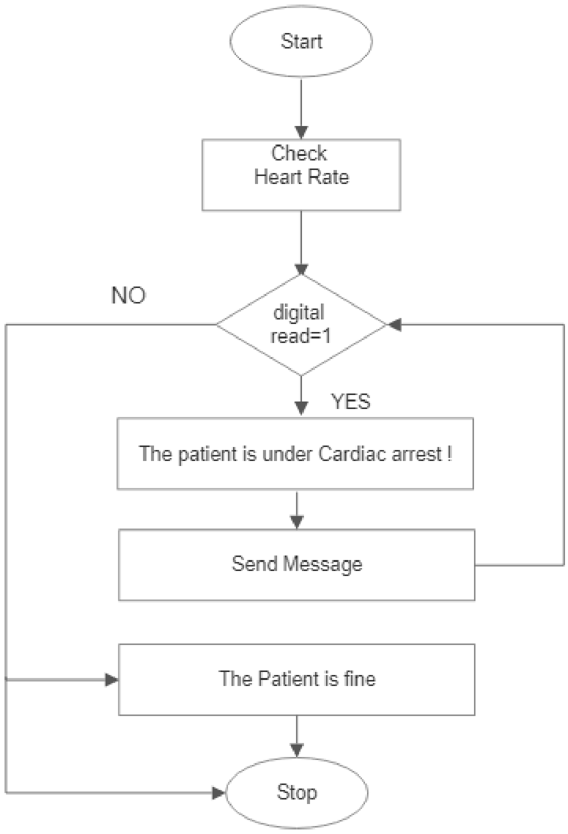

Fig 4.3.2 Flowchart of the program

DESCRIPTION OF FLOWCHART

- The flowchart is a detail description of the code to operate our Real Time Cardiac Monitoring System.
- It also shows the decisions making done, how a user should be notified in case of any abnormalities.
- We have set threshold values for each sensor to govern the ECG signals.
- The notification "The patient is under Cardiac arrest!" will be constantly sent until the patient is properly attended.

CODE

```
#include <WiFi.h>
#include <PubSubClient.h>

#define WIFISSID "PU_WIFI_CLOUD" // Put your WifiSSID here
#define TOKEN "BBFF-e576a9c371bb8bed41295be7b97f81c4ef2" // Put your Ubidots' TOKEN
#define MQTT_CLIENT_NAME "paruluni" // MQTT client Name, please enter your own 8-12
alphanumeric character ASCII string;
                                   //it should be a random and unique ascii string and different from all other
devices

/****************************************
 * Define Constants
 ****************************************/
#define VARIABLE_LABEL "sensor" // Assing the variable label
#define DEVICE_LABEL "esp32" // Assig the device label

#define SENSOR A0 // Set the A0 as SENSOR

char mqttBroker[]  = "industrial.api.ubidots.com";
char payload[100];
char topic[150];
// Space to store values to send
char str_sensor[10];

/****************************************
 * Auxiliar Functions
 ****************************************/
WiFiClient ubidots;
PubSubClient client(ubidots);

void callback(char* topic, byte* payload, unsigned int length) {
  char p[length + 1];
  memcpy(p, payload, length);
  p[length] = NULL;
  Serial.write(payload, length);
  Serial.println(topic);
}

void reconnect() {
  // Loop until we're reconnected
  while (!client.connected()) {
    Serial.println("Attempting MQTT connection...");

    // Attemp to connect
    if (client.connect(MQTT_CLIENT_NAME, TOKEN, "")) {
      Serial.println("Connected");
    } else {
      Serial.print("Failed, rc=");
      Serial.print(client.state());
      Serial.println(" try again in 2 seconds");
      // Wait 2 seconds before retrying
      delay(2000);
    }
  }
```

```
}

/****************************************
 * Main Functions
 ****************************************/
void setup() {
  Serial.begin(115200);
  WiFi.begin(WIFISSID);
  // Assign the pin as INPUT
  pinMode(SENSOR, INPUT);

  Serial.println();
  Serial.print("Waiting for WiFi...");

  while (WiFi.status() != WL_CONNECTED) {
    Serial.print(".");
    delay(500);
  }

  Serial.println("");
  Serial.println("WiFi Connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
  client.setServer(mqttBroker, 1883);
  client.setCallback(callback);
}

void loop() {
  if (!client.connected()) {
    reconnect();
  }

  sprintf(topic, "%s%s", "/v1.6/devices/", DEVICE_LABEL);
  sprintf(payload, "%s", ""); // Cleans the payload
  sprintf(payload, "{\"%s\":", VARIABLE_LABEL); // Adds the variable label

  float sensor = analogRead(SENSOR);

  /* 4 is mininum width, 2 is precision; float value is copied onto str_sensor*/
  dtostrf(sensor, 4, 2, str_sensor);

  sprintf(payload, "%s {\"value\": %s}}", payload, str_sensor); // Adds the value
  Serial.println("Publishing data to Ubidots Cloud");
  client.publish(topic, payload);
  client.loop();
  delay(500);
}
```

Ubidots

- Industrial companies use Ubidots to launch and measure operations for condition monitoring, smart manufacturing, cloud SCADAs, vibration analysis, and more.
- Ubidots provides a secure and easy way to make IoT results for scholars, makers and experimenters. It's used for transferring data from any Internet- enabled device to the cloud, driving actions and alerts based on that data, and imaging it.
- It's an IoT Application Enablement Platform (AEP) enabling System Integrators (SIs) and SMBs to fleetly assemble and launch IoT operations. Ubidots erecting blocks include drag-and- drop dashboards, device-friendly APIs, analytics, reports and cautions.

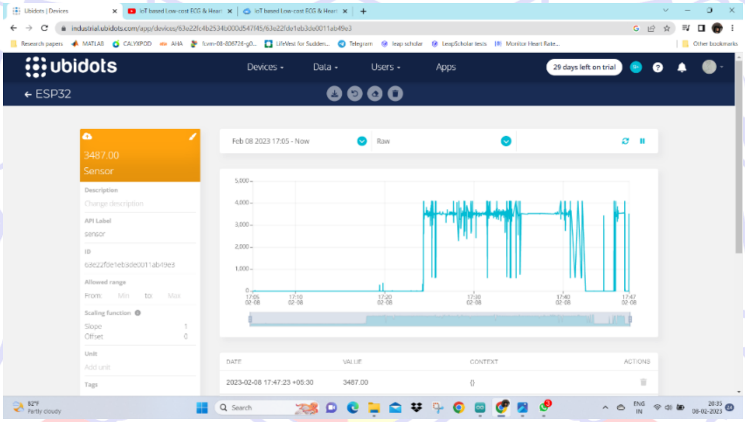

Fig 4.3.3 Ubidot Website

CHAPTER 5

5.1 Results and Description

Fig 5.1.1 Hardware setup

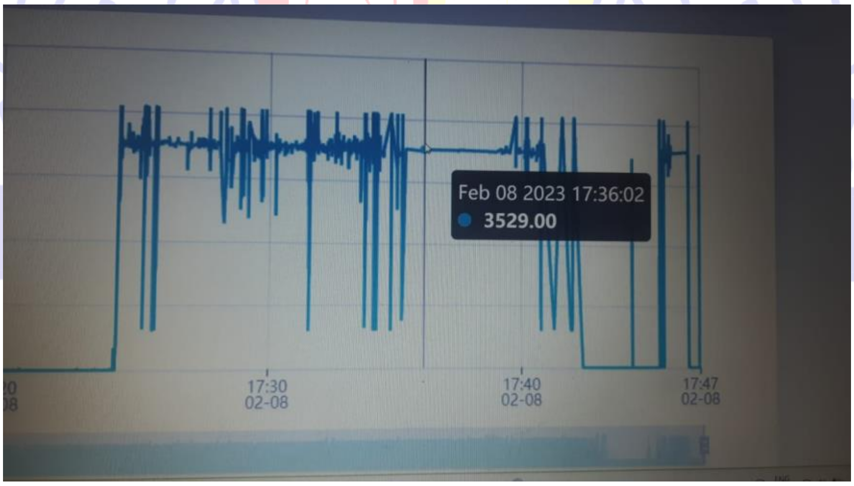

Fig 5.1.2 Hardware simulation result

5.1.2 STEPWISE WORKING OF HARDWARE

- The design and implementation of the Real Time Cardiac Monitoring system using ESP32 microcontroller performed and hardware is organized as shown in the Figure 5.1.1
- Connection is as shown in the diagram, the three electrodes are connected to the axillary nodes of the body.
- These electrodes collect the biopotential ECG signals. These signals are further sent to the AD8232 ECG module.
- The module amplifies and filters the input signals and sends them to the ESP32.
- The built in Wi-Fi module transfers the processed data to the cloud.
- From where users can extract them to their web servers.

5.2 Hardware Overview

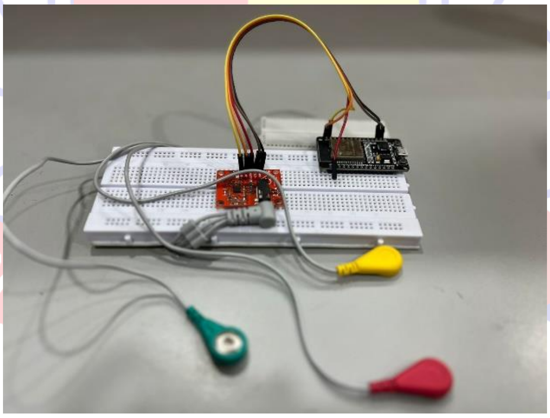

Fig 5.2.1 hardware setup

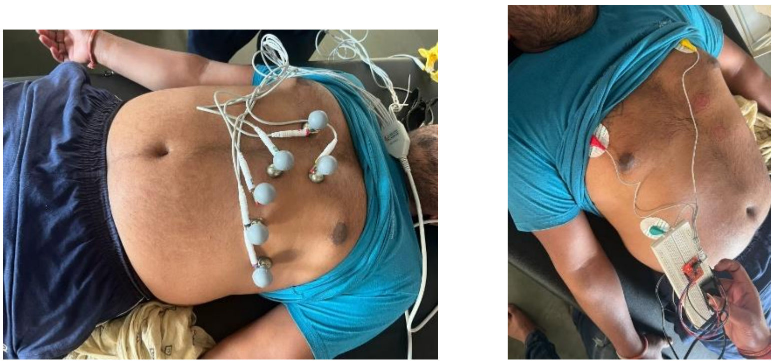

Fig 5.2.2 hardware setup for comparative study

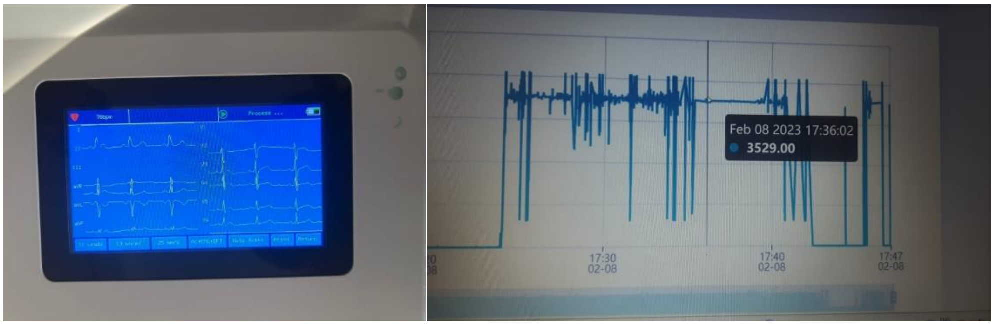

Fig 5.2.3 Results of comparative study

- The above figure are the results that we obtained from the conventional ECG machine in comparison with the device we have built.
- The experiment was conducted on a healthy male person.
- The gap in between the data collected by RTCMD depicts the time when the device was disconnected, to show that the data is real time.

5.3 Observation

- The Real Time Cardiac Monitoring Device, it is observed that in the sample rate of 3000-4100 Hz per 5 mins.
- For a normal person there are 60 to 85 heart beats per min, therefore we conclude that our derived data is accurate.
- The indicator shows that the person in observation is normal if the heart rate is between 3000-4100 Hz per 5 mins.
- If this value exceeds the indicator depicts that the patient is under cardiac arrest.

Fig 5.2.4 Results of the Indicator

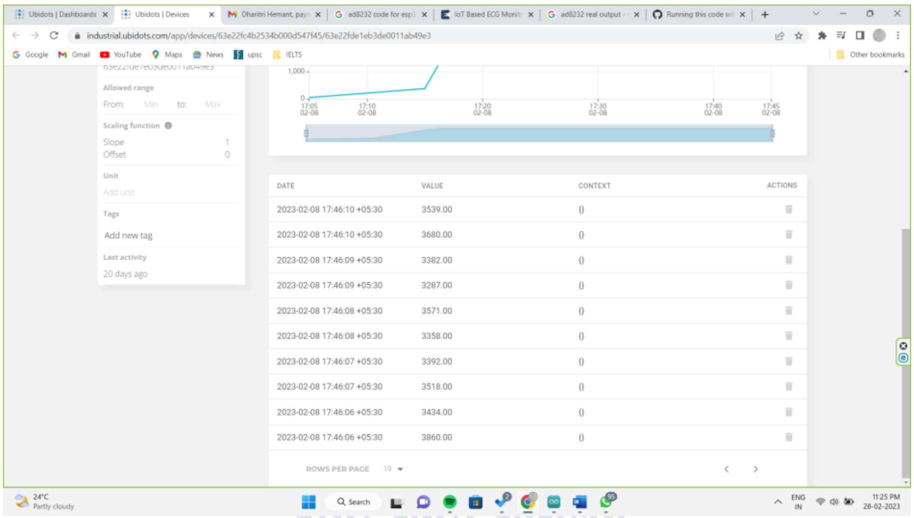

Fig 5.2.5 Results in value

- The above data depicts the increment and decrement of the value in numerical form.
- The data given in numerical form changes per second.
- Therefore one can see minimal changes in the numbers, as compared to that of the line graph.

CHAPTER 6

6.1 Conclusion

Health is wealth, this Real Time Cardiac Monitoring Device can save many lives. We In this project intended to develop the Real time cardiac monitoring device based on electrodes and ECG module as it is the most accurate way of acquisition of data from heart. The electrodes are connected to an ECG machine by lead wires. The electrical activity of the heart is then measured, interpreted, and transferred for the processing to the controller and if there is any abnormality the message is sent to help the patient. This device is going to be useful in taking actions toward patients on time as cardiac related issues needs to be addressed quickly. It could notify the near ones and relatives in case of emergency. It is capable of showing real time data so it can be used in hospitals to monitor more patients from distance.

6.2 Presentation Feedback:

- The Real Time Cardiac Monitoring Device was displayed at Parul Institute of Ayurveda, on the occasion of NAAC inspection.
- Our device was displayed as an inter disciplinary project, between the departments of Electronics and Communication Engineering and Rognidana dept.
- The observer suggested that we should develop it and launch it in the market, so that it can replace the existing ECG.
- The NAAC committee was impressed by, the economic cost of RTCMD.
- They also suggested that we must include the tridosha indicator.

Fig 6.2.1 Our team representation

6.3 Future Perspective

- In near, future we are going to study more on SCG sensing also as it has some advantages that it does not gets affected my magnetic fields.
- We will try to replace the Wi-Fi with Bluetooth so that it can be accessed without internet.
- We will focus on adding GPS so that the patient can be tracked making it easy.

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