IoT Based Advanced Cardiac Arrest Detection System with Automatic CPR, Defibrillation and Notification to Save Patients Life

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***Abstract*—Cardiac arrest is a critical medical condition that requires immediate intervention. An advanced cardiac arrest detection system uses advanced medical sensors, and real-time communication technology to detect cardiac arrests and initiate life-saving procedures. The system monitors the patient's vital signs and triggers an automated CPR mechanism. It also notifies medical personnel and by standards via real-time alerts, enabling swift response. The system also includes an automatic external defibrillator (AED) notification feature, allowing for faster defibrillation therapy. By incorporating IoT this system also has the potential to revolutionize cardiac arrest management by combining continuous monitoring, rapid analysis with real-time communication, there by maximizing patient survival chances and potentially saving live. The proposed work is developed to monitor vital signs and other indicators of cardiac arrest. Once cardiac arrest is detected, the system sends an alert to trained personnel nearby, such as paramedics or lifeguards. The system provides instructions on how to perform CPR and defibrillation for no voice users. The CPR mechanism is performed by an actuator whose functions are controlled by L298N drive. While, defibrillation is performed through defibrillation pads by generating internal shocks whose intensity is controlled by 2-channel relay.**

Keywords: IoT, ECG, AED, CPR.

I. INTRODUCTION

The development of cardiac arrest detection system has revolutionized cardiac care by integrating cutting-edge technologies. The systems provide real-time detection, swift initiation of cardiopulmonary resuscitation (CPR), and timely notifications for defibrillation, all working together to maximize patient survival. The system uses advanced algorithms and real-time monitoring to analyze electrocardiogram data for anomalies indicative of cardiac arrest, ensuring immediate response. Upon detection, the automatic CPR component is engaged, ensuring consistent and optimal blood circulation to vital organs. The system employs mechanical actuators and sensors to mimic the rhythm and force of effective chest compressions, eliminating variability in manual efforts. The system also has defibrillation notification functionality, alerting nearby medical personnel, first responders, and bystanders with the necessary training to bring a defibrillator to the patient's aid. This proactive approach minimizes the time between detection and defibrillation, significantly increasing the chances of a successful outcome.

II. LITERATURE SURVEY

An exhaustive literature survey was carried out and the work presented by researchers is listed below.

R Devi et.al [1] in their work focused on the development of an innovative system that aims at combating and safe guarding against heart diseases and attacks Their work is confined towards individuals while driving motor bike. In [2] The authors presented a technique for identifying sudden cardiac arrest through the utilization of the Pan-Tompkins Algorithm. This algorithm is employed to detect R-peaks in ECG readings from both individuals experiencing sudden cardiac arrest and those without such conditions. In [3] The authors discussed on global prevalence of sudden cardiac death (SCD) and arrhythmia which constitutes a significant public health challenge, contributing to 15-20% of total fatalities.In[4]The authors presented a method for identifying sudden cardiac arrest in electrocardiogram signals by utilizing a feature learning approach. This involves a modified variational mode decomposition technique, coupled with a Convolutional Neural Network and a Support

Vector Machine classifier. Herlitz J et al. [5] conducted a study to evaluate the influence on survival in individuals facing bystander-witnessed out-of-hospital cardiac arrest of cardiac origin. The study specifically examined the time duration between the estimated collapse and the initiation of the ambulance call.In [6] Their study examined 1,297 individuals who witnessed out-of-hospital cardiac arrest and received treatment from EMTs and paramedics, aiming to determine if early CPR bystanders improved survival. In their study documented in [7], Larsen et al. examined the correlation between survival rates during sudden out-of-hospital cardiac arrest and crucial prehospital interventions. The data encompassed the duration from collapse to CPR, defibrillation shock, and ACLS. The objective of the study documented in [8] was to develop a simple and broadly applicable predictive model for anticipating survival after out-of-hospital cardiac arrest associated with ventricular fibrillation. In [9], the authors examined the temporal symptomatic patterns of 17 patients who suffered cardiac arrest in an intensive care unit. They utilized a mixture of matrix normal distributions for analysis. In[10] authors suggests that a combination of sixteen HRV parameters and eight vital signs can effectively predict cardiac arrest within a 72-hour timeframe. In[11] The authors study introduces a support vector machine (SVM) capable of real-time classifying agonal breathing in bedrooms, achieving impressive accuracy with minimal false positive rates. In[12] The authors focus on medication administration for patients experiencing cardiac arrest, aiming to investigate its impact on predicting health condition deterioration through Cardiopulmonary Resuscitation (CPR). In[13] The authors study explores an algorithm using impedance cardiogram (ICG) from defibrillation pads to identify circulatory arrest promptly, potentially reducing delays in CPR. In[14] The authors study explores the use of photoplethysmography (PPG) to detect natural pulses in fingers, noses, or ears, aiming to enhance pulse assessments during CPR. In[15] The authors study aimed to assess the efficacy of a smartwatch's photoplethysmography sensor in accurately detecting the return of spontaneous circulation during cardiac arrest situations. In [16] the authors described the development of a cross-platform software application designed to assist ambulance paramedics in Cardio-Pulmonary Resuscitation (CPR). In their work [17] the authors referred to cardiac arrest as a heart attack marked by diverse heart-related disorders. It stands as the primary cause of worldwide mortality, attributed to various risk factors, underscoring the need for accurate, effective, and practical early diagnosis and treatment. In their publication labeled as [18], the authors state that cardiac arrest (CA) entails the cessation of circulation to vital organs, emphasizing the urgency of prompt and suitable interventions for potential reversal.

III. Objectives of the developed product

The motive behind this work is to

a).Study the various methods available for preventing Cardiac Arrest System.

b).To study the ways available for Cardiac Arrest.

c).Save the life of pupil who get affected by cardiac arrest.

d).Advance knowledge in Cardiac Arrest and implement further new systems.

e).Understand new technologies and implement/develop such modules to prevent Cardio vascular problems.

f) Make products with available facilities in our own country- A motive towards “make in India”.

IV. Methodology

The procedure adopted by the system and the working is given by the following steps:

a) The developed module is initialized with normal parameters governing the heart problems. first checks the heart rate and heart functioning by ECG and pulse sensors.

b) This module with various sensors is fixed on the chest of the person who is diseased with blood pressure and or cardio vascular disease.

c) The system first checks the heart rate and heart functioning by ECG and pulse sensors.

d) When under normal conditions the system stays in ideal state. Any deviations from the normal values the module starts functioning.

e) The functioning is divided into 2 mechanisms – CPR mechanism and AED mechanism.

f) In CPR mechanism, the Linear Actuator which is placed in middle of the chest position, will start functioning to stabilize the patient for normal value. If CPR mechanism fails in normalizing the module initiates the AED.

g) In AED mechanism, internal shocks will be given to the person to normalize the heart condition.

h) A message will be sent to their respected family members regarding this process Wireless communication technologies occurred through Blynk lot application,

which gives a notification to alert signals statement wise report analysis information.

V. Block Diagram of Cardiac Arrest System

The main blocks of cardiac chest belt setup are shown in Fig.1 It consists of a processor to control the various applications such as ECG and pulse sensors detection Circuit, the indication circuit develop the actuator mechanism and AED, current voltage control by relay drivers, rechargeable batteries were involved

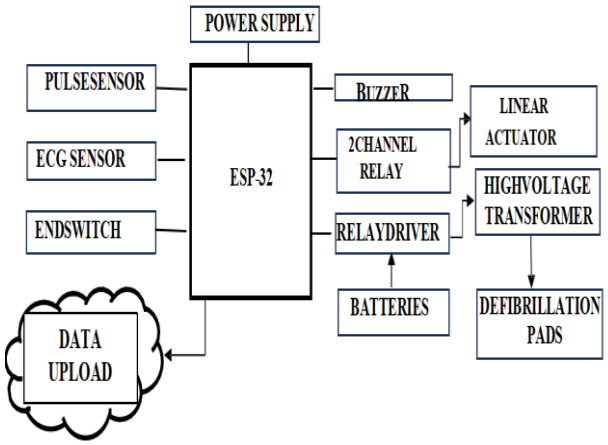


Fig.1: Block diagram of chest belt setup

ESP-32 is the brain of the module to control the system. End switch is required to perform the setup, buzzer gives the alert of action mechanism. All the Control system manages the components according to the situation.

VI. Flow Chart Depicting the Working of the Cardiac System

Fig.2 gives the working of the module developed. To begin with the power supply is turned ON. The normal values of heart beat and pulse rate are initialized in the processor. The processor compares the normal value with that of the variations of the patients. So long as the values are within the defined range the system is in the ideal state. any variations observed will cause the system to operate immediately. The operation is divided into 2 parts viz, CPR mechanism and AED mechanism. Initially during variations, the CPR module start functioning if the things go beyond control the system operates the AED module to bring to normalcy.

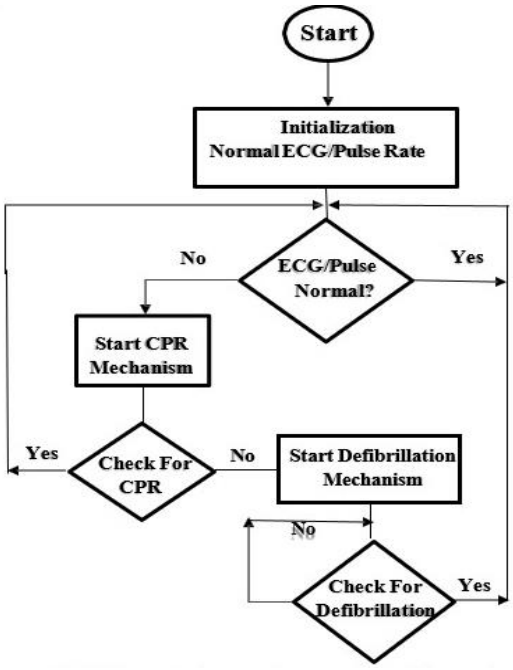


Fig.2: Flowchart Showing the working procedure of the cardiac arrest system

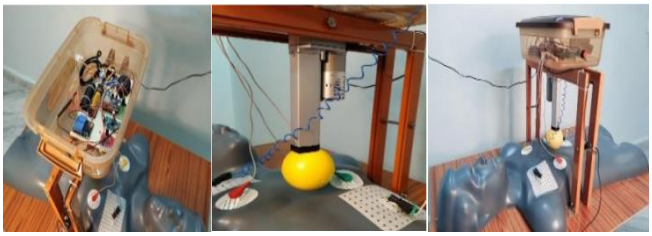
VII. Working of the Cardiac Arrest System

Fig.3(a) shows the ECG/pulse sensor detection range of heart values. This module is designed with various sensors that are fixed on the chest of the person who is diseased with blood pressure and or cardio vascular disease. The system first checks the heart rate and heart functioning by ECG and pulse sensors.

When under normal conditions the system stays in ideal state. Any deviations from the normal values the module starts functioning. Under abnormal conditions the CPR and AED starts functioning.

(b) shows the actuator which acts as a pump for performing CPR mechanism. This Linear Actuator placed in middle of the chest position, will start functioning to stabilize the patient pulse rate to normal value. In the event of failure by CPR mechanism, the AED mechanism starts functioning.

(c) shows the Defibrillation (AED)& Notification alerts receive from the Blynk IOT Platform. In AED mechanism, internal shocks will be given to the person to normalize the heart condition.



(a) **(b)** **(c)**

Fig.3(a)ECG and Pulse sensor detection**(b)** CPR Mechanism **(c)**AED Mechanism

VIII. Discussion

The cardiac arrest prevention module is fixed on the chest of the diseased, which is programmed with the normal values of body heart-beat. So long the pulse rate and heart beat is normal the circuit remain in ideal state. Once, there is a deviation from normal value the unit starts operating. Initially, the CPR unit starts functioning. After the stipulated time when no normal value is reached defibrillation starts functioning.

IX. Conclusion

In this paper an IOT Based Advanced Cardiac Arrest Detection System with Automatic CPR, Defibrillation and Notification to save Patients Life is implemented. This concept is introduced to bring a solution of Cardiac arrest, by measuring ECG and pulse rate with suitable sensors to detect the signals of heart beat. Any fluctuation above and below the normal value the developed system will take care as shown in flow graph. During variation the actuator performs a CPR mechanism by pumping the chest in the event of CPR failure mechanism, automatic external defibrillation mechanism starts functioning. The defibrillation pads (AED) play a key role by giving the shock treatment to improve the heartbeat. The complete system is automized for care taking besides sending the notification alert information through the IOT Blynk application to verify the configurations. It is the part of Bio medical instrumentation, where it can used in medical equipment's various industries and revolutionaries. Now a days a Bio-medical instrumentation project inventions can save's the mankind life& it is a Make in India project.

X. Future Scope

An IoT-based cardiac arrest detection system with automatic CPR and defibrillation, along with notifications to save patients' lives, is developed in this work in future the system can be advanced by integration of cutting-edge technologies to improve the system's effectiveness and efficiency, by incorporating AI and ML. Further, Using WI-FI public awareness by means of GMS GPS. The system can be deployed in health care in hospitals, residencies so that the patients are taken care to save them from sudden cardiac arrest.

Acknowledgment

The authors acknowledge the center of IoT, SR University and MUFA Tech solutions, Warangal for their technical support in developing the prototype model of the project. The authors also acknowledge

management of SR University in providing the platform to carry out the work smoothly in campus

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