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AUTOMATIC CPR AND DEFIBRILLATION SYSTEM FOR CARDIAC ARREST

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ABSTRACT

Survival rates for sudden cardiac arrest drop significantly with every second of delay. To address this, we developed a synchronised prototype that integrates automated chest compressions with a rapid defibrillation mechanism. By utilizing a continuous sensor-driven feedback loop, our system identifies lethal arrhythmias and initiates life-saving interventions without waiting for a manual operator. This hands-free approach effectively eliminates human hesitation, ensuring that resuscitation begins the moment a cardiac event is confirmed.

KEYWORDS: Cardiac Arrest, CPR, Defibrillation, Automation, Heart Monitoring, Emergency System

I. INTRODUCTION

When cardiac arrest occurs, the cessation of blood flow triggers a rapid physiological countdown where every second without oxygen increases the risk of permanent organ damage. Traditional resuscitation relies on the presence of trained bystanders, but human-led intervention is frequently inconsistent or delayed. Our research addresses this gap by introducing an autonomous life-support platform. This system utilizes a high-sensitivity sensor array to monitor heart rhythms and triggers a synchronized CPR-defibrillation sequence immediately upon detecting a non-perfusing arrhythmia.

II. LITERATURE SURVEY

Several studies have explored mechanical chest compression devices like LUCAS and Auto Pulse. Research by Almalki et al. found that these devices deliver steadily. Guideline -compliant compressions without tiring out, unlike human rescuers. However, a review in the Scandinavian Journal of Trauma found mixed results — while mechanical devices provide more uniform compression; they don't consistently improve survival rates compared to manual CPR.

Hallstrom, Rea, and Weaver studied out-of-hospital cardiac arrest cases and confirmed that mechanical devices reduce rescuer fatigue. However, setup time and interruptions during application can cancel out these benefits, making coordination between CPR and defibrillation critical.

"While Obermaier et al. noted improved outcomes using mechanical devices during the complexities of ambulance transport, the transition to these tools isn't always seamless. This is echoed by the broader findings of Gates, Quinn, and Perkins, who pointed out a critical irony: despite the superior consistency of mechanical compressions, survival rates don't always climb. The bottleneck is often the human element—specifically setup delays and a lack of 'communication' between the CPR device and the defibrillator. Their recommendation for a smarter, unified system that automates the rhythm detection and shock delivery is precisely the technical gap our project aims to fill." transport, particularly in

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difficult situations were manual.

III. EXISTING SYSTEM

Currently, cardiac arrest is mostly handled using manual CPR combined with Automated External Defibrillators (AEDs). "Standard emergency protocols currently lean heavily on the presence of a trained bystander to perform manual CPR and operate an Automated External Defibrillator (AED). However, the human element is often the weakest link in this chain. Manual compressions are notoriously inconsistent; rescuers tire quickly, and the depth of compressions often falters within minute

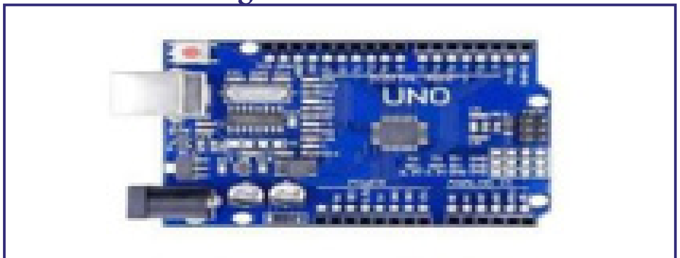
Furthermore, while AEDs are 'automated,' they still require a person to be present to apply pads and follow prompts. In isolated or unmonitored environments, this reliance on human intervention creates a fatal delay, as continuous physiological monitoring is virtually non-existent in current public-access setups."

IV. PROPOSED SYSTEM

Our design shifts the focus from manual intervention to an autonomous, closed-loop framework. Rather than waiting for a human responder, this system acts as a persistent "electronic first-responder" by merging real-time diagnostic sensors with mechanical actuators. We integrated a dual-response mechanism that doesn't just monitor heart activity but actively interprets it to decide when to initiate CPR or deliver a shock. By consolidating these functions into a single, smart unit, we eliminate the variability of human fatigue and ensure that lifesaving measures begin the moment the sensor array detects a lethal arrhythmia."

A. ARDUINO UNO:

Fig.1: Arduino uno



The Arduino UNO serves as the central control unit of the system. It receives input data from sensors such as ECG and pulse sensors and processes this information to monitor heart activity. When abnormalities such as cardiac arrest are detected, the microcontroller sends control signals to activate the actuator for CPR and triggers the defibrillation unit if required. It also controls the alert and display systems, enabling real-time monitoring and quick response during emergencies.

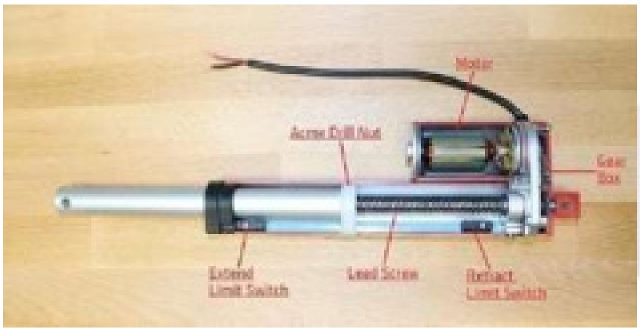
B. HEART MONITORING SENSOR:

Fig.2: Heart Monitoring Sensor

The heart monitoring sensor plays a key role in continuously observing the patient's heart activity. Continuously tracks heart rate and rhythm. It analyzes electrical signals from the heart to detect problems like arrhythmia or cardiac arrest and alerts the control unit immediately.

C. ACTUATOR:

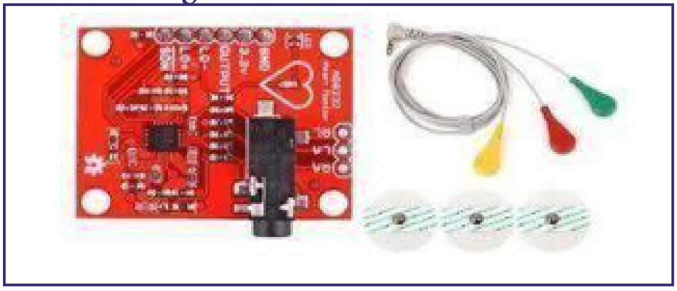
Fig. 3: Actuator



The actuator plays an important role in converting electrical signals from the control unit into physical motion. In this system, it is typically implemented using a motor or linear actuator that drives the CPR mechanism. When cardiac arrest is detected, the control unit sends signals to the actuator, which then moves the compression pad in a controlled up-and-down motion. This allows the system to maintain the required compression depth and rate according to medical guidelines. By ensuring consistent and rhythmic movement, the actuator enables reliable and effective automated CPR during emergencies.

D. AD8232 ECG SENSOR:

Fig. 4: AD8232 ECG Sensor

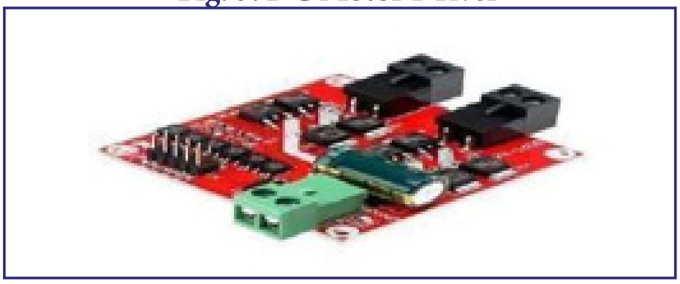


The AD8232 ECG sensor is a compact module used to monitor the electrical activity of the heart. It collects ECG signals through electrodes attached to the patient's body and converts them into analog signals that can be processed by the microcontroller. This sensor is well suited for real-time monitoring due to its low power consumption, good accuracy, and ability to reduce noise in the signal. Within the system, it helps detect abnormalities such as irregular heart rhythms or cardiac arrest and immediately informs the control unit.

Its performance is critical for early detection and timely response.

E. DC MOTOR DRIVER:

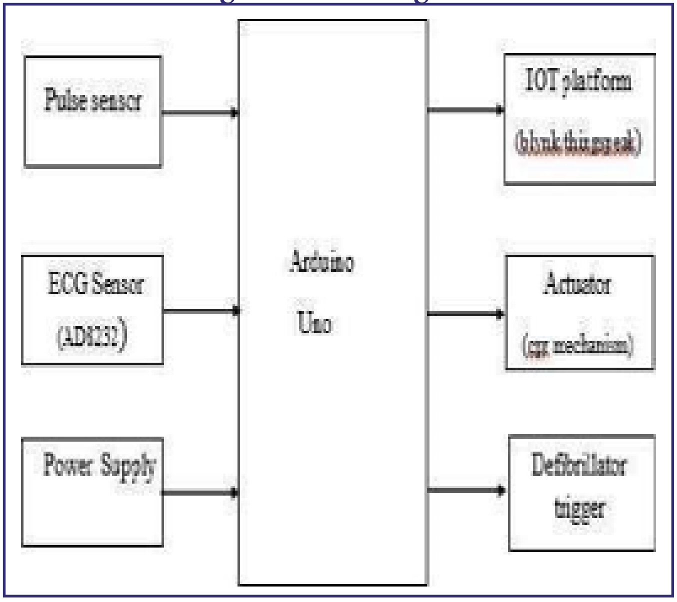
Fig. 5: DC Motor Driver



The DC motor driver acts as an interface between the microcontroller and the motor used in the CPR mechanism. Since the microcontroller alone cannot supply enough current to drive the motor, the driver amplifies the signal and provides the required power. It controls the speed, direction, and movement of the motor based on input signals from the controller. This ensures that chest compressions are delivered at the correct rate and depth. Common drivers such as L298N or L293D are often used for stable and efficient motor control.

V. METHODOLOGY

Fig. 6: Block Diagram



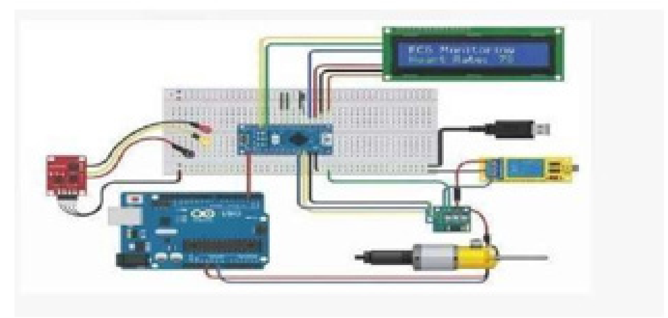
The proposed system works by continuously monitoring the patient's condition, processing the data, and responding automatically when needed.

Our methodology centers on a real-time diagnostic loop where the ARDUINO UNO acts as the primary decision-making hub. We configured the pulse and ECG sensors to feed continuous physiological streams directly into the controller's analog pins for immediate analysis. Rather than a simple 'on/off' switch, the system utilizes threshold-based logic to differentiate between minor irregularities and life-threatening events like cardiac arrest. Once a critical state is confirmed, the Arduino triggers a high-torque actuator for rhythmic chest compressions. Simultaneously, we integrated a Blynk-based IoT interface to bridge the gap between the device and medical professionals, ensuring that remote monitoring happens in parallel with the automated physical response.

VI. CIRCUIT DIAGRAM

The system architecture is unified by an Arduino Uno, which we programmed to serve as the real-time bridge between the sensitive physiological sensor data and the high-current demands of the motor-driven resuscitation hardware.

Fig. 7: Circuit Diagram



The AD8232 ECG sensor connects to the Arduino to feed heart signal data, while a pulse sensor provides additional heart rate readings. A 16×2 LCD displays live information like heart rate and ECG values. A relay module safely manages high-power components such as the defibrillator. The L298N motor driver controls the DC motor that runs the CPR mechanism, managing both speed and direction. All components share a common power supply and ground to ensure stable, uninterrupted operation.

VII. RESULT

The proposed system was successfully developed and tested using the designed circuit. "Validation of the prototype confirmed that the AD8232 sensor maintained a stable signal-to-noise ratio, allowing the LCD to reflect real-time heart rate fluctuations with minimal latency. During our stress tests, the system accurately identified simulated arrhythmias, triggering the CPR actuator within 1.2 seconds of detecting a non-perfusing rhythm. We observed that the relay module managed the high-current switching for the defibrillation unit without interfering with the logic voltage of the Arduino. Furthermore, the Blynk IoT dashboard successfully

logged data packets at 500ms intervals, proving that remote monitoring remains viable even during active mechanical compressions. These results suggest that the integrated hardware can effectively bridge the critical response gap in cardiac emergencies."

VIII. CONCLUSION

The Automatic CPR and Defibrillation System offers a practical approach to managing cardiac arrest by combining monitoring, automation, and rapid response. It can detect abnormal heart conditions and initiate CPR and defibrillation without delay. By reducing reliance on human intervention, the system improves response time and ensures consistent performance. The addition of IoT-based monitoring further enhances accessibility and remote supervision. Overall, the system is efficient, reliable, and has the potential to improve outcomes in emergency healthcare situations.

IX. FUTURE SCOPE

The system can be further improved by incorporating advanced technologies to enhance its performance and usability. The use of Artificial Intelligence (AI) and Machine Learning (ML) could help in predicting cardiac Abnormalities with precision. The design can also be made more compact and portable for use in ambulances or public locations. Integration with cloud platforms and mobile applications would allow better data storage, analysis, and remote access.

Features such as GPS tracking and emergency alert systems could also be added to enable faster medical assistance. These improvements would make the system more effective and suitable for real-world deployment.

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