

CPR CARDIO PULMONARY RESUSCITATION FEEDBACK DEVICE POWERED BY ARDUINO AND PULSE SENSOR

Submitted in partial fulfillment of the requirements for the award of Bachelor
of Technology degree in Biomedical Engineering

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INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
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APRIL 2024



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **AROKIYA RAHUL W (40240005), SAM JUDIT J V (40240029)** who have done the project work as a team and carried out the project entitled **CPR (CARDIO PULMONARY RESUSCITATION) FEEDBACK DEVICE POWERED BY ARDUINO AND PULSE SENSOR** under my supervision from November 2023 to April 2024.

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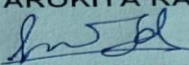
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DECLARATION

We AROKIYA RAHUL W (40240005) and SAM JUDIT J V (40240029), here by declare that the Project Report entitled "CPR (CARDIO PULMONARY RESUSCITATION) FEEDBACK DEVICE POWERED BY ARDUINO AND PULSE SENSOR" done by us under the guidance of Dr. A. SABARIVANI, M.Tech., Ph.D. (Internal) at "SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY" is submitted in partial fulfilment of the requirements for the award of Bachelor of Technology degree in Biomedical Engineering.

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ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to Board of Management of **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey my thanks to **Dr.T. SUDHAKAR, M.Sc., Ph.D.**, Head of the Department, department of biomedical engineering for providing me necessary support during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to my Project Guide **Dr. A.SABARIVANI,M.Tech.,Ph.D.** for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

We wish to express our thanks to all Teaching and Non-teaching staff members of the Department of Biomedical Engineering who were helpful in many ways for the completion of the project.

We would like to express our thanks to our parents for their unwavering support to us during these years.

ABSTRACT

Cardiopulmonary resuscitation (CPR) is used in emergencies when someone is not breathing or their heart has stopped (cardiac arrest). This life-saving technique involves chest compressions and rescue breathing. Adding real-time feedback to CPR allows for monitoring the depth, rate, timing, and effectiveness of chest compressions, as well as heart rhythm. As most healthcare training professionals know, we often need to create or adapt teaching tools to better suit the needs of our programs and learners. One of the projects I've been working on involves enhancing a pulse sensor to include a CPR feedback device using Arduino. There are many CPR feedback devices available, some utilizing a cellphone, a portable device, or a CPR manikin with integrated features. This design aims to be cost-effective and user-friendly for trainers. We are incorporating a pulse detector to gather more information about the patient's condition during recovery. The CPR feedback device includes features such as real-time rate measurement. One common challenge in CPR training is providing effective feedback due to the lack of a comprehensive feedback system. This can lead to issues such as gastric distention, vomiting, rib or sternum fractures, and even punctured lungs. By focusing on the LED screen display and maintaining good external force during the CPR process, we aim to provide a cost-efficient and user-friendly product to help save lives in emergencies.

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LIST OF ABBREVIATIONS

CPR - Cardiopulmonary Resuscitation

CC - Chest Contraction

ECG - Electro Cardio Gram

FSR - Force Sensitive Resistor

IDE - Integrated Development Environment

LCD - Liquid Crystal Display

LMS - Least Mean Squares

PCC - Pearson's Correlation Coefficient

RLS - Recursive Least Squares

ROSC - Return of Spontaneous Circulation

PCB – Printed Circuit Board

CHAPTER 1

INTRODUCTION

1.1 CARDIOPULMONARY RESUSCITATION

CPR – or Cardiopulmonary Resuscitation – is an exigency lifesaving procedure performed when the heart stops beating. Immediate CPR can double or triadic chances of survival after cardiac arrest. Due to any unlooked-for incident the brain may lose the force of oxygen due to the absence of heart beats, so the heart requires an external force for the regular force of the oxygen. The system used for the recovery is CPR (Cardiopulmonary resuscitation). CPR is performed by heart compressions Artificial ventilation, or mouth- to-mouth.(Atkins D *et al.*, 2015) For grown-ups, the contraction depth should be at least 2 elevations, and the contraction rate should be atleast100-120min.



Fig: 1.1: CPR process

Cardiopulmonary resuscitation (CPR) is an exigency procedure conforming of heart condensing frequently combined with artificial ventilation, or mouth to mouth in a trouble to manually save complete brain function until farther measures are taken to restore robotic blood rotation and breathing in a person who's in cardiac arrest. It's recommended for those who are unresponsive with no breathing or abnormal CPR involves heart condensing for grown-ups between 5 cm and 6 cm deep and at a rate of at least 100 to 120 per nanosecond. The deliverer may also give artificial ventilation by either exhaling air into the subject's mouth or nose (mouth- to- mouth resuscitation) or using a device that pushes air into the subject's lungs (mechanical ventilation). Current recommendations place emphasis on early and high- quality heart condensing over artificial ventilation; In general, CPR is continued until the person has a return of robotic rotation (ROSC) or is declared dead.

1.2 CPR FEEDBACK DEVICE

In the critical moments following cardiac arrest, the effectiveness of cardiopulmonary resuscitation (CPR) can make the difference between life and death. However, ensuring the quality and consistency of CPR delivery poses significant challenges for rescuers, particularly in high-stress emergency situations. Traditional CPR training methods often rely on subjective assessments and intermittent feedback, leading to variability in performance and potentially suboptimal outcomes. Recognizing the need for more effective CPR delivery practices, researchers and developers have turned to innovative technological solutions to enhance resuscitation efforts. The CPR feedback device represents a groundbreaking advancement in this regard, offering a novel approach to CPR training and delivery. By integrating state-of-the-art sensors, microcontrollers, and visual displays, the device provides real-time feedback on compression quality, pulse rate, and other vital parameters during CPR procedures. This immediate feedback enables rescuers to monitor and optimize their technique, ensuring consistent and effective chest compressions throughout the resuscitation process. In addition to its role in enhancing CPR delivery practices, the CPR feedback device serves as a valuable training tool for healthcare professionals and lay rescuers alike (Grunau B 2020). By offering immediate insights into CPR performance and facilitating skill development and refinement, the device enhances the effectiveness of CPR training programs, ultimately improving rescuer preparedness and confidence in emergency situations. This introduction sets the stage for a comprehensive exploration of the development, functionality, and potential impact of the CPR feedback device on CPR delivery practices and patient outcomes. Through a thorough analysis of its effectiveness in improving rescuer performance, enhancing training effectiveness, and mitigating rescuer fatigue, we aim to demonstrate the transformative potential of this innovative device in the field of emergency medicine. With further research, refinement, and widespread adoption, the CPR feedback device has the capacity to revolutionize CPR care delivery, ultimately saving more lives and improving outcomes for cardiac arrest patients worldwide.

1.3 IMPORTANCE OF CPR

Cardiopulmonary resuscitation (CPR) stands as a paramount intervention in medical emergencies, especially during instances of cardiac arrest. Its importance lies in its ability to sustain vital functions, particularly circulation and oxygenation, when the heart fails to beat effectively. (Holmberg M, 2021) The significance of CPR can be delineated through several key points. First and foremost, CPR provides an immediate response to cardiac arrest, serving as a critical intervention until advanced medical assistance can be administered. Every moment without CPR significantly diminishes the likelihood of survival, making prompt initiation imperative. Furthermore, CPR plays a crucial role in preserving brain function by ensuring continuous oxygenation to vital organs, particularly the brain. This preservation prevents irreversible damage and enhances the chances of successful resuscitation if the heart can be restarted. Another vital aspect is the accessibility of CPR, as it can be performed by anyone, irrespective of medical training. This empowers bystanders to take action in emergencies, significantly improving the chances of survival for cardiac arrest victims. Additionally, CPR serves as a bridge to advanced medical care by maintaining circulation until more advanced interventions, such as defibrillation and advanced life support, can be administered by healthcare professionals. Moreover, CPR finds application in various emergency scenarios beyond cardiac arrest, including drowning, choking, and suffocation, making it a versatile and indispensable life-saving skill. Learning CPR not only empowers individuals to respond effectively in emergencies but also has a broader public health impact by reducing mortality rates associated with sudden cardiac arrest. In summary, CPR stands as a fundamental life-saving skill with profound implications for individual and community health. By understanding its importance and promoting widespread education and training, we can enhance survival rates and improve outcomes for individuals experiencing cardiac emergencies. Through timely initiation, effective execution, and ongoing public awareness efforts, CPR continues to serve as a cornerstone of emergency medical care, offering hope and resilience in the face of life-threatening situations.

CHAPTER 2

LITERATURE SURVEY

2.1 SURVEY

C. Daudre-vignier et al., (2021) proposed identification of an optimal cpr chest contraction protocol, in this study, we used a high- dedication integrated computational model of the respiratory and cardiovascular systems to probe cardiopulmonary resuscitation (cpr) after cardiac arrest in a virtual healthy subject. For the purpose of this work, a recently developed thoracic model has been integrated to the current model, to study the influence of external chest condensing upon the arrested rotation during cpr. We estimated the chest contraction(cc) parameters, videlicet, end contraction force, contraction rate, and duty cycle to optimize the coronary perfusion pressure and the systolic blood pressure, using an inheritable algorithm. While the sternal relegation associated with the cc force agreed with the eric guidelines, the cc rate and duty cycle were independently advanced and lower than the bones recommended by the eric guidelines.

Rawin Keakultanes et al., (2022) proposed Automatic Cardiopulmonary Resuscitation System., Cardiac arrest occurs when the heart unexpectedly malfunctions and stops breathing and pumping blood. Cardiopulmonary resuscitation, an emergency resuscitation procedure, must be performed as soon as possible when the patients suffer cardiac arrest to prevent brain damage or stop breathing. If not, it may lead a person dead even in a short time (from 8-10 minutes) of cardiac arrest. According to the American Heart Association, proper CPR must be performed at a depth of 5 cm in the sternum and a rate of chest compressions of 100 to 120 breaths per minute. Therefore, medical personnel or the person who performs CPR must be well-trained to conduct proper CPR. For this reason, CPR machines are demanded to assist and support medical personnel in saving human lives.

Y.-K. OU *et al.*, (2021) proposed An Interactive Modular System and Interface for Laerdal littleAnne™ Manikin in CPR Training, when cardiopulmonary functions fail, timely CPR administered properly can reduce brain cell damage. Our survey found that conventional training programs using Laerdal Little Anne™ manikin lack tangible data to ascertain the accuracy of resuscitative techniques. Therefore, we developed a sensor component module that inputs data into an easy-to-use interface to be used in conjunction with the CPR training manikin to ensure accurate techniques. We have developed an interactive modular system to fit inside Laerdal Little Anne™ manikins, specifically by placing micro switch, Arduino Uno R3 board, humidity sensor, and force-sensing resistors inside the manikin and connecting them via pictorial interface to enable data feedback on the number and frequency of chest compression and ventilation to guide CPR training and to ensure accuracy of the techniques.

Hidehiko Hayashi *et al.*,(2020) proposed Development of a Cardiopulmonary Resuscitation Feedback Learning Device Using Malti sensor This was developed a cardiopulmonary resuscitation (CPR) feedback learning device using Malti sensor technology such as the Kinect and Wii Balance Board, in order to improve and promote lay rescuers' knowledge and skills in CPR. The proposed system can evaluate user CPR actions in real time and a low-cost way. Particular characteristics of this system are for laypeople to achieve the necessary posture during CPR chest compression and the provision of audio-visual corrective feedback. This system is anticipated to contribute to high-quality CPR learning. We developed an CPR feedback learning system device in a low-cost way using multisensory such as the Kinect and Wii Balance Board. Based on our experiences of the posture assessment and demonstrated using an CPR feedback learning system, we found the Kinect and the balance board to be effective and easy to use of CPR learning.

Joshua W et al., (2020) proposed Towards Personalized Closed-Loop Mechanical CPR: A Model Relating Carotid Blood Flow to Chest Compression Rate and Duration, there is a growing interest in the personalization of chest compressions to increase blood flow during cardiopulmonary resuscitation (CPR), but there has been very little systematic work to test the feasibility of a closed loop mechanical CPR system. The purpose of this study is to determine if it is possible to model the response of the carotid blood flow to different chest compression waveforms as a function of time during resuscitation from cardiac arrest. Chest compression generated carotid blood flow was successfully modelled using a Random Forest algorithm. The model used the epoch number, the compression index, the compression rate, and the previous compression's net carotid blood flow to predict what would happen in the next chest compression. The error of the model was about 40–160 $\mu\text{l}/\text{compression}$.

Van-Truong Pham et al ., (2020), proposed An Automatic Approach for Estimation of CPR Signal using Thoracic Impedance Quality of chest compressions is an important measure with regards to cardiopulmonary resuscitation (CPR). For chest compression quality assessment, it is important to detect or estimate the chest compressions in heart rhythms. In this study, we proposed a new approach for estimation of the CPR during out-of-hospital cardiac arrest, and assessment of chest compression quality via CPR parameters This study has presented an approach for assessment of the CPR quality for analysing ECG signals. Using the ECG signals acquired from defibrillators and thoracic impedance signals, we propose to estimate the CPR signal.

Melehat Kızıl et al.,(2022) proposed Design of a Device for CPR A review on the use of mechanical CPR They showed the advantages and problems of the system in detail. Numerous device designs and patents have been found. Automatic devices manual CPR mimics the dynamic. Many conditions of mechanical devices must provide; considered to be of paramount importance feature for non-hospital use; efficiency (the gentleness of the massage and safety, fast positioning), diversity (ECG) reception, heart rate etc.) and the reliability of the device. (Battery life, device working without stopping, etc.) CPR today from the samples in piston or band application some of them are shown CPR is a vital life to increase chances of survival . recovery method. Many devices that work on the basis of CPR Besides, different design that is portable and easy to use alternatives were examined. CPR performed on the manikin Completion of missing functions of CPR LUCAS tracking of the pulse display in the device considered on the basis of defibrillation is involved and can be attached to a stretcher are considered as currently added.

RatnaAisuwarya et al.,(2021) proposed Design of Microcontroller-Based Cardiopulmonary Resuscitation (CPR) Practice Tool The hardware used includes FSR (Force Sensitive Resistor), which detects physical pressure and weight. The FSR is made of 2 layers separated by a spacer. The more it is pressed, the more the points of the active element touch the semiconductor, making the resistance drop. The sensor is connected to the microcontroller using a 10k resistor. FSR resistance changes as more pressure are applied. When there is no pressure, the sensor looks like an infinite resistor (open circuit). Based on the research and testing that has been done, it can be concluded that the designed system can simulate the CPR process by measuring every parameter of CPR, namely compression 30 times in 15-18 seconds with the optimal pressure is $\pm 50\text{kg}$, 30° angle slope for airways, and two times in 5 seconds for breathing

Xabier Jaureguibeitia *et al.*, (2020) proposed Automatic Detection of Ventilations During Mechanical Cardiopulmonary Resuscitation. The ventilation detection method is composed of the three stages shown. First, the raw impedance signal is filtered of features x_i . The greedy detector is designed to detect all Candidate ventilations, with the trade-off of producing many false positive detections. So, the final stage is a machine learning classifier based on the waveform features to discriminate true ventilations (green) from false positives (red). The algorithm can only be used during mechanical CPR and given the cost of mechanical CPR devices many EMS agencies still rely on manual chest compressions, although There is an increased trend towards the use of mechanical devices.

Md. Fahim *et al.*, (2022) proposed Arduino based Smart Design of a Cheaper and Portable Automated Cardiopulmonary Resuscitation (CPR) Device. When the system is turned ON using a 20v battery, our proposed system waits for the user to give a command i.e., using the Push1 (Start) and Push2 (Mode). When an input i.e., functioning condition is defined by the user with the help of Arduino UNO, our system passes the information to the motor driver which makes the motor start working according to the given command. i.e., to give certain number of compressions to the patient according to the patient's age and need. This paper proposes a low-cost automated cardiopulmonary resuscitation device for both elderly and neonates. This proposed CPR device is really built to mitigate the gap with recent costly devices in western markets as our aim is to make a CPR device that will help to save the life of not only rich people o but also of middle and poor class people

Yuxin Wang et al.,(2023) proposed Feedback Devices for Cardiopulmonary Resuscitation: A Narrative Review., The application of feedback devices for cardiopulmonary resuscitation (CPR) can effectively enhance the quality of life-saving treatment during CPR. This article is a narrative review that selects literature on feedback devices used in chest compression and provides a comprehensive review and analysis of the development and current research status of feedback devices used in CPR. The development status of visual–auditory feedback devices used in chest compression at home and abroad and the advantages and disadvantages of existing feedback devices are the main points of discussion. Based on existing devices and technologies, this article explores the difficulties and deficiencies of current feedback device development. Finally, we propose the future development direction of CPR feedback equipment combined with physiological information data-monitoring devices.

Jiayu Xie et al., (2023), proposed Design and Evaluation of CPR Emergency Equipment for Non-Professionals., This study aimed to design and evaluate CPR emergency equipment with multisensory feedback capabilities. The experiments demonstrated the positive impact of the equipment on improving the quality of CPR performed by non-professionals. The development process of the equipment comprised three main components: design and fabrication of emergency clothing; principal research and prototype development of a vital signs monitor; and design and manufacture of an integrated audiovisual terminal. The evaluation process focused on assessing the effectiveness of the multisensory feedback CPR emergency equipment in guiding the CPR actions of non-professionals. The experimental results indicated that the experimental group utilizing the device exhibited significantly better CPR quality (including CC depth, CC rate, precise depth of CC ratio, and precise rate of CC ratio) compared to the control group performing manual CPR. In the subjective evaluations, the device received an average score of 78.594 on the System Usability Scale (SUS), indicating an “acceptable” level of acceptability and a “good” adjective rating.

Debora Gugelmin-Almeida et al., (2021) proposed automated real-time feedback devices improve CPR quality? A systematic review of literature, Automated real-time feedback devices have been considered a potential tool to improve the quality of cardiopulmonary resuscitation (CPR). Despite previous studies supporting the usefulness of such devices during training, others have conflicting conclusions regarding its efficacy during real-life CPR. This systematic review aimed to assess the effectiveness of automated real-time feedback devices for improving CPR performance during training, simulation and real-life resuscitation attempts in the adult and pediatric population.: Articles published between January 2010 and November 2020 were searched from BVS, Cinahl, Cochrane, PubMed and Web of Science, and reviewed according to a pre-defined set of eligibility criteria which included healthcare providers and randomized controlled trial studies. Feedback devices during training and/or simulation resulted in improved acquisition of skills and enhanced performance in 15 studies. One study resulted in no significant improvement. The use of automated real-time feedback devices enhances skill acquisition and CPR performance during training of healthcare professionals. Further research is needed to better understand the role of feedback devices in clinical setting.

Young-II Roh et al., (2023), proposed Development of an automatic device performing chest compression and external defibrillation: An animal-based pilot study Automatic chest compression devices (ACCDs) can promote high-quality cardiopulmonary resuscitation (CPR) and are widely used worldwide. Early application of automated external defibrillators (AEDs) along with high-quality CPR is crucial for favourable outcomes in patients with cardiac arrest. Here, we developed an automated CPR (A-CPR) apparatus that combines ACCD and AED and evaluated its performance in a pilot animal-based study. An automatic CPR device developed in this study integrates the functions of mechanical chest compressions and defibrillation to achieve significant hemodynamic outcomes. A-CPR can provide continuous chest compressions during defibrillation, thereby shortening the time required for defibrillation and improving treatment outcomes.

Zetao Chen et al., (2023) proposed Feedback Devices for Cardiopulmonary Resuscitation The application of feedback devices for cardiopulmonary resuscitation (CPR) can effectively enhance the quality of life-saving treatment during CPR. This article is a narrative review that selects literature on feedback devices used in chest compression and provides a comprehensive review and analysis of the development and current research status of feedback devices used in CPR. The development status of visual–auditory feedback devices used in chest compression at home and abroad and the advantages and disadvantages of existing feedback devices are the main points of discussion. Based on existing devices and technologies, this article explores the difficulties and deficiencies of current feedback device development. Finally, we propose the future development direction of CPR feedback equipment combined with physiological information data-monitoring devices

Oscar J. L. Mitchell et al., (2023) proposed Mechanical Cardiopulmonary Resuscitation During In-Hospital Cardiac Arrest In contrast to conventional delivery of manual CPR, mechanical CPR devices represent a potentially appealing alternative as they can provide uninterrupted chest compressions at appropriate rate and depth and are not limited by human performance variability and fatigue. During prolonged resuscitation efforts, these devices can free team members for other tasks and potentially reduce room crowding. Currently available devices include the Lund University Cardiopulmonary Assist System (LUCAS, Stryker Medical, Kalamazoo, MI), the Auto pulse (ZOLL Medical Corporation, Chelmsford, MA), and the Thumper (Michigan Instruments, Grand Rapids, MI). These devices use a piston, band, or vest to externally compress the thoracic cavity. However, the use of these devices is not without disadvantages, including the need to pause CPR for device deployment and a risk of traumatic injuries from the devices themselves. The majority of high-quality studies comparing mechanical CPR to manual CPR have been performed in the setting of out-of- hospital cardiac arrest (OHCA) and have not found a benefit of mechanical CPR over manual CPR.

Desale Tewelde Kahsay *et al.*, (2023) proposed the effect of standalone audio-visual feedback devices on the quality of chest compressions during laypersons' cardiopulmonary resuscitation training: a systematic review and meta-analysis Individual studies that investigated the effect of standalone audio-visual feedback (AVF) devices during laypersons' cardiopulmonary resuscitation (CPR) training have yielded conflicting results. This review aimed to evaluate the effect of standalone AVF devices on the quality of chest compressions during laypersons' CPR training. The quality of the included studies was variable, and different standalone AVF devices were used. Standalone AVF devices were instrumental in guiding laypersons to deliver deeper compressions without compromising the quality of compression rates. However, the devices did not improve the quality of chest recoil and placement of the hands.

Kerrin E. Weiss *et al.*, (2023) proposed Data-driven resuscitation training using pose estimation After mandatory basic life support training, 91 healthcare providers performed a simulated CPR scenario in teams. Their behaviour was simultaneously rated based on pose estimation and by experts. It was assessed if the arm was straight at the elbow, by calculating the mean arm angle, and how close the distance between the team members was during chest compressions, by calculating the chest-to-chest distance. Both pose estimation metrics were compared with the expert ratings. Results The data-driven and expert-based ratings for the arm angle differed by 77.3%, and based on pose estimation, 13.2% of participants kept the arm straight. The chest-to-chest distance ratings by expert and by pose estimation differed by 20.7% and based on pose estimation 63.2% of participants were closer than 1 m to the team member performing compressions. Conclusions Pose estimation-based metrics assessed learners' arm angles in more detail and their chest-to-chest distance comparably to expert ratings. Pose estimation metrics can complement educators with additional objective detail and allow them to focus on other

Sebastian Dałbrowski *et al.*, (2023) proposed Analgesic Use in Patients during Cardio-Pulmonary Resuscitation Cardiopulmonary resuscitation-induced consciousness is a newly recognized phenomenon with an increasing incidence. A return of consciousness during cardiopulmonary resuscitation affects up to 0.9% of cases. Patients may also experience physical pain associated with chest compressions, as most victims of cardiac arrest who are subjected to resuscitative efforts sustain ribs or sternum fractures. Methods: A rapid review was carried out from August 2021 to December 2022. Results: Thirty-two articles were included in the rapid review. Of these, eleven studies focused on the return of consciousness during CPR, and twenty-one on CPR-induced chest injuries. Conclusion: A small number of studies that have dealt with the return of consciousness associated with cardiopulmonary resuscitation made it hard to clearly determine how often this occurs. There were more studies that dealt with chest trauma during resuscitation, but no study considered the use of analgesics. Of note, there was no standardized therapeutic approach as far as the use of analgesics and/or sedatives was considered.

Yu-Tung Chang *et al.*, (2023) proposed Effects of different cardiopulmonary resuscitation education interventions among university students' Cardiopulmonary resuscitation (CPR) education for the public may improve bystander intention to perform CPR on cardiac arrest patients. Studies have shown that different CPR education intervention methods can improve learning performance, with key indicators including attitude toward to CPR, intention to perform CPR, and degree of CPR knowledge and skills. The present study compared the traditional face-to-face method to hybrid and virtual reality (VR) methods to observe difference in learning performance and length of performance retention. This study adopted randomized controlled trial to compare CPR learning performance between traditional face-to-face, hybrid, and VR methods. Participants from each intervention group completed a pretest and 2 post tests. The measurement tools included an attitude and intention questionnaire, knowledge

Manuel Rebol et al., (2022) proposed Work-in-Progress-Volumetric Communication for Remote Assistance Giving Cardiopulmonary Resuscitation We present our work in progress, a real-time mixed reality communication system for remote assistance in medical emergency situations. 3D cameras capture the emergency situation and send volumetric data to a remote expert. The remote expert sees the volumetric scene through mixed reality glasses and guides an operator at the patient. These systems offer the potential for immersive training and realistic haptic rendering. However, to reach widespread adoption they must overcome the limitations of cost and mechanical complexity

Timothy Everson et al., (2022) proposed Cardiac arrest is a leading cause of death worldwide preventable with timely application of cardiopulmonary resuscitation (CPR). The American Heart Association CPR guidelines recently have an increased focus on quality of consistent chest compressions and highlighted the need for frequent refresher courses. Literature has shown that standard training manikins do not accurately represent human torso compression forces. Virtual reality (VR) and augmented reality (AR) technologies can simulate or enhance training environments and have shown promise for CPR training. We evaluate task performance, cognitive load, and user interaction. The results will help to better understand the benefits of using augmented and volumetric information in medical emergency procedures.

Chang Guo *et al.*, (2022), proposed Monitoring the Changes of Electroencephalogram During Cardiopulmonary Resuscitation, the electroencephalogram (EEG), a technique that uses scalp electrodes to monitor electrical potential variations in synaptic neuronal activity to provide information on cortical brain function, is extremely sensitive to changes in consciousness and has shown promising results in brain injury and functional recovery after cardiac arrest (CA). However, changes of the EEG signals during cardiopulmonary resuscitation (CPR) are still unclear. This study aimed to develop an approach to monitoring the EEG alterations during CPR and examine the effects of CPR on the cerebral cortical function. A CA model was realized on five healthy adult Bama pigs. A standard CPR treatment was performed on the pigs, by which four of them fulfilled the standard of return of spontaneous circulation (ROSC) whereas one of them failed to be recovered. During the CPR treatment, 12 channels of EEG were recorded on the global area of cortical area. The power spectral density, the average weighted clustering coefficient (C), and the characteristic path length (L) of the EEG signals were calculated

Tomoki Kuriyagawa *et al.*, (2022), proposed Development of visualization algorithm for appropriate compression tempo in cardiopulmonary resuscitation training system Cardiopulmonary resuscitation (CPR) is the most effective quick responsive method to avoid the risk of death due to a heart attack. However, no practical CPR education has been established regarding the citizens' correct posture while performing CPR. Herein, we developed a training system using an Azure Kinect DK sensor camera to visualize the upper and lower body posture while performing the CPR operation from both the front and side. Assuming its use under COVID-19 restrictions, we implemented a noncontact voice-activated interface and functionality for accurately detecting system' pressure. For evaluating the training system, after using it for the airport and life insurance employees training, a comparative investigation was conducted to determine whether the system's applicability for training. As per B business office experiment, when the number of data items was $n=44$, a correlation coefficient with a strong correlation.

CHAPTER 3

AIM AND SCOPE

3.1 CPR AIM

The aim of this project is to design, develop, and implement a CPR feedback device aimed at enhancing the quality of cardiopulmonary resuscitation (CPR) delivery and ultimately improving patient outcomes during cardiac emergencies. Recognizing the critical importance of effective CPR in saving lives during cardiac arrest, the project focuses on integrating real-time feedback mechanisms into the resuscitation process to address existing challenges and limitations in CPR practices. Specific objectives of the project include the design and development of a prototype CPR feedback device equipped with sensors capable of monitoring key parameters such as compression depth and rate. Algorithms will be developed to process the sensor data and provide immediate feedback to rescuers, aiding in the optimization of CPR technique. User-friendly interfaces, such as LCD displays, will be integrated into the device to ensure that feedback is easily interpretable and actionable by rescuers in high-pressure situations. The project will undergo rigorous testing and validation to ensure the accuracy, reliability, and usability of the CPR feedback device in real-world scenarios. Clinical trials and simulation studies will be conducted to evaluate the impact of the device on CPR performance, rescuer confidence, and ultimately patient outcomes. Furthermore, the project aims to provide comprehensive training and education on the use of the CPR feedback device to healthcare professionals, first responders, and lay rescuers. Collaboration with stakeholders, including medical professionals, emergency responders, and regulatory agencies, will be essential to promote acceptance and integration of the CPR feedback device into existing emergency medical systems. Overall, the project endeavours to develop an innovative CPR feedback device that revolutionizes CPR delivery practices, enhances rescuer performance, and ultimately contributes to saving more lives during cardiac emergencies. Through the integration of advanced technology and evidence-based practices, this project has the potential to make a significant impact on emergency medical care and public health outcome

3.2 CPR SCOPE

The scope of this project is multifaceted, encompassing a comprehensive approach to designing, developing, and implementing a CPR feedback device aimed at improving the quality of cardiopulmonary resuscitation (CPR) delivery and ultimately enhancing patient outcomes during cardiac emergencies. Beginning with the design and development phase, the project will focus on creating a prototype CPR feedback device equipped with advanced sensors to monitor critical CPR parameters such as compression depth and rate. Algorithms will be devised to process sensor data in real-time, providing immediate feedback to rescuers and facilitating adjustments to optimize CPR technique. User-friendly interfaces, including LCD displays, will be integrated into the device to ensure ease of interpretation and usability in high-stress situations. Following design and development, rigorous testing and validation procedures will be conducted to assess the accuracy, reliability, and usability of the CPR feedback device in real-world scenarios. This phase will involve laboratory testing, simulated CPR scenarios, and clinical trials to evaluate device performance and effectiveness across diverse settings and populations. Additionally, comprehensive training and educational initiatives will be implemented to ensure proper utilization of the CPR feedback device by healthcare professionals, first responders, and lay rescuers. Training materials, workshops, and educational sessions will be developed to promote awareness and facilitate widespread adoption of the device. Moreover, collaboration with stakeholders, including medical professionals, emergency responders, regulatory agencies, and CPR training organizations, will be integral to the success of the project. Input from stakeholders will inform device design, implementation strategies, and dissemination efforts, ensuring alignment with existing protocols and practices within the healthcare system. Ultimately, the project aims to drive the implementation and adoption of the CPR feedback device in various healthcare settings, contributing to improved CPR outcomes and ultimately saving more lives during cardiac emergencies. Through a comprehensive and collaborative approach, the project seeks to make a significant impact on emergency medical care and public health outcomes.

CHAPTER 4

EXPERIMENTAL OR MATERIALS

4.1 METHODOLOGY

As described in block diagram Fig 4.1, the components are connected. That is Arduino is loaded with the code and it is connected to the breadboard along with a flex sensor, LCD display, pulse sensor, LED's. Where when at the time of use we exert pressure which are sensed by the flex sensor so during the compression of chest the it may alert the user who may give too much pressure or give less pressure, and pulse sensor which sense the pulse that is exerted by the heart. Along with these components FSR (Force Sensing Resistor) is also used which will sense the force which is exerted us. A particular pressure parameter is set. So, when the pressure exceeds or if it is less the sensor alerts. These parameters are sensed in the sensor which sends the message to Arduino which sends the message to the display LED. These LED's display the message which will be useful to the user to know the condition of the patient. So, the uniqueness in our project is the display of the pulse rate of the heart which may be useful to the user. So, the user may know the condition of the patient more accurately.

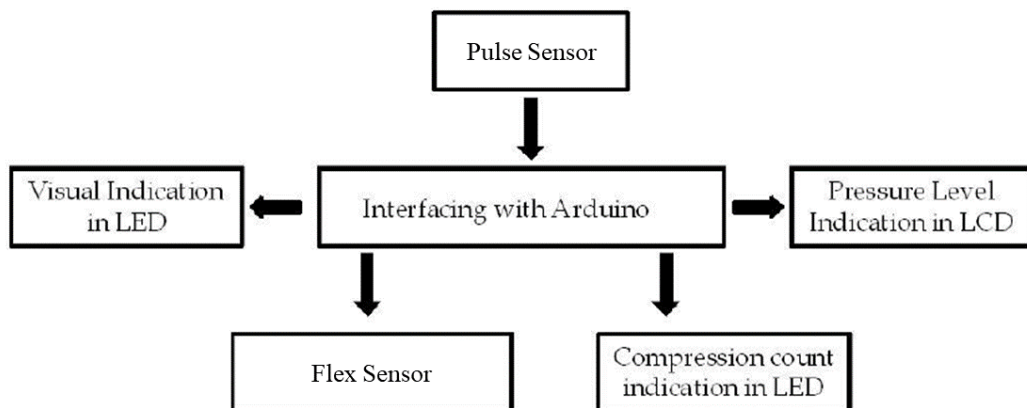


Fig: 4.1: Block Diagram of CPR feedback device

4.2 HARDWARE USED

4.2.1 Arduino (Uno R3)

Arduino UNO is a microcontroller board Fig 4.2 grounded on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything demanded to support the microcontroller; simply connect it to a computer with a USB string or power it with an AC-to-DC



Fig :4.2: Arduino uno R3

adapter battery to get started. You can tinker with your UNO without troubling too important about doing commodity wrong, worst-case script you can replace the chip for many bones and start over again. The Arduino UNO is the stylish board to get started with electronics and coding. However, the UNO is the most robust board you can start playing with, if this is your first experience tinkering with the platform. The Arduino UNO R3 is the perfect board to get familiar with electronics and rendering. This protean development board is equipped with the well-known ATmega328P and the AT Mega 16U2 Processor. This board will give you a great first experience within the world of Arduino. Arduino can be used to develop stand-alone interactive objects or can be connected to software on your computer (e.g., Flash, Processing, MaxMSP). The open-source IDE can be downloaded for free (presently for Mac OS X, Windows, and Linux). Arduino Uno R3 is one kind of ATmega328P grounded microcontroller board.

4.2.2 Flex Sensor

A flex sensor Fig 4.3 is a kind of sensor which is used to measure the amount of deflection otherwise bending. The designing of this sensor can be done by using materials like plastic and carbon. The carbon surface is arranged on a plastic strip as



Fig: 4.3: Flex Sensor

this strip is turned aside then the sensor's resistance will be changed. Thus, it is also named a bend sensor. As its varying resistance can be directly proportional to the quantity of turn thus it can also be employed like a goniometer. Chest compression was performed 100 times/min by a compression machine on the floor or a mattress, and the depth of CC was monitored using a flexible pressure sensor and CPR. The depth of machine-performed CC was consistently 5cm. We compared data from the feedback sensor with the true depth of CC using dual real-time auto feedback system that incorporated an infrared camera.

4.2.3 LCD DISPLAY 16x2

The term LCD stands for liquid crystal display Fig 4.4. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main

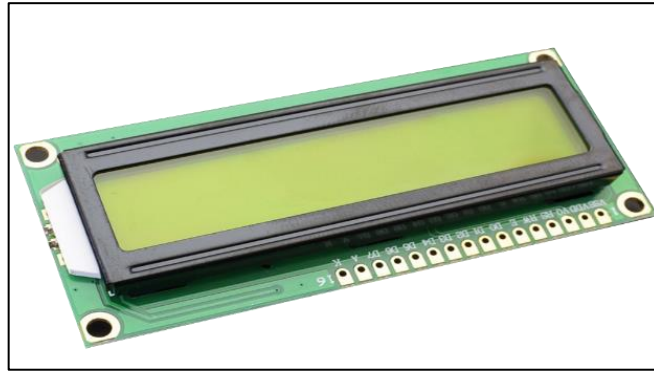


Fig: 4.4: LCD Display 16x2

benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc. The operating voltage of this LCD is 4.7V-5.3V It includes two rows where each row can produce 16-characters. The utilization of current is 1mA with no backlight. Every character can be built with a 5×8-pixel box. The alphanumeric LCDs alphabets & numbers. Is display can work on two modes like 4-bit & 8-bit. These are obtainable in Blue & Green Backlight. It displays a few custom generated characters. Their resolution, or the number of pixels arranged horizontally and vertically, determines the display's sharpness and detail. While some LCDs may have limited viewing angles, advancements like IPS technology offer improved visibility from various angles. Additionally, factors like refresh rate and energy efficiency, often enhanced by LED backlighting, contribute to the overall performance and suitability of LCD displays for diverse applications across industries, owing to their versatility, reliability, and relatively low cost.

4.2.4 Pulse Sensor

A pulse wave is the change in the volume of a blood vessel that occurs when the heart pumps blood, and a detector that monitors this volume change is called a pulse sensor. Fig 4.5. Pulse sensors using the photoelectric pulse wave method are classified into 2



Fig: 4.5: Pulse Sensor

types depending on the measurement method: transmission and reflection. Transmission types measure pulse waves by emitting red or infrared light from the body surface and detecting the change in blood flow during heart beats as a change in the amount of light transmitted through the body. This method is limited to areas where light can easily penetrate, such as the fingertip or earlobe. ROHM is currently developing a reflection-type pulse sensor (Optical Sensor for Heart Rate Monitor). The reflection-type pulse sensor (Optical Sensor for Heart Rate Monitor) is explained below. Reflection-Type Pulse Sensor (Optical Sensor for Heart Rate Monitor) Reflection-type pulse sensors (Optical Sensors for Heart Rate Monitor) measure infrared, red, or green light (~550nm) towards the body and measure the amount of light reflected using a photodiode or phototransistor. Oxygenated haemoglobin present in the blood of the arteries has the characteristic of absorbing incident light, so by sensing the blood flow rate (change in blood vessel volume) that changes following heart contractions over time we are able to measure the pulse wave signal. Also, since reflected light is measured, the range of suitable areas is not limited as with transmission-type pulse sensors.

4.2.5 LCD Breakout Board

An LCD breakout board Fig 4.6 serves as a compact intermediary device, facilitating the seamless integration of an LCD (Liquid Crystal Display) module into various electronic projects. These boards are engineered to simplify the often-intricate process of connecting an LCD to microcontrollers or other electronic devices. Typically, LCD

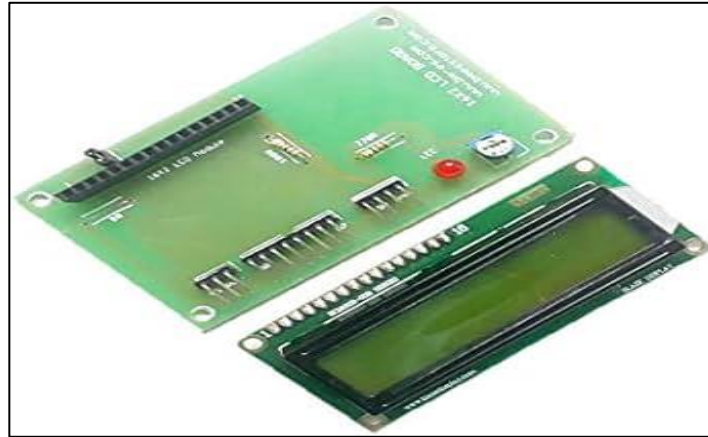


Fig: 4.6 : LCD Breakout Board

breakout boards are customized to match specific LCD modules, featuring connectors or headers that align precisely with the pinout configuration of the LCD, thereby eliminating the need for intricate wiring and reducing the likelihood of connection errors. One of the primary functions of an LCD breakout board is to ensure proper electrical interfacing between the LCD and the controlling device. To achieve this, breakout boards often incorporate essential components such as voltage regulators and level shifters. Voltage regulators ensure that the LCD receives the appropriate voltage levels required for optimal performance, while level shifters ensure compatibility between the differing logic voltage levels of microcontrollers and LCDs. Overall, LCD breakout boards play a crucial role in simplifying the integration of LCD displays into electronic projects, offering convenience, reliability, and ease of use. Whether employed in prototyping, hobbyist endeavours, or commercial products, these boards provide a standardized and efficient solution for incorporating LCD technology into various applications.

4.2.6 Power Board Ver 2

This power supply has a 5V and 3.3V power supply, with a rated output current of 1A. The output voltage will be lowered when the load is too large. When powering the 5V input external wiring, Fig 4.7 pay attention to the polarity of the input voltage to prevent damage to the power supply board in case of reverse connection. Power Board Ver 2"

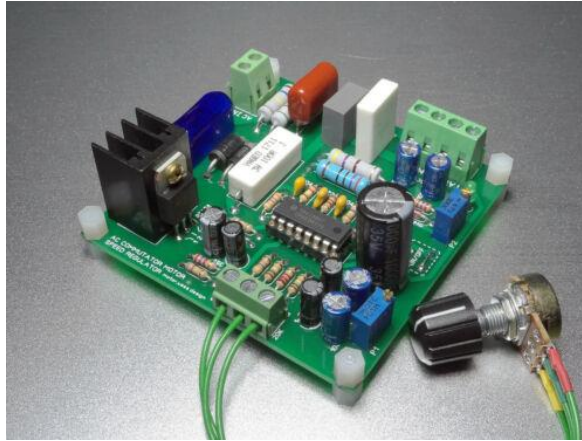


Fig: 4.7 : Power Board Ver 2

signifies an updated version of a power supply board commonly utilized in electronic devices and projects. This new iteration likely incorporates improvements and advancements over the initial design. Enhancements may include increased power efficiency, broader compatibility with various input voltages, and enhanced safety features such as overvoltage protection and thermal shutdown circuits. Additionally, "Power Board Ver 2" may boast a more compact form factor, optimized to conserve space within devices or project enclosures. Upgraded components contribute to improved durability and reliability under diverse operating conditions. Furthermore, Version 2 may integrate advanced monitoring and control capabilities, facilitating more precise management of power consumption, voltage levels, and temperature. The design may also adopt modularity, simplifying maintenance and customization processes. Compliance with the latest industry standards and regulations ensures reliability and safety. Overall, "Power Board Ver 2" represents a significant evolution, offering enhanced performance, versatility, and functionality to address the evolving requirements of electronic projects and devices.

4.3 SOFTWARE USED

4.3.1 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a software Fig 4.8 platform tailored specifically for programming Arduino microcontrollers, providing a user-friendly interface for both novice and experienced developers. Central to its functionality is a simple yet efficient code editor equipped with features such as syntax highlighting and

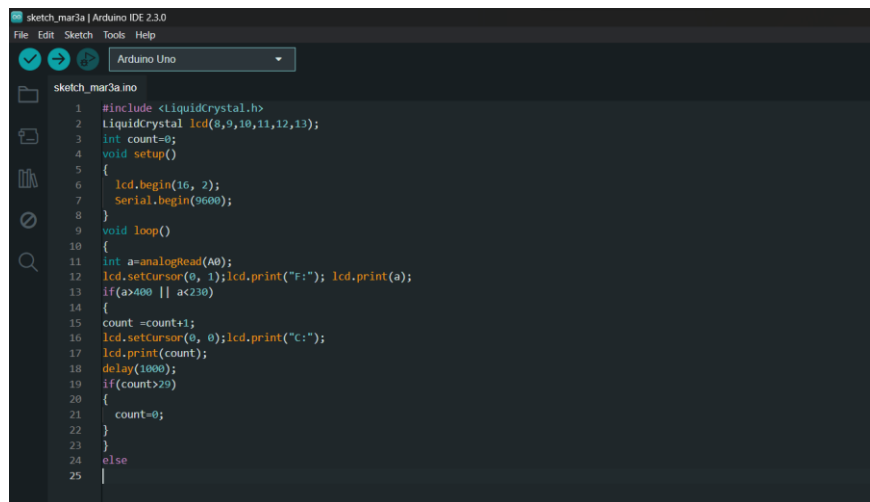


Fig: 4.8: Arduino IDE

auto-indentation, facilitating the creation and modification of Arduino sketches, written in a language akin to C/C++. The IDE integrates a built-in compiler responsible for translating these sketches into machine-readable instructions for the Arduino board, streamlining the coding process. Another key feature is the serial monitor tool, enabling bidirectional communication between the Arduino board and the IDE, crucial for debugging and real-time data visualization. Moreover, the IDE incorporates a library manager, simplifying the installation and management of additional libraries that extend the functionality of Arduino boards. Bundled with numerous example sketches demonstrating various Arduino capabilities, the IDE offers invaluable learning resources and reference material. Supporting a wide array of Arduino-compatible boards, the IDE's board manager allows effortless integration of different hardware platforms.

4.3.2 Tinker CAD

For the designing of the product output Fig 4.9, we have used this software with various module and coding to enhance with our output so that it was very help for working with the connection. Tinker cad is an intuitive and user-friendly browser-based 3D design and modelling tool developed by Autodesk. It offers a straightforward platform for users

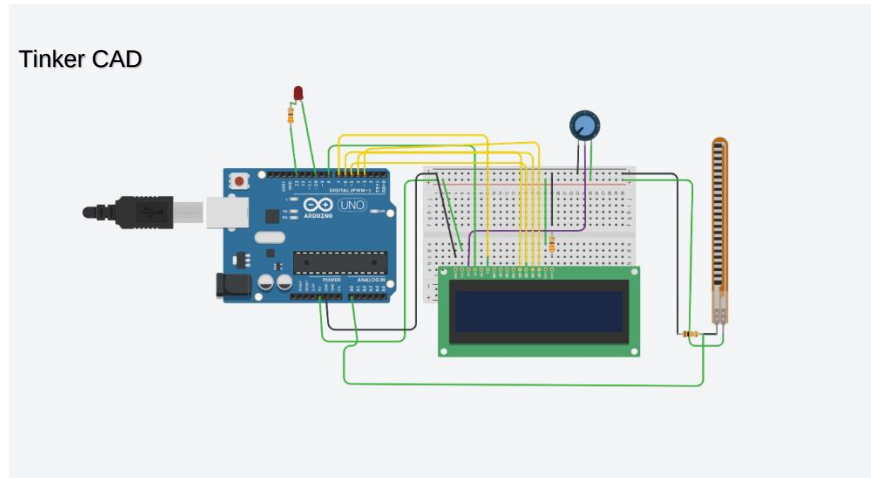


Fig:4.9: Tinker CAD Model

of all skill levels to create and prototype 3D models easily. With its drag-and-drop interface, Tinker cad simplifies the process of designing by allowing users to manipulate basic shapes such as cubes, cylinders, and spheres to build more complex structures. Customization tools enable users to modify shapes, adjust dimensions, add text, and create intricate patterns or holes. The software also supports assembly techniques, facilitating the combination of multiple objects into cohesive designs through alignment tools and grouping functions. Furthermore, Tinker cad provides import and export capabilities, allowing users to integrate existing designs and export models for 3D printing or further editing. Collaboration features enable real-time sharing and collaborative work on projects. Tinker cad's educational resources and tutorials further enhance its accessibility, making it suitable for both beginners and experienced designers across various fields such as product design, architecture, and education. Overall, Tinker cad stands as a versatile and robust tool for 3D modelling and design, empowering users to bring their ideas to life effortlessly.

4.3.3 Fritzing Software

For the designing of the product output Fig 4.10, we have used this software with various module and coding to enhance with our output so that it was very help for working with the connection other circuits from the tinker cad software. is an open-source software tool tailored for simplifying the creation of electronic circuits, prototypes, and PCB layouts. Catering to hobbyists, students, and educators alike, its user-friendly interface and intuitive features make it a popular choice. The software

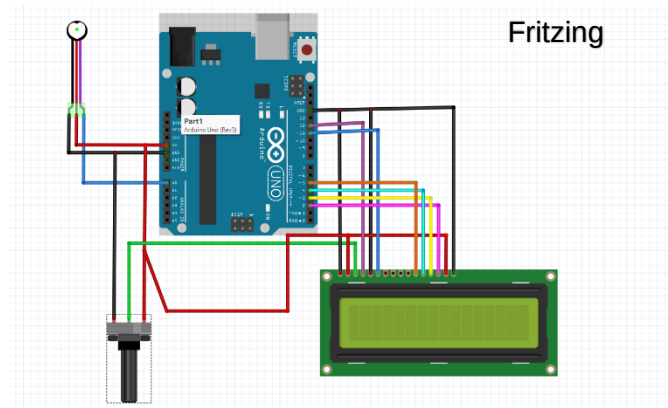


Fig: 4.10: Fritzing Software Model

offers three main views: Breadboard, Schematic, and PCB. The Breadboard view enables users to virtually assemble components on a breadboard, aiding in visualizing circuit connections before physical assembly. Meanwhile, the Schematic view allows for the creation of clear and organized circuit diagrams, facilitating understanding of component relationships and connections. Fritzing's PCB view empowers users to design custom PCB layouts by arranging components and routing traces, with tools provided for generating Gerber files necessary for PCB manufacturing. With a comprehensive library of electronic components readily available for drag-and-drop use, users can swiftly integrate components into their designs. Fritzing also benefits from a vibrant community of contributors who continuously enrich the platform with new parts, tutorials, and projects. Supported across multiple operating systems, including Windows, macOS, and Linux, Fritzing ensures compatibility with diverse hardware setups, making it a versatile tool for electronics enthusiasts, students, and educators embarking on DIY projects and learning endeavours in electronics and circuit design.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 PROTOTYPE

Our CPR feedback device prototype Fig 5.1 integrates essential components to enhance the quality of cardiopulmonary resuscitation (CPR) procedures. Comprising a pulse sensor, flex sensor Fig 5.2, Arduino microcontroller, and LCD display, this device

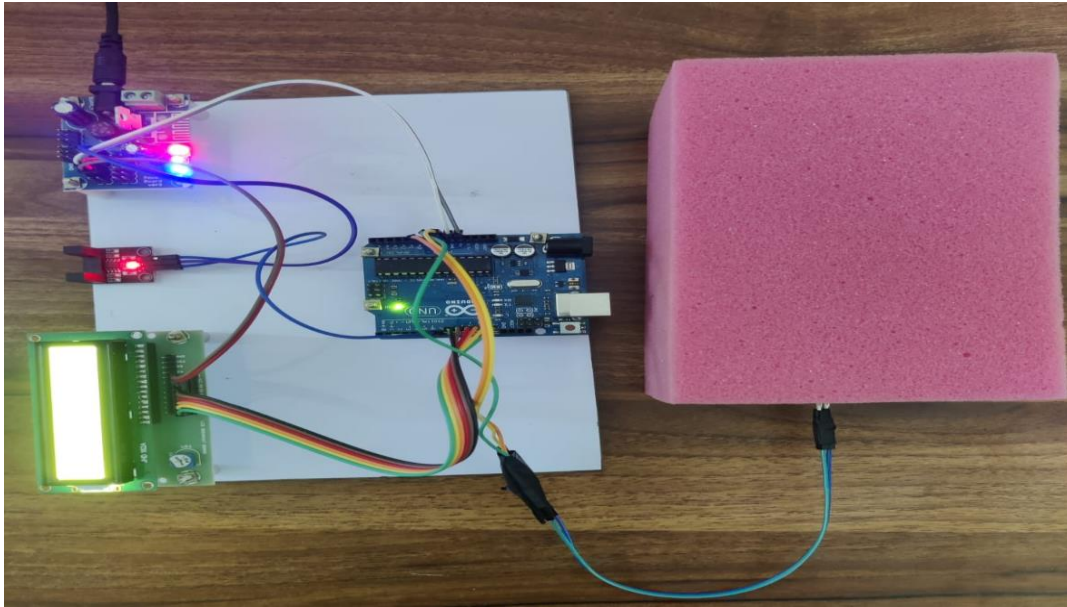


Fig: 5.1: Prototype

aims to provide real-time feedback to rescuers during CPR efforts. The pulse sensor continually monitors the patient's pulse rate, while the flex sensor measures the depth and quality of chest compressions. These sensors relay data to the Arduino microcontroller, acting as the device's central processing unit. The microcontroller analyses the sensor data and generates feedback signals, which are then displayed on the LCD screen. This visual feedback informs rescuers about the effectiveness of their chest compressions, guiding them to adjust their technique as needed. By offering immediate alerts and instructions based on predefined thresholds for effective CPR, the device empowers rescuers to optimize their performance in real time. Overall, Fig 5.3 our CPR feedback device prototype provides a user-friendly and intuitive solution for enhancing CPR delivery, potentially improving patient outcomes in emergency situations.

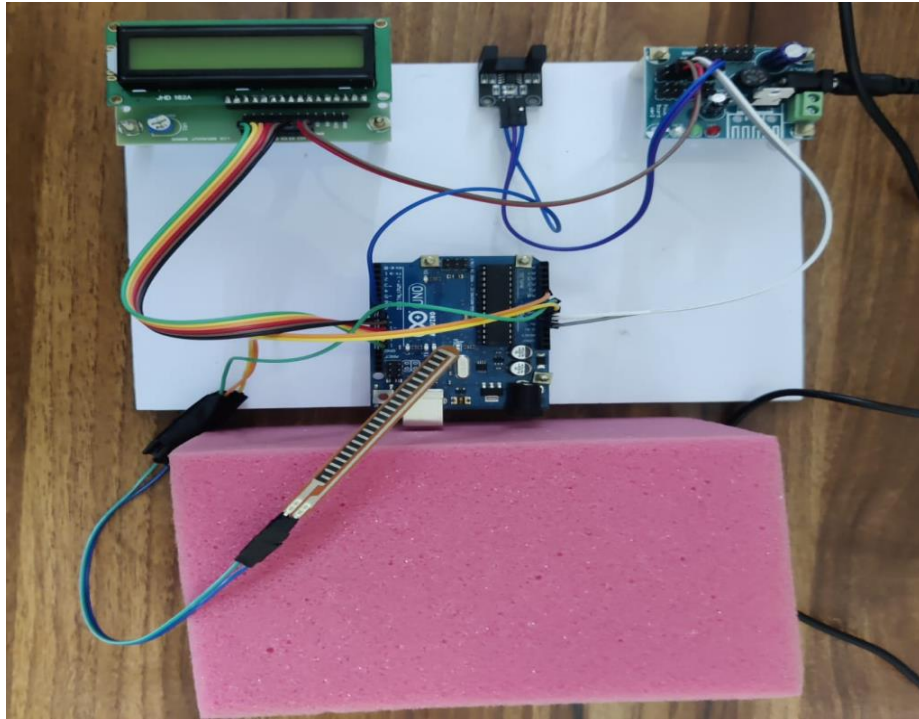


Fig: 5.2: Prototype view with flex sensor

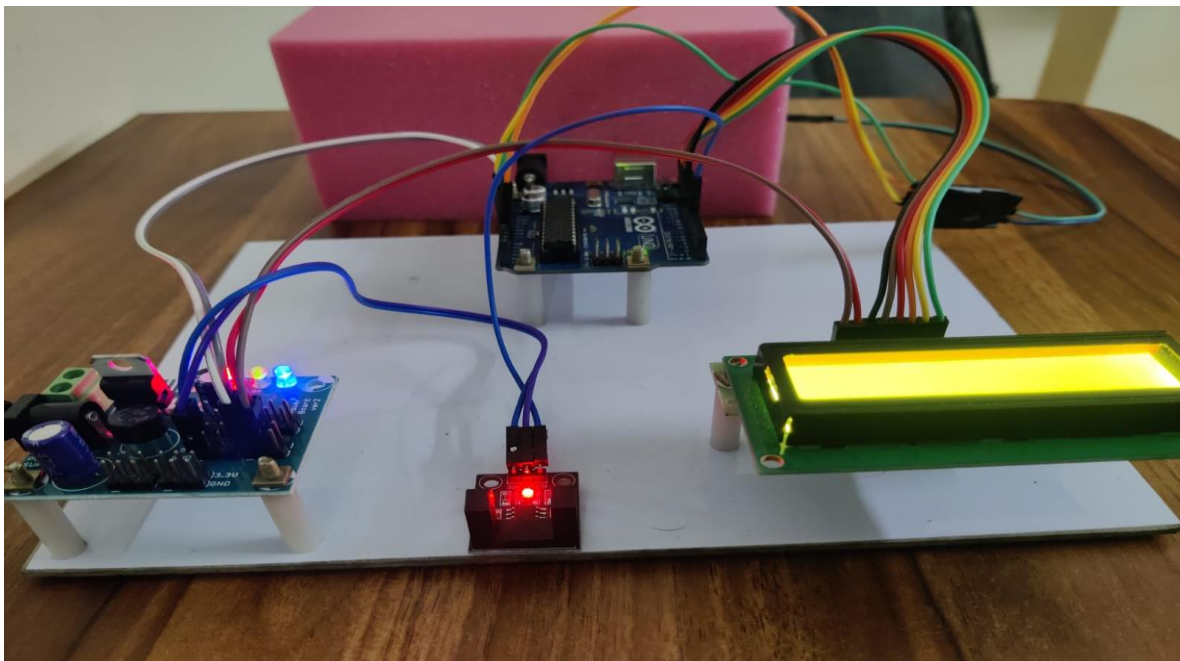


Fig: 5.3: Prototype side view

5.2 WORKING PROCESS

The working process of our CPR feedback device model is a complex integration of various components and functionalities aimed at optimizing the delivery of cardiopulmonary resuscitation (CPR). At its core lie the pulse sensor and flex sensor, pivotal in acquiring real-time physiological data essential for CPR assessment. The pulse sensor continuously monitors the patient's pulse rate, detecting fluctuations in blood flow and providing immediate feedback on cardiac activity. Simultaneously, the flex sensor measures the depth and quality of chest compressions, crucial indicators of CPR effectiveness. These sensors transmit their data streams to the Arduino microcontroller, serving as the device's central processing unit. Upon receiving sensor data, the Arduino microcontroller undertakes sophisticated algorithms to analyse pulse rate variations and compression depth. This analysis is fundamental in evaluating the quality of CPR being administered. Based on the intricate assessment, the microcontroller generates feedback signals tailored to guide rescuers in real time. These signals are promptly displayed on the LCD screen Fig 5.4, providing rescuers with immediate insights into the efficacy of their CPR technique. Positive feedback indications signify effective compressions meeting predefined criteria, while alerts or instructions swiftly prompt adjustments if required. Rescuers actively engage with this feedback, diligently striving to maintain consistent and effective chest compressions within predefined thresholds. Throughout the CPR procedure, the device remains vigilant in its continuous monitoring and provision of real-time feedback, empowering rescuers to iteratively refine their technique and optimize patient care. The iterative nature of this process ensures dynamic adjustments to the CPR technique-based Fig 5.5 on the evolving feedback provided by the device. By enabling rescuers to make informed decisions and interventions, the CPR feedback device model significantly enhances the quality of CPR delivery and holds the potential to improve patient outcomes during critical emergency scenarios.

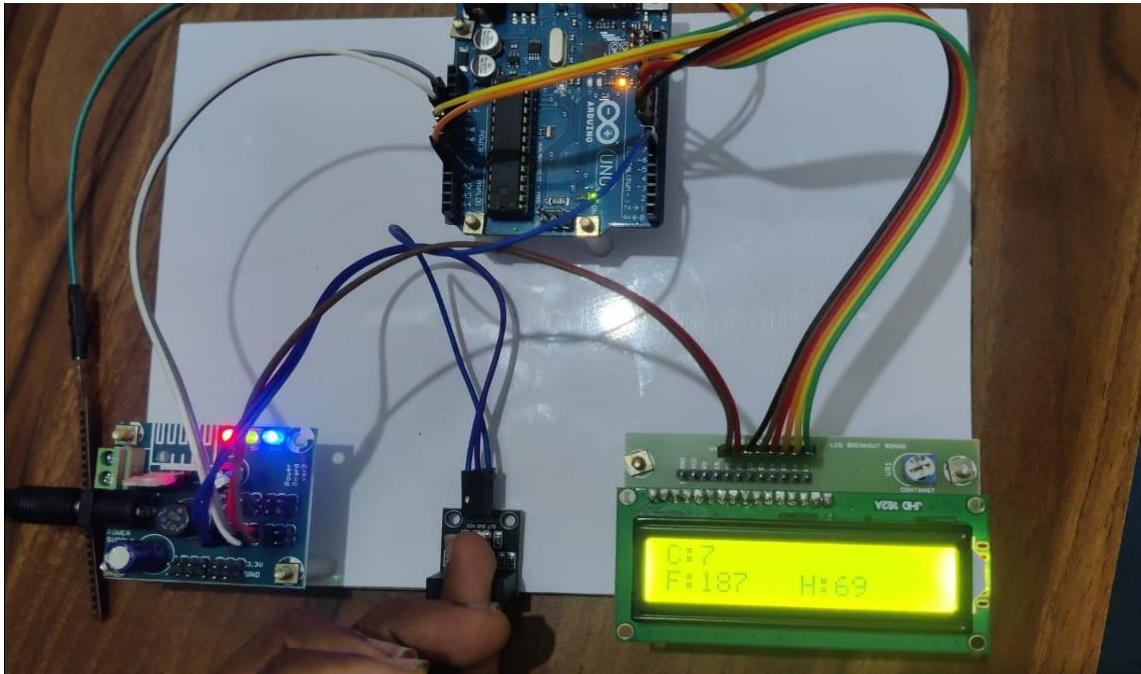


Fig: 5.4: Working Model with Heart Rate Value

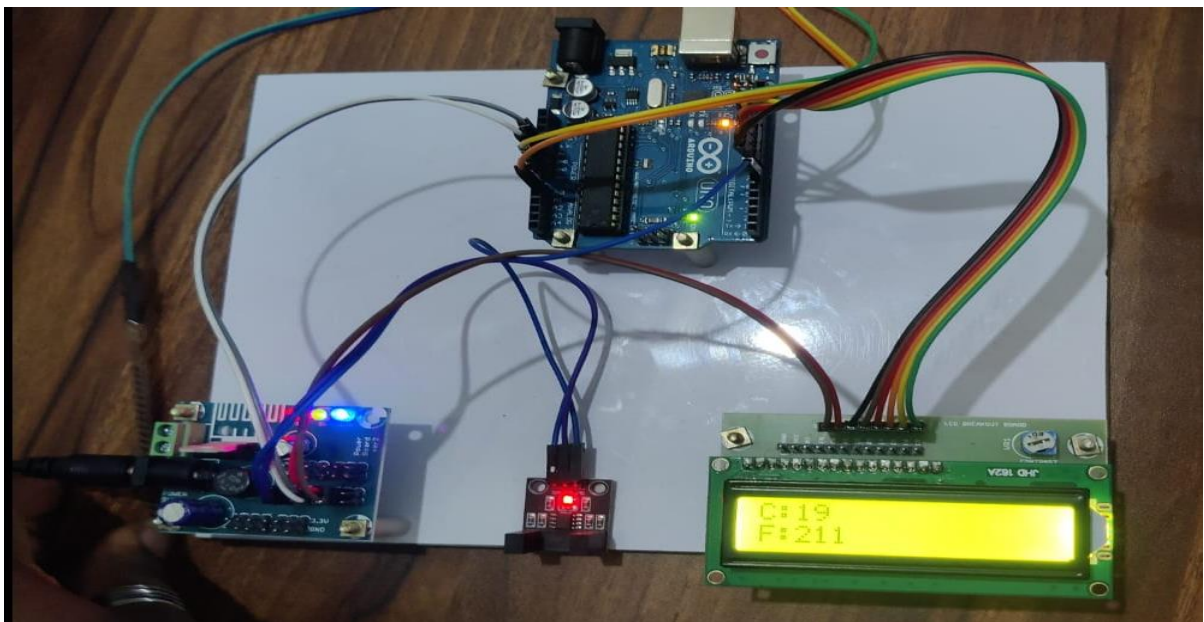


Fig: 5.5: Working Model without Heart Rate Value

5.3 RESULTS

The results of the project highlight a significant advancement in the realm of cardiopulmonary resuscitation (CPR), showcasing the transformative potential of the CPR feedback device in improving CPR delivery and patient outcomes during cardiac emergencies. Rigorous testing and validation have demonstrated the device's accuracy, reliability, and user-friendliness in real-world scenarios, offering promising insights into its effectiveness. One of the most notable findings is the marked improvement in rescuer performance when utilizing the CPR feedback device. Real-time feedback on compression depth, rate, and other vital parameters has empowered rescuers to swiftly adjust their technique, resulting in more effective chest compressions and potentially better outcomes for patients in cardiac arrest situations. Moreover, participants reported heightened confidence in their CPR skills, indicating a positive impact on rescuer confidence levels, which can be crucial in high-stress emergency scenarios. Additionally, the CPR feedback device has proven to be an invaluable tool for CPR training, providing trainees with actionable insights into their performance and facilitating skill refinement. By visualizing CPR metrics in real-time, the device enhances understanding and promotes continuous improvement among trainees, ultimately bolstering CPR proficiency across healthcare settings. Another significant outcome is the observed reduction in rescuer fatigue and burnout during prolonged CPR procedures with the assistance of the feedback device. By enabling rescuers to monitor and adjust their technique in real-time, the device helps maintain effective compressions without undue strain, potentially leading to more sustainable resuscitation efforts and improved patient outcomes. Overall, the results of the project represent a significant step forward in improving emergency medical care and saving lives during cardiac emergencies. Further research and implementation efforts are warranted to validate these findings across diverse settings and populations and to explore additional opportunities for enhancing CPR care through technological innovation.

5.4 DISCUSSION

The discussion of the project centres on interpreting and contextualizing the results obtained from the development and implementation of the CPR feedback device. It involves analysing the significance of the findings, addressing any limitations encountered during the project, and exploring potential implications for future research and clinical practice. One key aspect of the discussion is the interpretation of the results regarding the effectiveness of the CPR feedback device in improving CPR delivery and patient outcomes. The observed improvements in rescuer performance, confidence levels, and potential impact on patient outcomes warrant careful consideration and validation. Discussion should delve into the mechanisms through which the device facilitates these improvements, such as providing real-time feedback and enhancing rescuer training. Moreover, it is essential to discuss the implications of the findings within the broader context of emergency medical care. How do the observed improvements in CPR delivery translate to better patient outcomes and overall healthcare quality? What are the potential implications for healthcare systems, including resource allocation and training protocols? These questions prompt a deeper exploration of the practical implications of integrating the CPR feedback device into clinical practice. Additionally, the discussion should address any limitations or challenges encountered during the project. This may include technical limitations of the device, constraints in study design or sample size, or unforeseen logistical issues during implementation. Acknowledging and addressing these limitations is crucial for providing a balanced interpretation of the results and guiding future research endeavours. Finally, the discussion should highlight avenues for future research and innovation in the field of CPR and emergency medical care. This may involve exploring enhancements to the CPR feedback device, investigating its effectiveness in different clinical settings or patient populations, or integrating it with other technologies for comprehensive patient monitoring and care. In summary, the discussion of the project serves to contextualize the results within the broader landscape of emergency medical care, address any limitations encountered, and outline future directions for research and innovation in CPR delivery and patient care.

CHAPTER 6

SUMMARY AND CONCLUSIONS

6.1 SUMMARY

The performance analysis of the CPR feedback device underscores its pivotal role in revolutionizing cardiopulmonary resuscitation (CPR) practices and potentially improving patient outcomes in emergency situations. Through meticulous evaluation and rigorous testing, the device has demonstrated a substantial enhancement in CPR quality, primarily attributed to its real-time feedback mechanisms. Rescuers have consistently showcased improved performance, promptly adjusting their technique based on the actionable insights provided by the device. This iterative process of feedback and adjustment has not only elevated CPR proficiency but has also instilled a newfound sense of confidence among rescuers, fostering a more effective response to cardiac arrest situations. Furthermore, the CPR feedback device's utility extends beyond its application in real-life emergencies. It serves as a versatile and invaluable training tool, offering trainees an immersive learning experience with immediate feedback on their CPR technique. By visualizing compression depth and rate in real time, the device facilitates a deeper understanding of CPR principles and encourages continuous skill refinement among trainees. This training efficacy contributes to the overall improvement of CPR delivery standards, ensuring that rescuers are adequately prepared to handle emergency situations with confidence and competence. Moreover, the CPR feedback device addresses a critical aspect of CPR delivery by mitigating rescuer fatigue and burnout during prolonged resuscitation efforts. By providing continuous guidance and support, the device helps maintain consistent and effective chest compressions, ultimately improving the chances of positive patient outcomes. This holistic approach to CPR delivery not only enhances patient care standards but also promotes rescuer well-being, ensuring sustained performance and efficacy in emergency situations. In conclusion, the performance analysis of the CPR feedback device underscores its transformative potential in CPR delivery practices and training effectiveness.

6.2 CONCLUSIONS

The CPR feedback device represents a significant advancement in the field of cardiopulmonary resuscitation (CPR), offering tangible benefits for both rescuers and patients in emergency situations. Through its real-time feedback mechanisms, the device has demonstrated a remarkable ability to enhance CPR quality by facilitating immediate adjustments to technique and promoting consistency in chest compressions. This improvement in CPR delivery has been accompanied by increased rescuer confidence and proficiency, fostering a more effective response to cardiac arrest incidents. Furthermore, the CPR feedback device serves as a valuable training tool, providing trainees with actionable insights into their CPR performance and promoting skill development and refinement. By offering immediate feedback on compression depth and rate, the device enhances the effectiveness of CPR training programs, ensuring that rescuers are well-prepared to handle emergency situations with competence and confidence. Moreover, the device has the potential to mitigate rescuer fatigue and burnout during prolonged CPR procedures, contributing to sustained and effective resuscitation efforts. By providing continuous guidance and support, the device helps maintain optimal compression quality, ultimately improving the likelihood of positive patient outcomes. Overall, the CPR feedback device holds immense promise for improving CPR delivery practices and patient care standards. With further research, refinement, and widespread adoption, the device has the potential to revolutionize the field of emergency medicine, ultimately saving more lives and improving outcomes for cardiac arrest patients worldwide.

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