Design of Cardiopulmonary Resuscitation Machine

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- **ABSTRACT:-** CPR is the basic life support refers to the care healthcare providers and public safety professionals provide to patients who are experiencing respiratory arrest, cardiac arrest or airway obstruction. According to recent statistics sudden cardiac arrest is rapidly becoming the leading cause of death. once the heart ceases to function, healthy human brain may survive without oxygen for up to 4minutes without suffering any permanent damage.CPR is used to establish circulation and artificial ventilation in a patient who is not berthing an has no pulse, now a recent days many CPR devices are available in the market but all of require skill operator, and cost is more also that devices only used in hospitals. Because of this the work redefines the role of techniques an develop a framework to support the process of implementing a predictive microcontroller as a prime method To supporting the change.

Key words: -cardiac arrest, Reciprocate mechanism, Adriano controller, micro processer, and microcontroller

INTRODUCTION

In the case of a patient being in cardiac arrest, cardiopulmonary resuscitation (CPR) must be applied in both rescue breathing (mouth-to-mouth resuscitation) and chest compressions. Generally, the compression frequency for an adult is at the rate of about 100 times per minute with the depth of 4–5 cm using two hands, and the CPR is usually performed with the compression-to-ventilation ratio of 15 compressions to two breaths,1 so as to maintain oxygenated blood flowing to vital organs and to prevent anoxic tissue damage during cardiac arrest. Without oxygen, permanent brain damage or death can occur in less than 10 min. Thus, for a large number of patients who undergo unexpected cardiac arrest, the only hope of survival is timely application of CPR.

However, some patients in cardiac arrest may also be infected with other indeterminate diseases, and hence, it is very dangerous for a doctor to apply CPR directly to them. For example, before the severe acute respiratory syndrome (SARS) was first recognized as a global threat in 2003, in many hospitals, such kinds of patients were rescued as usual, and some doctors who had performed CPR on such patients were unfortunately infected with the SARS corona virus. In addition, chest compressions consume a lot of energy from doctors; for instance, sometimes it is necessary for ten doctors to work for 2 h to perform chest compressions to rescue a patient in a Beijing, China, and hospital.

This course now includes the 2020 AHA & ECC Interim Guidance for Healthcare Provider CPR in relation to the resuscitation of, suspected or confirmed, COVID-19 patients. National organizations released this interim guidance particularly to provide additional protection for healthcare providers who are exposed to, and heavily impacted by, COVID-19. Look for these interim updates throughout the course. Sudden cardiac arrest (SCA) is a leading cause of death among adults in the United States. Cardiopulmonary resuscitation (CPR) dramatically increases the chance of survival for a victim suffering from SCA. And CPR is a combination of chest compressions and breaths, and provides critical blood flow and oxygen to the heart and brain. If CPR is started within three to five (3-5) minutes of collapse, it increases a victim's chance of survival and reduces the chance of permanent damage

Therefore, a medical robot that can be used for chest compressions is urgently required. In view of this practical requirement, we will design and develop a medical parallel robot to assist in CPR operation and desire that the robot can perform this job well instead of doctors. There is no doubt that the emergency procedure known as CPR has given many sudden cardiac arrest victims a second chance at life. According to the American Heart Association, the immediate performance of CPR combined with defibrillation within the first 3-5 minutes after collapse greatly improves the victim's chance of survival (American Heart Association

CPR alone is unlikely to restart the heart. Its main purpose is to restore partial flow of oxygenated blood to the brain and heart. The objective is to delay tissue death and to extend the brief window of opportunity for a successful resuscitation without permanent brain damage. Administration of an electric shock to the subject's heart, termed defibrillation, is usually needed in order to restore a viable or "perusing" heart rhythm. Defibrillation is effective only for certain heart rhythms, namely ventricular fibrillation or pulse less ventricular tachycardia, rather than asystole,or pulses. Early shock when appropriate is recommended. CPR may succeed in inducing a heart rhythm that may be shock able. In general, CPR is continued until the person has a return of spontaneous circulation is declared dead

Problem statement

In India, approximately 4280 out of every one lakhs people die every year from sudden cardiac arrest. The Prime cause of Such a Low Success Rate is delay in getting Medical Assistance. Our Device Cardio Pulmonary Resuscitation (CPR) is going to provide temporary relief to the Patients who suffer from Cardiac Attack due to the delay timing of ambulance. Our project will give chest compressions in case of sudden cardiac arrest. It is an automatic, cost effective and portable, emergency alert based CPR device which will automatically compress the chest.

OBJECTIVES:

To save time and money- it reduce the manpower to keep the system on patient bed and monitoring. Reduce the cost of the device by using manufacturing materials and using micro controller.

1 A medical robot that can be used for chest compressions is urgently required.
2 It is portable and light weight.
3 Not require skill operator, it is very easy to operate than the other cpr
4 To reduce the unwanted vibration , when chest compression of the patient.

METHODOLOGY

Initially we collecting the information about the cpr devices And uses.and cost of the device. and plan to the concept generation about reduced the cost and frame of structure. Decide the suitable dc motor and Adriano controller parts ,in the design part we are selecting the catia software to design the structure of the frame structure, connecting rod, chess, and some other parts. We taking the information about the speed control of the dc motor from web source an asking the experts in the EC field about the Adriano controller working principle. as per the schedule worked and assemble the parts and welded structure of frame by using mild steel.

LITERATURE SURVEY

This literature survey is based upon the many medical treatments. There are numbers of Literatures are available on medical procedures. This information helped us to bring a new conclusion. After going through these journals we came to conclude that using mechanical devices we can perform CPR operation.

Design of a Mechanical CPR device: Automated CPR To-Go (ACT)

A. Mehta; A. Harr ; L. HernandezThe.,College of New Jersey, 2000 Pennington Road, Ewing, NJ 08628 Cardiopulmonary resuscitation (CPR) is the first step in treating victims of sudden cardiac arrest. Though manual CPR has been prevalent for many years, mechanical CPR has proven to be easier for the rescuer, safer for the patient, and more effective in pumping blood through the body. Current mechanical CPR devices, such as the AutoPulse by Zell, Inc., utilize a load-distributing band to apply circumferential chest compressions. However, it is very expensive and heavy, thus prohibiting its distribution to the general public. We propose to fabricate a mechanical CPR device, Automated CPR To-Go (ACT), which will be cost-effective and lightweight. The device will provide 2-inch deep anterior-posterior chest compressions to victims and will be able to be used by rescuers with minimal training. Material, electrical, and mechanical factors were taken into consideration when designing ACT. The major components of the device include the board, motor assembly, belt assembly, housing unit, microprocessor, and power source. Currently, ACT has been designed, and the materials have been chosen for its development. Upon completion of the project, it is expected that the device will be able to achieve the aforementioned goals of anterior-posterior displacement, easy application, and will be distributable to the general public.

Mechanical Cardiopulmonary Resuscitation Devices for Cardiac Arrest Calvin Young, Lory Picheca., The information in this document is intended to help Canadian health care decision-makers, health care professionals, health systems leaders, and policy-makers make well-informed decisions and thereby improve the quality of health care services. While patients and others may access this document, the document is made available for informational purposes only and no representations or warranties are made with respect to its fitness for any particular purpose. The information in this document should not be used as a substitute for professional medical advice or as a substitute for the application of clinical judgment in respect of the care of a particular patient or other professional judgment in any decision-making process. The Canadian Agency for Drugs and Technologies in Health (CADTH) does not endorse any information, drugs, therapies, treatments, products, processes, or services. While care has been taken to ensure that the information prepared by CADTH in this document is accurate, complete, and up-to-date as at the applicable date the material was first published by CADTH, CADTH does not make any guarantees to that effect. CADTH does not guarantee and is not responsible for the quality, currency, propriety, accuracy, or reasonableness of any statements, information, or conclusions contained in any third-party materials used in preparing this document.

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PERT Based CPR Machine

Ankit Tiwari1, Ajinkya Tekawade1, Akshay Bhagat1, Vivek Srivastav2., PERT is Personal Emergency Response Technique.CPR is an emergency procedure in which the heart and lungs are made to work by compressing the chest overlying the heart and forcing air into the lungs. CPR is used to give compressions to the patient in an emergency. Current CPR machines are only present in ambulances and need heavy and huge machinery and arrangements. Hence, it increases the cost and complexity. Sudden Cardiac Arrest (SCA) is a leading cause of death in India. It is estimated by the WHO census statistics that approximately 4280 out of every one lakhs people die every year from SCA in India. The design we are going to make would be adjustable in accordance to the patient's requirement and will have the maximum pumping capacity of 105 compressions/min. This CPR will be domestic device and can be used without any specialized knowledge / experience PERT Based Domestic Cardio-Pulmonary Resuscitation Machine is a very useful Bio-medical Product which combats the problems associated with sudden Cardiac arrest and provides temporary relief to the patient. This product can be used as First – Aid for the Cardiac Patient. Although, there are several products available in the market being used for avoiding Cardiac Arrest but have limitations like cost effectiveness, bulky products which is not portable, need of trained staff for operation. We are focusing on designing a product that eliminates the drawbacks of the CPRM available in market presently. We are trying to design a cost effective, slim and portable CPRM which is extremely user friendly. [3]

Neonatal chest compression device

Jillian Weber., The goal of the project was to design a neonatal chest compression device to be used in the NICU of the Monroe Carrel Jr. Children's Hospital at Vanderbilt during surgical procedures performed on the infant's abdomen or chest. During these procedures the surgeons cannot stop to perform the chest compressions so another doctor or nurse is needed; however, due to size constraints, there is no room for another person to step in around the bed to perform the compressions. Therefore, the device must occupy minimal space around the operating area and be quick and easy to set-up. In order to be a success, the device must provide chest compressions as effective as or more effective than the traditional, manual method. It must maintain a rate of 80-100 compressions a minute and provide 11-12 pounds of force in order to compress the width of the infant's chest by one third. The force value was obtained through a series of tests performed on Isabel, a SimNewB simulation baby housed in the NICU. Isabel was also used as the method of evaluation when testing the final prototype. The final design consisted of a compressed air actuated pneumatic cylinder placed directly above the infant's chest. The compressed air was supplied by a portable, quiet air compressor and the air flow was controlled by a three-way solenoid valve and electronic timer. From testing, it was concluded that the device was successful in meeting the basic criteria, however further work should be done to implement important safety aspects including maximum force control and sterilization.

Analyzing and improving automated cardiopulmonary resuscitation

John Wilder1 Thomas Killen2 Yunsoo Choi2., Currently, manual CPR methods do not provide the consistent, effective chest compressions needed to treat a patient. Paramedics often cannot provide the correct force needed and can tire easily while administering CPR. A solution to this issue is to eliminate the human element and utilize the benefits of a mechanized system. By analyzing current CPR methodologies and available automated CPR machines, as well as acquiring feedback from experienced paramedics, we have developed an improved automated CPR machine. Some of the major engineering strengths of current CPR machines are integrated into the improved automated CPR machine. This machine is lightweight and adaptable to be used widely by paramedics. The assembly time of the improved automated CPR machine is significantly enhanced. We believe that this device is a vital aid for paramedics and will undoubtedly be more effective in saving lives than manual CPR. [5]

Mechanical chest compression devices: historical evolution, classification and current practices., The standard treatment of cardiac arrest is cardiopulmonary resuscitation (CPR), performed with effective manual chest compressions. Although current CPR was developed 50 years ago, cardiac arrest still has a high mortality rate and manual chest compressions have some potential limitations. Because of these limitations, mechanical chest compression devices were developed to improve the efficiency of CPR. This CPR technology includes devices such as the mechanical piston load-distributing band, active compression–decompression CPR, simultaneous sterno-thoracic CPR, impedance threshold valve, phased thoracic-abdominal active compression–decompression CPR and active compression-decompression CPR with enhanced external counter pulsation, and the impedance threshold valve. The purpose of this manuscript was to draw attention to developments in this medical area and to examine studies on the effectiveness of these devices.

LUCAS - Lund University Cardiopulmonary Assist System Liao, Qiuming.,Lund University Cardiopulmonary Assist System (LUCAS) is a mechanical device providing automatic 5 cm deep chest compressions and active decompressions back to normal anatomical position with a frequency of 100 per minute, and a duty cycle of 50%, i.e., LUCAS is constructed to give chest compressions according to the latest international guidelines in cardiopulmonary resuscitation (CPR). The aim of the thesis was to study cardiac arrest using different porcine models of ventricular fibrillation. Four hypotheses were formulated: 1. LUCAS-CPR is superior to manual CPR regarding coronary perfusion pressure (CPP) and return of spontaneous circulation (ROSC). Hypothermic LUCAS-CPR is superior to normothermic

LUCAS-CPR in treating prolonged ventricular fibrillation. 3. The rate of ROSC after prolonged ventricular fibrillation will increase if LUCAS-CPR is given before defibrillation, and if defibrillation is given during on-going chest compressions. 4. LUCAS-CPR will cause fewer rib fractures than manual CPR. LUCAS-CPR gave significantly higher rates of ROSC and significantly higher CPP than manual CPR. LUCAS-CPR combined with surface cooling to 34°C was superior to normothermic LUCASCPR during 1 hour of CPR for ventricular fibrillation. Defibrillation was more effective to obtain ROSC after prolonged ventricular fibrillation if chest compressions were done before the shock, and if the shock was given during on-going LUCAS-CPR. LUCAS-CPR caused significantly fewer rib fractures during 20 minutes of CPR compared to manual CPR.

2.9.1 Benefits

- Benefits of Mechanical CPR Consistent compression rate
- Consistent compression depth
- Increase in CPP Increase in coronary and cerebral blood flow
- Continuous CPR during transport and defibrillation
- Use of a mechanical CPR device also allows EMS providers to concentrate on other aspects of resuscitation such as defibrillation and respirations 5 Mechanical CPR devices allow EMS providers to remain seated during patient transport which results in fewer injuries to EMS workers and less use of the hospital

Advantages of cpr

- Operation is very smooth and in this system we can get more output by applying less effort.
- Simple construction than the mechanical and hydraulic presses.
- No extra skill is required for operating this system.

2.9.2 Disadvantages of cpr

- Long interruption time needed to apply device
- Potential for incorrect application of the device
- One size does not fit all

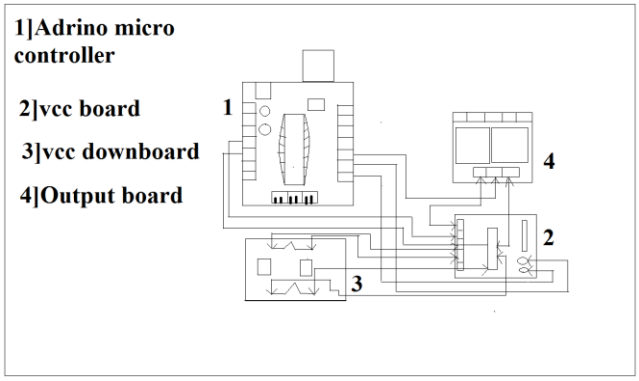
DESIGN & WORKING PRINCPLE

Adriano controller for speed

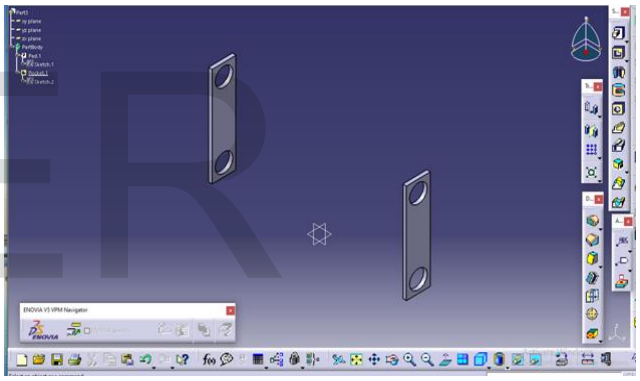
Adriano is connected to PC through the USB cable. We can send the command to PC on the serial monitor. We can change the speed of motor from 0 to 90. When 0 is

Adriano is connected to PC through the USB cable. We can send the command to PC on the serial monitor. We can change the speed of motor from 0 to 90. When 0 is sent over the Serial Monitor, the motor runs at minimum speed (that is zero). When the speed is varied from 1 to 9, the speed increases, with the value 90 set as the maximum speed of the motor. A PWM DC motor controller technology is used to control the speed. In PWM, the Adriano sends a pulsating wave that is similar to actable mode of timer IC.Digital output is good for digital devices but sometimes we need the antilog output. In such a case the PWM is very useful. In the PWM, output signal switches between zero and one, on high and fixed frequency.

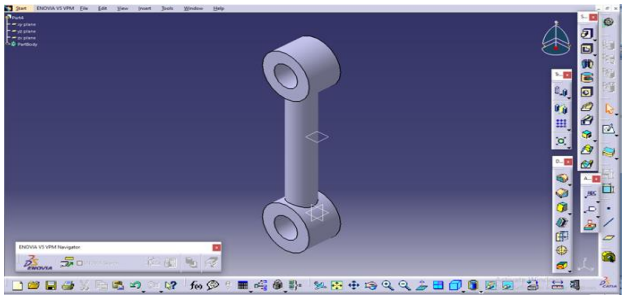
Accurately and quickly vary the speed of motor by using Adriano and PWM microprocessor devices.



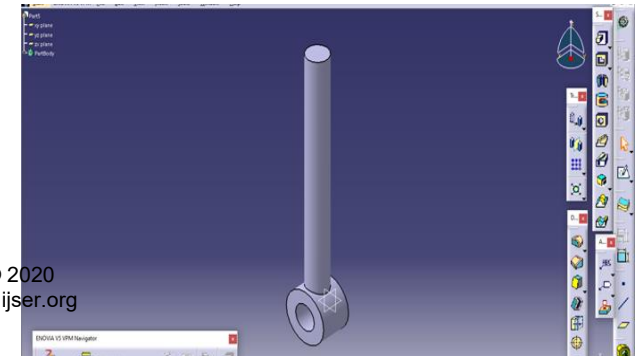
Design the 3d sketches in CATIA software



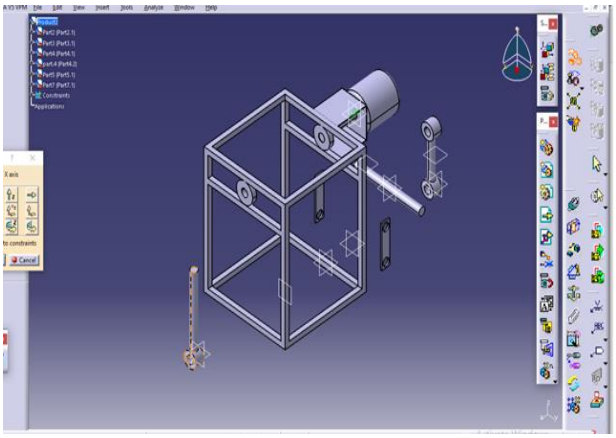
Part1:-connecting link



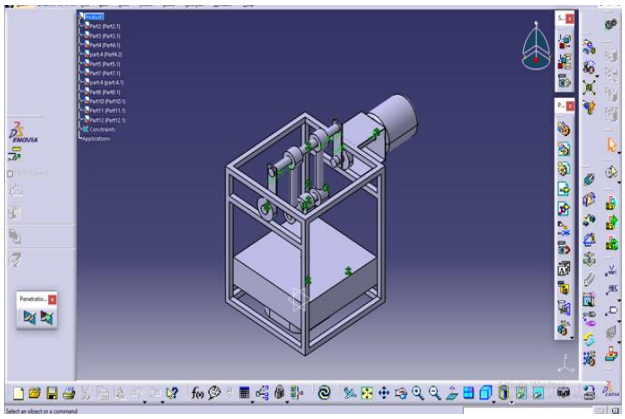
Part2:-connecting rod



Part 3:-yoke shaft connect



Part 4:-chassi



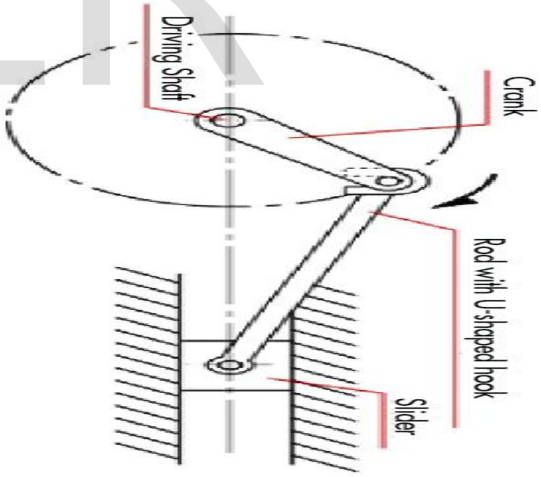
Part 5:-motor shaft bearing

Part 6:-Assembly part

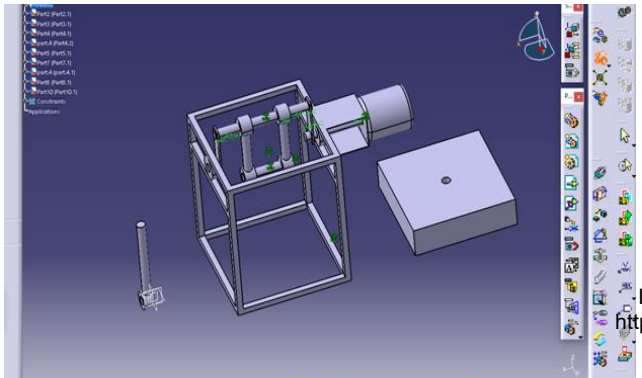
Crank and slotted lever mechanism

Under the principal of crank and slotted lever mechanism
The crank and slotted quick return mechanism convert the rotary
Motion into linear or reciprocating motion.
The similar mechanism is used in our project, here we used DC motor
To get rotary motion, then rotary motion is converted into reciprocating Motion.

Its reciprocate in up and down direction. the spung type smooth material is added at the end of the reciprocating lever .
The stand is provided under the cpr device it cover the patient and keep The device weight away from the patient body.
And it can be height adjustable due to this we can increase (or) decrease the depth of compression and device is portable also.



Crank and slotted lever mechanism figure



CONCLUSIONS

- A medical robot that can be used for chest compression is urgently required.
- We will design and develop a medical parallel robot to assist in CPR operation and desire that the robot can perform this job well instead of doctors.

2] "Mechanical Cardiopulmonary Resuscitation Devices for Cardiac Arrest Calvin" Authors-Young, Lorry Picheca
3] "PERT Based CPR Machine" Authors- Ankit Tiwari1, Ajinkya Tekawade1, Akshay Bhagat1, Vivek Srivastav2
4] "Neonatal chest compression device" Authors-Jillian Zebra
5] "Analyzing and improving automated cardiopulmonary resuscitation" Authors-John Wilder1 Thomas Killen2 Yunsoo Choi2
6] "Mechanical devices to compress the patient's chest in a state of sudden cardiac arrest future everyday life of emergency medicine" Authors- Rafał Czyż1, Marci Leśkiewicz1, Isabella Czyż2
7]"Analyzing and improving automated cardiopulmonary resuscitation" Authors- John wilder, Thomas Killen , Yunsoo choi
8] "Mechanical Chest Compression Devices: Historical Evolution, Classification and Current Practices" Authors-J.F Man well, J.G.McGowan

REFERENCES

1] "Design of a Mechanical CPR device: Automated CPR To-Go(ACT)"
Authors-A. Mehta; A. Herr; L. Hernandez The