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Research and Development of A Low Cost Smart Cardio Pulmonary Resuscitation (CPR) Device Using Locally Available Raw Materials for Cardiac Arrest Patients †

Mohammad Monirujjaman Khan * and Md. Mujtabir Alam

Department of Electrical and Computer Engineering, North South University, Bashundhara, 1229 Dhaka, Bangladesh

* Correspondence: monirujjaman.khan@northsouth.edu; Tel.: +8801779006296

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Abstract: Cardiovascular disease is the main worldwide reason for death. Cardiovascular diseases can cause the heart beat to stop. If a person experiences from cardiac arrests than direct treatment like (Cardio Pulmonary Resuscitation) CPR with chest compressions and artificial ventilation along with defibrillation is very possible to greatly develop the patient's possibility of survival. Usually, CPR is completed manually. Manual CPR is carried out by applying external chest compressions followed by artificial ventilation. It helps to pump blood around the person's body when their heart can't do this job. This paper presents development and analysis of a low cost cardio pulmonary resuscitation (CPR) device using locally available raw material for cardiac arrest patients. This CPR is automated, portable and it is very user friendly. This is very cost effective product and people can easily afford to buy it. The unit price of this CPR is USD 500.

Keywords: cardio pulmonary resuscitation (CPR); low cost; automated CPR; manual CPR; cardiac patients; multifunction

1. Introduction

According to recent study, it has been found that the main worldwide reason for death is due to Cardiovascular disease. Due to this disease, 17.3 million deaths for each year are identified. It is expected that by 2030, this number may cross more than 23.6 million [1]. In 2008, cardiovascular deaths accounted for 30 percent of every single worldwide demise, with 80 percent of those passing occurring in low and middle income nations [2]. Heart beat of people can be stopped due to the Cardiovascular diseases. Somebody can quit breathing as well as have heart failure from heart attack, strokes (when the blood stream to a piece of the brain abruptly stops),choking on something, close suffocating occurrences (when somebody is submerged for a really long time and stops breathing),a terrible neck, head, or back damage, extreme electrical stuns (like from touching a power line), being exceptionally wiped out from a genuine disease, an excessive amount of dying, serious unfavorably susceptible responses and gulping a medication or synthetic [3].

Cardiopulmonary resuscitation (CPR) is a life saving medical process that is principally applied to cardiac arrest sufferers. The end aim to restart the heart of the cardiac arrests, the well known technique is CPR. When a patient experiences from cardiac arrests than instant action like CPR with chest compressions and artificial ventilation along with defibrillation is very likely to greatly progress the patient's probability of survival. Currently conventional Cardiopulmonary

resuscitation (CPR) is manual method and that is applied by a medical personnel. It is carried out by applying external chest compressions followed by artificial ventilation. When the heart of the cardiac arrest patient cannot pump the blood around the his or her body the CPR assists to pump blood around patient's body.

To perform CPR a person presses up and down on the casualty's chest (chest compressions) and gives them a series of rescue breaths to help save their life when they are in cardiac arrest. The major issue in performing manual CPR is that we're not focusing on teaching the people who most need to be trained to perform this life saving task. It is even very difficult task for a trained personnel to keep constant CPR in manual process that extensively lessens the survival chances of the patient [4]. The method most generally taught is something that the huge majority cannot execute for ten minutes. Many of the people who will be called upon to execute CPR weigh too little to perform 2″ chest compression on a chest of average stiffness. Manual CPR is sometime not possible to continue perfectly. In this scenario an automated CPR device can perform constant and proper chest compressions as required for the cardiac arrest patients which may improve the survival rate of the cardiac arrest patients. In abroad, there are automated CPR device but the problem is that they are very expensive and cost as like as from USD 15,000 to USD 20,000 [5,6]. This paper focuses on the development and analysis of a low cost automated CPR device using locally available raw materials for cardiac arrest patients.

2. Material and Methods

Figure 1 shows the manual CPR process given by a person. In Figure 2 the automated expensive CPR device available in abroad is provided in Figure 2. The objective of this paper is to develop a low cost automated CPR using locally available raw materials. Figure 3 shows the block diagram of working principles of the proposed device. Designing part and working principles of the proposed CPR device are discussed in this section.

This device is automated piston driven based. It provides sternal compressions at the needed rate of 100–120 compressions per minute and complete a compression depth of at least of 2 inches. The proposed device operation is easy as there is no external human being need to do the manual perform of the CPR. The proposed device is automated and it has got controlling on and off operation buttons; see block diagram in Figure 3. First the device needs to be placed on stretcher or on the place where the automated CPR will be performed. Then the proposed device needs to be placed over the chest of the cardiac patients.

Figure 1. Manual CPR process given by a person [7].

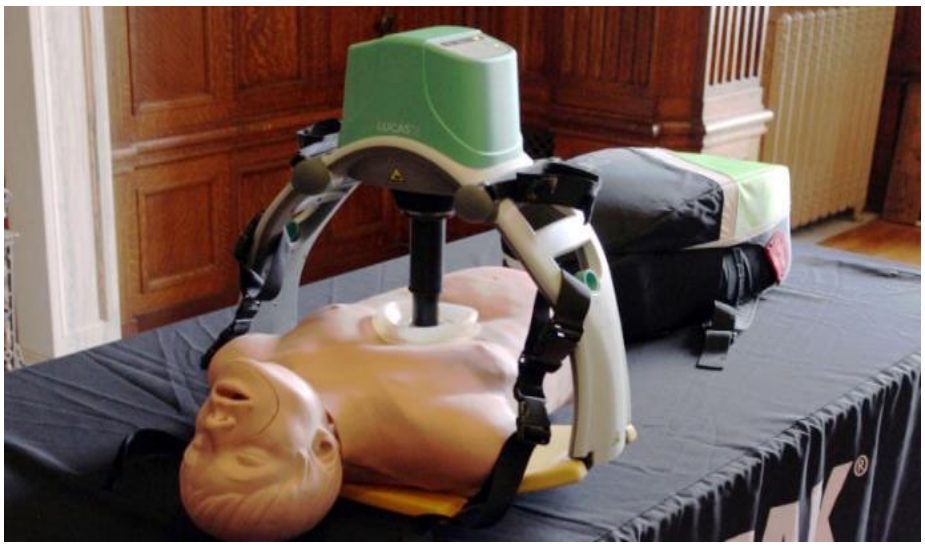

Figure 2. Automated CPR in Abroad [5].

For the operation of the device three switches have been integrated with the proposed system; see Figure 3. The switches are known as CPR ON/OFF, CPR (30:2), CPR (Continuous). Different switches have different functions as can be seen from Figure 3. The on and off switch is connected to electronic motor controller. This on/off switch is for the power up and shut down purpose of the device. When CPR 30:2 switch is pushed the device gives 30 chest compression followed by 2 artificial ventilations. When the CPR (Continuous) press switch is pushed then it will provide uninterrupted chest compressions at a rate of 100–120 compressions per minute.

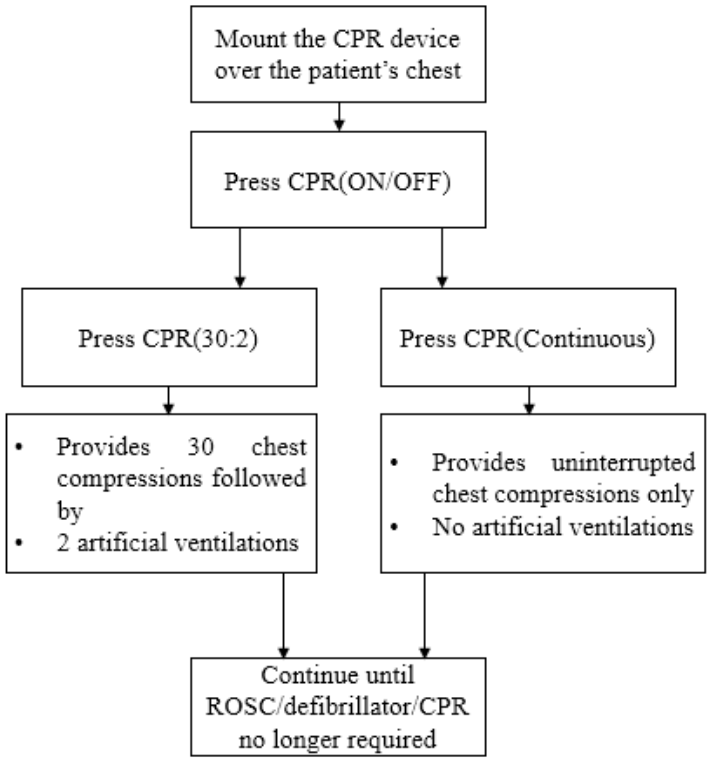

Figure 3. Block diagram of the proposed device how it works.

3. Results and Analysis

Figure 4 demonstrates the prototype of the proposed device. This device is developed in the Engineering Laboratory at the Department of Electrical and Computer Engineering of North South University. The proposed automated device is piston driven based. It provides sternal compressions at the needed rate of 100–120 compressions per minute and complete a compression depth of at least of 2 inches. The device is made up of using locally available raw materials procuring from the local market. After that all parts were assembled and tested in the laboratory. The device is designed through the combination of mechanical and electrical components. After development and integration of the device. The performance of the system was tested on the human like dummy. Figure 5 provides finishing model of the proposed device showing testing on dummy.

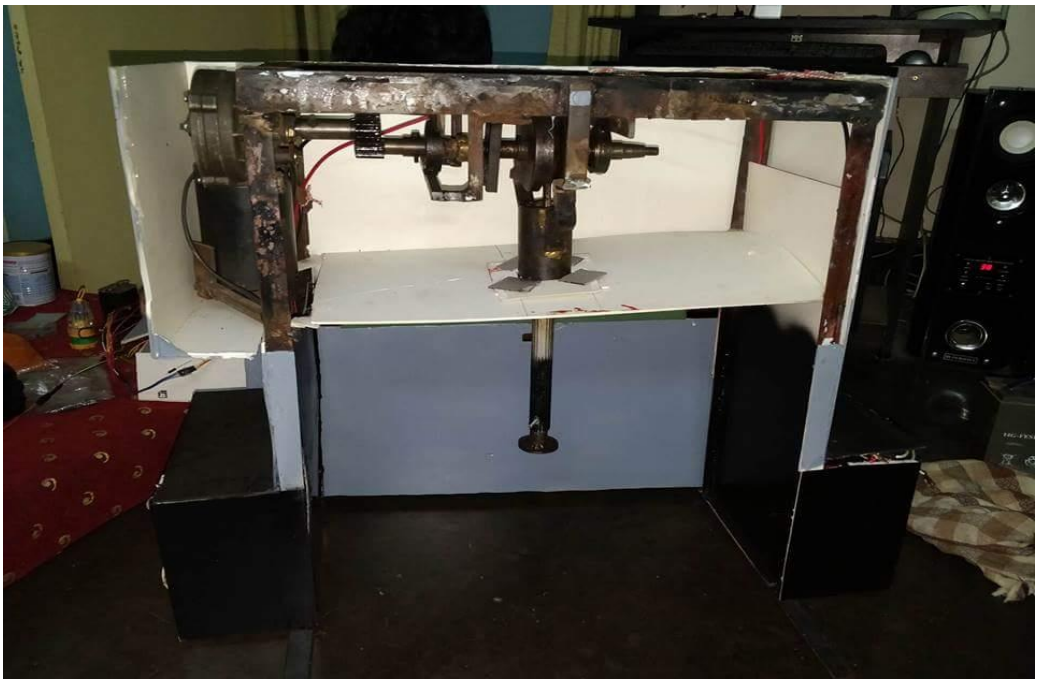

Figure 4. Prototype of the proposed device.

Figure 5. Final prototype of the proposed device testing on dummy.

After testing it on the human like dummy it was tested on real human test subject Figure 5 provides finishing prototype of the recommended machine testing on dummy. In Figure 5 the top part of the device looks gray because the internal part of the system was coved with light gray color board. Figure 6 shows final prototype of the proposed device testing on real human test subject. The device has been tested on 10 different real human volunteers to test the reliability of the performance of the device. An example of testing on one real human test subject is demonstrated here in Figure 6. After testing on human test subject it is observed that the device is working according to our design requirements and it meets those. Additional smart features have been added with this device. Due to lack of page limit more technical details and discussion in more details were not possible to provide here in this paper. However, the authors of the paper are writing an Article with more details of the devices and it will be submitted to MDPI for review.

Figure 6. Final prototype of the proposed device testing.

4. Discussion

The proposed device will be made more user friendly look. For outer and inner side mold will be designed for real life look. The development cost of the proposed CPR is 42,000 BDTAKA which is equivalent of $500. The same type of devices in overseas cost in the range of USD 15,000 to USD 20,000. The proposed device on the other hand cost only USD 500 which is very lower in price and cheap. This cost effective device can be easily used by any hospitals, emergency services like ambulances and can save a lots of lives. This CPR is automated, portable and it is very user friendly. This is very cost effective product and people can easily afford to buy it. The proposed solution of the stated problem is definitely innovative because it has never been tried before in Bangladesh. The product will be developed as a common platform for both medical and non-medical peoples. Currently we are working on the device o make it more light weight using different battery system like lithium ion and adding new features. After that the device will be tested on dummy and it will be applied to BMRC for final approval. This products will be sustainable as we know the users of this device is cardiovascular patients and their number are huge. By selling the product money will be generated which will make the device more sustainable. Due to lack of page limit more technical

details, results and discussions are not provided in this paper. However, summarizing all the results and findings an article will be written to be submitted in Applied Science Journal in MDPI. Authors of the paper is also working for developing the similar product for the children.

5. Conclusions

Developed design prototype, operation principles, testing results and analysis of a low cost automated CPR device using locally available raw materials for cardiac arrest patients are demonstrated. The automated low cost CPR device can perform constant and proper chest compressions as required for the cardiac arrest patients which may improve the survival rate of the cardiac arrest patients. This device is very user friendly and anyone with basic educational knowledge can operate it. It will increase the life expectancy of the patients of cardiovascular disease. The automated CPR device will be very helpful for the people in the world. Due to low cost of the developed automated CPR device, many users can afford to buy it. As mentioned earlier that the similar devices in abroad cost in the range of USD 15,000 to USD 20,000. However, the proposed device on the other hand cost only USD 500 which is very lower in price and cheap. It can be easily used by any hospitals, emergency services like ambulances and can save a lots of lives.

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Conflicts of Interest: The authors declare no conflict of interest.

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