

# Design and Working of a Vending Machine for Pre-Hospital Cardiac Aid in Pakistan

Haadia Rasheed<sup>†</sup>, Aamir Zeb Shaikh<sup>†</sup>, Shabbar Naqvi<sup>††</sup>, Sarah Salim<sup>†</sup>, Rubab Farooq<sup>†</sup>, Sania Fatima<sup>†</sup>, Talat Altaf<sup>†††</sup>

<sup>†</sup>Department of Electronic Engineering, NED University of Engineering & Technology, Karachi Pakistan

<sup>††</sup>Department of Computer Systems Engineering, Balochistan University of Engineering & Technology, Khuzdar Pakistan

<sup>†††</sup>Department of Electrical Engineering, Sir Syed University of Engineering & Technology, Karachi Pakistan

## Summary

Chest pain is one of the most frequently occurring symptoms after stomach and abdominal problems in USA. Heart disease is one of the highest occurring diseases that can be cured up to an extent if rapid medication is provided. The statistics around the world including Pakistan show a similar trend. Hence, a timely pre-hospital treatment can provide a possible way to cure the emergency patients. In this work, a healthcare vending machine is designed and its working has been shown. The machine can be installed near tolls at highways or in closed setups as well so that pre hospital medical aid can be provided to the patients with chest pain and related symptoms of cardio vascular disease. The proposed vending machine can also be used in suburban and rural areas of Pakistan so that a vast majority of population could be benefited. The vending machine uses Arduino-Uno based electronic engine. It can accept a Radio Frequency Identification (RFID) card as well as cash payments. Additionally, it also contains the GSM connection to inform the related company to fill the vending machine with required medical items as soon as the supply is about to finish.

## Key words:

*Vending machine, healthcare, Arduino, RFID*

## 1. Introduction

Cardiac related diseases such as Acute Heart Failure (AHF) typically show rapid worsening conditions of a patient. The symptoms include increased levels of natriuretic peptides in addition to heart failure signs. This is a life threatening condition that can be made better by providing pre-hospital medical aides [1]. It may prove to be saving the lives of emergency patients. In Pakistan, heart diseases are not only common but also on the rise. Latest record of Cardiac Centre of Pakistan Institute of Medical Sciences has shown over 40 per cent increase in number of heart patients in 2019 [2].

In [3], authors have analysed that healthcare management system of Pakistan is on the weaker side. Patients are generally not satisfied with the healthcare facilities and it leads to doing research and to find advanced methods to improve the healthcare facilities in Pakistan.

Vending machines are seen into commercial use since quite long now. The “vending” word is taken from English

language that means automated distribution channel [4]. The direct impact of a vending machine is translated into three domains into the market. These include manufacturers, producers and managers. Thus, typically automating a product through vending machine impacts at large to the population as well as main business players. Hence, vending machine can play a leading role towards successful implementation of automated medical aides and services. In this regard, many researchers have put forward ideas as well as given implementation details for successful implementation of smart and automated vending machines. Vending machine in general will help in getting rid of waiting into queues for hours before being able to complete their assignments. An example of similar queues can be seen at outside of most of the banks in Pakistan especially during the deadline of bill submission and property installments. Keeping this in view, Government of Pakistan has taken an initiative to start program called Digital Pakistan in order to transform the traditional systems in practice based on state of the art technologies in various sectors of public interest [5].

The aim of this research paper is to explain design procedure of an automated vending machine to provide emergency medical items to the supposedly cardiac patient. The machine uses Arduino hardware as prototype of the system. Radio Frequency Identification (RFID) cards besides cash payment have been put forward as an additional option for facilitation [6]. The proposed design can be used in cities as well as in remote areas of Pakistan and on motorways and highways. The paper is distributed in such a way that Section 2 provides details of the related work, Section 3 describes the proposed design of the automated vending machine. Section 4 explains the working of the vending machine which is followed by Section 5 which is discussion on the proposed system. Section 6 is the last section providing conclusion and future work.

## 2. Related Work

It is a known fact that the most significant cause of deaths in Asian continent is Cardiovascular Disease (CVD). In CVD, various types include coronary heart disease (angina or heart attack), different types of strokes, and peripheral arterial disease. Various factors causing CVD are cardiac hypertension, tobacco use, physical inactivity, elevated low-density lipoprotein cholesterol, diabetes, overweight/obesity etc. Because of its frequent occurrence, CVD also contributes to high cost spent on treatment. Pakistan is among those countries where people have high risk of developing heart diseases [7]. It is estimated that up to 40% deaths in Pakistan are result of heart related problems. It is also estimated that more than 40 patients die every hour because of heart disease in Pakistan [8].

In [9], authors performed a study on awareness about CVD among students of University of Gujrat, Pakistan. Descriptive statistical tools were used for analysis. Final selection of 100 students was based to perform the analysis. 47 male and 53 female students were part of study. A detailed questionnaire was prepared for this purpose. Results indicated that fair degree of awareness was shown by the students regarding CVD. Authors suggested that as CVD is a major cause of human mortality in Pakistan, therefore, steps are required to be taken to deal with this menace.

Authors in [10] provided an assessment of CVD and associated risk factors among office workers of Lahore, Pakistan. They found that 88% workers showed signs of stress which is considered a major cause of CVD. Lack of physical activity and smoking tobacco were among other major causes. They stressed the need to bring these modifiable factors under control so that CVD risks are avoided.

In Pakistan, because of poor literacy rate and because of most population residing in rural areas with less facilities, people have minimal knowledge about symptoms of CVD. It is worth mentioning that a study has shown that approximately half of the cardiac deaths are resulted within an hour of symptoms.

A recent example of the condition of CVD in Pakistan has been reported in [11], where a study was conducted in Chitral district of Pakistan on causes of seasonal deaths. It was found that CVD was the top most cause of mortality as shown in Fig. 1. Results of this study indicate that Pakistan is still making efforts to address this disease.

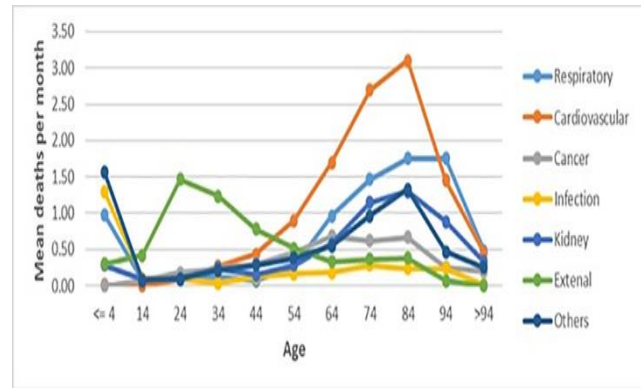


Fig.1 Causes of death in Chitral District of Pakistan [11]

The above analysis shows the significance of CVD in Pakistan's perspective. There is need to find methods based on new technologies and automation to find solutions that can help patients and Doctors dealing with CVD in providing better healthcare facilities.

In the literature, various researchers have worked on development and design of automated vending machines in healthcare sector. In [12], authors have designed a novel first aid vending machine for dealing with accidents on highways. The machine is used to dispense first aid items. They used PIC and CPLD controllers for controlling the system. The proposed machine also had sensors for checking pulse rate and respiration of the patient. They concluded that vending machines are very helpful with the concept of smart cities for providing immediate medical facilities to the patient.

In [13], authors have proposed a low cost automated medical unit as compared to common medical store. The system's main respondents were the people living in remote areas. Raspberry Pi was used as core of the medical unit. Patients with prescriptions access the system. The system captures the image of the system and provided authorization is done, medicines are provided to the patient. DC motors were used to ensure supply of medicines. RFID card readers were used to identify the patients. In Raspberry Pi module, different databases were created using mysql for patients, doctors and medicines. Authors concluded that proposed system provided a viable solution for remote areas and also time saving as generally found in case of busy pharmacies. Authors in [14], have proposed a vending machine for distribution of medicines on highways, deserts, remote areas and other places where it is hard to find a pharmacy. The machine had medicines to deal with basic health problems. The advantage of the system was that vending machine had option of refilling. Arduino microcontroller was used as main component of the system design dealing with input and output of the system through motors. The system had a simple working where patients are identified through login and password based on previously stored data. The system also had multiple sensors including pulse rate

sensor, temperature sensor and humidity sensor. The results on the data taken from experiments performed in a village showed 85% healthcare improvement after installation of the proposed system as compared to 25% without the proposed system. Authors urged the need to use Internet of Things (IoT) technology for future improvement of the system.

In [15], authors have designed a prototype of All Time Medicine and Health Device (ATMAH). The prototype consisted of two modules, first one was the vending module which used Rasperry Pi and second was a web module which provided an online portal for patient to keep him/her updated about the medicines dispensed and other related data. Accessibility and low cost of the system were major advantages of the system. Patient accesses the system with prescription with a unique identification. If the prescription is found valid, system provides the patient requested medicines. Another feature of the system is availability of a Doctor available online who can prescribe medicines to the patient based on the requirement of treatment of the diagnosed disease. In case of urgency, system is capable to providing assistance immediately by linking it to a concerned doctor. It was concluded that such type of automated systems are need of time and more work is required to be done to make them industry ready.

In [16], authors have proposed the design of an anytime medicine system which works twenty hours a days, seven days a week and provides medicines in emergency based on Internet of Things (IoT). Initially the system was used for common diseases including fever, cough, and headache. Patients were issued RFID tags, which allowed patients to enter the system and then obtain the medicines as per prescription. GSM technology was used to provide user transaction details to the patient. For the development of the system, LPC2148 microcontroller board based on a 16bit/32-bit ARM7TDMI-S CPU was used. It was concluded that system was a good option for providing basic healthcare on urgent basis to the patients.

It can be concluded from the survey of the literature that there is need to use automated methods to provide assistance in healthcare sector especially to deal with CVD. Vending machines provide a potential to provide pre-hospital care for CVD patients. Similarly RFID is a popular technology used in vending machine design for authentication. Next section provides architectural details of the proposed vending machine to deal with CVD.

### 3. Proposed System

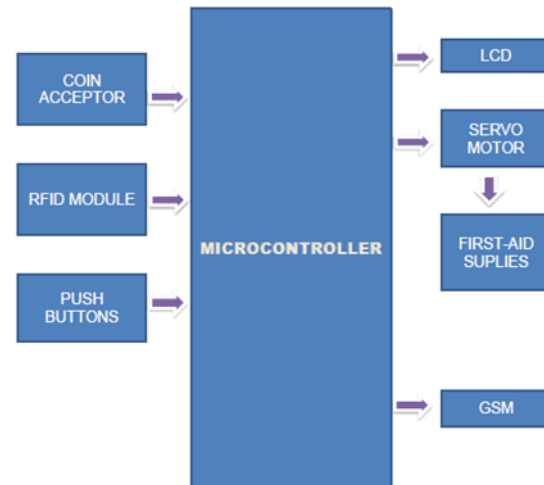


Fig. 2 Architecture of Proposed Vending Machine

The architecture of the proposed setup is presented in Fig 2. The centralized control is managed by Arduino-Uno based microcontroller unit. The two mechanisms are provided to input currency in the proposed system i.e. cash and RFID. Cash can only be input in the form of five rupee coins. Hence, based on this understanding all the entities are provided in such a manner that no remaining amount can be drawn off from the vending machine. Suppose supply is priced of Rs. 2.5 then the supply is doubled so that no remaining amount could be provided to the user. Thus, a bundled supply is provided for most of the items with lesser prices. This is a drawback of the proposed setup hence, in future, this issue will be resolved. Additionally, a second option of RFID cards is also provided to incorporate cashless provision of finance. Hence, the consistent users will be using the cards to buy the provisions. Push buttons are provided so that selection and ejection of items could be done through push buttons.

Fig. 3 shows the flow of events of the RFID system used in the current work. It can be seen that RFID reader after reading the card provides an option of selection of item available and if amount is available then issues the relevant item and subsequently deducts the amount form the card.

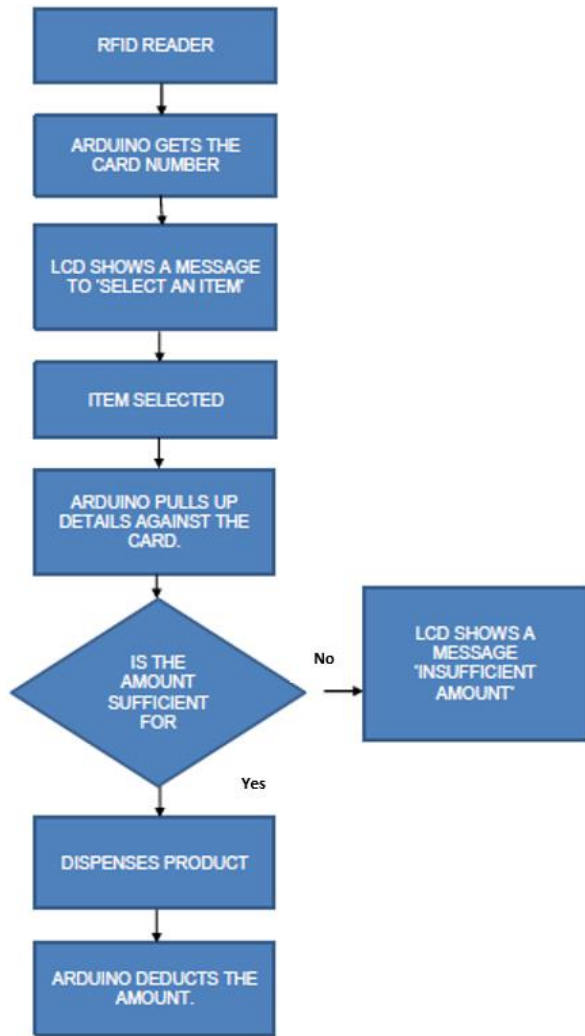


Fig. 3 Flow Diagram of RFID System

As far as the working of the proposed setup is concerned, the servomotors are used to eject the entities. Additionally, all the selected transactions can be viewed through LCD provided in the setup. SIM 800L GSM/GPRS module is a miniature GSM modem which is used in the proposed system. It is connected with the Arduino mega processor and is used to transmit text messages. This system transmits the periodic data of the entities to the producers or supply chain managers so that the system could be filled with the medical aides timely, and hence the human being activity and error is also reduced by automating the supply chain system of the smart vending machine. AB software has been used to view the 3D model creation of the proposed hardware. Figs. 4-6 show the top, front and back panel views of the vending machine created by the Software.

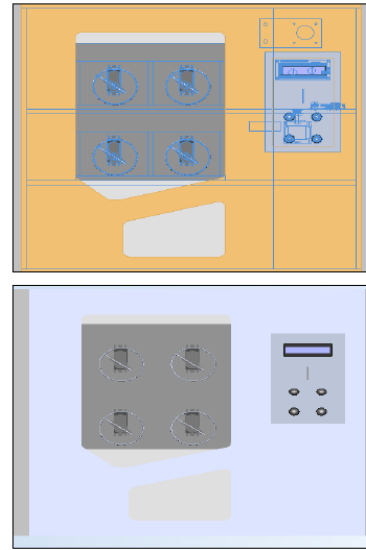


Fig 4: Front View

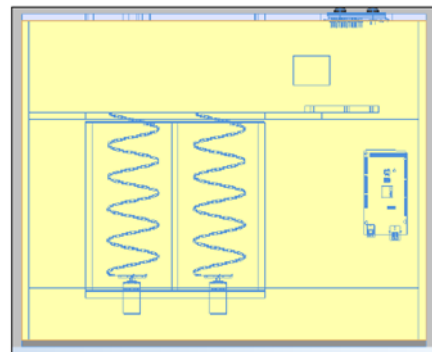


Fig 5: Top View

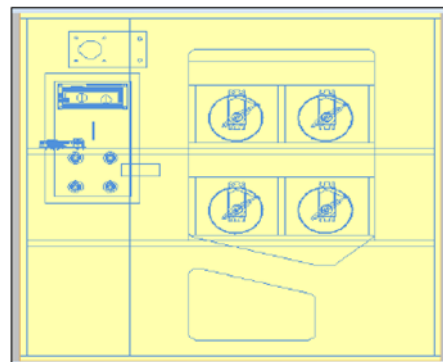


Fig 6: Back View

### 4. Working of the System

The proposed system allows the user to choose between the coin acceptor payment method and the RFID card method. The selection is up to their ease. For the coin acceptor method, the user is asked to insert a coin as shown in Fig 7. Once the coin is entered, the system asks the user to select an item of their choice as shown in Fig. 8 which is delivered as shown in Fig 9. For RFID, the machine asks the user to scan their RFID card that is given to them as shown in Fig. 10. Once the card is scanned, all its data is retrieved by the Arduino and the machine asks the user to select a product of their choice as shown in Fig.11. The new balance that is remained in the card is shown in Fig. 12.

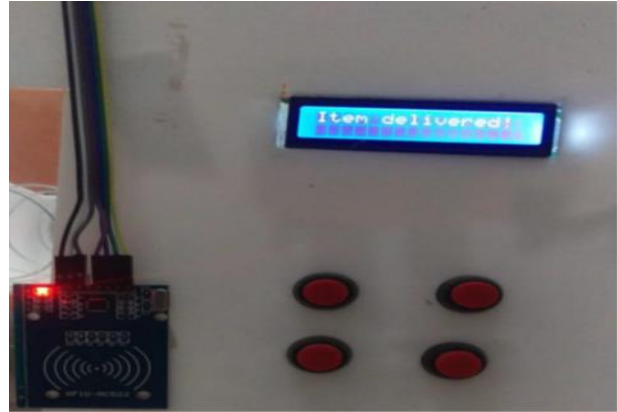


Fig. 9 An item dispatched message displayed on Screen

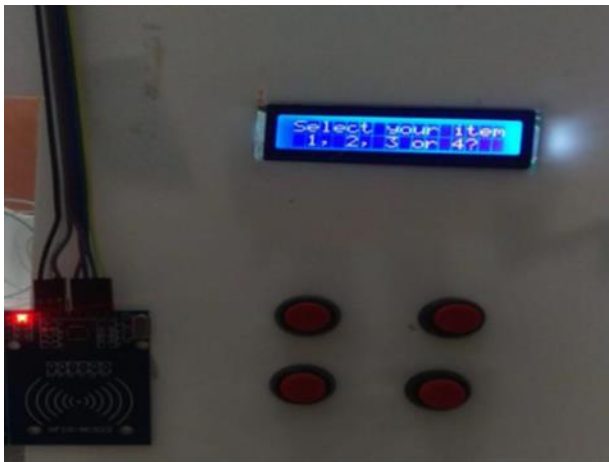


Fig. 7 LCD displays 'insert a coin message'



Fig. 10 Machine asking for RFID card



Fig. 8 Select an option item (item from the machine)



Fig. 11 System asking the user to select an item

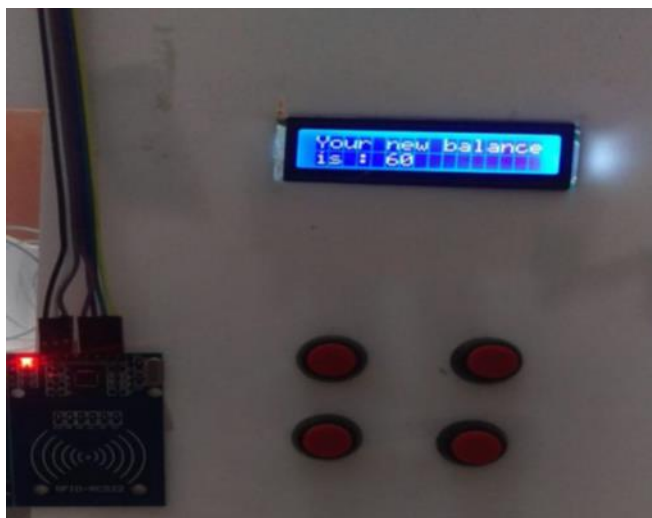


Fig. 12 New balance is displayed

## 5. Discussion

It can be seen from the working of the proposed system that details of the items delivered by the vending machine have not been provided and the term product or item is used in general. As selection of elementary medicines required for CVD patient's treatment in emergency requires detailed knowledge based on various types of CVD options available, therefore, this would be done in an independent study in future. An expert team of heart specialists would be selected and on the basis of their recommendations, common options of patients and medical products including medicines as well considered necessary for pre-hospital treatment, lists of items would be added in the system. A limitation of current work is unavailability of empirical data which would be available once experts decide about the lists of items to be available. After that vending machines would be installed at various places initially in Karachi Pakistan and results and analysis would be reported in a separate study. The current system provides a broad based prototype of the upcoming work. It will also serve as base line for future commercially available CVD vending machines which are envisaged to be cost effective as well. Also, adding the internet to the vending can give it a new nomenclature of Smart Vending Machine which would be accessible by smart phones as well in addition to web.

## 6. Conclusion and Future Work

The paper proposes a Vending Machine to deal with pre-hospital treatment for CVD patients of Pakistan. The prototype of the system has been presented and its working has also been shown. The proposed vending machine uses RFID technology in addition to cash payments in order to

allow secure and cashless payment along with the incorporation of GSM module so that it can alert the installer for a refill whenever an item is on the verge of running out. In future, it is planned to use IoT technology to convert the vending machine into Smart Vending Machine and also look for emerging technologies to be integrated into the system. One of the options is to use blockchain technology. It will increase trust among users using the system. A blockchain system would authorize specialist cardiac specialists to suggest medicines with the consent of patients in the chain.

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