SMART VENDING MACHINE

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Abstract—**This paper proposes a real-world deployment in building a smart system for vending machines. This system is proposed to solve the inconveniences of the vending machines that are commonly seen. The vending machines will be operated through Bluetooth based mobile application and a digital payment system with the incorporation of real-time database. The ultimate goal is to introduce a vending machine to enhance the customer purchasing experience with the adaption of digital money less payments.**

Index Terms—**Vending machines, mobile application, digital payment system**

I. INTRODUCTION

Vending machine represent an automatic seller machine, where buyer enters a payment in terms of coin or banknote to get the desired product which is stored in vending machine. The products include a variety of items such as drinks, snacks, cigarettes, lottery tickets and so forth. Vending machine is extensively and frequently used machine in many technologically advanced nations like USA, UK, China, Japan and more. A customer can buy products easily by inserting coin or banknote whichever is required.

Implementation of this vending machine is a new concept in the context of Bangladesh. The machine can be positioned in a location where there are no cafeterias in the vicinity. This makes it possible for people to access their favorite products during their leisure or work. Considering the pace at which the world is working today , it is important to have fast paced machines that dispense what consumers need. With the great importance of vending machine this paper aims to propose a smart vending machine that will allow the user to buy any kind of product available 24/7.

Smart Vending Machine is an integrated system where a prevailing vending machine will be connected to a mobile app so that a customer can buy any product by remote control. The app will let the user to select the desired display chamber of the vending machine by using Bluetooth signal and purchase the product by mobile banking. The system will use sensors to detect if a product is dispensed perfectly and if the customer has received the product or not.

The project Smart Vending Machine which is an automated system, is proposed with the intention to better the performance of the prevailing vending machines around the world so that these machines may cater for the needs of consumers whenever they need them. Another purpose is to use these systems not only in normal times but also in emergency situations i.e., pandemic, war etc. To these ends the paper is organized as follows : section 2 presents the literature review, section 3 presents the concept design and system architecture and section 4 summarizes the proposed methodology we have proposed with the specification of the software based real-time database and mobile application and the hardware prototype of a real vending machine.

II. LITERATURE REVIEW

This section delineates the features of the existing vending machines around the world and their limitations.

In Japan and Singapore, different kinds of vending machines are widely used. In Japan, there are a large amount of spiral vending machines using coins and cash situated in every local area. In fact in remote area there are some vending machines which are loaded regularly to serve the common users. [1] Using these vending machines saves their time and they do not need to go to departmental stores when they need something.[2]

In Singapore the vending machines are online banking based. Most of the people use credit cards to scan in the vending machine and thus completes the payment. There are different types of vending machines like pizza making vending machines besides the spiral vending machines. [3]

In our country in there are some vending machines installed in a few universities. They are mostly spiral vending machines using cash.But there are some limitations in the prevailing vending machines. Those vending machines can detect money exactly like the image delivered. They cannot detect if any cash is deformed or discolored which is why, sometimes they accept cash but the product may not be successfully delivered. Moreover, using cash and coins to buy stuffs is not quite safe when any pandemic breaks.

Sometimes while dropping a product it might get stuck inside the machine. As a result, sometimes a customer cannot receive the product. Another limitation is no vending machine can detect if the product is dropped in the take out port or not. So, there is no confirmation system if the customer has got the product or not.

That's why; this idea of buying a product from vending machine using an app in mobile phone (where the information of a credit or debit card will be used for purchase) is proposed. The customer's phone and the vending machine will be

connected by Bluetooth within a certain distance. And the system will detect if the product has been dropped or not.

III. CONCEPT DESIGN AND ARCHITECTURE

The proposed vending machine uses an android app. It will be wirelessly connected with the vending machine. From the Android app, a user will be able to choose an item from vending machine after successful connection via Bluetooth. After selection the signal will go to Arduino Mega with which servo continuous rotation motors are connected. The motor of the chamber in which the selected product will rotate and after the dispension of the product, the transaction will take place. And all the data will be updated in the real-time database.

The overview of the proposed system's architecture is presented in Figure - 1 that shows the link between the physical level and logical level. The required equipment are also given in architecture. The system have an ultrasonic sensor, Arduino Mega, servo continuous rotation motor and Bluetooth module. The motors are controlled from the app (which will be connected via bluetooth) after processing data by Arduino. Then the data is stored and updated in Firebase. This data can be retrieved from the user dashboards. Admin of this system can also edit data in Firebase real-time database system.
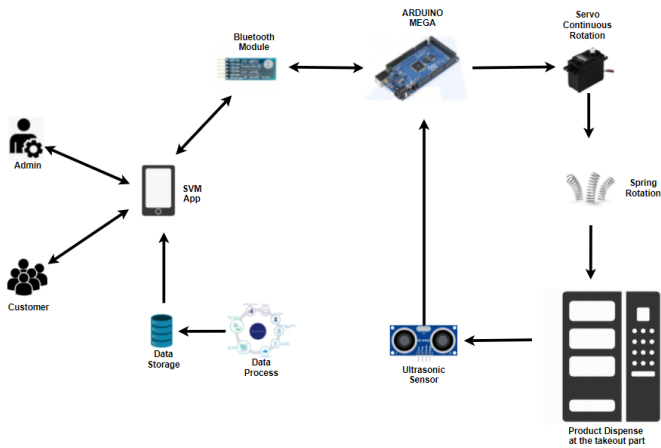

Fig. 1. System Architecture of Smart Vending Machine

The flow diagram in Figure - 2 shows the process of how the product can be bought from vending machine including the process of detection whether the product has been dispensed or not.

The overview of the proposed system's architecture is presented in Figure 1 that shows the link between the physical level and logical level. The required equipment is also given in architecture. The workflow of the system is shown in Figure 2.

IV. SYSTEM IMPLEMENTATION

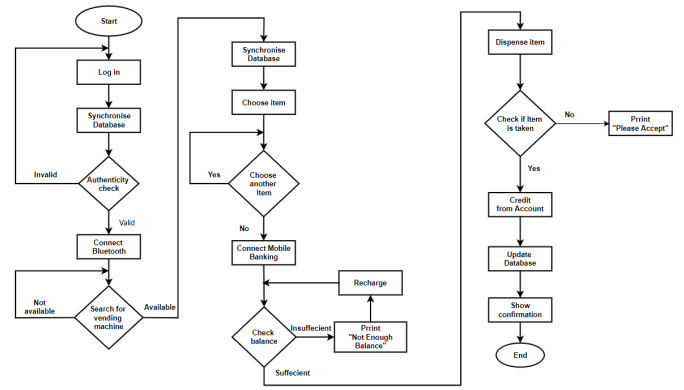The proposed system includes both the hardware and software parts.

Fig. 2. Workflow Diagram of Smart Vending Machine

A. Hardware Development

We have chosen Aeduino compatible electronic components to build our hardware prototype, to interact ith the android app. Figure - 3 is the circuit diagram of the vending machine prototype that showa how all the components of the hardware have been integrated.
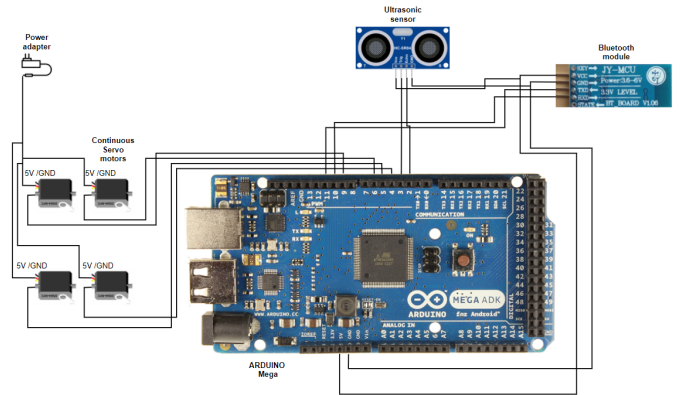

Fig. 3. Circuit Diagram of hardware prototype

The Bluetooth module and servo continuous rotation motors and ultrasonic sensors are connected in the Arduino Mega. The motors get power supply from an external power adapter. The motors are replaced in chambers in order to rotating the springs and dispensing the product. The ultrasonic sensor will detect the dispensed product in front of the takeout port. Figure - 4 shows the prototype of a real vending machine that we have built.

B. Software Development

The main purpose of front-end development is to make the proposed system easily accessible and usable for all the users. There will be different panels for two types of users (Admin and Customer). MIT App Inventor was used for front-end development and Firebase was used for back-end development of the app.

The process of purchasing products in our proposed system

takeout port.

V. EVALUATING THE PROTOTYPE

The android app and the hardware prototype was evaluated after the integration. We invited three participants and they were given a brief presentation about our proposed system as well as a proper demonstration of our proposed system. They performed a total 4 tasks with the system. The tasks include logging into the app, recharging the account, connecting the app with vending machine and buying a product from the vending machine.

All of the participant were asked to provide their feedback of the proposed system. The experimental study shows that each participant was able to perform the tasks with a comparatively minimum number of attempts. For sixty percent tasks, the participants did not have any queries from us. All three participants also provided scores considering various aspects on prevailing vending machine and smart vending machine. In the table the scores provided are specified. From their

Categories	Prevailing Vending Machines	Smart Vending Machine
Portability	2	9
Prone to Error	7	3
Integrity	5	9
Reliability	7	8
Effectiveness	8	8
Ease of use	8	9

Categories	Prevailing Vending Machines	Smart Vending Machine
Portability	3	8
Prone to Error	8	5
Integrity	5	9
Reliability	7	8
Effectiveness	5	8
Ease of use	9	9

Categories	Prevailing Vending Machines	Smart Vending Machine
Portability	1	8
Prone to Error	8	6
Integrity	3	9
Reliability	6	8
Effectiveness	5	8
Ease of use	7	9

Fig. 6. Scores given by the three participants

feedback and scores, it helped us to learn that the performance of smart vending machine is better than the prevailing vending ones.

VI. CONCLUSIONS

In this paper, a presentation about the design of smart vending machine has been given. This system will be efficient and useful for the people in our country in various aspects. The presentation includes the integration of mobile application and the prototype of vending machine which will allow the users to purchase desired products using the android app. The process used in our proposed system is user friendly and convenient. The incorporation of a digital payment system makes the user experience hassle free unlike the traditional payment methods. If this system can be extended industrially in an effective way then it will pave the way towards technological advancement.
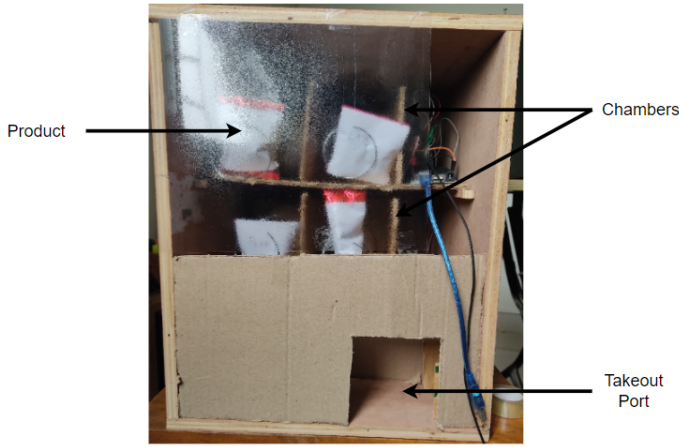

Fig. 4. The prototype of real vending machine

is extremely simple and it can be completed in 3 easy steps.

1. Connect with available vending machine via Bluetooth

2. Choose the product and select it from the app

3. Complete the transaction and collect the item

The user interface shown in Figure - 5 indicates that the user needs to connect to available vending machine from the list of available vending machines.

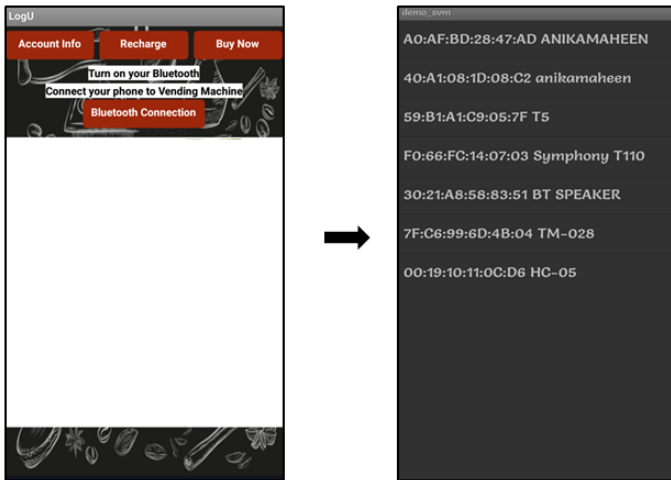After successful connection the app will display the list of the

Fig. 5. User interface for Bluetooth connection

products available with the prices and images of the products in the vending machine. The user can select a product he intends to purchase. If he proceeds to buy the the item will be dispensed.

After product dispension, the ultrasonic sensor will detect it and send a signal in the app. Then the user can proceed to make payment. Lastly, he can collect the product from the

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