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Vending Machine for Blind

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ABSTRACT: Current vending machines are widespread in public spaces, offering a variety of products, using visual interfaces and traditional payment methods like: coins and cards. However, they lack accessibility features for visually impaired users, who struggle to navigate menus independently. Additionally, most machines only support one language, limiting usability for non-native speakers. These shortcomings highlight the need for more inclusive vending solutions. The absence of braille on keypads limits accessibility for visually impaired users. These shortcomings exclude individuals with different language backgrounds and impairments from independently using vending machines. There is a pressing need for vending solutions that cater to diverse linguistics and accessibility needs to ensure equal access for all users. Our Voice Based Vending machine addresses these issues by operating solely through voice commands, ensuring accessibility for visually impaired users. It supports four languages and incorporates braille on keypads, enhancing usability for non-native speakers and those with visual impairments. With accessible payment methods like coins and Unified Payments Interface (UPI), it provides an inclusive and user-friendly vending experience for all.

KEYWORDS: Vending machine, Voice based, VBVM (Voice Based Vending Machine), Visually impaired.

I. INTRODUCTION

Vending machines are automated machines that dispense products after payment is made. These machines have revolutionized the way we shop, as they are now a common and convenient part of our daily lives. However, using vending machines can sometimes be challenging, as they often lack clear instructions on how to operate them. This can be frustrating for anyone, but especially for visually impaired individuals who rely on assistance from others for even simple tasks. While there are various vending machines available to the public, only a few are designed to accommodate the needs of physically challenged individuals. Some machines even incorporate Internet of Things (IoT) technology, allowing users to operate them remotely through a dedicated android app [1]. Some machines utilize FPGA boards for vending machine production [2-4]. Certain machines are tailored for vending electronics components like Integrated Circuits (IC). Additionally, a special vending machine was created using GSM board and wireless technology [5]. This system also incorporates speech recognition technology in Python. Some machines utilize voice recognition technology with different models using the V3 module [6]. In some vending machines for payment systems Unified Payments Interface (UPI) method is also used to keep the transactions cashless. To ensure secure payments, some machines have implemented a SMS gateway, enabling general transactions [7-8]. There have also been developments in stock availability detection using computer vision inside vending cabinets [9]. The addition of QR Code technology for payments is common in many vending machines as it bypasses the process of inserting coins and notes and is much safer and reliable [10]

Vision loss can affect people of all ages [11] and around 253 million people are visually impaired out of which 217 people have Moderate to Sever visual impairment (MSVI) and 36 million people are blind [12]. The vending machine we have designed includes multilingual support for up to 4 languages in the output, along with a flexible payment system that consists of a coin acceptor module and a UPI payment system. This Voice based Vending Machine features two input modes, both of which are accessible to visually impaired individuals. The voice mode allows users to input commands through voice, with the machine providing guidance on the necessary steps. The keypad mode, on the other hand, utilizes a braille-supported keypad for input, where users press keys to interact with the machine while receiving instructions through the speaker. Additionally, the machine is equipped with a buzzer that emits a beep sound signals to indicate when users should provide input or press a key.

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II. HARDWARE DESIGN

The prototype design of the voice-based vending machine comprises a wooden container in the shape of a box, which is divided into two sections.

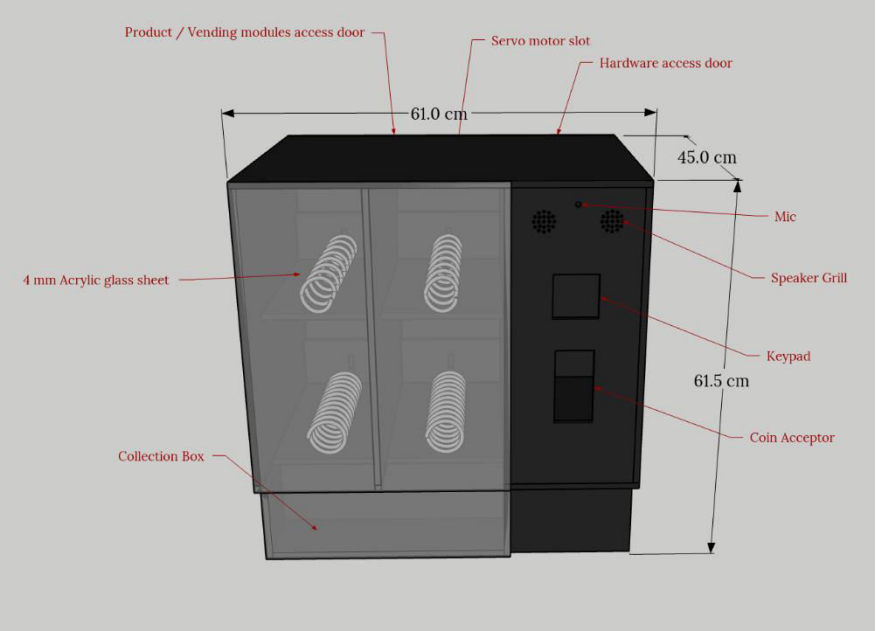

Fig.1. 3D Design of the Model (Front View)

Fig.1 Shows the front view of the model. The first section is further divided into four parts to hold a maximum of four products, while the second section contains all the necessary hardware components.

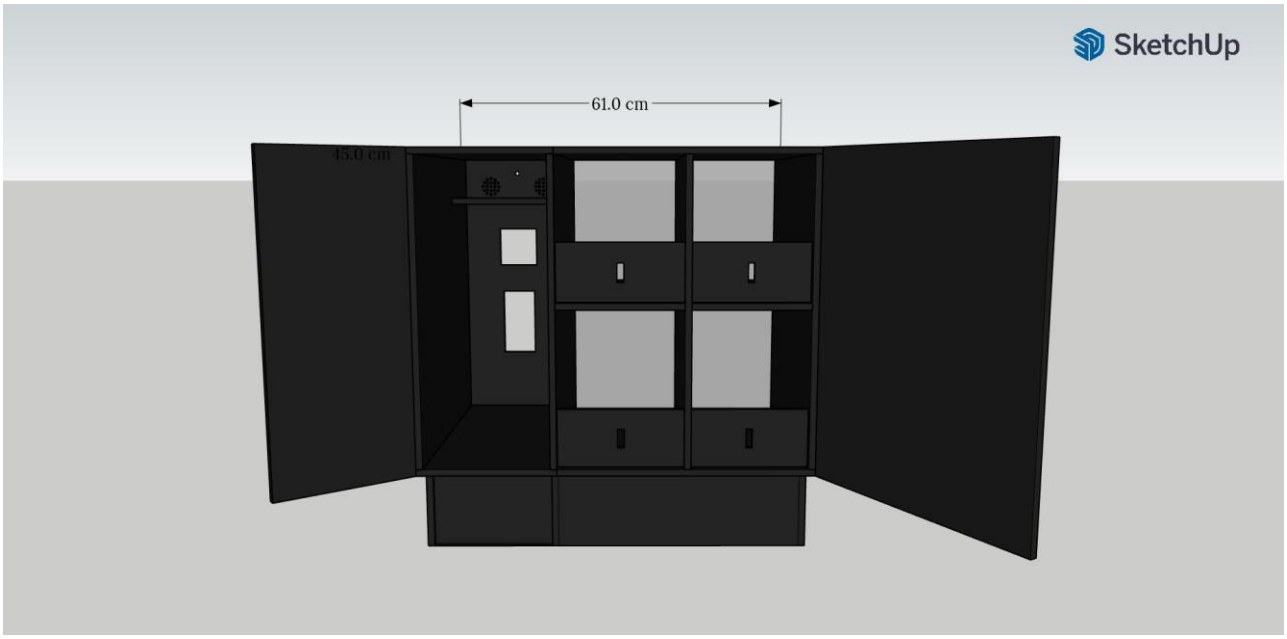

Fig.2. 3D Design of the Model (Rear View)

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Fig.2 shows Rear view of the model. Positioned beneath the section for product storage is the collection box, with the frontal enclosure and collection box door constructed from acrylic sheet material.

A. **Structure Design:**

The primary structure design consists of a wooden box measuring 47.5cm x 45.5cm. This box serves the purpose of housing the products for display and dispensing, as well as accommodating all the necessary components and the raspberry pi controller. Fig.3 displays the real time photo of the model.

On the exterior, there is an acrylic sheet that showcases the products, along with a collection box made from the same material. The collection box features a knob for easy access to retrieve the dispensed product.

Inside the box, there are coils with a diameter of 5cm that securely hold the products and facilitate their forward movement. To achieve this, servo motors (MG 90s) have been utilized. Additionally, all the necessary connections to the controller (Raspberry Pi), are housed within the box. A single breadboard is responsible for consolidating all these connections.

Fig.3. Model of Vending Machine for Blind

B. **Raspberry Pi Microcontroller:**

The Raspberry Pi 4 is equipped with a Broadcom BCM2711 quad-core Cortex-A72 (ARMv8) 64-bit SoC running at 1.5 GHz. It features 40 General Purpose Input Output pins that enable users to connect sensors, displays, and peripherals. The specific model used in this project is the Raspberry Pi 4B with 4 GB of memory. This model includes two micro-HDMI ports supporting up to 4K resolution, two USB 3.0 ports, two USB 2.0 ports, Gigabit Ethernet, dual-band 802.11ac Wi-Fi, and Bluetooth 5.0. The Raspberry Pi 4 is compatible with various operating systems such as Raspbian (now Raspberry Pi OS), Ubuntu, and different Linux distributions. Additionally, it has the capability to run Windows 10 IoT Core.

C. **Coin Acceptor Module:**

The coin acceptor module is commonly utilized to distinguish various coin types and assist a machine in comparing and dispensing the product equivalent to the coin's value. The coin acceptor can be trained with few simple steps [13], 15 samples of the same type coin are used. Once trained, the coin acceptor's values are incorporated into the coding to assign them to the respective products. Fig.4 is the pictorial representation of coin acceptor module. When the coin acceptor module receives a coin, it generates a pulse which is received by the RPi through the GPIO Pin and then, the pulse received gets matched with the coin value and then the coin value is subtracted from the total order value till the amount remaining is zero, Once the full amount is paid, then RPi provides signal to the corresponding motor to rotate and vend the product.

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Fig.4. Multi Coin Acceptor Module

D. **Mic & Speakers:**

The VBVM system incorporates essential components such as the SALAR Model M3 omnidirectional mic and the Zebronics PLUTO 2.0 speaker. The mic, measuring 6*5mm, is chosen for its S/N ratio of 65dB>. It is utilized to capture voice inputs from users for their snack selections. On the other hand, the compact Zebronics PLUTO 2.0 speaker, occupying a mere 347.91cm^3 of space, requires a power supply via USB connected to the Raspberry pi's USB port. To transmit and receive signals, the speaker is connected to the Raspberry pi's AUX port. Its primary function is to provide voice output for the machine.

E. **Servo Motors:**

The MG90S servo motor is a small and light motor created for accurate control of angular position. It operates between 4.8V and 6.0V, providing a high torque output of up to 2.5kg/cm at 6.0V, with a fast response time of about 0.08s/60°. Its sturdy design consists of a plastic gear train and a metal gear for the main drive gear. The MG90S utilizes a standard three-wire interface for simple connection to microcontrollers or servo controller boards, allowing it to be used in a variety of projects. For example, in a vending machine, the MG90S servo motor could be utilized to manage the dispensing mechanism, accurately releasing products when a selection is made, ensuring smooth and precise vending operations.

III. SOFTWARE

A. **Software Design:**

Once the user has selected their preferred input method, they can proceed to make their selection from the displayed inventory. The user can either speak the name of the product they wish to purchase or enter the corresponding number on the keypad. After the user has made their selection, the machine will confirm the choice and display the price of the selected item. The user can then choose to confirm the purchase by either speaking "Yes" or pressing a designated key on the keypad. Once the purchase is confirmed, the machine will dispense the selected product and update the inventory count accordingly. If the user decides to cancel the purchase at any point, they can do so by speaking "Cancel" or pressing a designated key on the keypad. Overall, the program is designed to provide a user-friendly and efficient vending experience by offering multiple input options and clear instructions for navigating the system.The user can provide voice input by speaking a complete sentence, such as "Hello Vending Machine, give me one packet of Chips." The machine will then analyse the language used in the greeting using speech recognition in python. For example, "Hello" corresponds to English, "Namaskar" to Marathi, "Namaste" to Hindi, and "Vanakkam" to Malayalam. By using keywords, the machine will analyse the user's sentence and identify the product, quantity, and language. Once all of this information has been analysed, the machine will prompt the user for payment. The user can choose their preferred payment method to expedite the process. In case the user is visually impaired and requires assistance, they can say the wake-up word "Hey, vending machine." Upon saying the wake-up word, the machine will guide the user throughout the entire process, including listing the available products and providing overall guidance.

The user will then be asked to specify their preferred payment mode, either coin or UPI. If the user selects coin, they will need to insert the exact change for the requested amount. Alternatively, if the user chooses UPI, a QR Code will be

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displayed on the screen. The user can then scan the QR Code and make the payment using any UPI payment app. If the user has pressed any key on the keypad, then the keypad mode gets activated, and the user is required to input information in keypad mode by utilizing the Braille keypad on the machine.
Initially, the machine prompts the user to press the product number corresponding to the desired item, followed by entering the quantity of the selected product. Subsequently, the user is prompted to choose the payment mode (Coin or UPI). In case the user opts for coin payment, they must insert the exact change for the specified amount. On the other hand, if the user selects UPI, a QR Code will appear on the screen for scanning, and the payment can be completed using any UPI payment application.

All the software process is shown with the help of flowchart in Fig.5. The machine is able to simultaneously checking voice and keypad inputs leveraging the multithreading capabilities of Raspberry Pi as described and explained in [14].

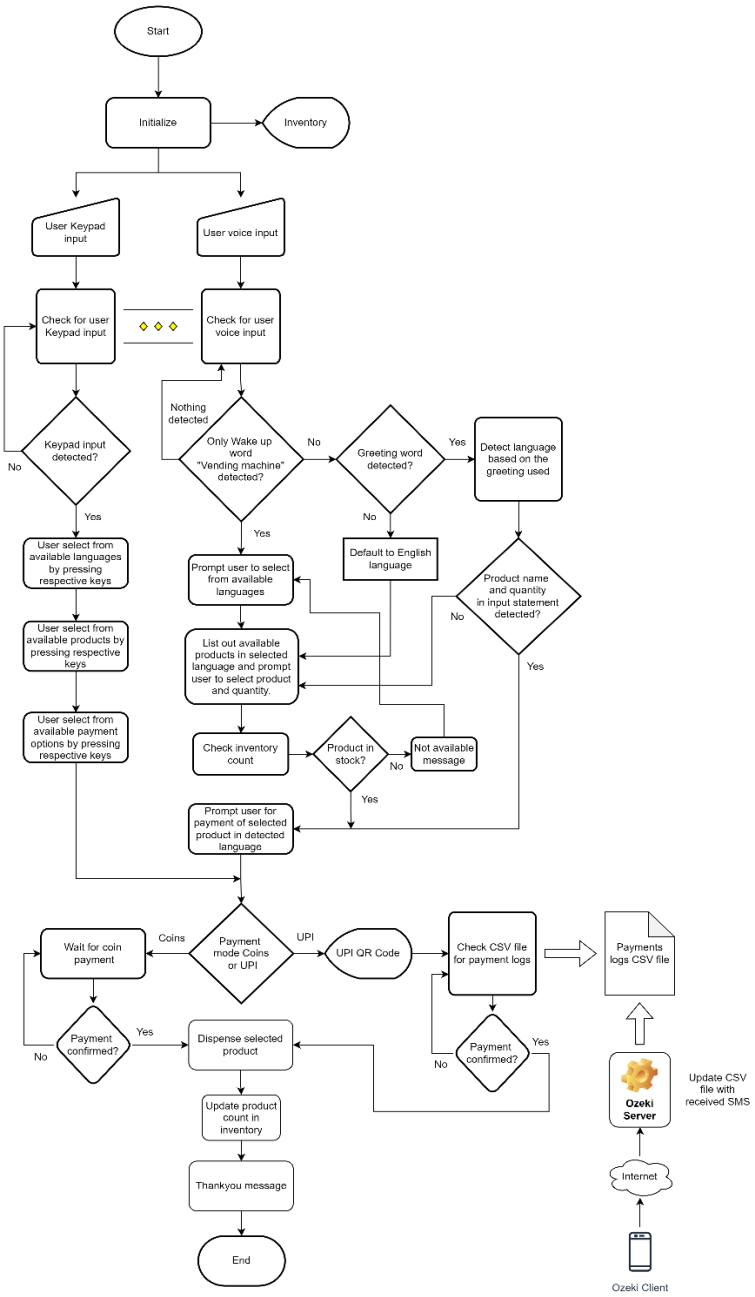

Fig.5. Process Flowchart of Vending Machine

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B. **UPI Payment:**

Ozeki SMS Client is a software application that allows sending and receiving SMS messages through a mobile phone connected to the computer. To keep track of the transactions, an Excel sheet is continuously updated in real-time for a month. This Excel sheet serves as a log of all the transactions made by the owner. It includes details such as the timestamp, payment amount, UPI ID, and sender information. Later, a Python program is utilized to retrieve and analyse the Excel sheet. The program extracts the messages received from the bank and performs various checks to ensure the validity of the transaction.

Firstly, the messages are checked to ensure they fall within a timestamp range of -2 minutes to +2 minutes from the current time. This helps in verifying the real-time nature of the transaction and prevents any delayed or fraudulent transactions. Next, the payment amount mentioned in the message is compared with the generated amount. If they match, it indicates that the payment was made for the correct amount. Furthermore, the authenticity of the UPI ID is confirmed by cross-checking it with the owner's UPI ID. This ensures that the payment is made to the correct recipient. Lastly, the program checks if the received message has come from the senders bank. This step adds an extra layer of security by verifying the source of the payment. i.e. if the message has come from the bank e.g. Indian Bank, the sender's address should contain "INDBNK" then only the message will get verified and the payment status will be shown as successful.

If all the checks pass successfully, the transaction is considered successful. This means that the payment was made for the correct amount, to the correct recipient, and from the owner's bank. The python code receives the payment confirmation message and subsequently activates the corresponding motor pin to initiate the rotation and dispensing of the product from the machine. In cases where the selected product quantity is greater than 1, the motor will rotate multiple times to ensure the exact quantity of the product is dispensed. Following each successful transaction, the item is dispensed utilizing a Servo Motor, and each successful transaction is logged in a text file. The record includes the purchase timestamp, purchased product, payment amount, and payment method. With the integration of the Ozeki SMS gateway, all incoming bank alert messages are stored in the system and accessible to the user via the .csv file.

IV. CONCLUSION

The operational proposed system has successfully met all its objectives in enhancing user experience for visually impaired individuals by providing voice guidance in four different languages. The primary goal of promoting accessibility for visually impaired users and fostering self-sufficiency while reducing dependency on others has been accomplished. The prototype is now prepared for implementation in small-scale organizations or schools for the blind. While the system can fulfill its intended objectives, it also possesses potential for further expansion. The voice-based vending machine has significant room for growth such as addition of a screen so it can be used by deaf people too. It can be integrated with existing automatic vending solutions in future. Features like customer history analysis, product consumption analysis, and personalized order capabilities can be implemented in this system too if required.

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