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IMPLEMENTATION OF VOICE OPERATED UPI AND COIN BASED SMART BEVERAGES AND WIFI VENDING MACHINE

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Abstract: This project presents the development of a multifunctional smart vending machine capable of dispensing beverages and items using voice commands, coin validation and UPI-based digital payments. The system is built around an Arduino Mega controller and integrates an HC-05 Bluetooth module for wireless voice operation, relay-driven motor pumps for dispensing hot milk, cold milk, and decoction, and a DC motor with a spring-based mechanism for item dispensing. A webcam-driven coin detection system enables the machine to accept only ₹10 coins while rejecting all invalid denominations.

The vending machine supports dual operating modes: voice-controlled operation via a mobile application and manual operation through four dedicated buttons for hot coffee, cold milk, item dispensing, and Wi-Fi activation. A Wi-Fi dongle provides 330 seconds of internet access per recharge, ensuring reliable connectivity for UPI transaction verification. The machine dispenses beverages or items only after confirming successful payment; otherwise, it returns the coin and aborts the process. A 16×2 LCD display provides real-time updates, including payment status, beverage selection, and Wi-Fi activation timing.

Overall, the proposed system delivers a cost-effective, automated, and user-friendly vending solution suitable for cafeterias, hostels, offices, and public environments, offering enhanced convenience through hybrid payment support and smart control functionality.

Keywords: Smart Vending Machine, Voice Control, UPI Payment, Coin Detection, Arduino Mega, HC-06 Bluetooth, Motor Pump, Wi-Fi Automation.

I. INTRODUCTION

This project focuses on developing a smart, automated vending machine capable of dispensing beverages and items using voice commands, UPI-based digital payments, and coin validation. Traditional vending machines rely heavily on manual operation and single-payment methods, often leading to delays, inaccurate dispensing, and limited accessibility. The proposed system enhances convenience by integrating voice-controlled operation using the HC-05 Bluetooth module, enabling users to interact with the machine wirelessly through simple spoken commands. Along with voice control, the machine supports manual operation using four dedicated buttons for hot coffee, cold milk, item dispensing through a motorized spring mechanism, and Wi-Fi activation.

To ensure secure transactions, the machine incorporates UPI payment verification and a webcam-based coin detection system that accepts only ₹10 coins while rejecting invalid ones. Beverage dispensing is automated using relay-controlled motor pumps for hot milk, cold milk, and decoction, ensuring accurate and consistent output. A Wi-Fi dongle provides timed connectivity for UPI verification, offering 330 seconds of access per recharge. The system also includes an LCD interface to display real-time status, payment confirmation, and operational feedback. By integrating automation, digital payment systems, and smart control technologies, this vending machine provides an efficient, user-friendly solution suitable for cafeterias, hostels, and public service environments.

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II. METHODOLOGY

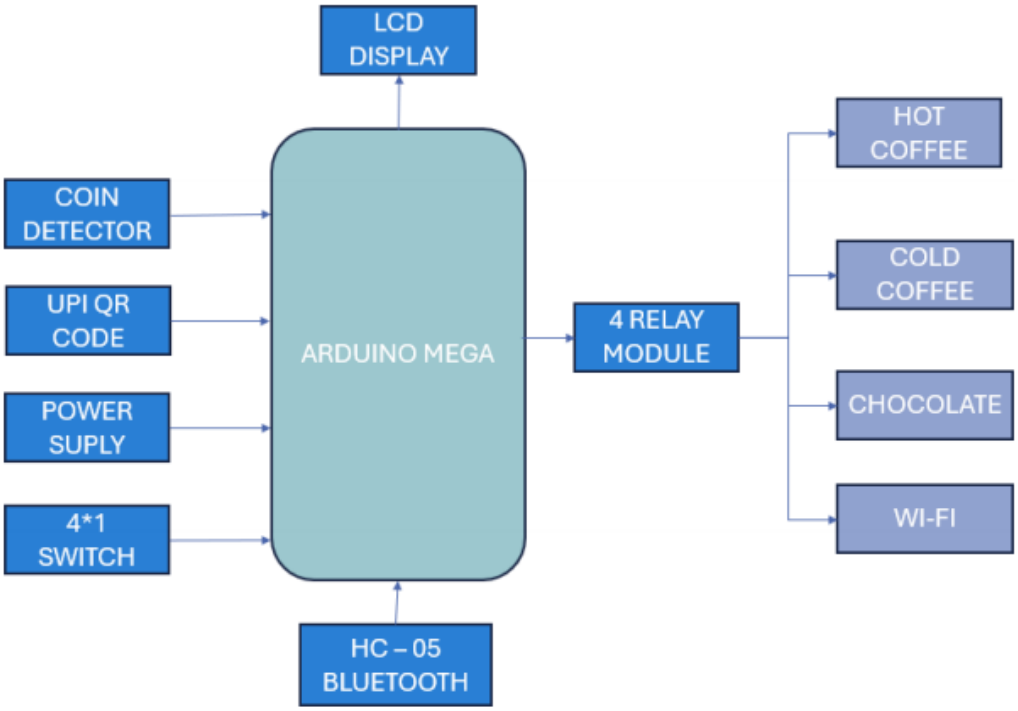

Fig 1: Block Diagram of Smart Vending Machine

The methodology of the proposed smart vending machine involves the sequential integration of voice control, payment verification, automated dispensing, and Wi-Fi-based UPI processing. Operation begins with voice commands received through the HC-05 Bluetooth module, where user instructions from a mobile application are transmitted to the Arduino Mega, the main control unit. In addition to voice mode, the system allows manual operation through four push buttons for hot coffee, cold milk, item dispensing, and Wi-Fi activation.

After a selection is made, the system moves to the payment verification stage. For coin payments, a webcam-based detection module validates only ₹10 coins using image processing. For digital payments, the user completes a UPI transaction, and only after successful confirmation does the system allow dispensing.

The beverage dispensing mechanism uses three relay-driven motor pumps to deliver hot milk, cold milk, and decoction with accurate timing. Solid items are dispensed using a DC motor with a spring-based rotational mechanism, ensuring single-item release. The Wi-Fi dongle activates for 330 seconds to support UPI verification when needed. A 16×2 LCD display provides real-time messages, including payment status, dispensing updates, and Wi-Fi activation time.

III. METHODS AND MATERIALS

1. Hardware Setup

Begin by assembling the complete vending machine hardware. Mount the Arduino Mega as the main controller and connect the HC-05 Bluetooth module for receiving voice commands from a mobile device. Install the motor pumps for hot milk, cold milk, and decoction, and attach the DC motor with a spring mechanism for solid item dispensing. A webcam module is positioned near the coin slot to detect and validate ₹10 coins. A Wi-Fi dongle is added to provide internet connectivity required for UPI payment verification.

2. Power Supply

Use a regulated power supply capable of supporting the Arduino Mega, relay modules, motor pumps, and the dispensing motor. Ensure stable voltage and sufficient current delivery during multiple concurrent operations. Proper power distribution and protection (fuses, decoupling capacitors) are implemented to prevent overload when pumps and Wi-Fi are active simultaneously.

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3. Voice Command Integration

Configure the HC-05 Bluetooth module and pair it with a mobile application that recognizes voice commands. The Bluetooth module transmits decoded instructions to the Arduino Mega, which interprets them to perform beverage selection, item dispensing, or Wi-Fi activation.

4. Manual Control System

Implement four push buttons for manual operation:

- Button 1 – Hot Coffee
- Button 2 – Cold Coffee
- Button 3 – Chocolate Dispensing (Spring Motor)
- Button 4 – Wi-Fi Activation

5. Payment Verification System

Integrate the webcam-based coin detection module to identify valid ₹10 coins by analyzing size, color, and pattern using image-processing algorithms. For digital payments, enable UPI verification; the machine releases beverages or items only after confirming a successful transaction. Unsuccessful or unverified transactions trigger coin return or rejection routines.

6. Dispensing Mechanism

Use relay modules to control the three motor pumps that dispense hot milk, cold milk, and decoction. A DC motor with spring rotation handles solid item dispensing. The Arduino Mega regulates pump run-time and motor rotation to ensure accurate and consistent quantities for each selection.

7. Wi-Fi Activation System

The Wi-Fi dongle provides internet access for UPI verification. When the Wi-Fi button is pressed, the system grants 330 seconds of connectivity per recharge. The dongle selection and buffering ensure stable performance even under busy network conditions.

8. LCD Display Integration

A 16×2 LCD display is configured to show real-time machine status, including: voice command acknowledgment, beverage preparation progress, payment confirmation, coin rejection messages, and the remaining Wi-Fi activation time.

Materials

1. Hardware

- Arduino Mega
- HC-06 Bluetooth Module
- Motor Pumps (Hot Milk, Cold Milk, Decoction)
- DC Motor with Spring Mechanism
- Relay Module (4-Channel)
- Webcam for Coin Detection
- Wi-Fi Dongle
- 16×2 LCD Display
- Push Buttons
- Power Supply Module
- Connecting Wires & Enclosure

2. Software

- Arduino IDE
- Bluetooth Voice Control Application
- Image Processing Logic for Coin Detection
- UPI Payment Validation System.

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IV. IMPLEMENTATION

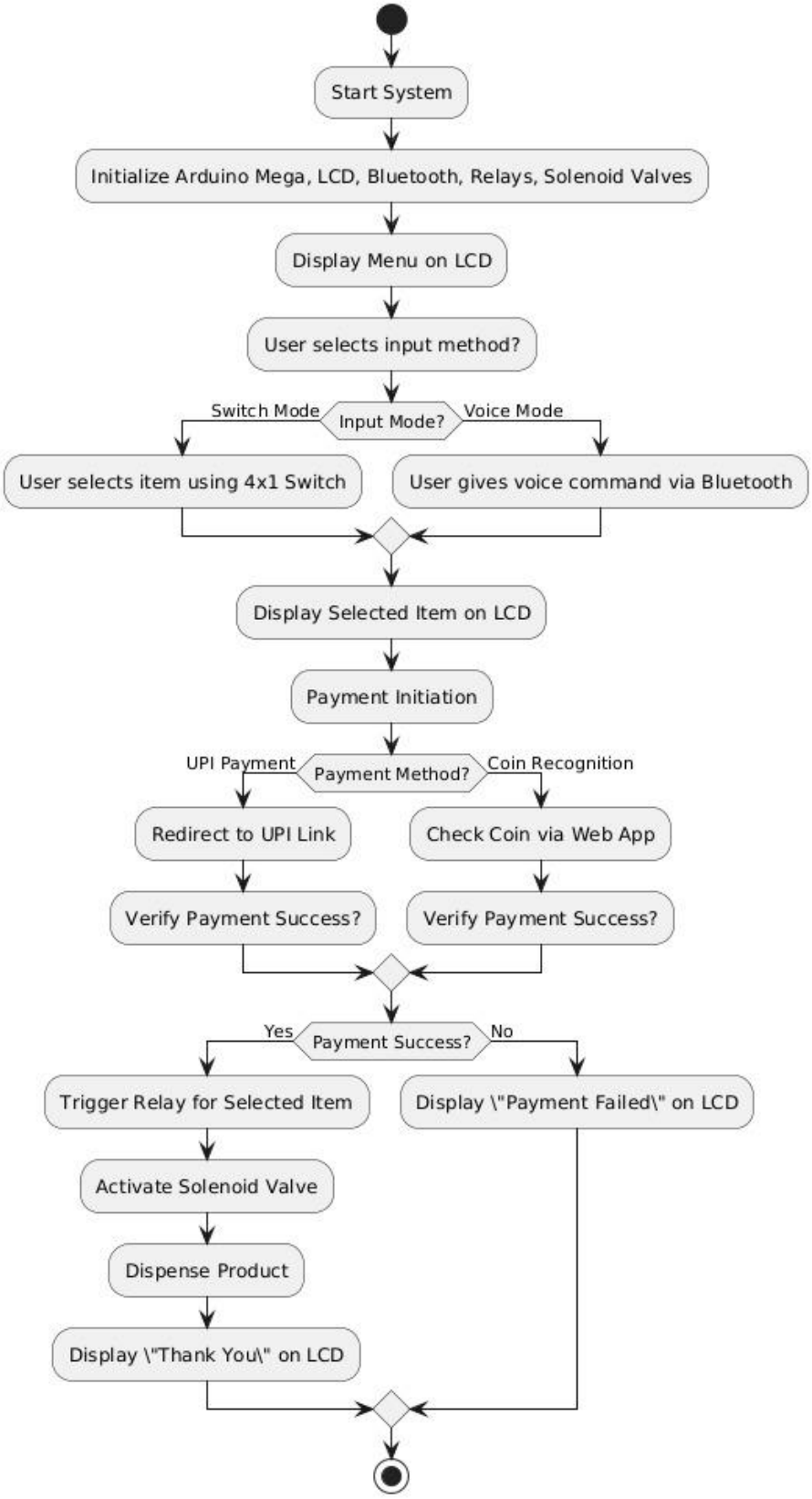

Fig 2: Flow of Smart Vending Machine

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1. Voice Recognition and Bluetooth Interface

Voice-based operation is implemented using a smartphone voice-recognition app paired with the HC-05 Bluetooth module. The mobile app converts spoken commands into ASCII commands (for example, "HOT_COFFEE", "COLD_MILK", "DISPENSE_ITEM", "WIFI_ON") and sends them over serial Bluetooth. The HC-05 forwards the text command to the Arduino Mega, which parses the string and maps it to an internal action. Basic command validation and a short command whitelist prevent malformed inputs. Acknowledgment strings are returned to the mobile app and shown on the 16×2 LCD.

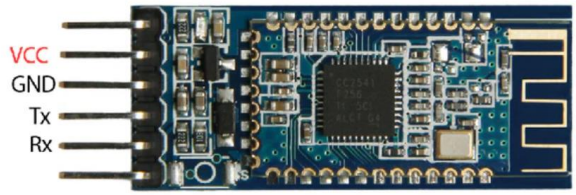

Fig 3: Bluetooth Module

2. Input Selection & Manual Operation

The system supports dual input modes: **Voice Mode** and **Switch Mode**. Four push-buttons provide for manual.

- **Button 1** — Hot Coffee
- **Button 2** — Cold Milk
- **Button 3** — Item Dispensing (Spring Motor)
- **Button 4** — Wi-Fi Activation

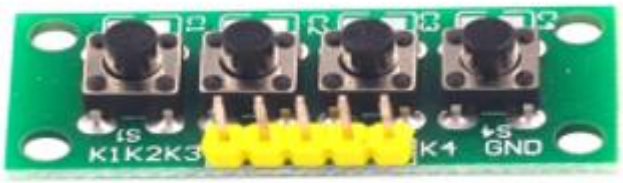

Fig 4 : 4x1 Push Button

3. Coin Detection & Image Processing

A webcam captures an image of every coin inserted. Image-processing is performed using lightweight OpenCV routines ported to a connected to an external microcontroller running Python/C++. The detection pipeline:

- Preprocessing: convert to grayscale, apply Gaussian blur.
- Edge and contour detection: locate circular contours.
- Feature extraction: compute diameter, color histogram, and embossed pattern matching using template matching.
- Decision logic: accept only if diameter, color range, and template score match pre-trained ₹10 coin parameters.Accepted coins generate a digital "coin_accepted" flag; invalid coins trigger an actuator to return the coin.

Fig 5: Coin Detector Web Camera

4. UPI Payment Verification Module

For digital transactions, the machine displays a QR/UPI link on the LCD (or mobile app) and grants a limited WiFi window (330 seconds) for the payer. The verification flow:

- User scans QR and sends payment.

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- Payment gateway or web-hook returns transaction status to the vending unit.
- Arduino Mega verifies TXN ID and amount against the expected order, with timeout handling.
- On success a PAYMENT_OK flag is set on failure or timeout the system displays “Payment Failed” and aborts.

5. Dispensing Pumps & Relay Control

Three **relay-controlled motor pumps** are dedicated to beverages:

- **Pump 1**: Hot milk
- **Pump 2**: Decoction
- **Pump 3**: Cold milk

Each pump is driven through a relay module or low-side MOSFET depending on current, with flyback protection and inrush current handling. Pump run-time is controlled by the Arduino using calibrated pulse-width timing, providing consistent dispense volumes regardless of fluid viscosity. Food-grade tubing and check valves prevent backflow.

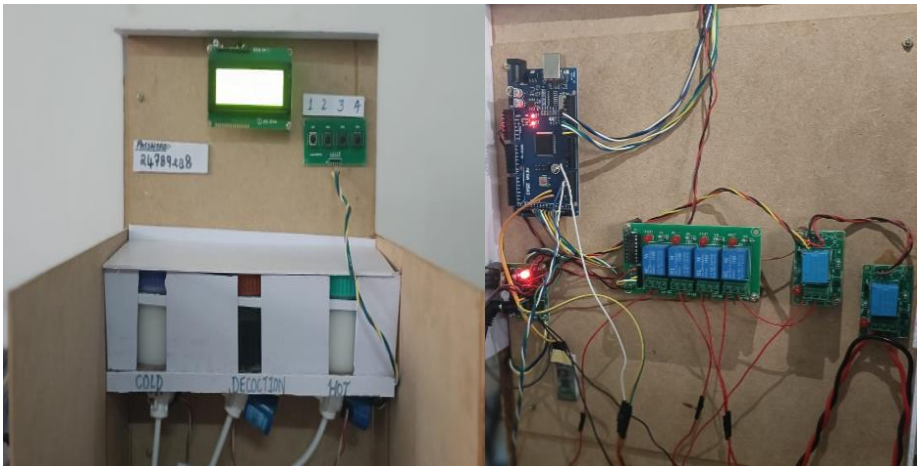

Fig 6: Motor Pump and Relay

6. Solid Item Dispensing (Spring Motor Mechanism)

Solid items are dispensed using a **DC motor coupled to a spring-rotation mechanism**. Implementation details:

- Motor rotates a helical spring or rotor by a fixed angle per activation using encoder feedback (or calibrated time-based rotation).
- A single rotation index releases one item; rotation stops immediately afterward to avoid double-dispense.
- Stall detection (current sensing or encoder mismatch) is used to detect jams and trigger retry/alert routines.

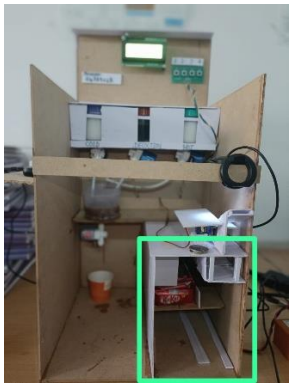

Fig 7: Spring Motor Machanism

7. Wi-Fi Activation & Network Management

The Wi-Fi dongle is controlled via the Arduino companion (or Raspberry Pi). On Wi-Fi button press, the dongle is powered and the network interface is brought up for **330 seconds**. A countdown timer is displayed on the LCD. Network health checks (ping or TCP handshake) are performed before attempting UPI verification; failures gracefully fall back to coin-only mode.

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8. LCD & User Feedback Interface

The **16×2 LCD** provides stepwise feedback:

- Welcome / Menu
- Input mode prompt (Voice / Manual)
- Selected item and price
- Payment method prompt
- Coin accepted / rejected messages
- UPI payment status and timeout warnings
- Dispensing progress and "Thank You" message

Fig 8: LCD Display

V. DISCUSSION

1. Dual Input Control: Voice Recognition and Manual Operation

The vending machine's combination of voice-based control through the HC-05 Bluetooth module and manual button input ensures a flexible user experience. Voice commands enable contactless operation, increasing convenience and hygiene in public environments, while manual switches provide a reliable fallback option. This dual-mode system enhances accessibility and ensures that the machine remains functional even during network or Bluetooth disruptions.

2. Hybrid Payment Mechanism: UPI and Coin Validation

The integration of both UPI digital payment and ₹10 coin-based validation significantly enhances the machine's usability. The webcam-based coin detection system reliably identifies valid coins through image processing, minimizing fraud and incorrect transactions. The UPI verification workflow, which includes QR scanning and OpenCV-based confirmation, ensures secure digital payments. This hybrid payment design makes the system versatile and accessible to all user groups, including those without access to online payment apps.

3. Automated Beverage Dispensing and Item Delivery

The relay-controlled motor pumps for hot milk, cold milk, and decoction demonstrated consistent flow and accurate quantity during testing. The DC motor with a spring-rotation mechanism successfully dispensed solid items with precision. Automated dispensing reduces human effort, eliminates manual errors, and ensures uniform product output, improving machine reliability and customer satisfaction.

4. Wi-Fi Activation and Timed Payment Window

The vending machine's Wi-Fi activation feature, which provides a 330-second payment window, ensures uninterrupted UPI verification. This time-bound internet availability optimizes resource utilization while maintaining security. The timed access also prevents unauthorized network usage and ensures that Wi-Fi is only available during payment operations.

5. User Feedback and Monitoring Interface

The 16×2 LCD display provided clear operational feedback, including menu options, payment status, coin acceptance, and dispensing progress. This real-time information flow significantly reduces user confusion and enhances machine transparency. Displaying "Payment Failed" ensures users are well-informed throughout the transaction cycle, improving the overall experience.

VI. CONCLUSION

The demand for automated and contactless service systems is rapidly increasing, especially in public places such as cafeterias, hostels, offices, and transportation hubs. Traditional vending machines rely on manual operation and limited payment options, often leading to inefficiency, inconvenience, and lack of flexibility. The proposed voice-operated UPI and coin-based smart vending machine effectively addresses these limitations by integrating automation, IoT-based control, and secure hybrid payment mechanisms. The system successfully provides a seamless user experience through voice commands, manual selection, automated beverage dispensing, and reliable item delivery.

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The incorporation of a webcam-based ₹10 coin recognition system and UPI payment verification ensures accurate, fraud-free transactions, reducing operational errors and human intervention. The machine's ability to dispense beverages and items autonomously increases service efficiency and reduces the need for constant staff monitoring. The inclusion of a 330-second Wi-Fi activation window for digital payment verification further strengthens system reliability while optimizing resource usage.

In the future, this vending system can be enhanced by integrating machine learning for advanced coin classification, cloud-based payment analytics, and mobile app-based monitoring for real-time inventory tracking. Additional sensors for temperature control and quantity measurement can further improve performance. Overall, this smart vending machine provides an effective, low-cost, and scalable solution that improves convenience, enhances automation, and supports modern digital payment ecosystems without requiring major infrastructure changes.

VII. ACKNOWLEDGMENT

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I am also thankful to the technical staff and my peers who assisted in the hardware configuration, troubleshooting, and integration of various modules such as the Bluetooth interface, payment verification system, and dispensing mechanisms. Their cooperation and insights greatly helped in overcoming challenges faced during experimentation and implementation.
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