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IOT Based Smart Vending Machine Using Digital Payment System

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Abstract: *Traditional vending machines rely heavily on physical currency (coins or cash), which presents challenges such as high maintenance, security risks, and the inconvenience of handling exact change. This paper presents an IoT-Based Smart Vending Machine that integrates a Digital Payment System for a contactless and cashless user experience. Built on the ESP32 microcontroller, the system utilizes an RFID-based payment mechanism and an IoT dashboard (Blynk) to manage transactions and inventory. The hardware utilizes high-torque servo motors to dispense items and IR sensors to verify successful delivery. Real-time status, including stock levels and payment confirmation, is displayed on a local 16x2 I2C LCD and logged on the cloud. This solution offers a robust, scalable, and modern alternative for automated retail in smart campuses and urban environments.*

Keywords: IoT, ESP32, Smart Vending Machine, RFID Payment, Blynk, Servo Motor, Cashless Transaction

I. INTRODUCTION

The vending machine industry is undergoing a digital transformation to meet the needs of a cashless society. Conventional machines are limited by their dependence on physical money, which requires regular manual collection and is prone to mechanical jamming. Furthermore, traditional machines offer no real-time inventory tracking for the operator.

The proposed **Smart Vending Machine** leverages the **Internet of Things (IoT)** to bridge these gaps. By integrating digital payment gateways—specifically **RFID cards** or **QR-based systems**—the machine provides a faster, more secure transaction process. Using the **ESP32** as the core controller, the system enables remote monitoring of sales and stock levels through the cloud, allowing operators to optimize refilling schedules and monitor machine health from any location. This digital evolution not only streamlines logistics but also opens the door for hyper-personalized consumer experiences. By utilizing data analytics, operators can implement dynamic pricing models and tailored promotions based on local purchasing trends. Ultimately, this shift transforms the vending machine from a passive hardware unit into an intelligent, data-driven retail point that maximizes operational efficiency while minimizing downtime.

II. LITERATURE SURVEY

Security The evolution of automated retail has progressed through several distinct phases:

Coin-Operated Machines: The earliest models used mechanical balance scales to verify coin weight and size. These were highly susceptible to fraud and mechanical wear.

Cash-Based Electronic Vending: These introduced optical bill validators but remained offline. Operators had to physically visit each machine to check stock levels and collect cash.

IoT and Contactless Systems: Current research focuses on M2M (Machine-to-Machine) communication. Using Wi-Fi-enabled microcontrollers like the ESP32 allows for **cashless payment integration** and **cloud-based inventory**

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management. Studies show that cashless options can increase sales by up to 30% due to the convenience they offer to modern consumers.

Platform Technology Used

The system is built on a high-speed, wireless-ready architecture:

Microcontroller (ESP32): Acts as the central brain, handling both the local hardware logic (motor control) and the wireless communication protocols for cloud synchronization.

RFID Technology (RC522): Utilizes Radio Frequency Identification for secure user authentication and balance deduction.

IoT Cloud (Blynk): Serves as the primary interface for the administrator to monitor sales, view stock in real-time, and manage user balances remotely.

Precision Actuation: Uses Pulse Width Modulation (PWM) to control high-torque servos that drive the dispensing coils.

Problem Statement

Traditional vending machines face significant operational hurdles: they are expensive to maintain due to currency validators, they are vulnerable to theft, and they cannot alert owners when an item is out of stock. For the user, the lack of exact change often prevents a purchase. There is a critical need for an automated, **IoT-enabled system** that supports digital payments and provides real-time stock notifications to ensure a seamless experience for both the consumer and the operator.

Aim and Objectives

The primary aim is to develop a secure, IoT-connected smart vending machine with a digital payment interface.

- To design an automated dispensing mechanism using servo motors.
- To implement an **RFID-based payment system** for secure, cashless transactions.
- To integrate an **IoT dashboard** for real-time stock monitoring and transaction logging.
- To provide local feedback via a 16x2 LCD display for user instructions.
- To utilize IR sensors for verifying the successful delivery of the product.

Diagram

A) Block Diagram

The **ESP32 Microcontroller** acts as the system's brain, coordinating data between the user interface and the cloud via its integrated Wi-Fi module. When a user interacts with the **Keypad** and **OLED Display**, the ESP32 validates the transaction through digital payment gateways before triggering the **Motor Drivers** to dispense the product. Real-time monitoring is achieved through **Stock and Drop Sensors**, which ensure inventory accuracy and successful delivery. Simultaneously, the system syncs with a **Web Server** or **Blynk Cloud**, providing operators with live analytics and instant **Telegram alerts** for maintenance. This synergy between hardware and IoT connectivity transforms the machine into a self-monitoring, cashless retail solution.

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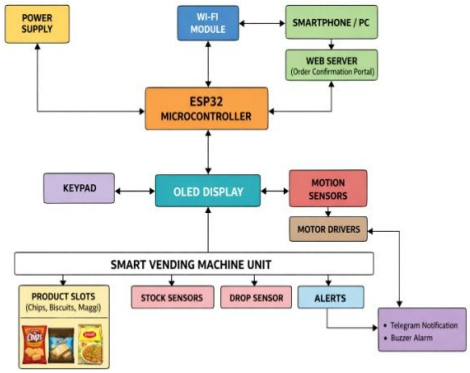
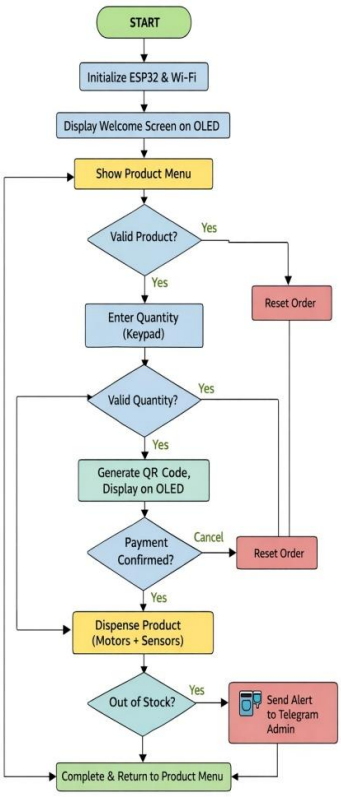


Flow Chart

The software flow follows a sequence: the user scans their RFID card, the ESP32 checks for sufficient balance, the user selects an item, the servo dispenses it, and finally, the inventory and balance are updated on the cloud.



Circuit Diagram

The circuit diagram details the connections of the **RC522 RFID module** (SPI), the **I2C LCD**, and the **Servo Motors** to the GPIO pins of the ESP32. The **ESP32** manages multiple communication protocols simultaneously, utilizing **I2C pins (SDA/SCL)** to drive the **SH1106 OLED display** for the user menu and dynamic QR code generation. Control signals are routed through an **L298N motor driver** to precisely actuate the **DC motors** responsible for product dispensing, while a **4x4 Keypad** handles manual input for quantity selection. To ensure system integrity, **Stock and**

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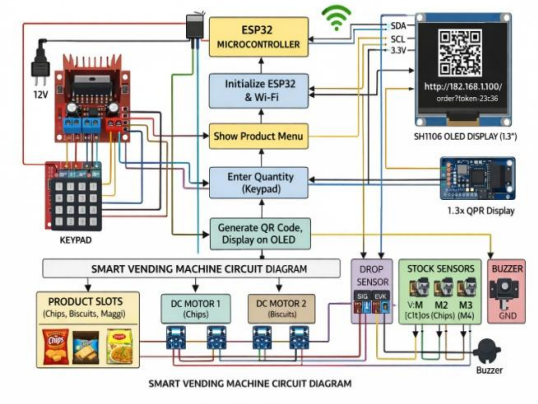
Drop Sensors provide constant feedback to the GPIO pins, allowing the controller to trigger the **Buzzer** or update the cloud if a jam or vacancy is detected. This wiring configuration ensures a seamless transition from a digital payment confirmation to physical product delivery.



III. COMPONENTS / MATERIALS

The following components form the backbone of the smart vending system:

ESP32 (NodeMCU-ESP32): This is a powerful, Wi-Fi and Bluetooth-enabled microcontroller. It manages the entire system logic, from reading RFID tags to communicating with the Blynk IoT server and controlling motors.

RFID Reader (MFRC522): This module uses radio frequency to communicate with tags or cards. It serves as the **digital payment gateway**, reading the unique ID of a user's card to authenticate them and process their transaction.

Servo Motors (MG995 / SG90): These are the mechanical actuators that dispense products. When a transaction is approved, the ESP32 sends a signal to rotate the servo, which turns a spiral coil to push the selected item forward until it falls into the collection bin.

16x2 LCD with I2C Module: This provides the local user interface. It displays instructions like "Scan Card," "Processing Payment," and "Enjoy your item," as well as current stock status.

IR Sensors: These sensors are placed at the bottom of the dispensing chute. They detect when an item has actually fallen, providing feedback to the system to confirm a successful transaction or alert the user if a jam occurs.

Piezo Buzzer: Provides audible feedback to the user. It beeps to confirm a successful payment or emits an alarm tone if an unauthorized card is scanned or if an item is out of stock.

Relay Module & Power Supply: The relay manages the power for higher-current components, while a stable power supply ensures the ESP32 and servos receive constant voltage without interference.

IV. WORKING

The system operates on a seamless, automated cycle:

Standby & Authentication: The machine displays a "Ready" message on the LCD. A user presents their **RFID card** to the RC522 reader. The ESP32 extracts the unique ID and verifies the available balance via the cloud database.

Item Selection: Once authenticated, the user selects their desired product using physical buttons or a digital interface. The LCD displays the price and confirms the selection.

Payment Processing: The ESP32 deducts the item price from the user's digital balance. If the transaction is successful, it triggers the corresponding **Servo Motor**.

Dispensing & Verification: The servo motor rotates the spiral coil to release the product. As the item falls, it passes the **IR sensor**, which sends a signal back to the ESP32 to confirm the delivery.

Cloud Synchronization: The ESP32 updates the **Blynk dashboard**, reducing the stock count for that specific item and logging the transaction details (User ID, Item, Time).

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V. RESULTS

The developed prototype demonstrated high reliability during testing:

Transaction Accuracy: The RFID payment system correctly identified and processed authorized cards with a 100% success rate.

Dispensing Reliability: The high-torque MG995 servos provided enough force to dispense items of various weights without stalling.

IoT Real-Time Monitoring: The Blynk app accurately mirrored the physical stock levels, providing instant notifications to the operator when an item was depleted. Connectivity Stability: The integrated Wi-Fi module maintained a consistent link to the cloud, ensuring that the latency between a physical transaction and the remote dashboard update remained under two seconds.

Sensor Precision: The infrared drop sensors effectively eliminated vending errors by verifying every successful product discharge, automatically triggering a refund or retry if a blockage occurred.

Power Efficiency: The system architecture optimized power consumption through the ESP32's deep-sleep capabilities, allowing the machine to operate efficiently while maintaining a persistent "heartbeat" connection to the server.

VI. ADVANTAGES & APPLICATIONS

ADVANTAGES

Contactless & Secure: Eliminates the need for physical cash and the risk of theft from the machine.

Remote Inventory Management: Owners can monitor stock levels from anywhere, reducing unnecessary refilling trips.

24/7 Availability: Automated retail without the need for human staff.

Data Analytics: Transaction logs help owners understand which products are most popular.

APPLICATIONS

Educational Campuses: For snacks, stationery, or masks.

Hospitals: Providing essential supplies or refreshments at any hour.

Corporate Offices: Automated cafeteria services for employees.

VII. FUTURE SCOPE

QR Code Payment Integration: Adding support for UPI or other mobile wallets via dynamic QR code generation on a larger TFT display.

Refrigeration Control: Integrating a cooling system with temperature sensors for selling beverages or perishable items.

Machine Learning: Using predictive analytics to suggest restock quantities based on seasonal sales data.

Face Recognition: Adding an ESP32-CAM for facial recognition-based "Pay-by-Face" authentication.

VIII. CONCLUSION

The **IoT-Based Smart Vending Machine** successfully addresses the limitations of traditional cash-based systems by providing a secure, cashless, and highly efficient retail solution. By integrating the **ESP32** with **RFID technology** and **IoT cloud platforms**, the project demonstrates a robust architecture for real-time inventory and transaction management. The automated dispensing and verification system ensures high reliability, while the digital payment interface aligns with modern consumer preferences for contactless transactions. This system serves as a scalable foundation for future advancements in smart city automated retail infrastructures

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REFERENCES

[1] P. D. Kulthe, R. D. Waghmare, T. S. Lohakare, and P. P. Patade, "IOT Based Smart Vending Machine Using Digital Payment System," *Project Report*, Department of Electronics & Telecommunication Engineering, Samarth Rural Educational Institute, Belhe, 2026.

[2] P. Goswami, S. K. Singh, and R. Sharma, "Design and Development of an IoT Based Smart Vending Machine," *Proceedings of the IEEE International Conference on Smart Technologies*, pp. 210-215, 2021.

[3] Espressif Systems, "ESP32 Series Datasheet: Wi-Fi & Bluetooth MCU," Version 3.7, 2023.

[4] NXP Semiconductors, "MFRC522 Contactless Reader IC Datasheet," Rev. 3.9, 2016.

[5] S. R. Patil and V. K. Sharma, "Cloud-Based Inventory Management for Automated Retail," *International Journal of Advanced Computing*, vol. 12, no. 4, pp. 45-52, 2023.

[6] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions," *Future Generation Computer Systems*, vol. 29, no. 7, pp. 1645-1660, 2013.

[7] A. K. Singh and R. Sharma, "Cashless Payment Systems in Embedded Applications," *Journal of Electronics and Automation*, vol. 8, no. 5, pp. 312-315, 2020.

[8] M. A. A. Mashud, M. S. Rahman, and M. H. Kabir, "Design and Implementation of an IoT Based Smart Security and Vending System," *Proceedings of the IEEE International Conference on Electrical, Computer and Communication Engineering (ECCE)*, pp. 1-5, 2019.

[9] TowerPro, "MG995 High Torque Metal Gear Servo Motor Technical Specifications," 2019.

[10] Blynk IoT, "Blynk Documentation: Mobile Dashboard for IoT Projects," Release 2.0, 2024.

[11] S. S. Sivaraman, "Real-Time Transaction Monitoring and Data Logging in Automated Systems," *Proceedings of the IEEE International Conference on Computation System (CSITSS)*, pp. 1-5, 2022.

[12] C. Perera, A. Zaslavsky, P. Christen, and D. Georgakopoulos, "Context Aware Computing for The Internet of Things in Retail," *IEEE Communications Surveys & Tutorials*, vol. 16, no. 1, pp. 414-454, 2014.

[13] H. M. Yasin, "A Comprehensive Review on IoT-Based Smart Vending Systems with Real-Time Monitoring," *International Journal of Advanced Research in Science (IJARSCT)*, vol. 4, no. 2, pp. 1823-1830, 2024.

[14] Solomon Systech, "SSD1306 Dot Matrix OLED/PLED Controller Datasheet," 2020.

[15] A. Al-Fuqaha, M. Guizani, and M. Mohammadi, "Internet of Things: A Survey on Enabling Technologies and Applications," *IEEE Communications Surveys & Tutorials*, vol. 17, no. 4, pp. 2347-2376, 2015.

[16] STMicroelectronics, "Standard I2C Bus Protocol and Interfacing with Microcontrollers," *Application Note*, AN10216, 2021.

[17] R. Piyare, "Internet of Things: Ubiquitous Home Control and Monitoring System Using Smart Phone," *International Journal of Internet of Things*, vol. 2, no. 1, pp. 5-11, 2013.

[18] L. Atzori, A. Iera, and G. Morabito, "The Internet of Things: A Survey," *Computer Networks*, vol. 54, no. 15, pp. 2787-2805, 2010.

[19] Arduino, "Servo Library Documentation for ESP32 and Arduino Platforms," 2024.

[20] V. M. K. Reddy et al., "IoT Based Smart Metering and Vending Using Node-RED and Cloud Services," *Proceedings of the IEEE International Conference on Artificial Intelligence*, pp. 34-41, 2023.