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Smart Vending Machine System Using Iot

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Abstract- This paper presents the design and implementation of a Smart Vending Machine System using Internet of Things (IoT) technology for automated dispensing of ready-made food items. The main objective of the proposed system is to provide a contactless, efficient, and user-friendly vending solution that reduces human intervention and waiting time. The system is built using an Arduino UNO microcontroller integrated with a Wi-Fi module to enable real-time monitoring and control. A QR code–based cashless payment mechanism is incorporated to enhance convenience and security. Once the payment is successfully verified, the controller activates the dispensing mechanism through a motor driver to deliver the selected food item automatically. The developed prototype was tested under different operating conditions and demonstrated reliable performance with accurate item delivery and quick response time. The proposed IoT-based vending machine system is cost-effective, scalable, and suitable for deployment in public places such as colleges, offices, and railway stations. Future enhancements can include mobile application integration and advanced inventory management for improved automation.

Keywords- Medical image diagnosis, Frequency Feature, Clustering, DIP.

I. INTRODUCTION

In recent years, the demand for automated and contactless service systems has increased significantly due to the need for convenience, speed, and reduced human intervention.

Vending machines play an important role in providing quick access to food and beverages in public places such as colleges, offices, railway stations, and shopping malls. However, many traditional vending machines rely on cash transactions and require frequent manual monitoring, which leads to limitations such as maintenance complexity, lack of real-time status updates, and reduced operational efficiency.

With the advancement of embedded systems and communication technologies, the Internet of Things (IoT) has enabled smarter and more connected automation solutions. By integrating microcontrollers with wireless communication modules, vending systems can be made more efficient, secure, and user-friendly. Cashless payment methods further enhance usability by providing fast and contactless transactions.

To address the limitations of conventional vending machines, this paper proposes a Smart Vending Machine System using an STM32 microcontroller and GSM module. The proposed system enables automated food dispensing after successful payment verification and supports remote communication through the GSM network. The system is designed to be cost-effective, reliable, and suitable for deployment in various public environments.

II. LITERATURE SURVEY

The concept of the Internet of Things (IoT) has revolutionized many domains, including retail and vending systems, by enabling intelligent automation, real-time monitoring, and enhanced customer experience. IoT connects physical devices to the internet, allowing them to communicate, process data, and perform actions with minimal human intervention. Zhou et al. (2020) described IoT as a core enabler of cyber-physical systems, where smart devices can sense, process, and respond autonomously, which is essential for modern automated vending solutions In recent years, several studies have explored IoT-based vending machines. Dimitris et al. (2018) proposed an automated shopping platform that leveraged IoT to offer personalized services and real-time interaction with customers. This approach allowed for dynamic inventory management and tailored product recommendations. Solano et al.

This approach represents a significant step forward in the evolution of smart vending technology, bridging the gap between traditional and modern payment methods while leveraging IoT for intelligent automation.

Our project aims to address these limitations by developing an IoT-based Smart Vending Machine that supports both digital and cash payments. The system will incorporate a microcontroller, sensors, and a Wi-Fi module to connect to a cloud platform for real-time monitoring and remote control. Customers will be able to interact with the machine through a mobile application, scanning a QR code to select products and make secure digital payments. Additionally, for users who prefer traditional methods, a cash acceptance module will be integrated, enabling hybrid payment options.

Once the payment is verified either digitally or in cash the machine automatically dispenses the selected product.
[1]. Author- Dimitris et al., & Year- 2018 [12], Technology Used- IoT-based customized shopping platform for vending, LimitationsLacked explanation of payment methods, Improvements- Can integrate mobile banking and wallet-based payments.
[2]. Author- Enugala & Vuppala, & Year-2018 [13], Technology Used- IoT-based smart classroom vending for resource management, Limitations,Narrow application domain, Improvements Expand to general-purpose vending with digital transactions.[3]. Author-Sambhi. et al., & Year-2020 [14], Technology Used- Reverse vending for plastic waste management, Limitations- Focus only on pollution control.
Improvements- Extend towards product vending with eco-friendly packaging
[4]. Author- Ramos et al., & Year- 2020 [15], Technology Used- Human mistake-free vending design, Limitations-Attempted to remove human involvement but not fully tested, Improvements Can integrate IoT automation with error detection and recovery.
[5]. Author- Alam et al., & Year- 2021, Technology Used- IoT-enabled vending with QR scanning & digital payment, Limitations-Limited to specific payment service (bKash), Improvements- Can be expanded7
The proposed smart vending system is designed to provide a fully automated, cost-effective, and secure platform for dispensing products. The methodology integrates IoT-enabled hardware, mobile applications, cloud services.

The block diagram of the Smart Vending Machine System consists of an STM32 microcontroller as the main control unit. The keypad and GSM module act as input units for product selection and payment verification.IR sensors are used to detect product availability and dispensing. The LCD display provide user interaction and status indication.

BLOCK DIAGRAM

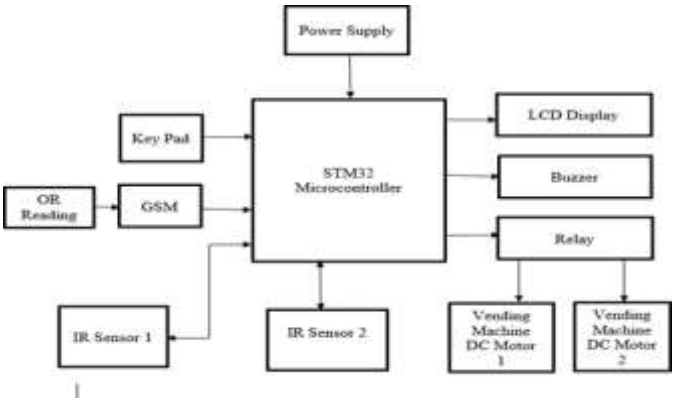

Fig 1. Block Diagram

The relay module controls the DC motors, which dispense the selected product. The power supply provides required voltage to all components.
The block diagram represents the overall structure of the Smart Vending Machine System. The STM32 microcontroller controls all operations by receiving inputs from the keypad and GSM module. Based on the input and payment verification, it sends control signals to the relay module and motors for product dispensing.
Overall, the system ensures automated and efficient vending operation.

II. SOFTWARE FRAMEWORK

1. The software framework of the proposed system is based on Embedded C programming for the STM32 microcontroller using Arduino IDE. The program controls all system operations such as user input, payment verification through the GSM module, and product dispensing.
2. The system follows a sequential process including initialization, product selection, payment processing, and activation of the motor for dispensing. The LCD display and buzzer provide user interaction, while IR sensors ensure proper operation of the system.

Software Tools

- Arduino IDE
- Embedded C
- UART Communication (GSM)

III. DESIGN METHODOLOGY

Smart vending machine provides automated product dispensing. The user selects a product through interface & makes payment digitally. After verification, the STM32 controller dispenses the product. Sensors ensure proper operation. GSM module is used for communication and payment verification through the cellular network.

Fig. 2. Design of project

IV. HARDWARE REQUIREMENT

In this project, the STM32 microcontroller acts as the main control unit that performs all operations, such as processing user input, verifying payment, and controlling the dispensing mechanism. The system is integrated with a GSM module, which is responsible for communication and payment verification through the cellular network.

The vending machine is provided with input devices such as a keypad for product selection and IR sensors for detecting product availability and successful dispensing. The output section includes an LCD display to show system status and a buzzer for indication.

A relay module is used to control the DC motors, which are responsible for dispensing the selected products. The basic elements required for this project are listed below:

- STM32 Microcontroller
- GSM Module
- Keypad
- IR Sensors
- Relay Module
- DC Motors
- LCD Display
- Circuit Diagram

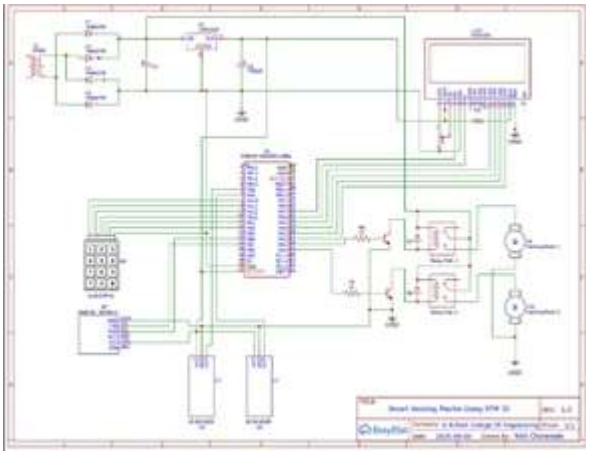

Fig. 3. Circuit Diagram

The circuit diagram of the Smart Vending Machine System is based on the STM32 microcontroller as the main control unit. A regulated power supply provides stable voltage to all components. The keypad is used for product selection, while the GSM module communicates payment verification to the controller. IR sensors are used to detect product dispensing. The LCD display shows system status, and the buzzer provides indication. The relay circuit controls the DC motors, which dispense the selected product based on signals from the STM32.

Overall, the circuit enables proper coordination of all components for efficient and automated vending operation.

V. FLOW CHART

The flow chart represents the working process of the Smart Vending Machine System. The process starts with the user selecting a product using the keypad. The system then prompts the user to choose the payment option (UPI).

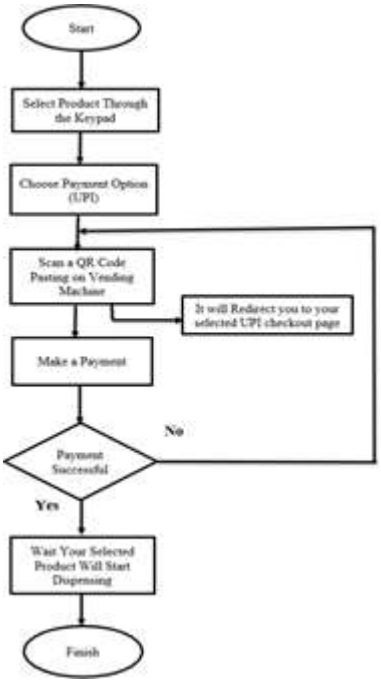

Fig 4. Flow chart

The user scans the QR code displayed on the vending machine, which redirects to the payment interface. After making the payment, the system checks whether the transaction is successful or not. If the payment is not successful, the process is repeated. If the payment is successful, the system activates the dispensing mechanism, and the selected product is delivered to the user.

1. Start: The system is activated and begins the vending process.
2. Select Product: The user selects the desired product using the keypad.
3. Scan QR Code: The user scans the QR code displayed on the vending machine for payment.
4. Make Payment: The user completes the payment through the UPI interface.
5. Payment Successful?: A decision point where the system verifies whether the payment is successful or not.

- If No (Payment failed): The system redirects the user to retry the payment process.
- If Yes (Payment successful):

6. Activate Dispensing Mechanism: The system sends control signals to the relay and motor.
7. Dispense Product: The selected product is dispensed using the DC motor.

VI. RESULT AND DISCUSSION

The Smart Vending Machine System was successfully designed and implemented using the STM32 microcontroller and GSM module. The system was tested for various operations such as product selection, payment processing, and product dispensing.

Fig .5.System prototype

The results show that the system responds accurately to keypad inputs and verifies payments reliably through the GSM module. After successful payment, the relay and motor mechanism works properly to dispense the selected product.

System Response Time

Table 1: Accuracy obtained based on detection distance

Trial	Operation	Time taken
1	Product selection	2 sec
2	Payment processing	5 sec
3	Product detection	1 sec
4	Product dispensing	5 sec
Operation result		10/10

VII. CONCLUSION

The Smart Vending Machine System has been successfully designed and implemented using the STM32 microcontroller

and GSM module. The system provides an efficient and automated solution for dispensing products with secure and reliable payment verification. The integration of embedded technology with digital payment methods ensures smooth and contactless operation. The use of sensors and control mechanisms improves the accuracy and reliability of the system.

The user-friendly interface makes the system easy to operate in real-time environments.
Overall, the proposed system demonstrates a cost-effective, reliable, and scalable solution that can be effectively deployed in public places such as colleges, offices, and commercial areas.

The proposed system also highlights the practical implementation of embedded systems in real-world applications. It demonstrates how automation and communication technologies can be effectively combined to enhance system performance and reduce human effort. The overall design ensures flexibility and adaptability, making it suitable for future upgrades and enhancements.

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