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Design and implementation of smart web-QR controlled vending system

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Abstract- The Research Paper "Design and implementation of smart web-QR controlled vending system" focuses on developing an intelligent and contactless vending system that integrates Internet of Things (IoT) technology with web-based QR functionality. Traditional vending machines rely on manual operation and cash-based payments, making them less efficient, unhygienic, and difficult to monitor remotely. The proposed system overcomes these limitations by using a Raspberry Pi 3B+ microprocessor as the central controller, connected to a Firebase real-time cloud database for monitoring inventory and transactions. Users can scan a QR code displayed on the vending machine to access a web interface built using React JS, which enables them to select products, view prices, and confirm purchases without physical contact. The Raspberry Pi processes the request and activates the corresponding motor driver to dispense the selected item, while sensors verify successful delivery and update the database automatically. This system provides touchless operation, real-time control, and efficient management of inventory. It also demonstrates scalability for integration with digital payment gateways and AI- based stock prediction. By combining IoT, cloud computing, and web technologies, the Research Paper aims to enhance user convenience, hygiene, and automation in next-generation vending solutions.

Keywords— Internet of Things (IoT), Smart Vending System, QR Code Technology, Raspberry Pi, Contactless Operation, Real-time cloud database, Firebase, React JS, automated inventory management.

1. Introduction

Traditional vending machines primarily rely on physical interfaces and cash-based transactions, which pose significant limitations in terms of hygiene, accessibility, and operational efficiency. These limitations have become more prominent in the post-pandemic era, where contactless and connected systems are increasingly demanded. Conventional vending systems also suffer from the absence of real-time inventory tracking, remote fault monitoring, and automated transaction management, leading to higher maintenance costs and reduced user convenience. To overcome these challenges, this paper proposes a NextGen IoT-enabled vending machine that integrates a QR-based web interface for touch-free user interaction. The system enables users to select products and complete transactions using their smartphones, while a cloud-based database manages real-time inventory and transaction data. A Raspberry Pi-based controller acts as the central processing and communication unit, interfacing between the web application, cloud services, and dispensing hardware. This research demonstrates how the integration of IoT and web technologies can modernize retail automation by delivering a scalable, hygienic, and efficient vending solution that enhances user experience and simplifies operational management.

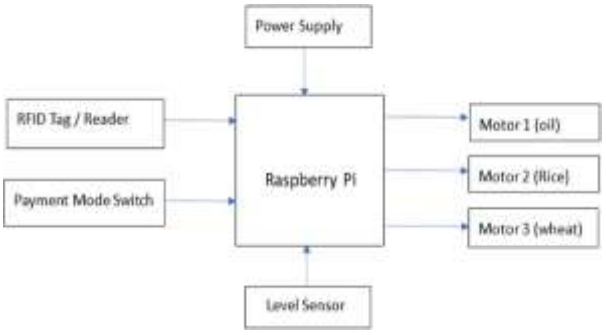

Fig1. Proposed Block Diagram

2. Methodology

The proposed system follows a structured IoT-based methodology to ensure seamless interaction between users, cloud services, and vending hardware. Initially, users connect to the system through smartphones with internet access, enabling continuous communication with the cloud infrastructure. Each vending machine is assigned a unique QR code that redirects users to a Virtual Vending Machine (VVM) web interface, where product availability and pricing are displayed in real time. The web application provides a secure and intuitive platform for contactless product selection and digital payment processing. At the hardware level, an IoT Gateway powered by a Raspberry Pi controls the vending unit and communicates with the cloud database to verify transactions and update inventory status. Upon successful payment confirmation, control signals are issued to motor driver circuits to activate the dispensing mechanism. Additionally, the system supports automated settlement by

distributing transaction revenue to the merchant after predefined commission deductions, ensuring transparency and efficient financial management within the IoT vending ecosystem.

3. System Architecture

The proposed vending machine system is built using cost-effective and reliable hardware components suitable for IoT-based automation. The Raspberry Pi 3 Model B+ serves as the central processing unit and IoT gateway of the system. It features a quad-core 64-bit processor with integrated dual-band Wi-Fi and Bluetooth connectivity, enabling seamless communication between the web-based user interface, the Firebase cloud database, and the physical dispensing hardware. The Raspberry Pi handles transaction verification, inventory updates, and the generation of control signals required to activate the dispensing mechanism.

The physical dispensing operation is performed using a DC motor, which acts as the primary electromechanical actuator in the system. The motor converts direct current electrical energy into mechanical rotational motion, allowing products to be dispensed reliably from the vending unit. The speed and direction of the DC motor are regulated through control commands issued by the Raspberry Pi, ensuring accurate and controlled item delivery during each transaction.

An I2C-based liquid crystal display (LCD) is incorporated to provide local system feedback and real-time status information. By utilizing the I2C communication protocol, which requires only Serial Data (SDA) and Serial Clock (SCL) lines, the display minimizes GPIO pin usage on the Raspberry Pi. The LCD is used to display product availability, pricing details, transaction status, and system notifications, thereby enhancing user awareness and operational transparency.

A motor driver module is employed to interface the low-power control signals from the Raspberry Pi with the high-current requirements of the DC motor. The driver operates using an H-bridge configuration, allowing bidirectional motor control and speed regulation. Additionally, it protects the Raspberry Pi from electrical damage by isolating it from high-current surges and voltage fluctuations, thus improving the overall reliability and safety of the vending machine system.

4. Results And Discussion

The operational architecture of the proposed IoT-enabled vending machine is structured into multiple functional layers to ensure efficient data flow and reliable system control. The Raspberry Pi 3 Model B+ acts as the central processing unit and IoT gateway, coordinating communication between all system components. User interaction is initiated through a smartphone connected to the internet, where a QR code affixed to the vending machine enables unique machine identification and access to the Virtual Vending Machine (VVM) web interface. The network layer consists of a cloud-based database that facilitates real-time data exchange between the web application and the Raspberry Pi, ensuring synchronized transaction and inventory updates.

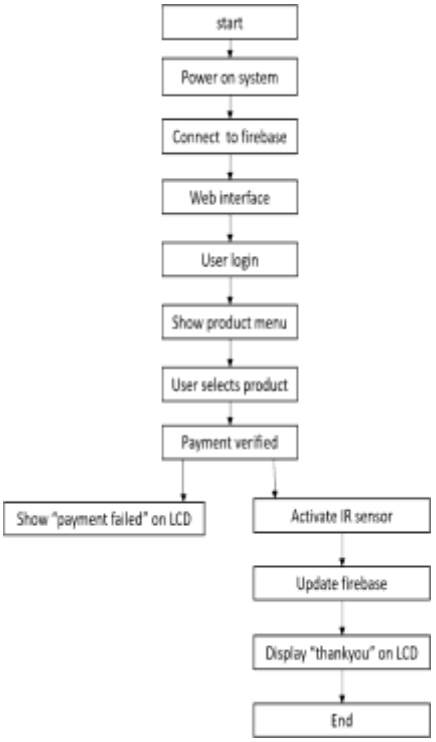

Fig 2. System workflow flowchart

The output layer includes a motor driver module controlled by the Raspberry Pi, which operates the mechanical product dispensing mechanism. Additionally, a financial layer is integrated within the web application through a secure digital payment gateway, enabling seamless and cashless transaction processing.

The user interaction and transaction workflow of the proposed smart vending machine system is designed to operate in a structured and sequential manner to ensure reliability, security, and seamless operation. the process is initiated when the user scans a unique QR code displayed on the vending machine, which redirects the user to a web-based virtual vending interface through a smartphone browser. using this interface, the user can view the available inventory and select the desired product. once the selection is confirmed, the payment transaction is carried out using a digital payment service over the iot network. the system continuously monitors the transaction status in real time; if the transaction fails, an appropriate error message is displayed to the user, whereas a successful transaction initiates the dispensing operation. the raspberry pi, functioning as the iot gateway, generates control signals for the motor driver circuit to activate the dispensing mechanism and deliver the selected item. subsequently, the merchant settlement module automatically processes the

payment distribution and updates the inventory information in the cloud database, thereby completing the transaction cycle efficiently.

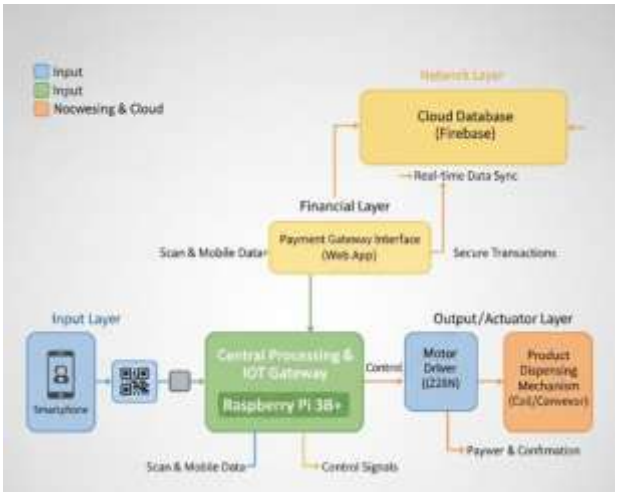

Fig. 3. System architecture and workflow of the IoT-based smart vending machine.

5. Future Scope

The proposed IoT-enabled smart vending machine provides a flexible foundation that can be further enhanced through advanced technologies and system integrations. Future work may focus on incorporating artificial intelligence and machine learning algorithms to analyze consumer purchasing behavior, enabling dynamic pricing, personalized product recommendations, and demand-based inventory optimization. The integration of computer vision techniques can facilitate automated product recognition, theft detection, and shelf-level inventory monitoring without relying on mechanical sensors. Additionally, the system can be extended to support multiple digital payment platforms, including near-field communication (NFC), biometric authentication, and blockchain-based transactions to further improve security and user convenience. Deployment of edge computing and predictive maintenance algorithms can reduce system latency and enable early detection of hardware faults, thereby minimizing downtime. Furthermore, large-scale deployment with centralized dashboards and data analytics can transform the vending ecosystem into a smart retail network, supporting real-time decision-making, energy-efficient operation, and sustainable automated retail solutions.

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REFERENCES

1. Alam, W., Sarma, D., Chakma, R.J., Alam, M.J., Hossain, S.: Internet of Things based smart vending machine using digital payment system. Int. J. Adv. Comput. Sci. Appl. 9 (2021) 719–731
2. Alrehily, A., Fallatah, R., Thayananthan, V.: Design of vending machine using finite state machine and visual automata simulator. Int. J. Comput. Appl. 115 (2022)
3. Solano, A., Duro, N., Dormido, R., González, P.: Smart vending machines in the era of Internet of Things. IFAC-PapersOnLine. 76 (2023)
4. Alam, W., Sultana, F., Saba, J.B., Kofi, A.C.: IoT based smart vending machine for Bangladesh. In: Proc. Int. Conf. on Emerging Technologies (2022)
5. Ramzan, A., Rehman, S., Perwaiz, A.: RFID technology: Beyond cash-based methods in vending machine. In: Proc. Int. Conf. on Control and Robotics Engineering (2020) 189–193
6. Maulana, A.J., Alimudin, E., Prasetia, V., Hidayat, M.R.: Snack vending machine using QR code as payment method. Jurnal Ecotipe. 11 (2024) 64–72
7. Umale, V., Donde, A., Wankhede, S., Karale, S., Dharpure, S., Tirpude, V.: QR-based automatic vending machine. Int. Res. J. Modernization Eng. Technol. Sci. (IRJMETS). 7 (2025) 1–6
8. Chowdhury, A.M., Mehran, M., Al-Mohamadi, A.S.M., Dahlan, A.R.A.: Scan&Go: Conceptual digital business model for QR-code vending machine. Int. J. Sci. Res. Publ. 10 (2020) 587–593
9. Nimbalkar, P.V., Magar, S.D., Nimbalkar, P.S., Chormal, N.D.: Insights into IoT-driven smart vending machine systems. Int. J. Adv. Electr. Electron. Eng. (IJAEEE). 13 (2024) 45–52