

VENDOLITE

**Aditi Shrikant Mashal¹, Vaishnavi Ramesh Nelwade², Akanksha Adesh Kashid³,
Vaibhavi Balaji Mule⁴, Prof. J. D. Kolhe⁵**

Department of Electronics & Telecommunication,
Shree Siddheshwar Women's College of Engineering, Solapur, India ^{1,2,3,4,5}

Abstract: *This paper presents the design and implementation of an IoT-based Multipurpose Smart Vending Machine using the ESP32 microcontroller integrated with a QR-code-based payment system. The proposed system provides a contactless and automated vending solution capable of dispensing multiple products through separate servo-controlled drawers. The ESP32 hosts a web server that generates a QR code linked to a payment webpage. Users can scan the QR code using a smartphone and select different products with corresponding payment options. After payment confirmation, the ESP32 activates the appropriate servo motor to dispense the selected item automatically. The system utilizes Wi-Fi communication, embedded web technologies, and servo motor automation to achieve efficient operation. Experimental testing demonstrated reliable performance, accurate dispensing, low response time, and stable wireless communication. The proposed vending system is economical, scalable, and suitable for modern IoT automation and smart retail applications..*

Keywords: ESP32, IoT, QR Code, Multipurpose Vending Machine, Servo Motor, Smart Automation, Embedded System, Digital Payment

I. INTRODUCTION

Automation technologies and digital payment systems have significantly transformed modern commercial and retail environments. Smart vending systems are becoming increasingly popular because they provide automated product dispensing with minimal human intervention. Conventional vending machines generally depend on cash-based or coin-operated mechanisms that require regular maintenance, increase operational complexity, and provide limited flexibility for modern cashless transactions. In addition, traditional vending systems are often expensive and difficult to implement in small-scale environments such as educational institutions, offices, and local retail stores [1][2].

The rapid growth of Internet of Things (IoT) technologies and digital payment platforms has created new opportunities for developing intelligent vending systems capable of contactless operation and real-time communication. IoT technology enables communication between embedded devices and web-based interfaces through wireless networks. Embedded controllers such as ESP32 provide integrated Wi-Fi capability, low power consumption, compact size, and efficient processing performance suitable for smart automation applications [3][4].

QR-code-based payment systems have become highly popular due to their simplicity, affordability, and compatibility with smartphone devices. Users can easily scan QR codes and access digital payment interfaces without requiring dedicated hardware systems. The integration of QR-code payment systems with IoT-enabled vending machines improves customer convenience and supports modern cashless transaction methods [5][6].

Recent advancements in embedded systems, web technologies, and servo motor automation have enabled the development of intelligent product dispensing systems. Servo motors are widely used in automation applications because they provide accurate angular rotation and efficient control mechanisms. By combining ESP32, web servers, QR-code generation, and servo automation, smart vending machines can automatically dispense products based on user selection and payment confirmation [7][8].

The proposed research presents an IoT-based Multipurpose Smart Vending Machine using ESP32 and QR-code-based payment interaction. The system hosts a web-based vending interface through the ESP32 web server. Users scan the QR code using a smartphone and select different products from the vending interface. After successful payment



confirmation, the ESP32 activates the corresponding servo motor to dispense the selected product automatically. The system supports multiple products through independent servo-controlled drawers and provides real-time operation using Wi-Fi communication.

The proposed system aims to:

- Develop a low-cost multipurpose smart vending machine
- Implement QR-code-based digital payment interaction
- Automate product dispensing using servo motors
- Provide contactless and cashless vending operation
- Demonstrate IoT integration using ESP32 technology
- Support scalable smart retail automation applications

The developed vending system provides a practical and cost-effective solution suitable for smart retail environments, educational institutions, offices, railway stations, and public vending systems [9][10].

II. PROBLEM STATEMENT

Traditional vending machines mainly rely on cash transactions, manual maintenance, and expensive hardware infrastructure. These systems often lack flexibility, remote accessibility, and support for modern digital payment methods. Manual vending operations may increase maintenance complexity and reduce operational efficiency. Furthermore, conventional vending systems generally support limited product management and require significant human supervision.

Therefore, there is a need for an intelligent, automated, and low-cost vending system capable of supporting contactless product dispensing, QR-code-based digital payments, real-time operation, and multipurpose product management using IoT technologies.

III. METHODOLOGY

The developed vending system follows a sequential operational methodology involving wireless communication, QR-code generation, user interaction, payment processing, and automated dispensing.

Initially, the ESP32 microcontroller establishes connection with the available Wi-Fi network using predefined network credentials. After successful initialization, the ESP32 activates the local web server and generates a QR code containing the vending webpage address.

Users scan the QR code using smartphone cameras, which redirects them to the vending webpage hosted by the ESP32 server. The webpage displays available products and corresponding payment options using a user-friendly graphical interface developed with HTML, CSS, and JavaScript.

After selecting the desired product, the webpage sends an HTTP request to the ESP32 server. The ESP32 processes the incoming request and identifies the selected dispensing compartment associated with the corresponding product.

PWM control signals are then generated to activate the appropriate servo motor. The servo motor rotates to open the dispensing compartment and release the selected product. After dispensing, the servo returns to its initial angular position and closes the compartment automatically.

The operational sequence can be summarized as follows:

- Wi-Fi initialization
- Web server activation
- QR-code generation
- User webpage access
- Product selection
- HTTP request transmission
- Servo motor activation
- Product dispensing



- Automatic compartment reset

The system continuously repeats this process for subsequent vending operations.

IV. HARDWARE COMPONENTS REQUIRED

Sr. No	Component Name	Purpose
1	ESP32 Development Board	Central processing unit
2	Servo Motors	Product dispensing
3	Breadboard	Circuit connections
4	Jumper Wires	Electrical interfacing
5	Wi-Fi Network	Wireless communication
6	Product Drawers	Product storage
7	Power Supply	Voltage source
8	Smartphone	User interaction

V. SOFTWARE USED

The software framework was developed using Arduino IDE and Embedded C++ programming language. The software architecture includes:

- Wi-Fi initialization routines
- Web server configuration
- QR-code webpage generation
- HTTP request processing
- Servo control algorithms
- User interface handling
- The following libraries were utilized:
 - ESP32Servo
 - ESPAsyncWebServer
 - AsyncTCP
- The vending webpage was developed using:
 - HTML
 - CSS
 - JavaScript

Asynchronous communication techniques were implemented to improve response speed and reduce processing delay during user interaction.

V. APPLICATION

The Multipurpose Smart Vending Machine can be used in various sectors due to its flexibility, automation, and digital payment capabilities.

A. Educational Institutions

The system can dispense stationery items, snacks, chocolates, notebooks, and beverages inside colleges and schools.

B. Railway Stations and Bus Terminals

Passengers can purchase quick-use products without waiting in long queues.

C. Shopping Malls

The machine can provide automated retail services with reduced manpower requirements.

D. Corporate Offices

Employees can access refreshments and utility products conveniently during work hours.



E. Hospitals

Contactless vending systems help maintain hygiene and reduce physical interaction.

F. Smart Cities

The system supports the concept of smart infrastructure through IoT-based automation and wireless communication.

VI. FUTURE SCOPE

The proposed system can be enhanced further by integrating:

- Real UPI payment gateways using Razorpay APIs
- Cloud-based inventory management
- Mobile application support
- AI-based product recommendation
- Smart stock prediction
- Voice-assisted interaction
- Remote monitoring systems
- Facial recognition-based authentication

These improvements can increase system intelligence and commercial deployment capability.

VI. CONCLUSION

The proposed AI-Based IoT Multipurpose Smart Vending Machine successfully demonstrates intelligent automation using ESP32, QR-code-based payment interaction, and servo-controlled dispensing mechanisms. The system integrates embedded systems, wireless communication, and web technologies into a compact vending architecture capable of supporting multiple products.

Experimental analysis confirmed stable wireless communication, accurate dispensing performance, efficient user interaction, and reliable automation operation. The developed system provides a low-cost and scalable solution suitable for modern smart retail environments and IoT-based commercial applications.

The proposed vending framework can be further extended using cloud technologies, AI analytics, and advanced payment integration to support future smart automation systems.

REFERENCES

- [1] S. Madakam, R. Ramaswamy, and S. Tripathi, "Internet of Things (IoT): A Literature Review," *Journal of Computer and Communications*, vol. 3, no. 5, pp. 164–173, May 2015.
- [2] 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, Sept. 2013.
- [3] Espressif Systems, *ESP32 Technical Reference Manual*, Version 5.0, 2025.
- [4] Arduino Documentation, "ESP32 Programming using Arduino IDE," Arduino Official Documentation, 2025.
- [5] K. Patel and R. Shah, "QR Code Based Smart Payment System for Automated Vending Applications," *International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)*, vol. 11, no. 4, pp. 2456–2462, April 2023.
- [6] A. Kumar and P. Singh, "Servo Motor Controlled Automated Product Dispensing System Using Embedded Technology," *International Journal of Engineering Research & Technology (IJERT)*, vol. 12, no. 6, pp. 785–790, June 2023.
- [7] R. Mehta, S. Kulkarni, and N. Patil, "IoT-Based Smart Retail Automation and Intelligent Vending Systems," *International Journal of Scientific Research in Engineering and Management (IJSREM)*, vol. 7, no. 8, pp. 1–7, Aug. 2023.
- [8] P. Sethi and S. R. Sarangi, "Internet of Things: Architectures, Protocols, and Applications," *Journal of Electrical and Computer Engineering*, vol. 2017, Article ID 9324035, pp. 1–25, 2017.



- [9] M. A. Razzaque, M. Milojevic-Jevric, A. Palade, and S. Clarke, "Middleware for Internet of Things: A Survey," *IEEE Internet of Things Journal*, vol. 3, no. 1, pp. 70–95, Feb. 2016.
- [10] S. Sharma and V. Kulkarni, "Design and Development of IoT-Based Multipurpose Smart Vending Machine with Digital Payment Integration," *International Journal of Advanced Research in Science, Communication and Technology (IJAR SCT)*, vol. 4, no. 2, pp. 512–518, Feb. 2024.
- [11] QRCode.js Documentation, "JavaScript QR Code Generator Library," Available: [QRCode.js Official Documentation](#)
- [12] ESPAsyncWebServer Documentation, "Asynchronous Web Server Library for ESP32," Available: [ESPAsyncWebServer GitHub Repository](#)
- [13] AsyncTCP Library Documentation, "Async TCP Library for ESP32," Available: [AsyncTCP GitHub Repository](#)
- [14] B. Gupta and A. Verma, "Smart Embedded Systems for Automated Retail Applications," *International Journal of Advanced Computer Science and Applications*, vol. 14, no. 3, pp. 311–318, 2023.
- [15] H. Ning and H. Liu, "Cyber-Physical-Social Based Security Architecture for Future Internet of Things," *Advances in Internet of Things*, vol. 2, no. 1, pp. 1–7, 2012.
- [16] D. Evans, "The Internet of Things: How the Next Evolution of the Internet is Changing Everything," *Cisco Internet Business Solutions Group (IBSG)*, White Paper, Apr. 2011.
- [17] L. Atzori, A. Iera, and G. Morabito, "The Internet of Things: A Survey," *Computer Networks*, vol. 54, no. 15, pp. 2787–2805, Oct. 2010.
- [18] A. Whitmore, A. Agarwal, and L. Da Xu, "The Internet of Things—A Survey of Topics and Trends," *Information Systems Frontiers*, vol. 17, no. 2, pp. 261–274, Apr. 2015.
- [19] M. Collotta and G. Pau, "A Novel Energy Management Approach for Smart Homes Using Bluetooth Low Energy," *IEEE Journal on Selected Areas in Communications*, vol. 33, no. 12, pp. 2988–2996, Dec. 2015.
- [20] S. Li, L. Da Xu, and S. Zhao, "The Internet of Things: A Survey," *Information Systems Frontiers*, vol. 17, no. 2, pp. 243–259, Apr. 2015.

