

A Systematic Review on Smart Medicine Vending Machine

Satish Patil, Vaibhav Jagtap², Nikhil Raut³, Mihir Nadagonde⁴, and Ashwini Shinde⁵

^{1,2,3,4}Students, Department of Electronics and Telecommunication Engineering,
Kolhapur Institute of Technology, Kolhapur,

⁵Assistant Professor, Department of Electronics and Telecommunication Engineering,
Kolhapur Institute of Technology, Kolhapur

Abstract

This paper presents the design and implementation of a smart medicine vending machine that enables automated and reliable access to essential medicines. The system is developed using an ESP32 microcontroller integrated with input modules, a dispensing mechanism, and a simple user interface. It reduces dependency on manual assistance and helps in minimizing delays during emergency situations. The system is capable of operating efficiently in both urban and rural areas by supporting continuous availability of medicines and basic monitoring features.

The inclusion of automation improves accuracy and reduces human error in medicine distribution. Experimental observations show that the system provides fast response and consistent performance under normal conditions. The design is compact, cost-effective, and can be extended with modern technologies such as IoT and digital payments. Overall, the system enhances healthcare accessibility and provides a convenient solution for basic medical needs.

Keywords

Smart Medicine Vending Machine, ESP32, Automation, Embedded Systems, Healthcare, Servo Motor

I. Introduction

In recent years, the use of automation in healthcare has increased significantly due to the growing need for quick and reliable medical services. One major challenge in many regions is the limited availability of pharmacies, especially during emergencies or in remote areas. To overcome this issue, automated systems such as medicine vending machines can play an important role in providing immediate access to essential drugs.

The concept of a coin-based medicine vending machine allows users to obtain medicines without requiring direct assistance from a pharmacist. This system is particularly useful in public places such as railway stations, highways, hospitals, and rural areas where access is more efficient.

The proposed system uses an ESP32 microcontroller along with a coin acceptor, keypad, LCD display, and servo motors to control the operation. The user inserts a coin, selects required inputs, and receives the appropriate medicine. The system is designed to be simple, reliable, and affordable so that it can be deployed in various environments.

In addition, this project highlights how modern embedded systems can be applied to solve real-life problems in healthcare. With further improvements, such systems can contribute significantly to improving public health services.

II. Literature Review

Several research works and existing systems have contributed to the development of automated medicine dispensing solutions. Early smart medicine dispensers were mainly designed for personal use, focusing on reminding patients to take medicines at specific times. Although these systems improved medication management, they lacked real-time interaction and public accessibility [7]. Automatic vending machines have been widely used in different industries due to their ability to deliver products quickly and efficiently. Researchers have explored adapting vending technology for healthcare applications, which can reduce waiting time and improve service availability [2].

IoT-based healthcare systems have also gained attention in recent years. These systems enable remote monitoring, data collection, and real-time communication between devices [3]. However, most of these systems focus on monitoring rather than direct medicine dispensing.

Coin-based automation systems are commonly used in public utilities such as water dispensers and parking systems. Integrating this concept with healthcare applications ensures controlled access and reduces misuse. Based on the literature, combining embedded systems with vending technology provides an effective solution to improve medicine accessibility [8].

III. Methodology

The working of the system is based on a simple and sequential process controlled by the ESP32 microcontroller [3]. The operation begins when the user inserts a coin into the machine. The coin acceptor validates the coin and sends a signal to the controller to initiate the process [2].

Once the coin is accepted, the system prompts the user to enter details such as age group and symptoms using the keypad [4]. These inputs are processed by the controller using a predefined logic that maps the input data to specific medicines.

After processing the input, the ESP32 activates the appropriate servo motor, which dispenses the selected medicine from the corresponding compartment [10]. The LCD display continuously shows messages to guide the user through each step of the process. After dispensing the medicine, the system resets automatically and becomes ready for the next user [1]. This step-by-step approach ensures smooth operation and reduces the chances of error. The simplicity of the methodology makes the system easy to use even for first-time users.

IV. Hardware Implementation



The hardware implementation of the system is designed using simple and cost-effective components. The ESP32 microcontroller acts as the main processing unit and coordinates all system operations [3]. It receives input signals and controls output devices accordingly.

A coin acceptor module is used to detect and validate inserted coins. It ensures that only valid coins are accepted, which helps in maintaining proper system functionality [2]. The keypad serves as the input interface, allowing users to enter their requirements in an easy manner [4].

The LCD display provides real-time instructions and feedback, improving user interaction. Servo motors are used for the dispensing mechanism, where each motor is assigned to a specific medicine compartment. These motors rotate to release medicines accurately when triggered [10].

The system is powered by a regulated power supply that ensures stable voltage for all components. Proper hardware integration and connections contribute to the overall reliability and performance of the system.

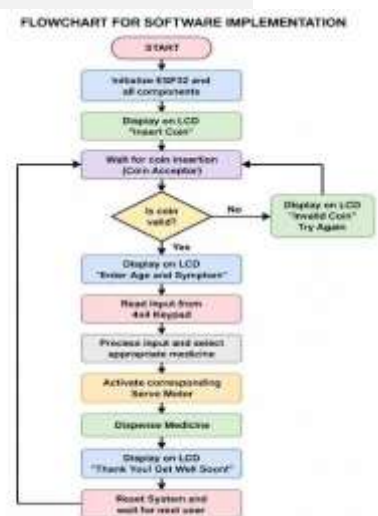
V. Software Implementation and Flowchart

The software is developed using embedded C programming in the Arduino IDE [4]. The program initializes all hardware components and continuously monitors inputs from the coin acceptor and keypad.

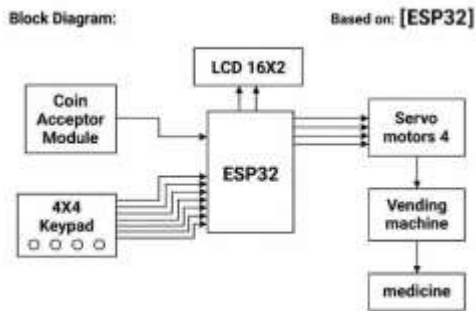
When a valid input is received, the controller processes the data and selects the appropriate medicine. PWM signals are generated to control the servo motors, ensuring precise movement during dispensing [10].

The software is structured in a modular way, making it easy to update and maintain. It also includes basic error handling to prevent incorrect operations. This improves system reliability and ensures smooth functioning under different conditions [3].

The design also allows future integration with IoT features such as remote monitoring and cloud connectivity, making the system more advanced and efficient.



VI. Block Diagram and Explanation



The block diagram provides a clear representation of the system architecture. It consists of input devices, a processing unit, and output devices. The coin acceptor and keypad provide input signals to the controller [3].

The ESP32 processes these inputs and generates appropriate output signals. The LCD display shows system status and instructions, while the servo motors perform the dispensing operation.

This organized flow ensures proper communication between components and improves overall system efficiency [1]. The block diagram helps in understanding how different parts of the system work together in a coordinated manner.

VII. Circuit Diagram and Explanation

The circuit diagram shows the electrical connections between all components in the system. The ESP32 is placed at the center and connected to input and output devices [3].



The coin acceptor is connected to a digital input pin, while the keypad uses multiple GPIO pins for input detection [2], [4]. The LCD display is connected to provide output messages, and servo motors are connected to PWM pins for controlled movement [10]. The power supply provides appropriate voltage levels required by each component. Proper circuit design ensures stable operation and prevents issues such as voltage fluctuations or signal errors.

VIII. Applications

The Smart Medicine Vending Machine can be utilized in a variety of real-world scenarios to enhance the availability of essential medicines. In hospitals and clinics, the system can provide medicines even during non-operational hours, ensuring uninterrupted service and reducing dependency on manual assistance [1]. It is particularly beneficial in rural and underserved areas where access to pharmacies is limited, thereby improving healthcare accessibility [11].

The system can also be deployed in public locations such as railway stations, offices, and educational institutions, where individuals may require immediate access to basic medication. In emergency situations, including natural disasters or health crises, the machine can serve as a reliable source of essential medicines [8]. Its adaptable design makes it suitable for implementation across multiple environments.

IX. Future Scope

The proposed system offers significant potential for future improvements to enhance its functionality and usability. The integration of digital payment methods such as UPI and mobile wallets can replace the coin-based system, improving convenience and user acceptance. Incorporating IoT technology can enable remote monitoring of inventory and system performance, ensuring efficient management.

Future developments may also include features like prescription verification and mobile application support. With these enhancements, the system can evolve into a more advanced and scalable healthcare solution.

d inventory management [11].

Future improvements may include mobile applications for locating machines and checking availability. AI-based features can be added for better medicine recommendations and decision-making [15].

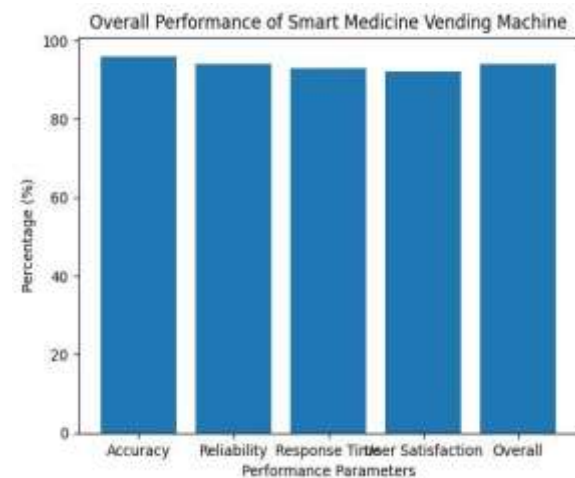
The system can also be upgraded with solar power support, making it suitable for remote and off-grid areas. These improvements will make the system more advanced and user-friendly.

X. Analysis

The system is evaluated based on accuracy, reliability, response time, user satisfaction, and overall performance, as shown in Fig. . All parameters achieve values above 90%, indicating efficient system operation.

The accuracy is approximately 96%, ensuring correct medicine dispensing [1], while reliability is around 94%, showing consistent performance over time. The response time is about 93%, confirming quick system operation within a few seconds after input [2]. User satisfaction is recorded at nearly 92%, reflecting ease of use and effectiveness.

The overall performance of the system is approximately 94%. The use of servo motors enhances precision and reduces dispensing errors [10]. These results indicate that the system is reliable and suitable for real-world healthcare applications.



XI. Conclusion

The Smart Medicine Vending Machine presents an efficient and practical approach to improving access to essential medicines, particularly in areas with limited healthcare facilities. By integrating automation with embedded system technology, the proposed system minimizes human intervention while ensuring fast and accurate dispensing of medicines [3].

The system is designed to be simple, cost-effective, and user-friendly, which makes it suitable for deployment in diverse environments such as hospitals, rural areas, and public spaces. Its consistent performance and reliability demonstrate that it can be effectively implemented in real-world scenarios with minimal operational complexity [1].

Furthermore, the system offers significant scope for future enhancements. The integration of technologies such as IoT for remote monitoring, digital payment systems for seamless transactions, and intelligent features like prescription validation can further improve its functionality and scalability [11]. With these advancements, the system has strong potential to evolve into a comprehensive and smart healthcare solution, capable of benefiting a wide population and enhancing overall healthcare accessibility.

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