

DESIGN AND DEVELOPMENT OF A PLC-BASED INTELLIGENT AUTOMATIC PHARMACY VENDING AND MEDICINE DISPENSING SYSTEM

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Keywords:

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Introduction:

The rapid advancement of automation technologies has significantly transformed various industries, including healthcare. There is an increasing need for efficient, accurate, and contactless systems in pharmacies to improve service quality and reduce human errors. Traditional medicine dispensing methods rely on manual handling, which can lead to mistakes and long waiting times. They also depend heavily on skilled personnel, making the process less efficient. To overcome these challenges, automated pharmacy vending machines have emerged as an effective solution. This system uses a Programmable Logic Controller (PLC) to control and manage the dispensing process with high precision and reliability. PLCs are widely known for their robustness and real-time control capabilities in industrial automation. A Human Machine Interface (HMI) is integrated to provide easy and user-friendly interaction for medicine selection. The system incorporates stepper motors and threaded mechanisms for accurate positioning. Pneumatic actuators ensure smooth and efficient dispensing of medicines. Sensors and safety features are included to prevent incorrect delivery and enhance reliability. The system reduces human intervention and minimizes errors. It also supports inventory management and real-time monitoring. Overall, the system improves efficiency and accessibility in healthcare. It represents a smart solution aligned with modern Industry 4.0 concepts



Figure 1: Integration of PLC, HMI, Pneumatics, and Medicine Dispensing System

Objectives:

1. To design and develop a PLC-controlled automated pharmacy vending machine.
2. To ensure accurate and reliable medicine dispensing.
3. To integrate a user-friendly HMI for easy operation.
4. To achieve precise positioning using stepper motors.
5. To utilize pneumatic systems for smooth dispensing

Methodology:

The methodology of the PLC-controlled automatic pharmacy vending machine begins with the design and planning of the overall system architecture, including components such as PLC, HMI, sensors, motors, and pneumatic units. Suitable hardware components are selected based on system requirements, and the PLC is programmed to control input processing, logic execution, and output operations. A user-friendly HMI interface is developed to enable easy selection of medicines and system monitoring.

The mechanical structure is designed using stepper motors and threaded rod mechanisms to ensure accurate positioning of medicine compartments, while pneumatic actuators are used for smooth and controlled dispensing. Sensors are installed to detect position and confirm proper dispensing, and safety mechanisms are incorporated to prevent incorrect or multiple dispensing. All components are then integrated through proper wiring and communication links to ensure coordinated operation.

After integration, testing is carried out to verify the proper functioning of individual components, followed by full system testing under different conditions. Errors identified during testing are corrected to improve reliability. Finally, the system is optimized for better performance and demonstrated as a working model, showing reduced human effort, improved accuracy, faster service, and enhanced convenience in medicine dispensing.

Result and Conclusion:

The results of the PLC-controlled automatic pharmacy vending machine show that the system operates efficiently and reliably in dispensing medicines. The integration of PLC and HMI enables smooth control and easy user interaction, allowing accurate medicine selection with minimal errors. Stepper motors ensure precise positioning of medicine compartments, while pneumatic actuators provide smooth and consistent dispensing. Sensors effectively detect the presence and position of medicines, reducing the chances of incorrect delivery and improving system reliability. The system also reduces waiting time compared to traditional manual dispensing methods.

During testing, the machine performed consistently under different operating conditions, proving its stability and robustness. The safety features successfully prevent multiple or incorrect dispensing, ensuring reliable operation. The system also supports basic inventory monitoring, making it more practical for real-time applications. In conclusion, the developed system successfully automates pharmacy operations using PLC technology, reducing human effort, improving accuracy, and increasing efficiency. It highlights the importance of industrial automation in healthcare and supports smart healthcare solutions aligned with Industry 4.0 concepts.

Project Outcome and Industry relevance

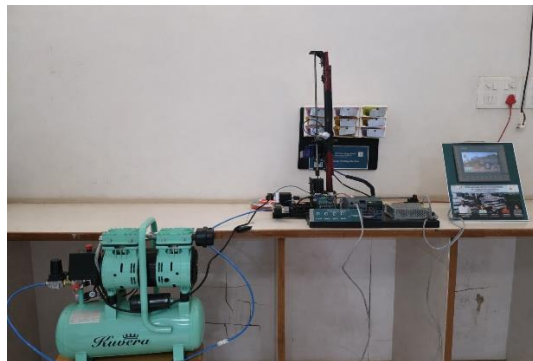
The PLC-controlled automatic pharmacy vending machine successfully demonstrates an efficient and reliable solution for automated medicine dispensing. The project outcome highlights accurate operation, reduced human intervention, and improved speed in delivering medicines. The integration of PLC and HMI ensures smooth control and user-friendly interaction, while the use of sensors, stepper motors, and pneumatic systems enhances precision and reliability. The system also supports basic inventory monitoring, making it more practical for real-time applications. Overall, the project showcases the effective implementation of industrial automation in the healthcare domain.

In terms of industry relevance, this system aligns with modern automation trends and Industry 4.0 concepts. It has potential applications in hospitals, clinics, pharmacies, and remote healthcare centres where quick and error-free medicine dispensing is essential. The project reflects real-world industrial practices such as PLC programming, system integration, and process automation, which are highly valued in industries. It also opens opportunities for further advancements like IoT-based monitoring and smart healthcare systems, making it a significant step toward future-ready medical automation solutions.

Working model v/s Study

Working Model

- The project is implemented as a real-time working prototype of an automated pharmacy vending machine.
- It uses actual components like PLC, HMI, stepper motors, sensors, and pneumatic actuators.
- Medicines are dispensed physically based on user input through the HMI.



Study

- The system is only designed conceptually without physical implementation.
- It includes block diagrams, circuit designs, and system flow explanations.
- No real PLC programming or hardware integration is involved.
- Medicine dispensing is not performed physically, only explained theoretically.
- No real-time testing or validation of system performance.
- Limited to understanding the concept of automated pharmacy systems.

Project outcomes and Learnings

- The project successfully developed a PLC-controlled automatic pharmacy vending machine for efficient medicine dispensing.

- It demonstrated accurate operation with reduced human intervention and improved reliability.
- Gained practical knowledge of PLC programming and logic development.
- Hands-on experience with HMI design and user interface development.

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Future Scope:

The future scope of this project includes:

- Integration of IoT for remote monitoring and control.
- Cloud-based data storage for real-time inventory tracking.
- Digital prescription verification for secure dispensing.
- Implementation of AI for smart decision-making.
- Demand prediction using data analytics.
- Support for multiple types of medicines.
- Integration of barcode/QR code scanning.
- Multilingual HMI interface for better accessibility.
- Use of advanced sensors for error detection.
- Real-time alerts and notifications.