# Design and Development of an IoT-Enabled Automatic Pills Dispenser

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**Abstract.** With the global rise in aging populations, ensuring accurate and consistent medication intake has become a critical healthcare challenge. Elderly individuals, in particular, face difficulties in managing multiple prescriptions, often resulting in missed doses or incorrect medication intake with severe health implications. The Automatic Pills Dispenser addresses this issue by combining precise hardware and intelligent software to deliver a reliable, user-friendly solution for medication management. The device integrates a stepper-motor-driven pill compartment, a 3D-printed rack and pinion mechanism, and a servo-powered vacuum pump for accurate dispensing, aided by a Hall effect sensor to reduce human error. Remote accessibility via an ESP32 module and an admin panel developed with Next.js allows caregivers and healthcare providers to monitor and control the system. Experimental evaluation demonstrated a dispensing accuracy of 96% when tested over 100 dispenses and an average response time of 6.2 seconds, validating the system's reliability and efficiency. While current limitations include the inability to manage temperature-sensitive drugs and vulnerability to manual interference, the prototype shows strong potential for deployment in hospitals, old age homes, and household settings. During pandemic situations, the device reduces physical contact while safeguarding medication adherence. In conclusion, Automatic Pills Dispenser marks a step toward safer, smarter, and more compassionate healthcare by easing caregiver burdens and advancing assistive healthcare innovation.

## 1. Introduction

The global rise in elderly populations has amplified the need for reliable and accessible healthcare solutions, particularly in developing countries like Nepal. Many elderly individuals struggle to manage complex medication schedules, leading to missed doses and adverse health effects. This issue underscores the necessity for automated, IoT-enabled solutions that can improve medication adherence and reduce human error.

This project presents the design and implementation of an automatic pills dispenser that combines mechatronic precision with real-time IoT monitoring. It ensures timely and accurate medication delivery, thereby supporting both patients and caregivers in maintaining consistent treatment routines.

*1.1 Motivation*

Physical limitations, declining memory, and the lack of constant caregiver supervision make it challenging for elderly users to maintain medication schedules. [1] The motivation behind this work is to develop a cost-effective, reliable, and remotely accessible solution that simplifies the process of medication administration while improving adherence.

*1.2 Significance*

This device holds importance for hospitals, elderly care homes, and households, especially in Nepal where healthcare accessibility remains limited. By integrating automation and IoT monitoring, it provides both safety and convenience in medication delivery. [2]

*1.3 Objectives*

- To design and implement and automated medication dispensing mechanism.
- To develop an IoT-enabled system for real-time monitoring and control.
- To validate performance through testing for accuracy and response efficiency.

## 2. Related Work and Technology Background

Previous studies and commercial products have explored automated medication dispensing with varying levels of user control and connectivity. MYR et al. [3] developed a smart dispenser named MEDIC for unsupervised medication delivery. Glomsaring et al. [4] examined user experiences with welfare technology among elderly individuals, emphasizing usability and in- volvement. Patel et al. [5] analyzed electronic medication adherence tools and found interface simplicity and cognitive load as critical success factors. Davenport and Kalakota [6] highlighted AI's potential in healthcare automation.

Technologically, modern automation benefits from low-cost microcontrollers like the ESP32, precise servo and stepper motors, and cloud communication through REST APIs. Additive manufacturing via 3D printing facilitates rapid, low-cost prototyping for customized designs. These combined technologies form the basis for the proposed pills dispensing system.

## 3. Methodology

The system integrates mechanical, electronic, and software modules, coordinated by an ESP32 microcontroller. It includes multiple compartments, each holding specific medications, and operates through a stepper motor–driven rotation mechanism, [7] servo-controlled rack and pinion system, and vacuum suction for pill handling.

*3.1 System Overview*

The pills dispenser uses a stepper motor to rotate the medication compartment to the appropriate position. A Hall effect sensor detects alignment using embedded magnets. A servo motor then lowers a 3D-printed rack-and-pinion system, activating a suction pump to lift and release the pill into a collection tray.

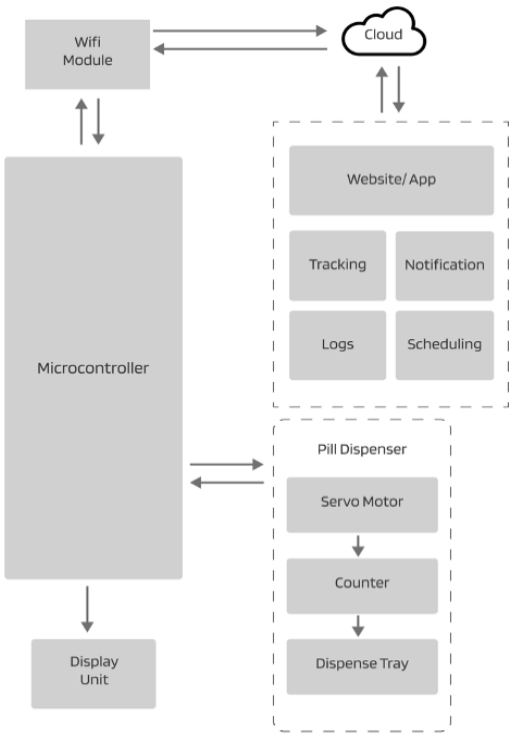


**Figure 1.** Block diagram and hardware prototype of the IoT-enabled automatic pills dispenser, showing the ESP32 controller, motor-driven compartments, sensing unit, and dispensing mechanism.of the IoT-enabled automatic pills dispenser system.

*3.2 Hardware Implementation*

The prototype was assembled with six medication compartments, each driven by a stepper motor, and connected to the ESP32 control unit.

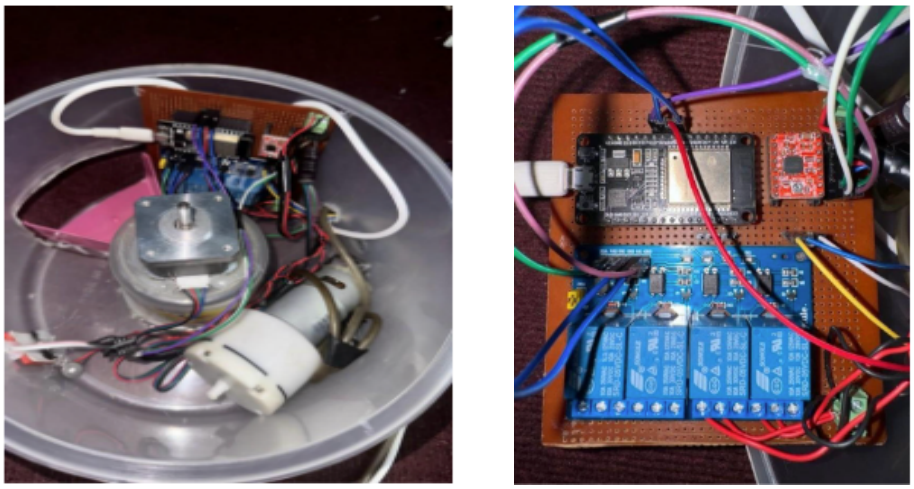

**Figure 2.** Hardware implementation of the automatic pills dispenser prototype showing the assembled mechanical structure and electronic modules.

*3.3 Software Implementation*

The software architecture includes an IoT backend built with Express.js and MongoDB, and a cloud-connected admin panel built using Next.js. The ESP32 communicates via Wi-Fi, receiving dispensing commands from the server and logging data for monitoring. Automated CRON jobs schedule dispensing times and notifications. [8]

*3.4 Simulation and Fabrication*

Simulation tools such as Proteus were used to validate circuit design and control logic. Mechanical structures were modeled and printed using CATIA and 3D printers. Six compartments were fabricated in a circular configuration for balanced weight and space optimization.

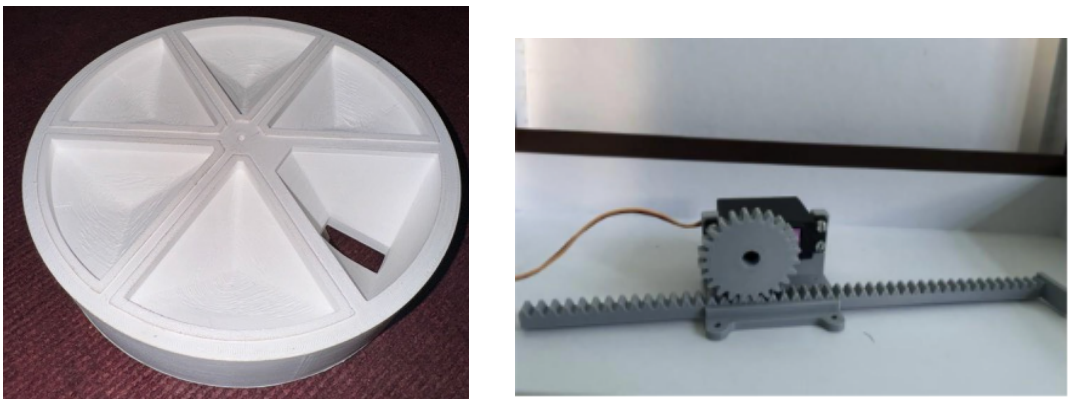

**Figure 3.** Fabrication and assembly stages of the automatic pills dispenser prototype with 3D-printed mechanical components and integrated electronics.

## 4. Results and Discussion

*4.1 System Integration*

The prototype successfully integrates stepper and servo motors with precise synchronization. The Hall sensor ensures accurate alignment, while the vacuum suction achieves reliable pill extraction. IoT control through the admin panel allows for real-time monitoring and manual override.

*4.2 Performance Evaluation*

**Table 1.** Performance Evaluation Results

| Performance Metric | Result |
|---|---|
| Average dispensing accuracy | 96% |
| Average response time per command | 6.2 s |
| Continuous stable operation (dispenses) | 100 |

This results demonstrate high reliability and precision suitable for practical healthcare applications.

*4.3 Challenges*

Calibration for different pill sizes required extensive fine-tuning. Manual rotation of the compartments caused misalignment errors. Further, variations in suction performance affected consistency with lighter pills.

## 5. Limitations and Future Work

*5.1 Limitations*

- Inability to store temperature-sensitive or liquid medications.
- Calibration drift if manually tampered.
- Limited to predefined compartment capacities.

*5.2 Future Enhancements*

- Integration of temperature and humidity control for diverse drugs.
- Development of a mobile app for notifications and analytics.
- Enhanced suction and sensor calibration for improved robustness.

## 6. Conclusion

The IoT-based automatic pills dispenser demonstrates a practical approach to addressing medication adherence challenges among the elderly. Combining precision mechanics and IoT connectivity, it provides an effective solution for automated and monitored drug delivery. The system's modular design, affordability, and ease of use make it promising for large-scale deployment in hospitals, elderly care homes, and personal healthcare environments.

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