

# A Review and Comparative Analysis of Smart Medicine Dispenser Technologies

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**Abstract**—This paper presents advanced robotics, machine vision, and IoT-based communication to ensure the safe, accurate, and personalized delivery of medicines in real time. Utilizing a microcontroller, line-following, and obstacle detection sensors, the robot moves independently through designated routes to each patient's location. A facial recognition module confirms patient identity before dispensing the prescribed medicine, ensuring secure and error-free delivery. Cloud connectivity links the robot to the hospital database for real-time updates and tracking of medication schedules. The proposed research also includes a literature review of twelve referenced papers that collectively focus on IoT- and AI-enabled medication and pill dispensing systems that aim to improve adherence, safety, and independence for elderly or disabled patients by automating dose scheduling, identification, and delivery. They span hardware-software designs for smart dispensers and accessories, integrate features such as facial recognition and sensor fusion for patient identification and error reduction, and include human-centered and systematic reviews that evaluate usability, reliability, and workflow impact in real healthcare contexts.

**Index Terms**—Smart medicine dispenser, facial recognition, Internet of Things (IoT), healthcare automation, medication adherence, autonomous mobile robot, patient identification, sensor-based dispensing, cloud connectivity, assistive healthcare technology.

## I. INTRODUCTION

In modern healthcare settings, ensuring *timely and accurate medicine administration* is critical for effective patient treatment and recovery. However, manual dispensing of medication often poses challenges such as *human errors, increased workload on nursing staff, and dependence on caregivers*. These challenges can lead to *medication non-adherence, adverse drug events, and compromised*

*patient outcomes*. To address these issues, *automation and robotic systems* have emerged as innovative solutions that can streamline the medicine dispensing process, enhance precision, and improve patient compliance. Numerous studies have demonstrated the potential of *automated medicine dispensers* to reduce errors and provide reliable medication delivery. We present a *comprehensive review of existing literature* related to automated medicine dispensing, summarizing insights from twelve key studies. The objective of this paper is to explore the *design considerations, functionalities, and benefits* of the *Smart Medicine Dispenser using Facial Recognition system* in advancing healthcare technology for medication management. This approach aligns clearly with its research focus and situates it within the broader context of *healthcare automation technology*.

## II. LITERATURE REVIEW

S.Susila Sakthy *et al.* [1] developed an Automated Medicine Dispenser Assistant (AMDA). AMDA is an advanced system based on Raspberry Pi integrating facial recognition for identifying patients and dispensing the prescribed medication from one of ten compartments. The system uses stepper motors for compartment control, load sensors to verify dosage, and ultrasonic sensors for obstacle detection to enable safe autonomous movement. Caregivers can remotely monitor and adjust medication regimens via a Flask web server on the Raspberry Pi. Voice commands and feedback replace costly touchscreens, emphasizing cost-effectiveness while maintaining security with encryption. This system is designed to reduce medication errors, improve adherence, and assist both clinical and home care settings.

R. Achammal *et al.* [2] designed a Smart Automatic Drug Dispenser for elderly people. Published by IEEE, this paper details a smart automatic drug dispenser designed to aid elderly and disabled patients with complex medication regimens. Using microcontrollers, the device dispenses both solid and liquid medicines according to preset schedules. It incorporates features like alarms, sensors to detect pill retrieval, and remote monitoring through smartphone integration. The design emphasizes accessibility, ease of use, and safety, aiming to reduce hospitalization caused by medication errors and non-adherence.

L. Gargioniet *al.* [3] conducted a systematic review on medication dispensers. This paper systematically reviews existing pill and medication dispensers focusing primarily on human-centered aspects such as ease of use, patient acceptance, and interaction design. Using PRISMA methodology, the authors surveyed studies indexed in Scopus and PubMed that propose hardware/software architectures for dispensers. They classify solutions by development stage and analyze user interface designs and user involvement in managing dispensers. The review highlights challenges like usability for elderly and cognitively impaired users, integration with caregivers, and remote monitoring capabilities. The paper provides directions for future research to improve healthcare outcomes by enhancing dispenser design with patient-centered innovation.

C. H. Patil *et al.* [4] developed an IoT-based smart medicine dispenser model that enhances healthcare monitoring and ensures timely medication delivery through sensor integration and connectivity. This IEEE conference paper proposes an IoT-enabled smart medicine dispenser prototype using Arduino Mega with integrated fingerprint authentication, real-time clock, vibration motors, and IR sensors to automate and secure medication delivery. The dispenser sounds alarms when doses are due and only dispenses medication after user authentication, preventing unauthorized access and errors. The model facilitates communication between patients and caregivers via automated alerts, improving adherence for elderly or disabled users. The authors emphasize scalability and adaptability for broader healthcare applications.

V. Peddisetti *et al.* [5] introduced a smart medication management system combining an IoT-based pill dispenser with a smart cup to enhance patient adherence and simplify dosage tracking. This paper presents a comprehensive IoT solution for medication adherence, targeting vulnerable populations such as the elderly and mentally impaired. The system integrates three components: a Smart Pill Dispenser powered by Arduino Nano RP2040 for precise pill dispensing; a Smart Cup equipped with accelerometer, gyroscope, and ultrasonic sensors to verify pill consumption; and an Android app for real-time notifications and medication tracking. Communication between components uses Bluetooth Low Energy (BLE) for efficient, low-power networking. The cup uses wireless charging for ease of use by elderly patients. Fail-safe mechanisms prevent overdosing, and comprehensive logs enable users/caregivers to monitor adherence. Future work aims to expand dispenser capacity, improve app usability, and enhance data security.

J. Kim *et al.* [6] proposed the Pill Good system, an automated and interactive pill dispenser using facial recognition to ensure that medicines are accessed by the correct patient. Pill Good is a fully automated smart pill dispenser combining AI-driven facial recognition deployed on a Raspberry Pi with dispenser hardware and a mobile app. Each patient's prescription is uploaded via the app; the system detects the patient using face recognition, alerts them via app and speaker when it's time to take medication, and dispenses the exact pill quantity accordingly. Post-dispensation logs are synced to the cloud and accessible through the app. The dispenser hardware features a 3D-printed rotating plate for sorting pills and uses infrared sensors and PID control for precise dosing. User studies showed a 94% face recognition accuracy and high user satisfaction, indicating the system's clinical applicability for enhancing medication safety and reducing human errors.

V. A. Shendkar *et al.* [7] designed an automatic smart medication dispenser aimed at improving accuracy and reducing human intervention in medicine administration. This work presents an intelligent IoT-based automatic medication dispenser targeting elderly patients and individuals with chronic

conditions. The system implements sensor technology, including real-time clocks and microcontrollers, to automate timely pill dispensing and send reminders through apps or embedded interfaces. It allows setting and monitoring medication schedules remotely, improving adherence and reducing care-giver burden. The design integrates safety features to prevent overdosing and supports easy refill and dosage customization. This paper focuses on practical implementation steps and user-friendly interface design.

N.Krishna *et al.* [8] developed PILLBOT, a non-contact medicine dispensing system for patients in quarantine, minimizing direct human contact and improving safety in health-care settings. PILLBOT proposes a voice-controlled medicine dispensing robot tailored for quarantined patients, aiming to minimize direct contact between healthcare workers and infected patients amid COVID-19. The robot uses Google Assistant for voice commands, cloud services like IFTTT and Adafruit IO for communication, and NodeMCU for control. It features two dispensers: one for pills and another for syrup (cough medication), ensuring timely medicine delivery. The robot's mobility enables it to navigate hospital wards, and voice feedback enhances interaction. This non-contact system is designed to reduce infection risk, automate medication delivery, and provide remote control through web interfaces.

N.Dheerthi *et al.* [9] presented IoTAAMD, an IoT-assisted systematic medicine dispenser that uses logical sensor associations to provide precise dosage control and monitoring. This paper presents the IoTAAMD system, an advanced IoT-assisted medication dispenser integrating multiple logical sensors (e.g., weight, IR, and motion sensors) to ensure accurate medication dispensing and adherence. The system's architecture allows real-time data acquisition, automated dispensing, and remote monitoring through cloud services. The logical association of sensors helps detect errors such as missed doses or incorrect pills and sends alerts to users and caregivers. Experimental results demonstrate improved medication management efficiency in hospital and home settings.

S. L. Ullankala *et al.* [10] proposed a live-streaming smart pill dispenser designed to assist elderly and visually impaired individuals, enabling caregivers to monitor dosage remotely in real-time. This study focuses on a portable medicine dispenser designed for elderly and visually impaired users who often struggle to take medication correctly or on time. The device uses an Arduino controller with Bluetooth connectivity linked to a mobile app for setting alarms and dispensing schedules. Pills are stored in compartments mounted on a stepper motor-driven circular container. The dispenser alerts users through speaker and LCD at medication times. A live streaming ESP32 Cam monitors the patient's pill-taking remotely, easing the caretaker's job. This approach balances automation with minimal manual intervention and addresses critical issues of patient monitoring and visual impairment.

S. P. Adithama *et al.* [11] implemented a face recognition system for patient identification using transfer learning, which can be integrated with smart dispensers for secure medication dispensing. This study focuses on improving patient safety by implementing facial recognition technology for patient identification in hospitals. Using transfer learning with convolutional neural networks (CNN) such as SENet50, VGGFace2, and ResNet models, the system addresses misidentification errors that can cause wrong medication and treatment. The CNN-based biometric authentication enhances accuracy over traditional name or number-based identification. Results demonstrate high precision in patient verification. The system represents a critical step toward reducing clinical errors through reliable automatic patient identification.

V. N. Thanh *et al.* [12] developed a restaurant-serving robot with a dual-line sensor-following approach, demonstrating the application of robotics and sensor integration similar to that used in automated dispensers. This study differs in focus as it concerns a restaurant-serving robot rather than medical devices. The robot uses a double line sensor approach combined with a PID controller to follow predefined tracks reliably and deliver food or goods in restaurant environments. The paper discusses mechanical design, line sensing techniques, and control algorithms for stable and efficient robot

movement. The methodologies could relate indirectly to robotics used in healthcare automation.

The overall summary of the referred papers shows that across these systems (IoT pill dispensers, smart cups, live-streaming dispensers, PILLBOT, facial-recognition devices, and line-following robots), the common limitations are: prototype-stage or small, short-term studies with weak clinical evidence; limited human-centered design and usability testing with real elderly/disabled users; fragile technical robustness due to reliance on stable power, connectivity, controlled lighting/camera conditions, or clear floor lines; superficial handling of security, privacy, and ethics, especially for cloud and biometric data; minimal integration with hospital/clinic IT, prescriptions, or telehealth; and AI models tested on narrow datasets with uncertain generalization and fairness. Correspondingly, the shared research scope is to conduct large-scale clinical and field trials, co-design interfaces and workflows with patients/caregivers/clinicians, harden systems with offline fallbacks and more capable navigation for mobile robots, build deep interoperability with healthcare infrastructures, and develop rigorous cybersecurity, privacy, ethical and regulatory frameworks while using AI for more personalized, adaptive adherence support.

### III. PROPOSED METHODOLOGY

The research gaps on which we work are Human error, poor documentation, operational burden, security risks, no automatic ingestion verification. We proposed integrated mobile dispensing solution, that combines autonomous navigation, facial recognition-based authentication, and scheduled dispensing into a single platform. The use of face recognition eliminates the need for physical tokens, ensuring secure and contactless verification. Additionally, partial local processing reduces reliance on continuous internet connectivity while maintaining IoT-based monitoring for alerts and logging. This approach enhances reliability, accessibility, and patient safety, particularly in controlled healthcare environments.

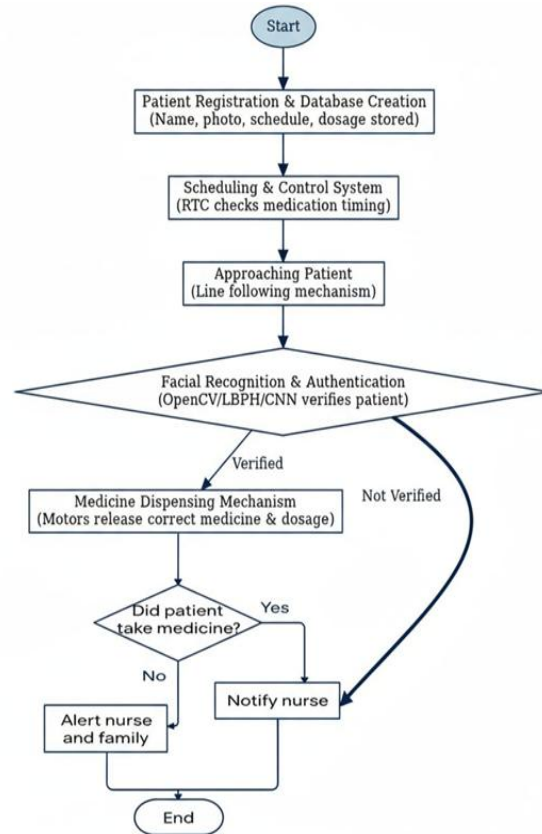


Fig. 1. Flow Chart

Figure 1 illustrates the working of Smart Medicine

Dispenser using Facial Recognition, starting with patient

registration and database creation, followed by scheduling and patient approach. Facial recognition ensures authentication, after which the medicine dispensing mechanism releases the correct dosage. If the patient doesn't take medicine, alerts are sent to nurses and family for timely intervention. The detailed methodology steps are as follows:

#### 1. Patient Registration Database Creation

Each patient's details (name, photo, medication schedule, dosage) are stored in a secure database. Facial images are captured and trained using recognition algorithms.

#### 2. Scheduling Control System

A real-time clock (RTC) module checks medication timing against the stored schedule. When the time matches, the system prepares to dispense the medicine.

### 3. Approaching the patient

The prototype will track and approach the patient using line following mechanism.

### 4. Facial Recognition Authentication

A camera detects and verifies the patient's face using algorithms (e.g., OpenCV with LBPH / CNN). Only authorized patients can access their assigned medication.

### 5. Medicine Dispensing Mechanism

Stepper/servo motors control compartments for different medicines. The correct medicine and dosage are released automatically.

### 6. Notification Alerts

If the face is not recognized, alerts are sent to only caregivers

## IV. CONCLUSION

The papers on existing system collectively conclude that automated medicine dispensers significantly enhance medication adherence, safety, and healthcare efficiency by ensuring accurate, timely dispensing and can minimizing human errors. Integration with IoT and AI technologies like facial recognition and line following enables remote monitoring and patient-specific customization, benefiting elderly, disabled, and chronically ill populations. These smart dispensers can reduce the burden on healthcare staff by automating medication management, tracking inventory, and preventing drug diversion. User acceptance is generally positive when devices are reliable and easy to use, supporting patient independence and caregiver relief. Overall, automated dispensers represent a trans-formative advancement in medication management, improving clinical outcomes and operational workflows in healthcare settings.

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