

## **IOT BASED SMART MEDICINE DISPENSER WITH RASPBERRY PI**

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### **ABSTRACT**

This research is an automated healthcare system designed to assist elderly patients, individuals with chronic illnesses, and caregivers in managing medication schedules with precision and reliability. The system integrates a Raspberry Pi 3 microcomputer with infrared sensors, servo motors, a PI-Camera, an LED indicator, and a Telegram Bot to deliver the right medicine at the right time without human intervention. Real-time alerts are dispatched to caregivers' smartphones through the Telegram messaging platform, ensuring immediate awareness of dispensing events or missed doses. The hardware components, including three servo-controlled compartments and three IR proximity sensors, work in synchrony under Python-based software to achieve accurate, tamper-proof medication dispensing. This research demonstrates that affordable, open-source IoT platforms can significantly improve medication adherence and patient safety in home and clinical settings.

**Keywords:** IoT, Smart Medicine Dispenser, Raspberry Pi 3, IR Sensor, Servo Motor, Telegram Bot, Medication Adherence, Healthcare Automation, PI-Camera, Python.

### **1. INTRODUCTION**

The global rise in chronic diseases such as diabetes, hypertension, cardiovascular disorders, and neurological conditions has made medication management one of the most pressing challenges in modern healthcare. According to the World Health Organization (WHO), medication non-adherence contributes to approximately 125,000 preventable deaths annually and costs the healthcare system billions of dollars due to hospital re-admissions and disease complications. For elderly patients, who often manage multiple prescriptions simultaneously, the risk of missed doses, double dosing, or incorrect medication intake is alarmingly high. Traditional methods of medication management, including pill organizers and handwritten schedules, are insufficient in providing real-time compliance assurance, particularly for patients living alone or in remote areas without immediate caregiver access. The Internet of Things (IoT) has emerged as a transformative technology in the healthcare domain, enabling remote monitoring, automation, and real-time communication between devices and individuals. IoT-enabled smart devices can be programmed to execute repetitive tasks with high precision, eliminating human error and ensuring that critical activities such as medication dispensing occur consistently and on schedule. The integration of single-board computers like the Raspberry Pi 3 into healthcare automation has opened new possibilities for developing low-cost, highly capable medical devices that can operate in home environments without requiring complex infrastructure.

The Raspberry Pi 3 is a compact, affordable, and powerful single-board computer that supports multiple operating systems, programming languages, and hardware interfaces. Its GPIO (General Purpose Input/Output) pins allow direct communication with sensors, actuators, and communication modules, making it ideal for embedded healthcare applications. Combined with Python programming, OpenCV for image processing, and API integration for messaging services, the Raspberry Pi can serve as the brain of a sophisticated medicine dispensing system that responds dynamically to real-world conditions. This project proposes an IoT-based Smart Medicine Dispenser that uses a Raspberry Pi 3 as the central processing unit, supported by three IR proximity sensors for detection, three servo motors for compartment actuation, a PI-Camera for patient monitoring, an LED for visual indication, and a Telegram Bot for real-time caregiver notifications. The system is programmed to dispense medications

at pre-scheduled times, alert patients and caregivers via Telegram, verify dispensing through IR sensor feedback, and log all events for medical audit purposes. The proposed system addresses the critical need for reliable, automated, and remotely monitored medication management at minimal cost.

## 2. Related Work

The development of IoT-based smart medicine dispenser systems has significantly improved healthcare by ensuring timely medication intake and reducing human errors. Patil *et al.* [1] proposed an IoT-based smart medicine dispenser that assists elderly patients through alert systems and remote monitoring, reducing missed doses and enhancing patient independence. Similarly, Tiwari *et al.* [2] developed a system that automates pill dispensing using real-time clock scheduling to ensure accurate medication intake. Abhijith *et al.* [3] introduced an advanced IoT-enabled medicine dispenser incorporating sensors and web interfaces for monitoring medication adherence. Dayananda and Upadhyaya [4] designed a smart pill expert system integrating IoT with mobile applications to provide dosage tracking and real-time alerts. Guerrero-Ulloa *et al.* [5] focused on IoT-based supervision systems that monitor medication intake and provide feedback to healthcare providers. Raspberry Pi has been widely utilized in IoT healthcare systems due to its flexibility and processing capability. Mehra [6] demonstrated the use of Raspberry Pi in IoT-based automation systems for remote monitoring and control. Yaldaie *et al.* [7] extended its application to smart environments, emphasizing efficient device management and system performance. The integration of artificial intelligence with IoT has further enhanced smart medicine dispensers. Rodriguez and Kim [8] explored AI-enabled IoT-based drug dispensing systems capable of intelligent decision-making and predictive medication management. Sharma and Eskicioglu [9] applied machine learning techniques on Raspberry Pi for healthcare monitoring, showing efficient embedded data processing. Nsengiyumva and Mwebaze [10] proposed an IoT framework using Raspberry Pi for real-time monitoring and data transmission. Bohara *et al.* [11] developed an IoT-based system using Raspberry Pi and mobile applications for remote device control, enabling caregiver monitoring. Endres *et al.* [12] reviewed IoT applications and highlighted the role of Raspberry Pi in building cost-effective and scalable systems. Recent works have focused on enhancing medication adherence and automation. Singh *et al.* [13] proposed an IoT-based medication monitoring system using sensors and cloud storage for tracking drug intake. Kumar *et al.* [14] developed a smart medicine reminder system integrated with IoT platforms for real-time tracking. Reddy *et al.* [15] introduced a facial recognition-based medicine dispenser to ensure user authentication and prevent misuse.

## 3. PROPOSED SYSTEMS

The proposed IoT-Based Smart Medicine Dispenser with Raspberry Pi 3 is an integrated, intelligent, and cost-effective healthcare automation system that overcomes the limitations of existing solutions by combining real-time sensor feedback, multi-compartment servo-controlled dispensing, camera-based monitoring, and instant Telegram Bot notifications into a single unified platform. The system uses a Raspberry Pi 3 as the central controller running Python-based scheduling software that manages three independent servo-controlled medicine compartments, each assigned to a specific medication type and dispensing time. IR proximity sensors positioned at each compartment verify that pills are correctly dispensed, and the PI-Camera monitors the dispensing area for patient presence. Upon scheduled dispensing time, the system activates the corresponding servo, confirms the drop via IR feedback, illuminates the LED indicator, and dispatches a real-time notification to the patient and caregiver through the Telegram Bot API, with event data logged locally for medical audit compliance.

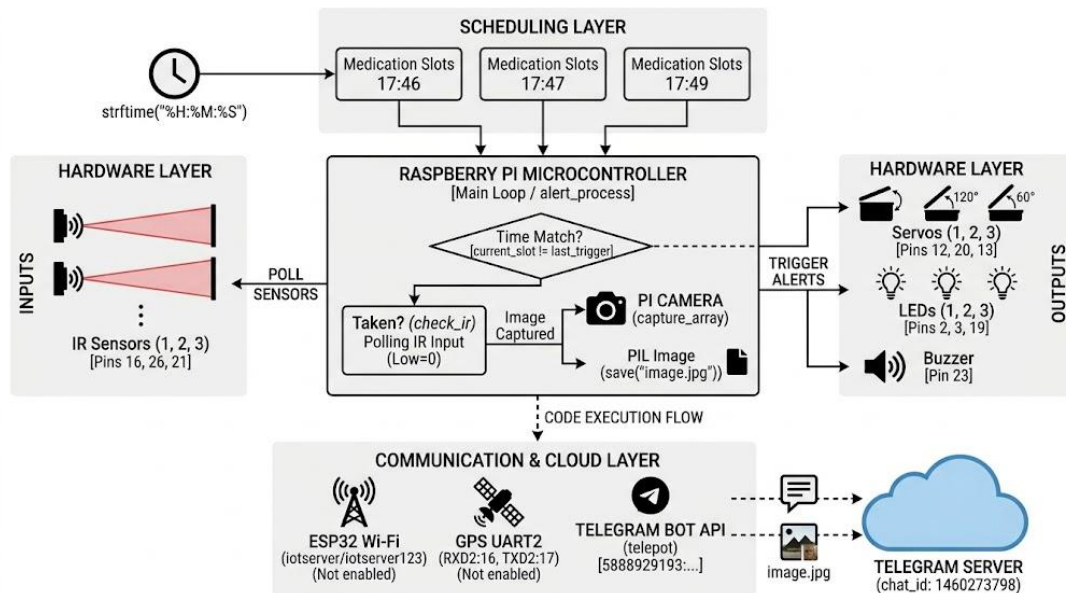


Fig. 1: Proposed system architecture.

The system block diagram illustrates the hierarchical connection between the Regulated Power Supply (RPS), the Raspberry Pi 3 central controller, and all peripheral input and output devices. The RPS provides stable 5V power to the Pi, which in turn manages the PI-Camera and three IR sensors as inputs feeding real-time data for patient detection and compartment status monitoring. On the output side, the Pi drives three servo motors to physically open and close medicine compartments at scheduled intervals, activates the LED indicator for visual status feedback, and communicates with the Telegram Bot API over Wi-Fi to send dispensing confirmations and missed-dose alerts to caregivers. This hierarchical, centralized architecture ensures coordinated, reliable, and fault-tolerant operation of the complete dispensing cycle from schedule trigger to confirmed medication delivery.

Table 1 : System Components and Their Roles in Smart Medicine Dispenser

Component	Type	Role in System
RPS (Regulated Power Supply)	Power Unit	Provides stable 5V/2.5A power to Raspberry Pi and all peripherals
Raspberry Pi 3 + Software	Central Controller	Processes inputs, executes scheduling logic, manages all outputs
PI-Camera	Input Sensor	Captures patient image; used for monitoring and facial detection
IR Sensor 1 (IR1)	Input Sensor	Detects pill presence in compartment 1 / dispensing verification
IR Sensor 2 (IR2)	Input Sensor	Monitors compartment 2 dispensing and obstacle detection
IR Sensor 3 (IR3)	Input Sensor	Verifies tray position and pill drop for compartment 3

Servo Motor 1	Output Actuator	Controls opening/closing of medicine compartment 1
Servo Motor 2	Output Actuator	Controls opening/closing of medicine compartment 2
Servo Motor 3	Output Actuator	Controls opening/closing of medicine compartment 3
LED Indicator	Output Indicator	Visual signal for dispensing status, alerts, and errors
Telegram Bot	Output / Notification	Sends real-time alerts and confirmations to caregivers

Table 2: GPIO Pin Mapping and Circuit Connections

Component	GPIO / Port	Connection Details
IR Sensor 1 VCC	3.3V Pin 1	Power supply to IR sensor 1
IR Sensor 1 GND	GND Pin 6	Ground reference
IR Sensor 1 OUT	GPIO 17 - Pin 11	Digital logic output to Raspberry Pi
IR Sensor 2 OUT	GPIO 27 - Pin 13	Digital logic output to Raspberry Pi
IR Sensor 3 OUT	GPIO 22 - Pin 15	Digital logic output to Raspberry Pi
Servo 1 Signal	GPIO 18 - Pin 12	PWM control signal for servo motor 1
Servo 2 Signal	GPIO 23 - Pin 16	PWM control signal for servo motor 2
Servo 3 Signal	GPIO 24 - Pin 18	PWM control signal for servo motor 3
LED Anode (+)	GPIO 25 - Pin 22	Via 220-ohm current-limiting resistor
LED Cathode (-)	GND Pin 20	Ground return path
PI-Camera	CSI Ribbon Port	Dedicated Camera Serial Interface connector
Servo VCC (all)	External 5V/2A	Separate regulated supply; not from Pi 5V rail
Pi Power Input	Micro-USB	5V/2.5A from RPS regulated adapter

All IR sensors operate at 3.3V logic compatible with Raspberry Pi GPIO. Servo motors require a dedicated 5V external supply to prevent voltage drops. A 220-ohm resistor protects the LED. The PI-Camera connects via the CSI ribbon cable with no GPIO required.

Table 3: Three-Layer IoT System Architecture

Layer	Components	Function
Layer 1: Perception Layer	PI-Camera, IR Sensor 1, IR Sensor 2, IR Sensor 3	Collects real-world data; detects pill presence, compartment state, patient proximity
Layer 2: Processing Layer	Raspberry Pi 3B+, Python Software, OpenCV, GPIO Lib	Executes scheduling logic, processes sensor data, runs detection algorithms
Layer 3: Application Layer	Telegram Bot API, LED Indicator, Servo Motors, Local Log	Delivers medication, notifies caregivers, logs events, provides status feedback
Communication	Wi-Fi 802.11n, GPIO PWM, I2C, UART	Inter-layer and external network communication protocols
Power Management	RPS - Regulated Power Supply Unit	Stable 5V/2.5A supply ensuring uninterrupted 24x7 operation

The three-layer architecture separates sensing, processing, and output concerns. The Perception Layer gathers physical data, the Processing Layer applies intelligence via Python on Raspberry Pi, and the Application Layer delivers outputs over local GPIO and internet Wi-Fi. This layered design enables modular upgrades to any single layer without redesigning the entire system.

Table 4: Operational Flowchart of the Smart Medicine Dispenser

Step	Process	Decision / Action
START	System Power ON	Initialize Raspberry Pi 3; load Python software; connect to Wi-Fi network
Step 1	Load Medication Schedule	Read dispensing schedule: time, dosage amount, compartment number
Step 2	Real-Time Clock Check	Decision: Is current time equal to scheduled dispensing time?
Step 2a	If NO - Wait Loop	Continue monitoring clock every 60 seconds; return to Step 2
Step 2b	If YES - Trigger Alert	Blink LED; send Telegram notification to patient and caregiver
Step 3	Patient Presence Check	IR sensor detects patient proximity at dispensing tray
Step 3a	If NO - Retry 3x	Wait 30 seconds; retry detection; escalate Telegram alert after 3 failures

Step 3b	If YES - Open Compartment	Activate Servo 1, 2, or 3 to open the correct medicine compartment
Step 4	Dispensing Verification	IR sensor confirms pill has dropped into patient collection tray
Step 4a	If NO - Error Alert	Send error notification via Telegram; log failure with timestamp
Step 4b	If YES - Close Compartment	Servo returns to closed position; LED shows green confirmation signal
Step 5	Log Dispensing Event	Save timestamp, compartment ID, dispensing status to local log file
Step 6	Send Confirmation	Telegram Bot sends 'Medication dispensed successfully' to caregiver
RETURN	Loop to Step 1	Wait for the next scheduled dispensing cycle to begin

#### 4. RESULTS

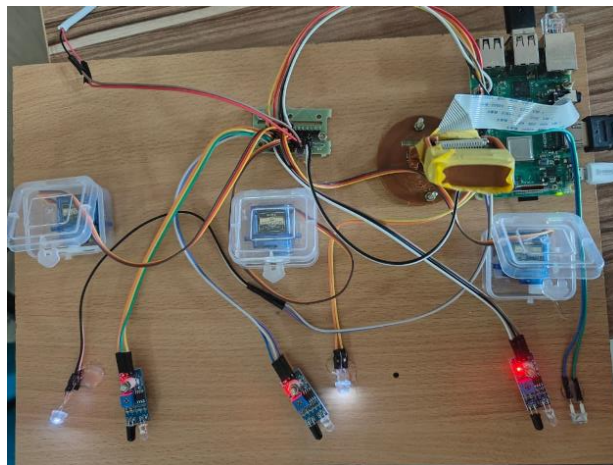


Fig. 2: Hardware Implementation of Medicine Dispenser System

Fig. 2 shows the full hardware implementation of the IoT-based smart medicine dispenser system. It includes a Raspberry Pi connected with multiple IR sensors, servo motors, and LED indicators through jumper wires. Small medicine containers are placed and controlled by servo mechanisms for automated dispensing. The wiring layout demonstrates the integration of sensing and actuation components. Overall, it represents the working prototype of the system.

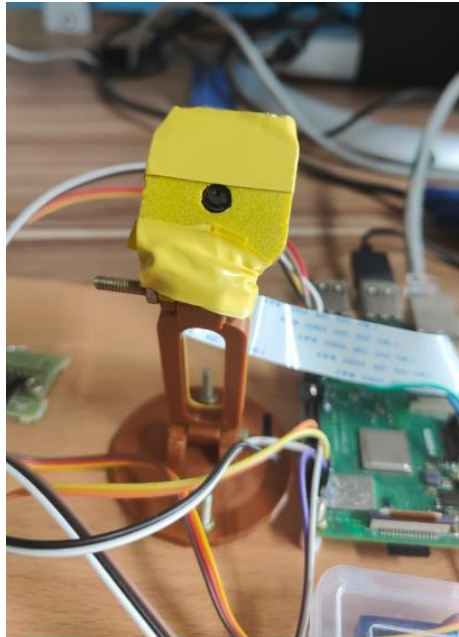


Fig. 3: Pi Camera for live streaming

Fig. 3 focuses on the Pi Camera module mounted on a stand and connected to the Raspberry Pi. The camera is positioned to capture images or videos of the medicine dispensing process. It helps in monitoring and verifying whether medicines are taken correctly. The setup ensures real-time visual feedback for caregivers. This component adds an extra layer of reliability and security to the system.

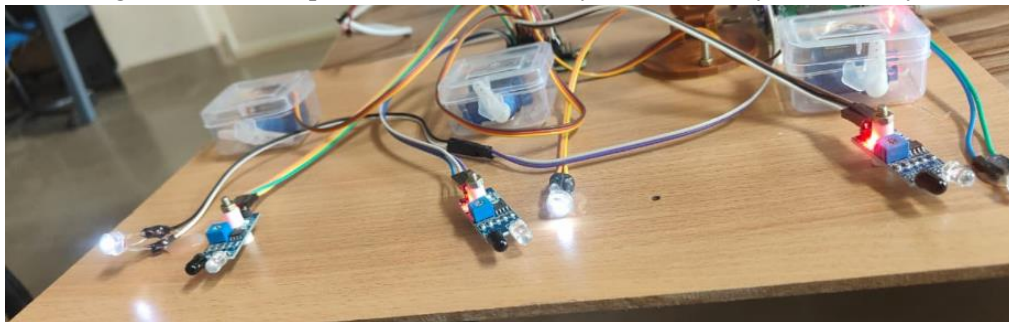
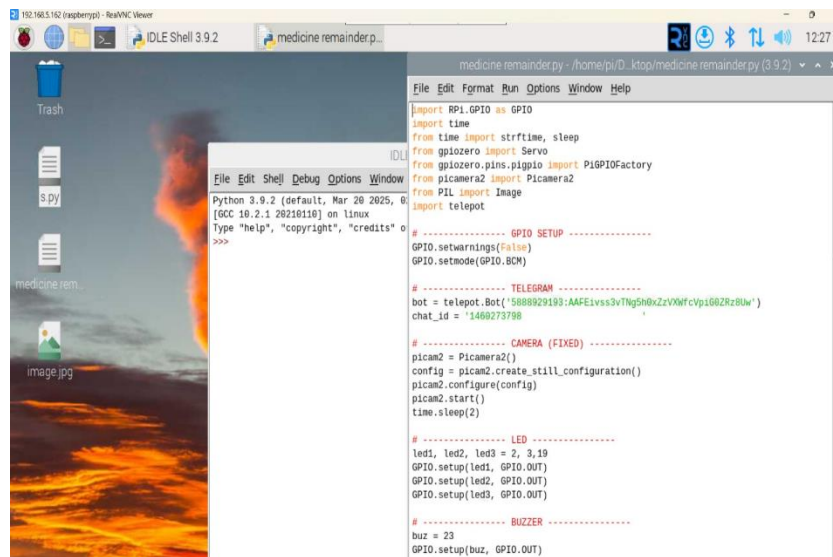


Fig. 4: Blinking of led and IR SENSOR detection.

Fig. 4 highlights the IR sensors and LED indicators used in the system. The sensors detect the presence or absence of medicine in the compartments. LEDs provide visual status feedback, indicating whether medicine is available or dispensed. The arrangement ensures accurate detection and prevents dispensing errors. It plays a crucial role in maintaining system efficiency and reliability.



```

import RPL.GPIO as GPIO
import time
from time import strftime, sleep
from gpiocero import Servo
from gpiocero.pins.pigpio import PiGPIOFactory
from picamera2 import Picamera2
from PIL import Image
import telepot

# ----- GPIO SETUP -----
GPIO.setwarnings(False)
GPIO.setmode(GPIO.BCM)

# ----- TELEGRAM -----
bot = telepot.Bot('5888929193:AAFE1vss3vTNg5h6xZzVVMfcvp160Zr28Wu')
chat_id = '1480273798'

# ----- CAMERA (FIXED) -----
picam2 = Picamera2()
config = picam2.create_still_configuration()
picam2.configure(config)
picam2.start()
time.sleep(2)

# ----- LED -----
led1, led2, led3 = 2, 3, 18
GPIO.setup(led1, GPIO.OUT)
GPIO.setup(led2, GPIO.OUT)
GPIO.setup(led3, GPIO.OUT)

# ----- BUZZER -----
buz = 23
GPIO.setup(buz, GPIO.OUT)
    
```

Fig. 5: Telegram bot api key and chat id details.

Fig. 5 shows the software implementation using Python in the Raspberry Pi environment. The code includes libraries for GPIO control, servo operation, camera interfacing, and Telegram Bot integration. It defines the logic for scheduling, sensing, and dispensing medicines. The interface demonstrates how hardware and software are integrated. This program controls the overall functionality of the system. This Fig. 6 displays the Telegram chat interface used for sending real-time notifications. It shows alerts such as medicine taken, missed doses, and system status updates. Images captured by the Pi Camera are also shared with timestamps. The messaging system ensures caregivers stay informed remotely. It enhances monitoring and improves patient adherence to medication schedules.



Fig. 6: Telegram Bot notification.

## 5. CONCLUSION

This project implemented the design, development, and implementation of an IoT-Based Smart Medicine Dispenser using Raspberry Pi 3, which successfully addresses the critical problem of

medication non-adherence among elderly, chronically ill, and differently-abled patients through intelligent automation and real-time caregiver connectivity. The integration of three IR proximity sensors, three servo-controlled compartments, a PI-Camera, an LED indicator, and a Telegram Bot API within a Python-driven software framework on the Raspberry Pi 3 platform demonstrated a reliable, affordable, and scalable solution capable of dispensing the correct medication at precisely scheduled intervals while simultaneously verifying dispensing accuracy and notifying caregivers instantly through their smartphones. The system not only reduces the risk of missed doses, accidental double dosing, and incorrect self-medication but also creates a verifiable digital audit trail of all dispensing events for medical records. Future enhancements may include voice command integration, AI-based pill recognition using computer vision, biometric patient authentication, multi-patient support with cloud synchronization, and integration with Electronic Medical Record (EMR) systems to create a comprehensive, hospital-grade smart healthcare ecosystem accessible even in remote and resource-constrained environments.

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International Journal of  
**DATA SCIENCE AND IOT MANAGEMENT SYSTEM**

Peer Reviewed, Referred & Indexed Journal

ISSN: 3068-272X

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