International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 02 | Feb - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

Med-Vault: Affordable AI–IOT Based Smart Medicine Box

Soham Adhikari, Tushar Khodbe, Meet Malkar, Rohit Yadav, Parul Jha

Electronics and Computer Science, St. John College of Engineering & Management

ABSTRACT

Medication non-adherence is a major challenge in healthcare, especially among elderly patients and individuals with chronic diseases. Missed doses, incorrect timing, and improper storage of medicines can lead to severe health complications. This project presents **Med-Vault**, an affordable **AI–IoT based smart medicine box** designed to ensure timely medication intake, monitor medicine usage, and provide real-time alerts to patients and caregivers.

The proposed system integrates low-cost IoT hardware such as **ESP32**, sensors, and actuators with **Artificial Intelligence (AI)** for intelligent scheduling and adherence analysis. The system sends reminders through a mobile application, provides alerts for missed doses, and securely stores medication data on a cloud platform. Med-Vault aims to deliver a **cost-effective, scalable, and user-friendly healthcare solution**, particularly suitable for home healthcare, hospitals, and rural areas.

INTRODUCTION

Proper medication management plays a critical role in effective healthcare treatment. Patients suffering from chronic illnesses often require multiple medications at specific intervals, increasing the risk of missed or incorrect doses. Traditional medicine boxes and alarm-based reminders rely heavily on user discipline and lack real-time monitoring or intelligent feedback mechanisms.

Recent advancements in **Artificial Intelligence (AI)** and the **Internet of Things (IoT)** have enabled the development of smart healthcare devices capable of monitoring patient behavior and automating routine healthcare tasks. By combining AI-driven decision-making with IoT connectivity, medication adherence systems can be transformed from passive reminder tools into intelligent healthcare assistants.

The **Med-Vault system** leverages IoT sensors to track medicine access, AI algorithms to analyze medication adherence patterns, and cloud services to store and synchronize data. The system provides real-time notifications to patients and caregivers through a mobile application, ensuring improved compliance, reduced health risks, and enhanced quality of life.

PROBLEM STATEMENT

Medication non-adherence is one of the leading causes of treatment failure, hospital readmissions, and increased healthcare costs. Existing solutions such as manual pill organizers and basic reminder applications suffer from several limitations, including lack of real-time monitoring, no confirmation of medicine intake, and limited support for elderly users.

Additionally, most smart healthcare solutions are expensive and require complex infrastructure, making them unsuitable for low-income households and rural healthcare settings. There is a need for an **affordable, intelligent, and easy-to-use medicine management system** that ensures medication adherence while maintaining data security and scalability.

LITERATURE SURVEY

Recent studies highlight the effectiveness of IoT- based healthcare systems in improving patient compliance and reducing medical errors.
Researchers have explored smart pillboxes using sensors and mobile notifications, but many systems lack intelligence to analyze patient behavior or predict non-adherence.

AI-based healthcare systems introduced in recent years focus on pattern recognition, predictive

analytics, and personalized healthcare recommendations. However, integrating AI with low-cost IoT hardware remains a challenge due to limited processing power and memory constraints. Med-Vault addresses these issues by adopting lightweight AI models and cloud-assisted intelligence..

METHODOLOGY

The Med-Vault system follows an AI–IoT based approach to ensure proper medication management and adherence monitoring. The methodology begins with configuring the medication schedule using a mobile application or predefined system settings. These schedules are stored securely in a cloud database.

An **ESP32 microcontroller** acts as the central control unit, interfacing with sensors that detect medicine box access (such as lid opening or weight change). At the scheduled time, the system triggers **visual and audible alerts** using LEDs and a buzzer to remind the user to take medication.

Sensor data is continuously monitored and transmitted to the cloud via Wi-Fi. **Artificial Intelligence algorithms** analyze the collected data to verify whether the medicine was taken on time and to identify irregular or missed doses. If a dose is missed, the system automatically sends notifications to caregivers through the mobile application.

This integrated methodology ensures **real-time monitoring, intelligent decision-making, and improved medication adherence** while maintaining affordability and scalability.

Requirements Analysis and Related Work Review

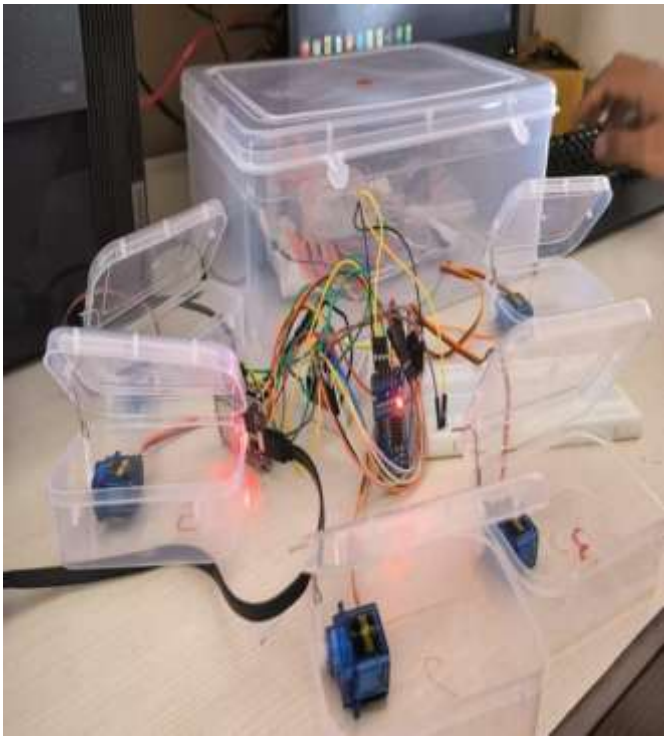
The Med-Vault system requires a **cost-effective IoT-based hardware platform**, reliable sensors to detect medicine access, and **wireless**

The proposed system consists of an ESP32-CAM module for image acquisition, a Node MCU controller for communication, a CNN model deployed using TensorFlow Lite for threat detection, Firebase services for data synchronization, and an Android application for user alerts. The system captures image frames, processes them using the CNN model, and sends alerts to authorized users upon detection of suspicious activity.

communication for real-time data transmission. A user-friendly **mobile application** is needed to

Existing research on smart medicine boxes primarily focuses on reminder-based systems using alarms and notifications. Although these systems improve adherence, they lack **intelligent verification** of medicine intake and advanced behavioral analysis. AI-driven healthcare monitoring solutions offer improved insights but are often **expensive and complex**, limiting their adoption. The Med-Vault approach addresses these gaps by combining **affordable IoT hardware with lightweight AI models**, providing an efficient and practical medication management solution.

DIAGRAM



Project Explanation Using Diagram

The circuit diagram represents a **microcontroller- based intelligent control system** built using an **Arduino Uno**, motor driver ICs, sensors, and output devices. The system is designed to control multiple motors based on sensor input and generate alerts using a buzzer.

Arduino Uno (Main Controller)

The **Arduino Uno** acts as the central control unit of the system. It receives input signals from the **color sensor**, processes the data according to the programmed logic, and generates control signals to operate motors and the buzzer. All decision-making and control operations are performed by the Arduino.

Power Supply

A **12V battery** is used as the main power source. The battery supplies power to the motor driver ICs for driving motors, while the Arduino and sensors operate at regulated **5V supply**. Common ground is maintained across all components to ensure stable operation.

Color Sensor Module

The color sensor is connected to the Arduino through digital input pins. It detects different colors based on reflected light intensity and sends corresponding signals to the Arduino. These signals are used to control motor movement or system behavior depending on the detected color.

Motor Driver IC (L293D)

Two **L293D motor driver ICs** are used to control **four DC motors** (Motor 1 to Motor 4). The L293D acts as an interface between the low-power Arduino and high-power motors. It allows bidirectional control of motors and protects the Arduino from high current and voltage spikes.

- **IN1–IN4 pins** receive control signals from Arduino
- **OUT pins** are connected to motors
- **ENA and ENB pins** enable motor operation

DC Motors

Four DC motors are connected to the output terminals of the motor driver ICs. These motors perform mechanical movement such as forward, backward, left, and right motion depending on control signals from the Arduino.

Buzzer (Alert Unit)

A buzzer is connected to one of the digital output pins of the Arduino. It provides **audible alerts** for system events such as detection, error, or completion of a task.

Working Principle

1. The system is powered using a 12V battery.
2. The color sensor detects the input condition (color).
3. Arduino processes the sensor data.
4. Based on logic, Arduino sends signals to the L293D motor drivers.
5. Motors operate accordingly (movement control).
6. The buzzer activates to indicate alerts or status.

ADVANTAGE

1. Improved Medication Adherence

Med-Vault helps patients take medicines on time by providing timely reminders and verifying intake using sensors and AI analysis. This reduces missed doses and improves treatment effectiveness, especially for elderly and chronic patients.

2. Affordable Healthcare Solution

The system uses low-cost IoT components, making it economical and suitable for home use, rural

healthcare, and small clinics without requiring expensive infrastructure.

3. Real-Time Monitoring

Caregivers can remotely monitor medication adherence through a mobile application. Instant alerts are generated for missed doses, allowing quick intervention and improving patient safety

4. AI-Based Intelligence

Artificial Intelligence analyzes medication intake patterns to detect irregular behavior and predict non-adherence, reducing false alerts and improving system reliability.

5. Scalable Architecture

Med-Vault can be easily expanded for use in hospitals, clinics, and old-age homes, supporting multiple users through a centralized cloud platform.

DISADVANTAGES

1. Internet Dependency

The Med-Vault system relies on internet connectivity for cloud data storage, real-time alerts, and mobile application communication. In areas with poor or unstable internet access, system performance and timely notifications may be affected.

2. Limited Edge Processing Capability

Since the system uses low-cost IoT microcontrollers, the processing power and memory are limited. This restricts the use of complex AI models directly on the device and may require cloud-based processing.

3. Initial Setup and Configuration

The system requires correct setup of medication schedules, user details, and network settings. This initial configuration may be challenging for elderly users without caregiver assistance.

4. Data Privacy and Security Concerns

Medical and personal data are stored and transmitted through cloud platforms. Without strong encryption and secure authentication, there is a risk of data breaches or unauthorized access.

APPLICATIONS

The **Med-Vault: Affordable AI–IoT Based Smart Medicine Box** can be applied in a wide range of healthcare environments to improve medication management and patient safety. It is highly suitable for **home healthcare**, where elderly patients or individuals living alone often forget to take medicines on time. By providing timely reminders and confirming medicine intake, the system reduces dependency on family members and improves treatment adherence. Med-Vault is also very useful in **old-age homes and assisted living centers**, where caregivers are responsible for administering medicines to multiple residents. The system allows caregivers to remotely monitor medication adherence and receive alerts for missed doses, reducing workload and human error.

In **hospitals and clinics**, Med-Vault can assist healthcare professionals in managing patient medications more efficiently, ensuring accurate dosage and timing, especially for patients requiring long-term treatment. It also plays a significant role in **chronic disease management**, helping patients suffering from conditions such as diabetes, hypertension, and heart disease maintain strict medication schedules and avoid serious health complications. Additionally, due to its **low-cost design and simple IoT-based architecture**, Med- Vault is well suited for **rural and remote healthcare systems**, where access to advanced medical infrastructure is limited. Overall, the project supports improved healthcare delivery by combining affordability, intelligence, and real-time monitoring

FUTURE SCOPE

The **future scope of the Med-Vault: Affordable AI–IoT Based Smart Medicine Box** is broad and promising, with several opportunities for enhancement and expansion. One major improvement area is the integration of **advanced Artificial Intelligence algorithms** to enable more accurate prediction of non-adherence behavior and personalized medication reminders based on patient habits and health conditions. The system can also be enhanced with **voice-assisted reminders** and multilingual support, making it more user-friendly for elderly and visually impaired patients.
Integration with **wearable health devices** such as smartwatches and fitness bands can allow real-time monitoring of vital parameters like heart rate and blood pressure, enabling more proactive healthcare management.

In the future, Med-Vault can be connected to **electronic health record (EHR) systems**, allowing doctors to monitor medication adherence remotely and adjust prescriptions accordingly. The use of **blockchain technology** can improve data security and ensure safe sharing of medical information.
Additionally, edge computing can be incorporated to reduce dependency on cloud connectivity and improve system reliability in low-internet areas.
With these enhancements, Med-Vault can be scaled for large healthcare institutions, smart hospitals, and national digital health programs, making it a key component of next-generation smart healthcare ecosystems..

Conclusion

The **Med-Vault: Affordable AI–IoT Based Smart Medicine Box** successfully demonstrates how modern technologies such as Artificial Intelligence and the Internet of Things can be effectively applied to solve real-world healthcare challenges. The system ensures timely medication intake, verifies adherence, and provides real-time alerts to patients and caregivers, thereby reducing missed doses and improving treatment outcomes. By using low-cost IoT components and lightweight AI techniques, Med-Vault offers an affordable and scalable solution suitable for home healthcare, hospitals, old-age homes, and rural medical centers. Although certain challenges such as internet dependency and data security remain, the system shows strong potential for future enhancements. Overall, Med-Vault represents a reliable, intelligent, and practical approach toward improving medication management and supporting smart healthcare systems.

REFERENCES

1. A. Kumar, S. Patel, and R. Sharma, "IoT-Based Smart Healthcare Systems: A Review," *IEEE Access*, vol. 10, pp. 45678– 45690, 2022.
2. S. Patel and M. Shah, "Smart Pill Box for Medication Adherence Using IoT," *International Journal of Engineering Research & Technology (IJERT)*, vol. 11, no. 4, pp. 215–219, 2022.
3. World Health Organization (WHO), "Adherence to Long-Term Therapies: Evidence for Action," WHO Press, Geneva, 2003.
4. R. Kumar and P. Singh, "Artificial Intelligence in Healthcare: Applications and Challenges," *Elsevier Computer Methods and Programs in Biomedicine*, vol. 190, 2020.
5. N. S. Prasad et al., "Design and Implementation of Smart Medicine Box Using Internet of Things," *International Journal of Scientific Research in Computer Science*, vol. 8, no. 2, pp. 45–50, 2021.
6. S. Verma and A. Tiwari, "AI-Based Patient Monitoring System Using IoT," *International Journal of Advanced Research in Engineering and Technology (IJARET)*, vol. 12, no. 6, pp. 98–104, 2021.
7. Firebase Documentation, "Firebase Realtime Database and Cloud Messaging," Google Developers, 2023. Available: https://firebase.google.com
8. M. Chen, Y. Hao, K. Hwang, L. Wang, and L. Wang, "Disease Prediction by Machine Learning Over Big Data From Healthcare Communities," *IEEE Access*, vol. 5, pp. 8869–8879, 2017.