International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 04 | April - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

IOT-Enabled Medication Reminders: A Review

Prof. Fatima Ansari[1], Chandni Qureshi[2], Falak Shaikh[3], Firdos Shaikh[4], Zikra Siddiqui[5]

[1]*Asst. Professor, Department of Computer Engineering, M.H. Saboo Siddik College of Engineering, Mumbai, India*

[2,3,4,5]*Student, Department of Computer Engineering, M.H. Saboo Siddik College of Engineering, Mumbai, India*

Abstract - This review explores how the Internet of Things (IoT) is reshaping healthcare, with a focus on improving medication adherence. As healthcare shifts toward more personalized and proactive treatments, IoT systems are emerging as key tools for managing patient care cost-effectively. By systematically examining current literature, this review identifies trends and gaps regarding IoT applications in medication management. The analysis highlights various systems—such as smart pill dispensers, connected devices, and mobile applications—that continuously monitor medication intake and deliver timely reminders. These innovative solutions not only help prevent missed doses but also support inventory management and also facilitates proactive intervention by caregivers and healthcare professionals. In addition, the review discusses the challenges that are critical to the successful integration of these technologies into routine healthcare. Moreover, this paper demonstrates the potential of IoT-driven approaches to improve patient compliance, reduce the burden on healthcare systems, and promote independent living, particularly for vulnerable populations dealing with chronic diseases.

***Key Words*:** Internet of Things, IoT, medication adherence, smart healthcare, pill dispenser, smart medicine box.

I.INTRODUCTION

Medication management is a critical aspect of daily life, particularly for those dealing with chronic conditions and memory-related impairments. Over the past decades, rapid advances in medical technology have contributed to significant improvements in disease treatment, yet effective medication adherence remains a pressing challenge. Aging naturally increases the risk of chronic diseases—a fact reflected in India, where about 21% of the elderly population suffers from at least one chronic condition, with hypertension and diabetes being the most prevalent [1]. These conditions, often exacerbated by the aging process, can be better managed through timely and consistent medication intake.

Memory impairment, often referred to in clinical settings as amnesia or unusual forgetfulness, further complicates the task of medication adherence. For many seniors who live independently, the challenge is not only in managing their health but also in remembering to take their medications accurately and on time. As technology becomes an increasingly integral part of everyday life, there is a growing focus on developing systems that can alleviate these challenges by providing timely reminders and real-time monitoring.

Recent research highlights the severity of non-adherence issues. For instance, an Indian study found that over half (55.14%) of participants did not follow their antidiabetic therapy properly, with nearly 60% neglecting to take their medication as prescribed [2]. Similarly, a study conducted at the University of Ghana revealed that approximately 35% of patients failed to take their diabetes medication on schedule [3]. These figures underscore the potential benefits of integrating Internet of Things (IoT)-enabled medication reminder systems into everyday healthcare routines. By leveraging real-time data collection and sensor technology, such systems could offer continuous monitoring of medication consumption, promptly notify patients and their caregivers when a dose is missed, and ultimately ease the burden on healthcare resources.

II.LITERATURE SURVEY

R. Aparna, et.al. [4] have developed MediSync leverages advanced IoT sensors, cloud computing, and machine learning to improve patient outcomes by ensuring accurate medication consumption and inventory management. The system is implemented in three stages: Pill Detection, Pill Recognition, and User Reminder. Initially, the Pill Detection stage employs the YOLOv4 Darknet framework on Colab to detect the presence of pills in a smart pillbox. This is followed by the Pill Recognition stage, where the same framework is used to accurately identify individual pills, thereby enabling precise tracking of medication inventory and alerting users when a refill is necessary. The final stage, User Reminder, utilizes the IFTTT API in conjunction with button sensors to send timely notifications to patients and their designated contacts whenever a scheduled dose is missed. Through continuous monitoring and intelligent alerting, MediSync not only enhances medication adherence but also reduces the healthcare system's burden by preventing missed doses and ensuring optimal medication management.

As discussed in [5], the IoT-based pill management system addresses the critical issue of medication non-adherence among elderly patients, including those with cognitive or sensory impairments, by integrating a smart pill dispenser with a mobile application. Its architecture enables a coordinated workflow where doctors edit prescriptions through the app, pharmacists wirelessly schedule and load medications, and patients receive timely and progressive reminders via mobile notifications, LED lights, an LCD display, and an audible buzzer. A key technical feature is the secure locking mechanism on the dispenser, which regulates access based on prescribed timing and dosage, effectively preventing misuse and ensuring safe medication delivery. The system also allows real-time remote monitoring by caregivers and doctors, promoting adherence and reducing caregiver involvement. In a practical trial involving three seniors, a caretaker, a doctor, and two pharmacists over three days, the seniors—despite mild visual and auditory impairments—found the system intuitive and supportive. Feedback highlighted increased confidence, reduced stress, and overall satisfaction, showcasing the system’s potential to improve adherence, support independent living, and enhance medication safety for elderly users.

P. A. Harsha Vardhini, et.al. [6] presents a low-cost, accessible solution to support medication adherence among memory-impaired and elderly individuals, particularly those with limited literacy and financial means. The core of the system is a smart medicine box developed for under Rs.1000, integrating IoT technology to automate reminders and enable real-time monitoring. The hardware architecture includes a Node MCU microcontroller (ESP8266) as the central processing unit, LDR (Light Dependent Resistor) sensors to detect medication intake, magnet reed switches for secure compartment access, and DC motors to automate the opening and closing of the medicine box lids. At scheduled times, the Node MCU triggers the corresponding motor to open the lid; if the LDR sensor detects light—indicating pill removal—the lid closes after a short delay. If no intake is detected, the system logs the missed dose and updates a web server via Wi-Fi, allowing caregivers to remotely track adherence. This smart assistive system demonstrates how affordable embedded technology and IoT can be combined to create inclusive, patient-centric healthcare solutions that enhance medication compliance and improve the quality of life for vulnerable populations.

P. Ranjana, et. al. [7] have proposed an IoT-enabled automatic medicine reminder and health monitoring system designed to the elderly—in adhering to their medication schedules and managing their health conditions. The system features a specialized medicine box that automates dosage management and issues timely reminders to ensure medications are taken correctly, thereby reducing the risk of human error. It also integrates continuous health monitoring using sensors that track parameters such as blood pressure and ECG from the user’s home. These sensor readings are collected and stored in a database, where they are analysed against predefined thresholds to determine if the symptoms are within a normal range. If any parameter falls below or exceeds the set limits, the system generates alerts to prompt medication intake or recommend consulting a doctor.

M. Shrinivas, et. al. [8] have proposed an IoT-enabled intelligent medicine box with wireless connectivity and an Android application to support patients in managing their medications while ensuring close communication with healthcare providers. The system features a compartmentalized medicine box integrated with an Arduino microcontroller and ESP8266 Wi-Fi module, enabling real-time data transmission to a hospital-managed web interface. Each compartment of the box is equipped with an LED indicator to signal the correct medication to be taken; if the patient opens the wrong

compartment, a buzzer is triggered as a warning. The Arduino, coupled with a Wi-Fi shield, collects and sends data about patient interactions to the hospital's web portal for monitoring by medical staff. Patients use an Android app to view prescriptions and receive medication reminders directly on their smartphones. The system not only provides timely alerts for medicine intake but also notifies guardians or caregivers of any irregularities in patient behaviour or vital sign changes.

S .Y. Sohn, et. al. [9] presents an IoT-enabled self-alarm medication system designed to assist elderly patients in taking their medication on time using smart pill bottles equipped with weight sensors and image processing technology. The system architecture comprises three main modules: the sensor module, the classifier module, and the alarm module. In the sensor module, a digital scale continuously records the weight of the pill bottle 24 hours a day, while a connected video camera captures the display of the scale. Image processing techniques extract weight data from the video feed, which is used to detect changes in medication usage. The classifier module analyzes variations in pixel information from the video to determine whether medication has been consumed, comparing the current weight to preset baseline values for the bottle and an individual pill. A ten-minute interval is used to validate the action, accounting for user response time. If no weight change is detected, the system assumes the patient has missed a dose. The alarm module then issues a reminder message to the patient, whereas successful intake results in no notification. The system also experimented with using an accelerometer to detect bottle shakes, but due to inconsistent motion patterns across users, this method proved less reliable than weight-based tracking. In a user satisfaction survey involving 10 participants aged 20 to 60, the system scored an average satisfaction rating of 94. Most users reported improved punctuality in medication intake, though some noted limitations in mobility and expressed that the alert messages lacked urgency. Despite minor drawbacks, the system demonstrates strong potential for improving adherence and supporting home care services through intelligent, non-invasive monitoring.

III. COMPARATIVE ANALYSIS

Table 1 provides a brief overview of research papers that utilize IoT-based solutions to improve medication adherence. It highlights the key technologies, system components, and reminder mechanisms used to support timely medication intake, especially for elderly and memory-impaired patients.

Table 1: Analysis Table

Ref	Technical Approach & Architecture	Key Components & Features	Target Users & Use Case	Unique Contributions
[4]	Combines IoT sensors, cloud processing, and machine learning within a three-tier structure	Uses YOLOv4 on Colab for pill detection and recognition; IFTTT API with button sensors for reminders	Patients needing automated medication tracking and inventory control	Implements a multi-stage solution that improves adherence by detecting pills, tracking inventory, and sending timely alerts
[5]	Integrates a smart pill dispenser with a mobile application for a coordinated workflow	Incorporates a secure locking dispenser, multi-channel reminders (notifications, LED, LCD, buzzer), and wireless scheduling by pharmacists	Elderly individuals, including those with cognitive or sensory impairments requiring secure medication delivery	Emphasizes real-time remote monitoring and controlled access, reducing caregiver involvement and enhancing medication safety
[6]	Develops a low-cost, embedded IoT solution for medication	Centers on a Node MCU (ESP8266) paired with LDR sensors, magnet reed switches, and DC motors to automate	Memory-impaired and financially constrained elderly, focusing on affordability and ease	Demonstrates that affordable technologies can provide effective real-time monitoring and automated

	management	medicine box operations	of use	reminders
[7]	Merges automated dosage control with continuous health monitoring in an IoT framework	Utilizes a specialized medicine box, and sensors tracking vital health metrics (e.g., blood pressure, ECG), with database analytics for threshold alerts	Elderly patients with chronic conditions who benefit from integrated health monitoring alongside medication adherence	Integrates health parameter tracking with medicine scheduling to trigger early interventions and reduce human error
[8]	Uses an Arduino-based system with wireless connectivity paired with smartphone integration	Features a compartmentalized pill box with LED indicators, buzzer alarms, and real-time data transfer via an ESP8266 module to a hospital portal	Patients requiring detailed medication management with oversight from caregivers and healthcare providers	Provides a dual approach, combining visual and audible alerts with an Android app for comprehensive monitoring and communication
[9]	Leverages sensor fusion and image processing to monitor pill usage through non-invasive methods	Combines weight sensors with digital scale data and video-based image analysis to validate medication intake; also experimented with accelerometers	Elderly users and broader home care scenarios where adherence is critical; validated with user satisfaction surveys	Introduces a self-alarm mechanism based on weight change detection, achieving high user satisfaction and reinforcing timely reminders

IV. CHALLENGES

A. *Data Privacy, Security, and Confidentiality*: The use of IoT in healthcare demands the handling of highly sensitive personal health data. In the case of IoT-enabled medication reminders, devices continuously collect, store, and transmit patient data such as medication schedules, adherence logs, and sometimes even biometric health metrics. Without robust encryption and access controls, there is a significant risk of unauthorized access or data breaches. This is particularly critical because any compromise of medical information can not only lead to identity theft or fraud but may also affect patient trust in using such technologies. Ensuring end-to-end data protection and compliance with healthcare regulations like HIPAA or GDPR is a complex yet essential aspect of IoT integration in medication management systems [10].

B. *Usability and Technical Literacy Among Elderly or Vulnerable Populations*: IoT devices often require users to interact with mobile apps, receive notifications, or understand indicator signals like buzzers or LED lights. For elderly users or individuals with cognitive impairments, low vision, hearing loss, or limited exposure to digital technologies, these tasks can be confusing or overwhelming. If the interface is not intuitive, or if support and guidance are not readily available, these users may avoid using the system altogether, reducing its intended benefit of improving adherence. Designing user-friendly, accessible systems that cater to diverse needs—such as voice alerts, tactile buttons, or caregiver support features—is crucial [11].

C. *Energy Consumption and Power Management*: Most IoT-enabled medication reminders rely on battery-powered microcontrollers (like NodeMCU or Arduino), sensors (e.g., weight or light sensors), and wireless modules (e.g., Wi-Fi or Bluetooth) to operate. These components, when running continuously to track and transmit data in real time, can quickly drain power. Frequent recharging or battery replacement can be inconvenient, especially for elderly patients who may forget or struggle with maintenance tasks. Energy-efficient design and power optimization strategies—like deep sleep modes or low-power components—must be incorporated to ensure long-term usability without regular intervention [12].

D. *User Convenience and Interface Complexity*: The effectiveness of any health technology depends on how seamlessly it fits into the user's daily routine. If an IoT-enabled reminder system requires too many steps to set up or operate, such as configuring Wi-Fi, managing passwords, syncing with apps, or understanding multi-stage instructions, users may find it burdensome. This complexity can hinder adoption and diminish adherence benefits. Simple plug-and-play setups, automated scheduling, and remote configuration by caregivers or health providers can greatly enhance usability and acceptance [13].

E. *Integration with Healthcare Systems and Caregiver Support:* For these systems to be truly impactful, they must not function in isolation. Integration with electronic health records (EHRs), pharmacy databases, or caregiver dashboards ensures that all stakeholders—patients, caregivers, and clinicians—are aligned. However, interoperability issues, inconsistent standards, and lack of technical infrastructure can limit such integration. If reminders are not accurately synchronized with updated prescriptions or if caregivers cannot receive real-time alerts, the system's efficiency is compromised.

F. *Cost and Accessibility Barriers*: While IoT devices are becoming more affordable, initial setup costs and ongoing maintenance may still be a barrier, particularly in low-income or rural areas. For a solution to be widely adopted, it must be cost-effective without compromising quality. Governments, NGOs, or healthcare institutions may need to step in with subsidized solutions, awareness campaigns, or community support programs to bridge the accessibility gap.

V. FUTURE SCOPE

The future of IoT-enabled medication reminders lies in creating smarter, more personalized systems that support precision monitoring. With advancements in sensor technology and AI integration, future devices can track not only whether a dose was taken but also how the medication is affecting a patient's vital signs in real time. These systems could alert caregivers or doctors immediately in case of missed doses or unusual health patterns, allowing for early interventions. Additionally, by analyzing adherence trends and health data over time, these devices can offer adaptive reminders tailored to each individual's habits and medical needs, making healthcare more proactive and precise.

Another promising direction is the focus on energy-efficient, user-friendly, and inclusive design. Future IoT devices will likely use ultra-low-power components and smart charging solutions to reduce the need for frequent maintenance. For elderly users or those unfamiliar with technology, interfaces will become more intuitive—featuring voice commands, automated notifications, and integration with wearable devices or smart home assistants. Accessibility features like language support, tactile feedback, and caregiver sync will make these systems more inclusive. As healthcare moves toward home-based solutions, IoT medication reminders will play a key role in supporting independent living while ensuring safety and adherence.

CONCLUSION

This comprehensive review emphasizes the promising role of IoT-enabled medication reminder systems in enhancing medication adherence and supporting better healthcare outcomes. The reviewed literature indicates a steady rise in research interest, showcasing the growing recognition of medication adherence as a critical component of healthcare that deserves attention comparable to other clinical interventions. A wide array of IoT-based systems—including sensor-driven solutions, smart dispensers, vision-based tracking, fusion models, and proximity detection technologies—have been explored, each offering unique strengths and inherent limitations. These systems enable real-time tracking, scheduled reminders, and remote monitoring, providing patients with timely prompts and caregivers with essential insights, all of which contribute to more effective medication management. Nevertheless, challenges such as data security, high deployment costs, user-friendliness for elderly populations, and limited energy efficiency continue to present barriers to implementation. Despite these issues, the evidence supports the continued development and refinement of IoT-based solutions as a viable path toward improved medication adherence. Future efforts should focus n addressing the existing technological gaps and validating the long-term effectiveness and scalability of these systems in real-world healthcare environments.

REFERENCES

[1] Jana A, Chattopadhyay A (2022) Prevalence and potential determinants of chronic disease among elderly in India: Rural-urban perspectives. *PLOS ONE* 17(3): e0264937. doi: 10.1371/journal.pone.0264937.

[2] Bhattarai B, Bista B, Shrestha S, Budhathoki B, Dhamala B. Contributing Factors of Non-Adherence to Treatment among the Patients with Type II Diabetes Mellitus. *Journal of Manmohan Memorial Institute of Health Sciences*. 2019 May 14;5(1):68-78.

[3] Afriyie GE. "Non-Adherence to Medication and Associated Factors among Type 2 Diabetes Mellitus Patients Attending Tema General Hospital" (Doctoral dissertation, University of Ghana).

[4] R. Aparna, K. S. Aravinda Kashyap, S. K R, S. R B, J. E. Rao and S. M, "MediSync: An IoT and ML-Powered Medication Adherence Solution," *2023 7th International Conference on Computation System and Information Technology for Sustainable Solutions (CSITSS)*, Bangalore, India, 2023, pp. 1-6, doi: 10.1109/CSITSS60515.2023.10334070.

[5] R. Boudrali and R. Boudour, "An IoT-Based Pill Management System for Elderly," *Informatica*, vol. 46, pp. 457–468, 2022, doi: 10.31449/inf.v46i4.4195.

[6] P. A. Harsha Vardhini, M. S. Harsha, P. N. Sai and P. Srikanth, "IoT based Smart Medicine Assistive System for Memory Impairment Patient," *2020 12th International Conference on Computational Intelligence and Communication Networks (CICN)*, Bhimtal, India, 2020, pp. 182-186, doi: 10.1109/CICN49253.2020.9242562.

[7] P. Ranjana and E. Alexander, "Health Alert and Medicine Remainder using Internet of Things," *2018 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC)*, Madurai, India, 2018, pp. 1-4, doi: 10.1109/ICCIC.2018.8782349.

[8] M. Srinivas, P. Durgaprasadarao and V. N. P. Raj, "Intelligent medicine box for medication management using IoT," *2018 2nd International Conference on Inventive Systems and Control (ICISC)*, Coimbatore, India, 2018, pp. 32-34, doi: 10.1109/ICISC.2018.8399097.

[9] S. Y. Sohn, M. Bae, D. -k. R. Lee and H. Kim, "Alarm system for elder patients medication with IoT-enabled pill bottle," *2015 International Conference on Information and Communication Technology Convergence (ICTC)*, Jeju, Korea (South), 2015, pp. 59-61, doi: 10.1109/ICTC.2015.7354494.

[10] Rasool, R. U., Ahmad, H. F., Rafique, W., Qayyum, A., & Qadir, J.(2022). Security and privacy of internet of medical things: A contemporary review in the age of surveillance, botnets, and adversarial ML. *Journal of Network and Computer Applications*, 201, 103332. doi: 10.1016/j.jnca.2022.103332.

[11] Coughlin, J. F., D'Ambrosio, L. A., Reimer, B., & Pratt, M. R. (2007). Older adult perceptions of smart home technologies: Implications for research, policy & market innovations in healthcare. *2007 29th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, pp. 1810–1815. doi: 10.1109/IEMBS.2007.4352665.

[12] Nižetić, S., Šolić, P., González-De, D. L.-I., & Patrono, L. (2020). Internet of Things (IoT): Opportunities, issues and challenges towards a smart and sustainable future. *Journal of Cleaner Production*, 274, 122877.

[13] Perković, T., Damjanović, S., Šolić, P., Patrono, L., & Rodrigues, J. J. P. C. (2020). Meeting challenges in IoT: Sensing, energy efficiency, and the implementation. In X.-S. Yang, S. Sherratt, N. Dey, & A. Joshi (Eds.), Fourth International Congress on Information and Communication Technology (Vol. 1041, pp. 419–430). Springer Singapore. doi: 10.1007/978-981-15-0637-6_36.