ONLINE ISSN: 3007-3197 | PRINT ISSN: 3007-3189

http://amresearchreview.com/index.php/Journal/about

Annual Methodological Archive Research Review
http://amresearchreview.com/index.php/Journal/about
Volume 3, Issue 6 (2025)

Smart Pill Dispenser: An IoT Based Medicine Alert and Dispensing System with Remote Monitoring and Management of Drugs

Hiba Pervaiz [1], Natasha Mukhtiar [2 *], Kaswa Memon[3], Barkha Kumai [4], Laiba[5], Maria Memon [6], Saeed Ahmed [7]

Article Details

Keywords: Medication, Healthcare, Alert System, dispensing system, Internet of Things (IoT), geriatric people

Hiba Pervaiz
Institute of Biomedical Engineering and Technology, Faculty of Basic Medical Sciences, Liaquat University of Medical & Health Sciences, Jamshoro, 76090, Pakistan
Natasha Mukhtiar (Corresponding Author)
Lecturer, Institute of Biomedical Engineering and Technology, Faculty of Basic Medical Sciences, Liaquat University of Medical & Health Sciences, Jamshoro, 76090, Pakistan
Email: natasha.mukhtiar@lumhs.edu.pk
Kaswa Memon
Institute of Biomedical Engineering and Technology, Faculty of Basic Medical Sciences, Liaquat University of Medical & Health Sciences, Jamshoro, 76090, Pakistan
Barkha Kumai
Institute of Biomedical Engineering and Technology, Faculty of Basic Medical Sciences, Liaquat University of Medical & Health Sciences, Jamshoro, 76090, Pakistan
Laiba
Institute of Biomedical Engineering and Technology, Faculty of Basic Medical Sciences, Liaquat University of Medical & Health Sciences, Jamshoro, 76090, Pakistan
Maria Memon
Institute of Biomedical Engineering and Technology, Faculty of Basic Medical Sciences, Liaquat University of Medical & Health Sciences, Jamshoro, 76090, Pakistan
Saeed Ahmed
Lecturer, Institute of Biomedical Engineering and Technology, Faculty of Basic Medical Sciences, Liaquat University of Medical & Health Sciences, Jamshoro, 76090, Pakistan

ABSTRACT

Individuals gradually lose their vision and memory with aging, and they may also fail to take their medications on time, which is harmful to their health. Sorting medications for elderly patients is difficult and can be challenging. The fact that those in charge of arranging large quantities of medication for elderly patients make countless negligent in medical dosage and it is challenging for elderly patients to remember their medication. To overcome these hurdles a prototype of pill dispenser device that can release the tablets without the caregiver intervening is created. The pill dispenser is recommended for use by emergency rooms, hospitals, individuals who take ongoing prescriptions, and geriatric people with different diseases. Smart pills Alert and dispensing system is based on internet of things which will be controlled by caretaker remotely, the doctor or caregiver will preset the prescribed time (morning, evening and night) of the medicine at distance which will reduce the full time intervention of caretaker. The Smart pill alerts and dispensing system will alert the patient at the designated time to take their prescription. Additionally, the consists of buttons which will avoid opening of dispenser by infants. As soon as, patient unlocks the dispenser, the right pill will be released. The caretaker has control over the timing of the pills due to the program of this dispenser which is based on Internet if Things (IoT). It also has an alarming system that may remind the patient about their pills. This one will self-dispense pills. The application displays alarms for taking prescriptions, showing "Morning Dose Time," "Evening Dose Time," and "Night Dose Time" when time approaches.

INTRODUCTION

According to estimates, more than 100,000 persons per year in the United States die naturally in part as a result of not following treatment recommendations [1]. As concerning to one in five (21%) patients do not follow their medication, and 1 out of ten (10%) patients do not take their medication as directed [2]. There may be many people out there that require ongoing assistance, including the elderly, family members, and persons with special needs [3]. Six percent of patients out of twenty are unable to acknowledge their own medications [4]. Medication is used to enhance well-being and lower injury and mortality rates [5]. If drugs are utilized cautiously and effectively to treat the condition, result progressive [6].

By preventing prescription errors, the ultimate focus of health care services is to maintain wellness of patients [7]. Elderly patients with dementia who are taking medication need assistance from any caregiver with their daily pills [8]. Elderly people, however, are greatly impacted by medication schedules, and because ageing is accompanied by declining vision and memory, they frequently forget to take their regular medications [9]

Healthcare professionals may suggest reducing the number of medications prescribed, utilising pill organizers or other reminder devices, including carers in medication administration, and addressing any underlying cognitive or sensory deficits to resolve this issue [10]. Additionally, it is crucial to regularly assess and modify medication schedules to make sure they are appropriate for the patient's medical conditions and general state of health [11].

This prototype controls when patients take prescription medication, is based on an ESP32.The timing and dosage are set up according to the doctor's instructions remotely. The pill dispensing system is "smart" since it is simultaneously managed and operated without theregular interruption of a caregiver. Additionally, the automatic distribution of pills from the slot includes button lock mechanism to identify the patient, preventing interference from children and minimizing medication waste, as well as the addition of a buzzer to remind patients to take their medications. The pill dispenser will only dispense the recommended medication, making it easier for people with impaired vision to recognize the medication.

The prototype is in considerable interest since it may be used in homes, hospitals, andsenior centers where patients require additional care. It will be especially useful in such environments because it can regulate patient medication timing, reducing their need to worry about our patients. Due to the fact that they must manage numerous medications. The caretaker's workload will be minimized, and time will be saved with this technology [12].

In 2012, the remotely programmable smart pillbox was developed in which the pillbox does have a web application that the doctor, nurse, or caregiver can use to configure and monitor the pillbox [13]. In 2015, Italy developed smart pill dispenser, the technology automatically identifies patients and updates the carer on pill uptake activities via the smart phone, simplifying data transfer between the dispenser and the patient [4]. In 2016, medicine reminder machine was designed. Concept suggests a Wireless wristband and a medical alert device for domestic use [7]. In 2017, a low-cost pill dispensing system was introduced that was easy to use, portable and provides patient care with health practitioner-prescriped medication. This affordable system was designed to dispense medication automatically by programming in the background [9]. In 2018, the smart medicine reminder device was designed specifically for elderly people. The Novelty of the design was its architecture, it uses raspberry pi as a micro-controller and it is IoT based system [3]. In 2019, Medication dispenser was developed which was controlled by small servo motors to push the medicine towards the consumer [14]. In 2020, work on Artificial intelligence was done and smart pill system which is IoT based

was developed. Design is unique in that it was an AI-based IoT system. The proposed system intends to assist each individual and institution that is reliant on medicine by providing expertise in real-time diagnosis [15]. In 2021, Intelligent medication box with medication monitoring and reminder system for elderly people was developed. The suggested medicationis considerably safer because it clearly conveys information about time, dosage, and drug stock. It also arranges various pills in the appropriate sub boxes for the next fill by the caregiver. The novelty of this box was that it will maximum 3 times alert the patient [16]. In 2022**, S**mart medicine system was developed, the system was totally IoT based and they specifically designed it for elderly patients. The novelty of the system was that in order to check a patient's medication compliance, this project was created using amagnetic switch sensor and an FSR sensor as its primary components [17].

METHODOLOGY

There are two significant modules that make up the proposed smart pill alert and dispensing system;the dispensing system and the alarm system. The alarm system is controlled remotely via telehealth by the caregivers or specialist, as shown in figure (1) and it will operate in accordance with the prescribed hours and days. The alert system, on the other hand, will manage the system that will dispense the medicines.



Figure 1: General diagram of system flow

Hardware Interface

The hardware of the system interfaces with the application, which is controlled by the caretaker. The caretaker places the medication for a week in the slots. The system consists of three slots that are designated for morning, evening, and night doses which are subdivided to carry medicines of a week. According to the doctor's prescription, the medical attendant will place the medications in the slots. The box will be opened in accordance with the caretaker's preset morning, evening, and night times. The alarm system will notify the patient to take the medication at the specified time. The system contains a push buttons to unlock mechanism that will release slots for the administration of medicine.

The hardware is controlled by an ESP 32 microcontroller in the system. When medicine indications are made by leds and a buzzer, two buttons are used to open and close the medicine slots. System interface is provided by a mobile application. The system's block diagram is displayed in Figure (2).

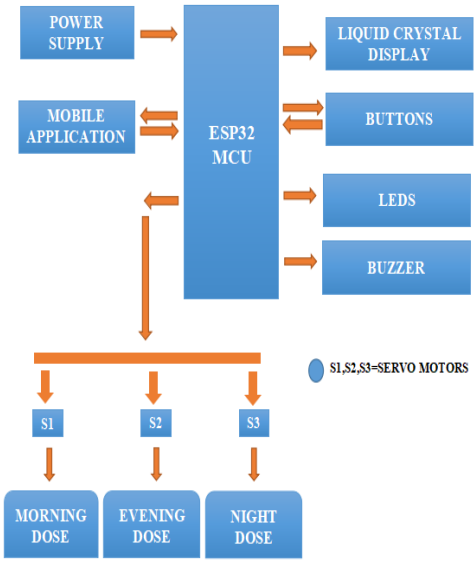


Figure 2: Block diagram of Prototype

Figure (3) displays how the device operates. The device will perform the three main functions:

- Control of dispenser through IoT
- Indication of Pills by Alert system
- Dispense off required medicine by dispenser model.

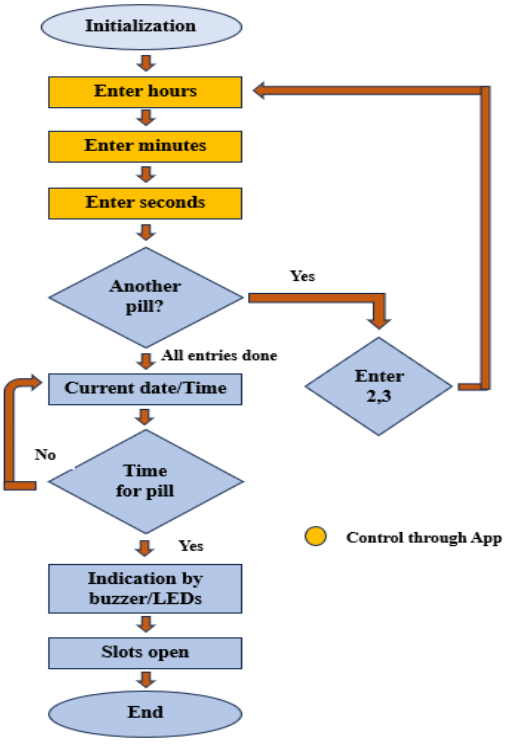


Figure 3: Flow chart

Control of Dispenser through IoT: The internet of things (IoT) is used to operate the smart pill and dispensing system. Doctors and caregiver may easily access data remotely due to the IoT. The provider sets the dosage, time, and quantity of the medication, which helps the dispenser work well.
Indication of Pills by Alert system: The smart pill dispenser uses an alarm system with LED blinking to alert patients about prescribed medicine times. It buzzes the alarm and turns on the LED of the appropriate slot.
Dispense off required medicine by dispenser model: System is initialized by the caretaker. Caretaker must first enter the medication time in the application of the system. As the medicine time draws near, the system will use the current time to indicate it via buzzer or led. The slots open as soon as the patient presses the open button, dispensing the medication. When patient presses the close button the medication is rejected and application displays that information to caretaker. The micro-controller is attached to servo motors that drive the dispenser. The desired medication slot will be opened after the microcontroller sends the appropriate command to the servomotors. Figure (3) shows how the system works.



Figure 4: Final layout of Designed Prototype

Software Interface
An application interface enables the user to track and continuously monitor their medication routine from any location at any time. Even when there is no direct touch, the doctor and carer may keep an eye on the patient thanks to our user-friendly programme. The application shows a broad overview of the medicines that must be taken each day along with their timing after login in.

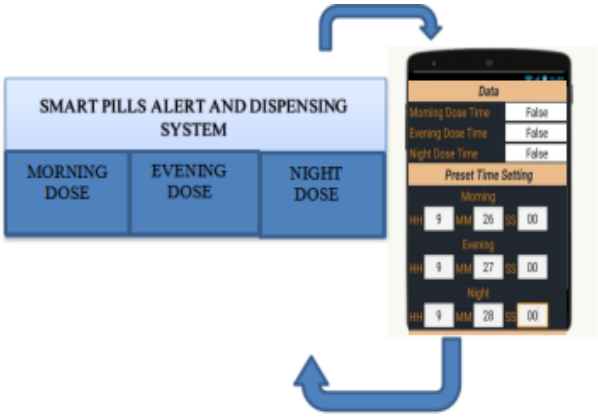


Figure 5: Software Interface

The application is divided into two sections: The data section displays the system's current state, including morning, evening, and night conditions. If a patient takes tablets, the condition is fulfilled, and a voice-text message “dose taken” is sent. If the patient rejects the pill, voice-text message “the dose has been rejected” is sent to informed the carer. The text boxes in the preset time setting will accept integer values as commands. Text boxes allow preset morning, evening, and night dose times, ensuring medication administration without delays. The HH stands for hour, MM for minutes, and SS for seconds in the above diagram. The Smart Pills alert and dispensing system will update as soon as the time is selected and begin dispensing pills in accordance.

RESULTS AND DISCUSSION

The results were obtained by analyzing the interfacing between the system and mobile application. Once time is set to the system via mobile application, the time is recognized and analyzed by system and system alarms the patient and dispense the medicine on required time. The outcome of the project is measured by success rate of pill dispenser.

The application displays an alarm for taking morning, evening, and night prescriptions. It displays "Morning Dose Time", "Evening Dose Time" or “Night Dose Time” when the time approaches. When the patient opens the drawer and takes the medication. The application displays “Morning Dose Taken”, “Evening Dose Taken” or “Night Dose Taken”. “Dose Not Taken is displayed when patient rejects the medication. Figure (6) shows the status of the morning prescription.

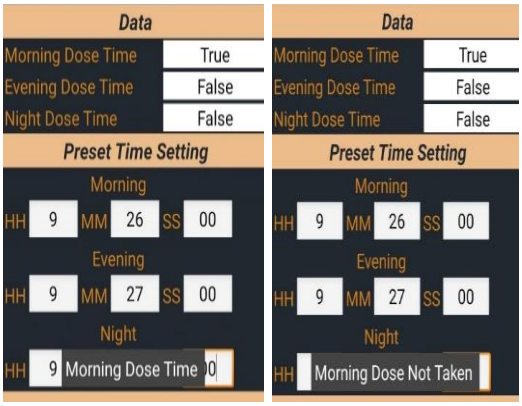


Figure 6: Morning Dose Status

When the time approaches, patients have the choice of taking their prescription or not. There are two red buttons one for accepting medicine and other for its rejection shown in below figure. When patient open the drawer a message ‘pick your pills’ is displayed on LCD. When patient takes the medicine a message ‘Dose Taken’ is display on LCD.

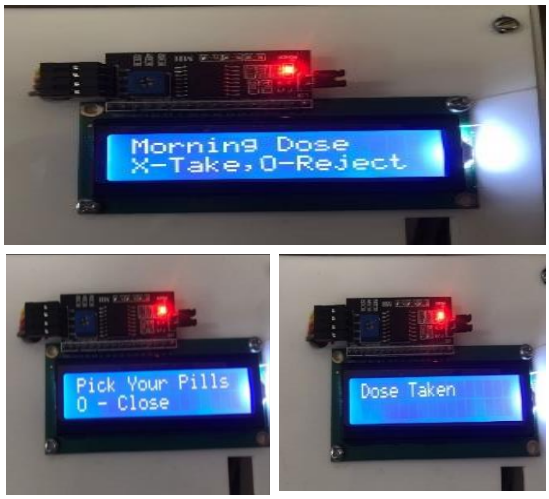


Figure 7: LCD display

The development of smart medicine Reminders have been accompanied by a dramatic rise in the prevalence of the elderly population growth worldwide. The smart pills alert and dispensing system is a tool that uses an alarm to prompt users to take their medications either alone or with the assistance of a carer. IoT, which is still a developing industry, has the potential to significantly alter how we live. IoT will connect individuals and machines, resulting in a more connected way of living.

Elderly people need to take various drugs since their physical and, in rare instances, mental abilities are deteriorating. In light of this, the idea of an IoT-Based Smart Medication Reminder Gadget will present an excellent commercial opportunity. Many studies have revealed that only a very small percentage of elderly people actually remember to take their medicines [18].

This system gradually reminds users to take their drugs in order to assist them follow their prescriptions. It first alerts the patient via a smartphone notice about his or her scheduled medication, and then it does so utilizing the pill dispenser's LCD, LED, and buzzer. The technology in place also makes it possible for the doctor and carer to monitor the patient's intakes. Studies reveal that the elderly value the proposed system and are motivated to take their medications successfully, safely, and without causing any disruption [13].

Smart pills alert and dispensing system is tested at an elderly patient at home who is under the supervision of a single caretaker. Since the caretaker is unable to recall all of the patient's medications and dosages. Following initial authentication of the patient and caretaker, the caretaker refills the medication ones a week as the system can store medicines for a week. Based on the motor controller, the correct drawer will be pushed with the help of servo motors. The drawer has seven sub slots where each slot carries medicine for single time of the day. The development of mobile applications as well as intelligent devices for healthcare services can have the desired possible expansion given the recent dramatic growth in the use of cell phones and mobile apps. Despite the fact that there are numerous mobile applications available for medication reminders, improved all-around smart medicine apps and gadgets are required to assist with proper drug administration and improve medication compliance. When drugs are taken according to the right methods, the severity of going through a difficult moment in a patient's life may be minimized.

The Internet of Things based smart medication reminder device is currently only being created as an Android mobile application. The IoT-Based Smart Medication Reminder Device's lack of a self-developed cellular

connection is another flaw, making it entirely dependent on external connections like the Internet.
The IoT-based smart medicine reminder device has the potential to provide the patient with pill information on the medications they need to take. This offers an additional degree of security because some users might unintentionally take the wrong medication due to an accident or temporary memory loss. Additionally, this IoT-based smart medicine reminder device has a unique selling point in that it can remind consumers visually and aurally. With these extra features, the patient will be more likely to remember to take their meds on schedule. Last but not least, this IoT-Based Smart Medication Reminder Device will be one of the first prescription reminder devices that include IoT.

CONCLUSION

The designed smart pills alert and dispensing system is very effective for patients who have dementia and elderly aged people who forget to take their pills at the correct time which will help patients to take their medicines timely and to avoid any misfortune.

The smart pill alert and dispensing system is reliable in delivering medication timely and accurately. The system assures patients, caregivers, and healthcare providers to deliver medication reminders at designated times, minimizes errors, and ensures that patients receive the right medications at the right time. Patients receive prompt notifications, which lowers the possibility that a dose will be missed, and precise dosages are routinely given. Caretaker can use the system application to remotely check on the status of their medications.

Unlike previous dispensers that required caretaker availability, this system is reliable and user-friendly. It is suitable for Tele-care patients and hospitals, which minimize the need for care taker requirements and allowing patients to be more independent.

FUTUREWORK

There are some ideas to make it more useful. By using the fingerprint lock it is more secure as it provides more safety from children/unknown person. Use of GSM module for SMS communication. This ensures reliable message transmission to the caretaker or doctor when internet access is disrupted. Using the pills counter that counts the pills and gives reminders when there is only one-day medicine is left in the box. Reminder for the replenishment of dispenser box when there is a request after a week for filling of the dispenser. Make it more useful by adding a special box and reminder that can only serve medication and gives a reminder for a specific time These approaches make this prototype more convenient and sophisticated.

REFERENCES

[1] "Smart Pill Dispenser for Aged Patients _ IEEE Conference Publication _ IEEE Xplore."
[2] L. Boquete, J. M. Rodriguez-Ascariz, I. Artacho, J. Cantos-Frontela, and N. Peixoto, "Dynamically programmable electronic pill dispenser system," *Journal of Medical Systems*, vol. 34, no. 3. pp. 357–366, 2010. doi: 10.1007/s10916-008-9248-3.
[3] D. S. Abdul Minaam and M. Abd-ELfattah, "Smart drugs:Improving healthcare using Smart Pill Box for Medicine Reminder and Monitoring System," *Future Computing and Informatics Journal*, vol. 3, no. 2, pp. 443–456, 2018, doi: 10.1016/j.fcij.2018.11.008.
[4] C. Crema, A. Depari, A. Flammini, M. Lavarini, E. Sisinni, and A. Vezzoli, "A smartphone-enhanced pill-dispenser providing patient identification and in-take recognition," *2015 IEEE International Symposium on Medical Measurements and Applications, MeMeA 2015 - Proceedings*, pp. 484–489, 2015, doi: 10.1109/MeMeA.2015.7145252.

[5] J. M. Parra, W. Valdez, A. Guevara, P. Cedillo, and J. Ortiz-Segarra, "Intelligent pillbox: Automatic and programmable Assistive Technology device," *Proceedings of the 13th IASTED International Conference on Biomedical Engineering, BioMed 2017*, pp. 74–81, 2017, doi: 10.2316/P.2017.852-051.

[6] D. Divakar, S. K. Singh, and F. Dkhar, "Smart Medicine Box using IoT with Alarm and SMS Notification," vol. 15, no. 1, p. 2022, 2022.

[7] Y. W. Bai and T. H. Kuo, "Medication adherence by using a hybrid automatic reminder machine," *2016 IEEE International Conference on Consumer Electronics, ICCE 2016*, pp. 573–574, 2016, doi: 10.1109/ICCE.2016.7430735.

[8] H. K. Wu *et al.*, "A smart pill box with remind and consumption confirmation functions," *2015 IEEE 4th Global Conference on Consumer Electronics, GCCE 2015*, pp. 658–659, 2016, doi: 10.1109/GCCE.2015.7398716.

[9] G. A. Mugisha, F. M. Uzoka, and C. Nwafor-Okoli, "A framework for low cost automatic pill dispensing unit for medication management," *2017 IST-Africa Week Conference, IST-Africa 2017*, no. 2002, pp. 1–10, 2017, doi: 10.23919/ISTAFRICA.2017.8102411.

[10] M. Connectivity, "Medication Compliance — Helping Patients," vol. 14, no. 9, pp. 875–880, 2008.

[11] S. Chawla, "The autonomous pill dispenser: Mechanizing the delivery of tablet medication," *2016 IEEE 7th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference, UEMCON 2016*, pp. 2–5, 2016, doi: 10.1109/UEMCON.2016.7777886.

[12] E. Stip, P. D. Vincent, J. Sablier, C. Guevremont, S. Zhornitsky, and C. Tranulis, "A randomized controlled trial with a canadian electronic pill dispenser used to measure and improve medication adherence in patients with schizophrenia," *Front Pharmacol*, vol. 4 AUG, no. August, pp. 1–6, 2013, doi: 10.3389/fphar.2013.00100.

[13] B. Abbey *et al.*, "A Remotely Programmable Smart Pillbox for Enhancing Medication Adherence Department of Occupational Therapy," *In: 2012 25th International Symposium on Computer-Based Medical Systems (CBMS)*, pp. 1–4, 2012.

[14] M. O. Ibitoye, A. O. Raji, and S. O. Nafiu, "Inexpensive automated medication dispenser for persons with neurodegenerative illnesses in low resource settings," *J Med Eng Technol*, vol. 43, no. 8, pp. 451–456, 2019, doi: 10.1080/03091902.2019.1692935.

[15] J. E. Pedi Reddy and A. Chavan, "AI-IoT based Smart Pill Expert System," *Proceedings of the 4th International Conference on Trends in Electronics and Informatics, ICOEI 2020*, no. Icoei, pp. 407–414, 2020, doi: 10.1109/ICOEI48184.2020.9142946.

[16] B. Ayshwarya and R. Velmurugan, "Intelligent and Safe Medication Box in Health IoT Platform for Medication Monitoring System with Timely Remainders," *2021 7th International Conference on Advanced Computing and Communication Systems, ICACCS 2021*, pp. 1828–1831, 2021, doi: 10.1109/ICACCS51430.2021.9442017.

[17] F. Sharmila, M. Nasir, O. A. Hassan, M. Rusydi, and M. Razif, "Smart Medication Adherence System using IoT for Elderly Patient," vol. 3, no. 1, pp. 559–570, 2022.

[18] S. B. Kumar, W. W. Goh, and S. Balakrishnan, "Smart Medicine Reminder Device For The Elderly," *Proceedings - 2018 4th International Conference on Advances in Computing, Communication and Automation, ICACCA 2018*, pp. 1–6, 2018, doi: 10.1109/ICACCAF.2018.8776734.