An Automated and Online-Based Medicine Reminder and Dispenser

Shayla Sharmin, Md. Ibrahim Khulil Ullah Ratan, and Ashraful Haque Piash

Abstract It is important to take the right medications at the right times and in the right amounts. Patients, on the other hand, often fail to take their medications at the times specified in their prescriptions, causing disease or illness to develop more slowly, especially in the elderly or those who are too preoccupied with their job. An automated and online-based medicine reminder and dispenser application is introduced in this paper. A three-part package, an LCD on top of the box, a buzzer, and a multicolored LED light were all included in this unit. This interface also reminds the consumer when it is time to take their medicine. An Android application on this device displays some of the results. The input interface and the output interface are the two components of this mobile app interface. Prescriptions are accepted or modified via the input interface. Empty lists, previous data, and whether or not to take medication are all shown on the data interface. The LED lights and buzzer will switch on when it is time to take medicine, and the LCD will show the prescription at the same time. So that the patient is conscious that drug time has arrived. The proposed method is assessed both quantitatively and subjectively. The results show that the success rate in terms of perfect functioning is 90%, and the participants scored the overall system on average 4.6 out of 5 in subjective assessment.

Keywords IoT · Arduino · Android · Medical dispenser

1 Introduction

People nowadays are susceptible to a variety of diseases, so staying healthy and fit is important and diseases can be prevent by medicines and drugs [1, 2]. Because of today's hectic lifestyles, people often fail to take their medications on time. However, patients must take the right doses at the right time to lead a healthy life, whether they are in a hospital or at home [3]. It is especially important for the elderly because they

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can mismanage and take one medication twice or fail to take the correct one [4, 5]. In certain nations, finding a caregiver for an elderly person is difficult. Adherence to medication refers to the level or degree to which a patient takes the appropriate drug according to a doctor's prescription at the appropriate time. Non-compliance has recently become a major issue, as many studies have shown that non-compliance may have a direct effect on the patient and raise healthcare costs. Medication non-adherence is a long-term, difficult, and costly problem that results in poor patient outcomes and drains healthcare resources [6]. The growing trend of prescription non-adherence can be attributed to a number of factors. Non-compliance is often due to a lack of confidence in the need for medication, a desire to prevent side effects, difficulty handling several dosages per day, or a variety of prescription regimens.

This project created an automatic dispenser that could be controlled by an Android phone, while also considering the importance of a proper intake scheduler, reminder, and monitoring system. The contribution of this work are given below:

- Developed a dispenser which has three compartments containing medicines.
- Proposed a system to remind medicine at the right time via buzzer and light.
- Proposed a model to notify when a storage is low.
- Tracked down whether users have taken their medications or not.
- Evaluated the framework with subjectively and quantitatively.

The following section outlines relevant works in Sect. 2, elaborates the proposed model in Sect. 3, and then implements and analyzes the findings in Sect. 4; before concluding the paper in Sect. 5.

2 Related Works

On the basis of the medication reminder dispenser, various works have been completed [7] recently.

Jabeena et al. [8] used hardboard to build the dispenser and also used GSM to send messages. Ulloa et al. [9] created an IoT-based smart medication dispenser, but this work does not include any warnings about low storage. In 2019, Chawariya et al. carried out a research on medication reminder systems in 2019, but their findings were not applied [10]. Park and Lim [11] and Pak and Park [12] proposed and developed a smart drug dispenser with high scalability and remote manageability. It also allows medical personnel and system administrators to deal with drug dispensers rather than end-users, which saves money and ensures safe device operation.

Ashwini et al. [13] present an Android application for patients that automatically sets reminders in the user's phone to remind them to take the proper medicines in the proper quantity at the proper time. Tiwari et al. [14] suggested robotic platforms that have the potential to extend the user interface's versatility to make personalized experiences more engaging and encouraging, as well as to proactively reach out to elderly users to assist with their healthcare delivery. A multi-robot prototype system that can deliver pills and water to a person in a real-world home environment was proposed by Emeli et al. [15]. The computer consists of a mobile robot with a tray, a stationary dispensing robot, and a smartphone kept by the user.

3 Proposed Methodology

The proposed model is described in detail, as well as the hardware which refers to the medicine dispenser and the software module thus the mobile app, in this section.

3.1 Proposed Approach

There are two sections to the proposed work. One is a hardware module, such as a dispenser, and the other is an Android app that can be mounted on any smartphone. The input in the mobile app includes the name of the drug, the amount, the time, and meal detail, among other things. These inputs will be stored in a text file in JSON format on a cloud server. The data is then processed by the Wi-Fi module and Arduino, and the countdown begins. If it is time for treatment, the prescription will appear on the LCD screen. This is where the user will find the names of all the medicines you've been given, as well as their dosages. The alarm often sounds to warn the user to take his or her medication on time. Figure 1 depicts the suggested technique.

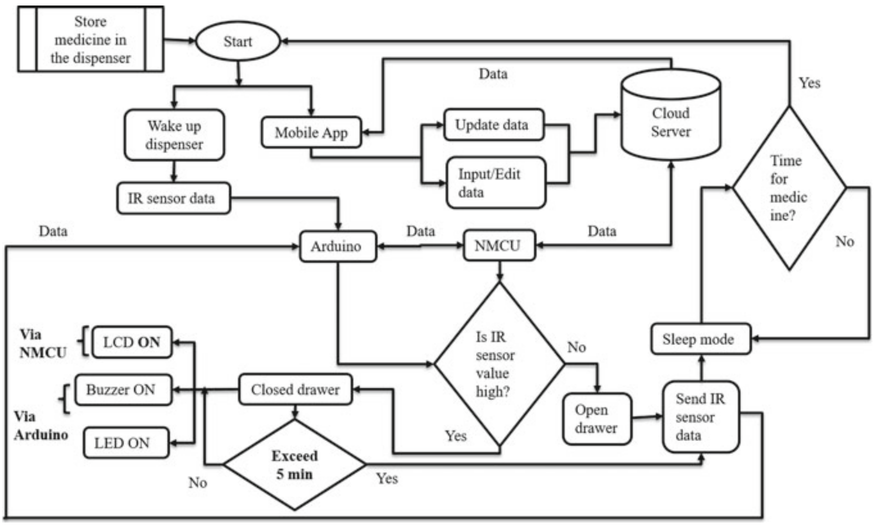

Fig. 1 Process diagram of the proposed medicine dispenser

The proposed medicine box has three drawers that divide one day into morning, noon, and night parts. Each drawer holds a different kind of medication. In addition, each drawer in the box has an LED light that indicates which medication must be taken right now. The various LED lights show the parts of the medication are taking longer. For example, if the LED light in the first drawer turns on, it means that it is time for morning medicine.

The dispenser is initially refilled with medication according to the time. In the mobile app, all of the data was collected at the start. When it was time to take medication, the Arduino-enabled LED lights and a buzzer, assisting the user in taking medicine on time. In addition, at that moment, Node MCU displays the medicine information collected from the cloud on an LCD monitor at the required time. When the user opens the drawer, the value of the IR sensors drops, indicating that the user has opened the drawer to take medication. After the running task of closing the drawer is completed, it will move on to the next task. As a result, the device is up and running, and the user is reminded at the appropriate time. If the drawer is opened within five minutes of the alarm, the system sends the message "yes" to the cloud; if the user does not open it, the system sends the message "no." These messages are stored in the cloud and shown in the mobile app, assisting the user in remembering to take medicine and alerting the caregiver that his or her patient is having difficulty taking medications. When the dispenser storage becomes zero, the Arduino activates the LED light at the top of the package, as well as the buzzer, to notify the consumer that medicine storage is limited. If the drawer is opened, the inventory status in the app will be changed.

The data from each drawer is saved in the cloud server after it is opened and closed. These data can be seen in the mobile app, and the prescription can also be changed through the app.

3.2 Designing of the Medical Dispenser

The medicine dispenser is permitted to store the medications and remind the patient when it is time to take them. It also alerts the customer when storage space is running low. An Arduino, a Wi-Fi module, IR sensors, a buzzer, an LCD monitor, and an LED are all included in the dispenser's configuration. The Arduino uses a cloud server to transfer data from the IR sensor to an Android app, which is then used to decide if the medicine door has been opened or not. The Node MCU connects the box to the cloud server and displays medicine data on the LCD panel.

Figure 2 shows the structure of the proposed medicine dispenser. Figure 2a shows the front view of the dispenser and an Android mobile which has the installed medicine reminder app Fig. 2b shows the top view of the dispenser showing all the circuit components.

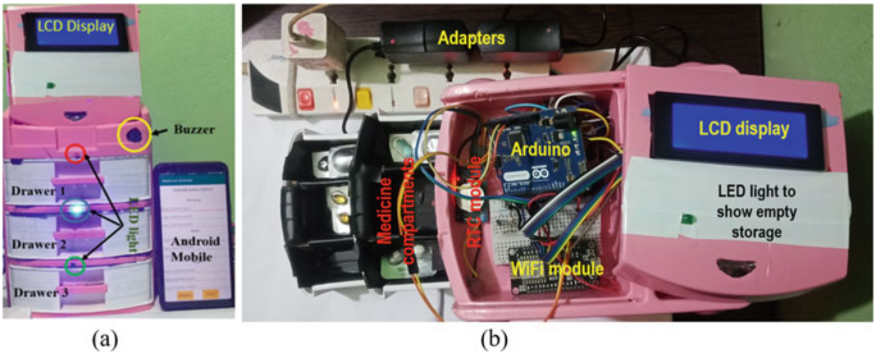

Fig. 2 Proposed model **a** front view **b** top view

3.3 Designing the Mobile App

The mobile app has two interfaces: one is an input interface for taking detailed medication information, and the other is an output interface that displays inventory status and whether or not the drug has been taken.

In this input interface, the user is allowed to insert medicine name, time, unit along with the amount of medicines loaded. Figure 3a shows the input interface indicating the fields. Figure 3b shows the Data interface. It shows how the user can track down his/her medication.

After entering the users' details, this data interface allows them to view the inventory and prescription. If the drawer is opened, the Node MCU sends a "yes" message to the server, otherwise "no," and the app retrieves the medication consumption status. If the system receives a "yes," it will change the inventory by decreasing the amount of medication the user has taken and notifying the user that medicine has been taken, indicating "yes." If the system does not receive a "yes," the inventory will not be changed and the status will remain "no." The flowchart Fig. 4 depicts the medication monitoring process.

4 Implementation and Result

In this section the implementation of the propose method and result analysis have been described.

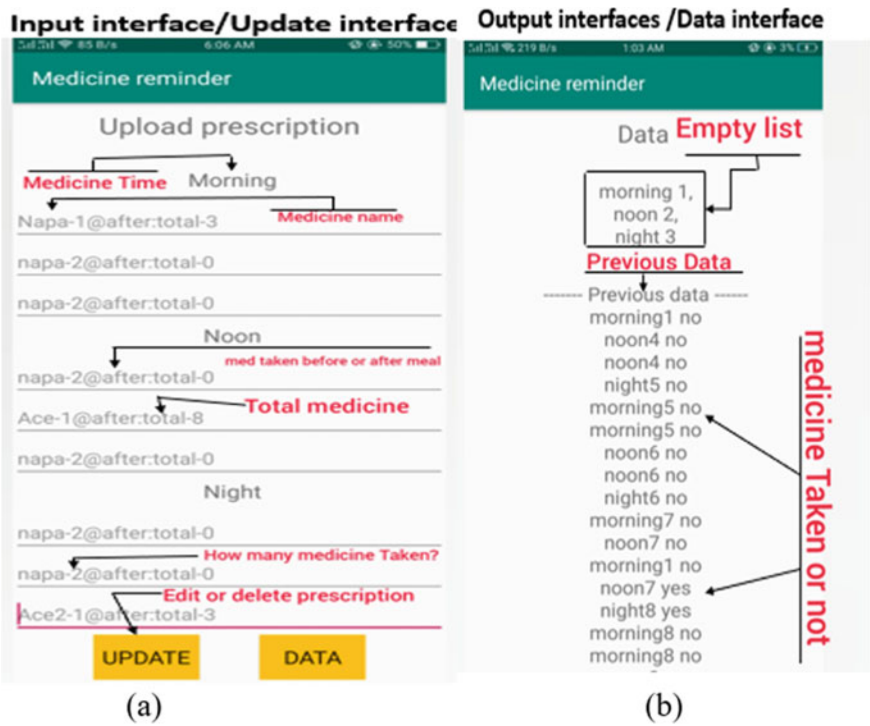

Fig. 3 Mobile app: **a** input medicine information **b** showing inventory and medicine consumption status

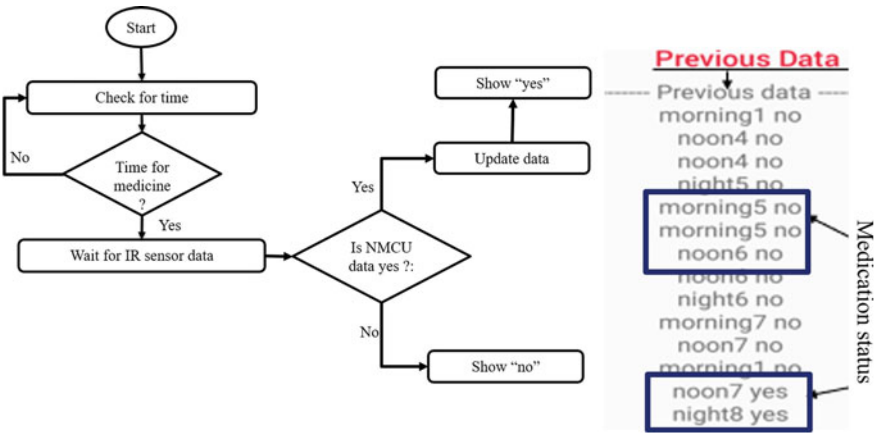

Fig. 4 Mobile app: tracking medication and updating inventory status

4.1 Implementation

To implement the proposed methodology a dispenser box has been installed at a particular place and the app is installed in at least two mobile phone. Figure 5a shows that it is time for medicine at noon as the middle drawer light is shown. Also the LCD is showing which medicine need to be taken. Figure 5 shows the alert when the dispenser is out of medicine. Figure 6a shows the initial inventory status of the dispenser, (b) shows that updated inventory status and (c) shows the message "yes" that means the user has taken the medicine. On the other hand, Fig. 7a shows the initial inventory, (b) shows that the inventory has not been updated, and (c) shows the message "no" that has been shown which refers that the user did not take the medicine.

4.2 Experimental Environment and Result Analysis

The main goal of this project is to create a medical reminder dispenser that is simple to use and keeps accurate track of medication. There is a box in this proposed architecture that holds medicines that the consumer has allocated. The patient's and caregiver's phones both have an Android app installed. For the assessment of the proposed method, both subjective and quantitative analysis were used.

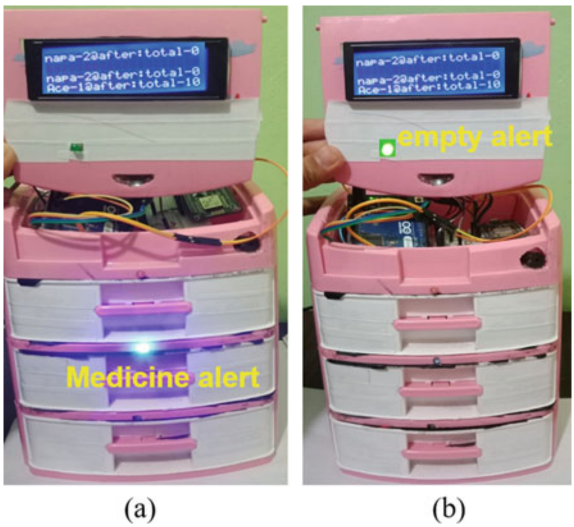

Fig. 5 Medicine dispenser **a** medicine consumption alert **b** empty storage alert

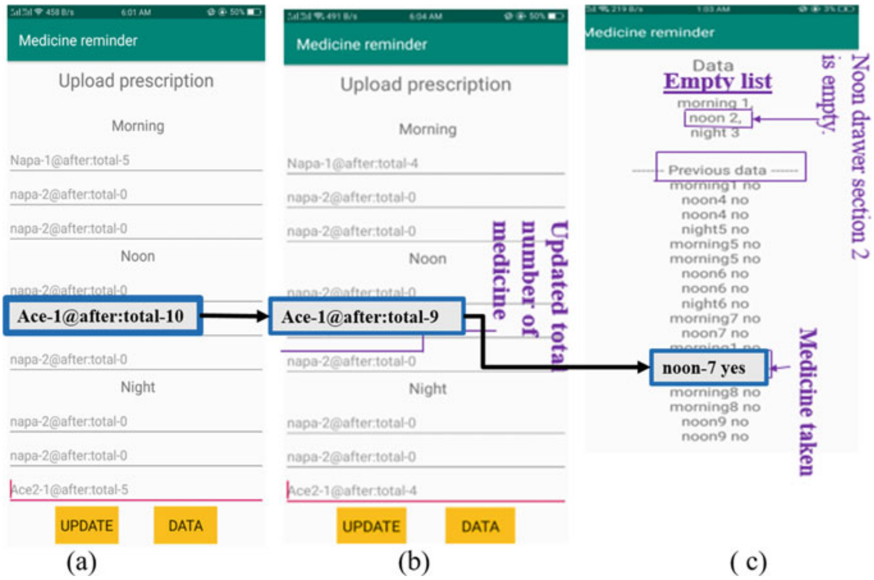

Fig. 6 Mobile app **a** initial inventor **b** updated inventor **c** medicine consumption status ("yes")

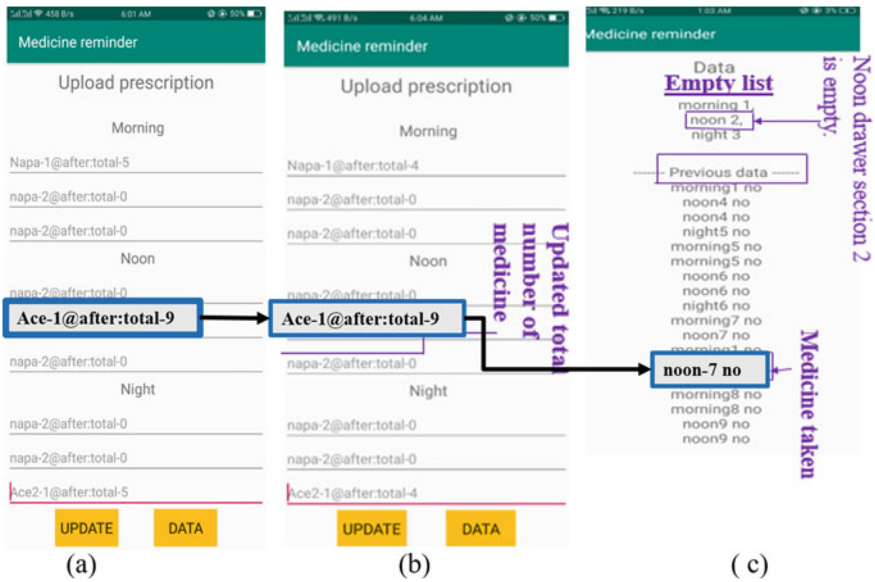

Fig. 7 Mobile app **a** initial inventor **b** unchanged inventor **c** medicine consumption status ("no")

4.2.1 Experimental Setup and Configuration

The dispenser was placed in the Tilpapara, Khilgaon, Dhaka-1219, Bangladesh, to evaluate our proposed system. We also installed the Android app in patient's and caregiver's mobile. To build this dispenser, we used Arduino leonardo, Wi-Fi module (ES8266), IR sensor, breadboard, box, buzzer, LCD display, LED, etc. The box is made of plastic with three drawers where we planned to put the medicines.

4.2.2 Participant

The proposed approach was evaluated by a total of ten patient participants. Every participant's home had the device installed for one day. The patient's phone and their caregiver's phone have both been updated with the mobile app (son, daughter, etc.). In general, two apps were installed on each unit, and the assessment included ten patients and ten caregivers.

4.2.3 Subjective Evaluation

To evaluate the system subjectively, the patients and the caregivers were given questionnaires. The participants were asked to evaluate the system by 1–5 scale Likert scale where 1 refers low and 5 represents high, and three questions that have been asked are listed below:

- Did you find that system provides accurate timing and information?
- Did you think that you without prior theoretical knowledge this system is easy to use?
- Rated overall expression on this system.

The outcome is depicted in Fig. 8. The average score for questions from patients and caregivers is 4.6, indicating that the system's time management and information delivery were satisfactory. When it came to providing theoretical expertise, the caregiver scored slightly higher (4.7) than the patients (4.3). The average score from both the patient and the caregiver was 4.6 and 4.7, respectively.

4.3 Quantitative Analysis

Patients and caregivers were allowed to use the six features of our project for quantitative analysis. The total number of attempts was twenty. Eighteen attempts were successful, and two attempts were unsuccessful because of power failure. As a result, it is concluded that project's success rate is 90%. The quantitative evaluation analysis is given in Table 1.

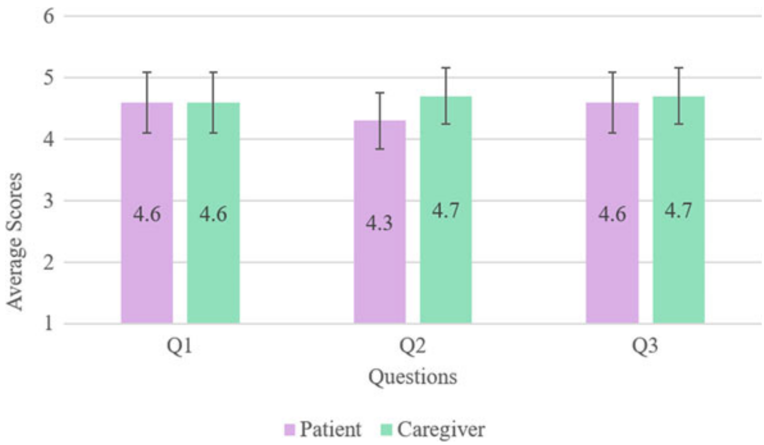

Fig. 8 Mean value of Q_1, Q_2, and Q_3 where error bar shows the standard deviation

Table 1 Quantitative analysis

# of Participants		Total attempts, T_N	Successful attempts, T_S	Unsuccessful attempts
Patient	Caregiver			
10	10	20	18	2
Success ratio = $\frac{T_S}{T_N} * 100\% = 90\%$				

4.4 Comparison with the Previous Work

We have introduced some new features which minimize the limitation of the previous works which is given in Table 2.

Table 2 Comparison with previous works

Features of previous works	Features of the proposed model
Used hardboard to build the dispenser and also used GSM to send messages [8]	Used a plastic box and Wi-Fi module which is more convenient
Did not give low storage warning [8–10]	Low storage alarm has been introduced
Developed only a Android application [13]	Developed both a dispenser and Android application
Emphasized only on elder people [14]	Kept in mind all ages

5 Conclusion

The key focus of the project is the development of a reminder system for elderly and busy people who often fail to take their medications on time. This proposed system focuses on a modern technology-based drug system. The reminding system aims to raise awareness among the elderly and workaholics by providing services that enable them to live a comfortable and stress-free life. By defining such a crucial problem, the proposed structure defines core features of the work. The device is capable of meeting requirements in any way. The proposed framework can be used everywhere. There is no need to put this in a specific location. As a consequence, the subject of setting space is unimportant. As a consequence, it is really simple to set up and use. This device's primary function is to remind them to take their drugs at the appropriate times. The participants gave the systems an average of 4.6 out of 5 for overall results, with 90 % accuracy based on providing medicine information in real time via buzzer and light. We attempted to keep the cost of this device reasonable, and the project's overall cost was 3340 BDT (39 USD).

While the proposed methodology works flawlessly, it does have some flaws, such as the possibility of it ceasing to operate due to a power outage. A Lipo battery can be used to solve this issue. The mobile app is missing details, such as a medication timer warning, which should be included. To make the framework more user friendly, it is intended to create a multi-user app and redesign the mobile interface to make it easier to understand. In addition, potential work will include automatic drawer opening and closing.

References

1. Tsai PH, Shih CS, Liu JWS (2011) Mobile reminder for flexible and safe medication schedule for home users. In: International conference on human-computer interaction, pp 107–116
2. Tsai PH, Yu CY, Wang MY, Zao JK, Yeh HC, Shih CS, Liu JWS (2010) iMAT: intelligent medication administration tools. In: The 12th IEEE international conference on e-health networking, applications and services, pp 308–315
3. Kader MA, Uddin MN, Arfi AM, Islam N, Anisuzzaman M (2018) Design & implementation of an automated reminder medicine box for old people and hospital. In: 2018 International conference on innovations in science, engineering and technology (ICISET), pp 390–394
4. Ahmad S, Hasan M, Shahabuddin M, Tabassum T, Allvi MW (2020) IoT based pill reminder and monitoring system. Int J Comput Sci Netw Secur 20:152–158
5. Kumar SB, Goh WW, Balakrishnan S (2018) Smart medicine reminder device for the elderly. In: 2018 Fourth international conference on advances in computing, communication & automation (ICACCA), pp 1–6
6. Dharmoji S, Patil A, Anigolkar A (2020) Design of smart medicine reminder (SMR) box with an android application. Int J Innov Res Sci Eng Technol 9:4207-4214
7. Suwanthara J, Noinongyao A, Vittayakorn S (2019) WiseMed: medication reminder for seniors. In: 2019 23rd International computer science and engineering conference (ICSEC), pp 409–414
8. Jabeena A, Sahu AK, Roy R, Basha N (2017) Automatic pill reminder for easy supervision. In: 2017 International conference on intelligent sustainable systems (ICISS), pp 630–637

9. Ulloa GG, Hornos MJ, Dominguez CR, Coello MF (2020) IoT-based smart medicine dispenser to control and supervise medication intake. Intell Environ 28:39–48
10. Chawariya A, Chavan P, Agnihotri A (2019) Fundamental research on medication reminder system. Int Res J Eng Technol (IRJET) 6
11. Park K, Lim S (2012) Construction of a medication reminder synchronization system based on data synchronization. Int J Bio-Sci Bio-Technol 4:1–10
12. Pak J, Park K (2012) Construction of a smart medication dispenser with high degree of scalability and remote manageability. J Biomed Biotechnol 2012:381493–381503
13. Ashwini B, Sapna K, Ishwari B, Pallavi P, Achaliya PN (2013) An Android based medication reminder system based on OCR using ANN. Int J Comput Appl 975:8887
14. Tiwari P, Warren J, Day K, MacDonald B, Jayawardena C, Kuo IH, Igic A, Datta C (2011) Feasibility study of a robotic medication assistant for the elderly. In: Proceedings of the twelfth Australasian user interface conference, vol 117, pp 57–66
15. Emeli V, Wagner AR, Kemp CC (2012) A robotic system for autonomous medication and water delivery. Georgia Institute of Technology