International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 6, Issue 2, 2019

Design a Mobile Medication Dispenser based on IoT Technology

***Mohammed Hussein Shukur[a],** [a]Cihan University-Erbil, Iraq
***Corresponding Author Email:** mohammed.shukur@cihanuniversity.edu.iq

This paper proposes the design of an IoT medication dispenser attached to mobile devices. The dispenser has the capability to organize three different doses of pills for the patient including the elderly, those who have memory shortage, and those taking many medications. The dispenser acts as an aid, a reminder that organizes medication so it is given as scheduled, a remote monitoring mechanism and can update dosage via the medical practitioner through a web application.

Key words: *IoT, Medical Dispenser, QI, wireless charging.*

Introduction

Many people in their modern busy lives need to take different pills, supplements or vitamins at a specific time and keep track of which medicine has to be taken throughout the day. Age, workload, and some diseases that causes a slow decline in memory along with poor knowledge about how or when to take medicines make it difficult to remember correct process and can lead to grave repercussions (Anum Saqib, 2018), (Hye, 2012). Taking medication as prescribed can be the difference between life and death (Susan Levine et al., 2019).

There is a need for a dispenser to organize medication given as scheduled (Jara, 2010) with an alarm which sounds before medicine needs to be taken and an alarm that alerts a family member regarding untaken medicine. Further, the dispenser keeps the medicine out of children's reach, is a form of remote monitoring and can update dosage via the medical practitioner through a web application (Pei-Hsuan, 2011)

The Mobile Medication Dispenser Based on IoT Technology that is described in this paper is designed to assist and monitor the taking of many medications without professional

supervision. The dispenser organizes multi-medications in one container (Statement from FDA, 2017) and schedules medications based on prescriptions and user timing. The dispenser then reminds the user to take medications at the same time, monitors medication cabinet contents and regulates the medication schedule as needed. When the user is late in taking medication or fails to comply with the administration schedule, the dispenser sends notifications based on drug importance to a family member\doctor. Consequently, the dispenser helps the user stay compliant without having to understand the directions. This design is effected cooperatively by mobile application and cabinet control in an action-oriented manner.

The rest of the paper is organized as follows. Section 2 presents an overview of existing medication dispensers and compares with the dispenser under study in this research. Section 3 presents the IoT design including major components of the dispenser cabinets, along with prototype software of the dispenser. Section 4 presents an overview of the dispenser operations and use scenario. Section 5 summarizes the paper and discusses possible future work.

Related Works

There are a large range of medication dispenser devices available for use by unprofessional users. Many of them are stand-alone devices available as either manual or automated products with multi-compartment compliance.

With a manual dispenser, the user must set the individual doses of medications into the device and manually set the time for each container, keep track of medications, keep the dispenser or its key safely out of reach of children. The manual dispenser does not have the ability to update the dose by the medical prescriber and this is a failure of one of the most vital essentials (Samir and Zanjala, 2015), fig 1 shows the pill dispenser (e-pill MedTime , 2019); (Hussein, 2017).

Figure 1. pill dispenser

Smart solutions exist for fully automatic pill dispensers, where medication management is achieved cooperatively by the dispenser controller and the medication scheduler in an action-oriented manner. However, these automatic dispensers are still a home based solution, mobility does not existing in such devices. Fig 2, shows the home based smart dispenser. The dispenser is big enough to be held but not easy to carry when travelling (Pei-Hsuan, 2011); (Kassem et al., 2019).

Figure 2. SINICA Home Based Smart Dispenser (Pei-Hsuan, 2011)

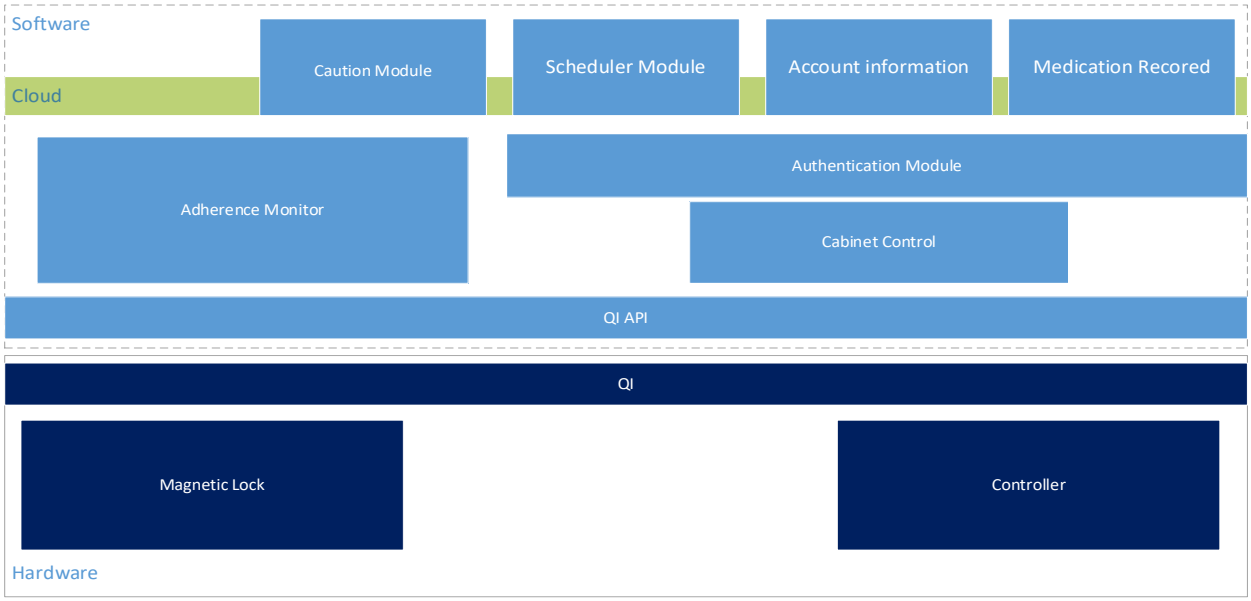
The proposed solution in this paper overcomes issues of existing dispensers by addressing mobility, medications management, monitoring, updating medication schedule remotely and authenticates medicine taking.

Dispenser Design

Fig. 3 shows software and hardware modules. The dotted box at the top contains software components, while the bottom box contains the hardware components. The current prototype is designed for smartphones with reverse wireless charging only. Software modules are responsible for controlling and the monitoring medication dispenser system. The data is

stored locally and on a cloud and synchronization if performed upon login. The clouds will provide access to the user's medical practitioner to change or update the dosage but not to change the medicine. To dispense the pills, the smartphone automatically connects to the hardware parts via QI wireless charging and sends commands to container magnet locks as shown in Fig. 5.

Figure 3. Dispenser Design



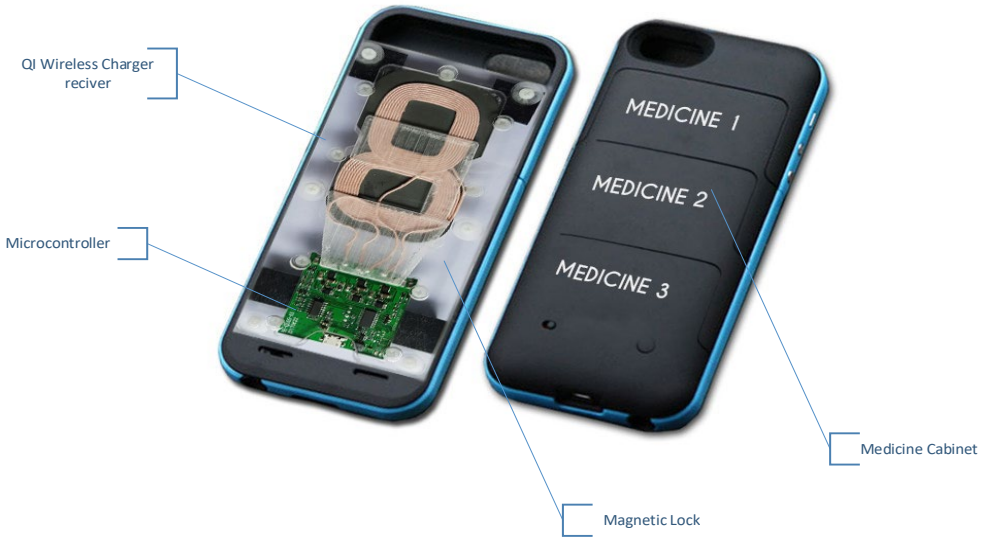
The cabinet controller, scheduler, and adherence modules are central to dispenser operations. The cabinet controller is responsible for opening the cabinet after authentication is verified by the authentication module. This process is automatic once the scheduler sends a notification about the medicine to be taken. The scheduler extracts information from the medicine recorded as scheduled, adherence monitoring gathers information about medicine usage and format for schedule purpose. The scheduler determines an initial medication schedule instantly on activation and is also responsible for adjusting the schedule when the user is late in order to prevent failure to comply. The Monitor has an adherence function which will provide such feedback to determine the actions to carry out when a failure to comply event takes place

There is a caution module which is in charge of generating and sending alarm and notifications in different ways when cited by the cabinet controller to do so. Based on date and time an alarm SMS is sent to registered family member and captures user preference and records user attitudes in order to reschedule administration if possible.

The hardware module is shaped as a mobile case with three containers, the case contains a QI wireless charging receiver, Microcontroller, and three cabinets with magnetic locks as it

shown in Fig 4. A rigid case will provide mobility, as it is modelled on a mobile case and people tend not to forget their mobile, and based on this assumption the case has been designed to ensure people don't forget their medicines and pill dispensers.

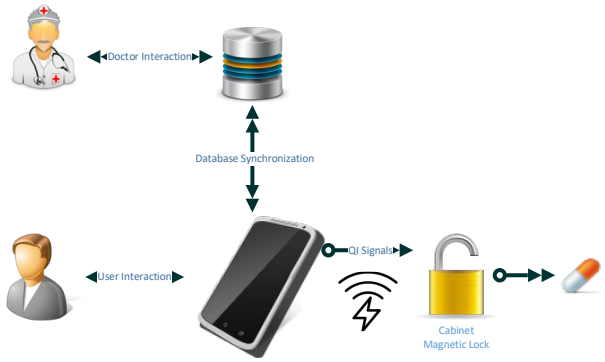
Figure 4. Mobile Medication Dispenser Based on IoT Tech.



The data transaction between software application and the hardware is very low and thus, no battery is required, rather, QI coils (Li, 2016) are used to power the microcontroller to manage the communication and open the magnetic locks for each cabinet.

In general, a Mobile will send QI wireless charging to power up the controller, then send signals to specify which cabinet should be opened using a bit array. Containers holding medications are locked by magnetic lock, the three cabinets are closed by default and are opened only when attached to the mobile with a command to take or insert medicine.

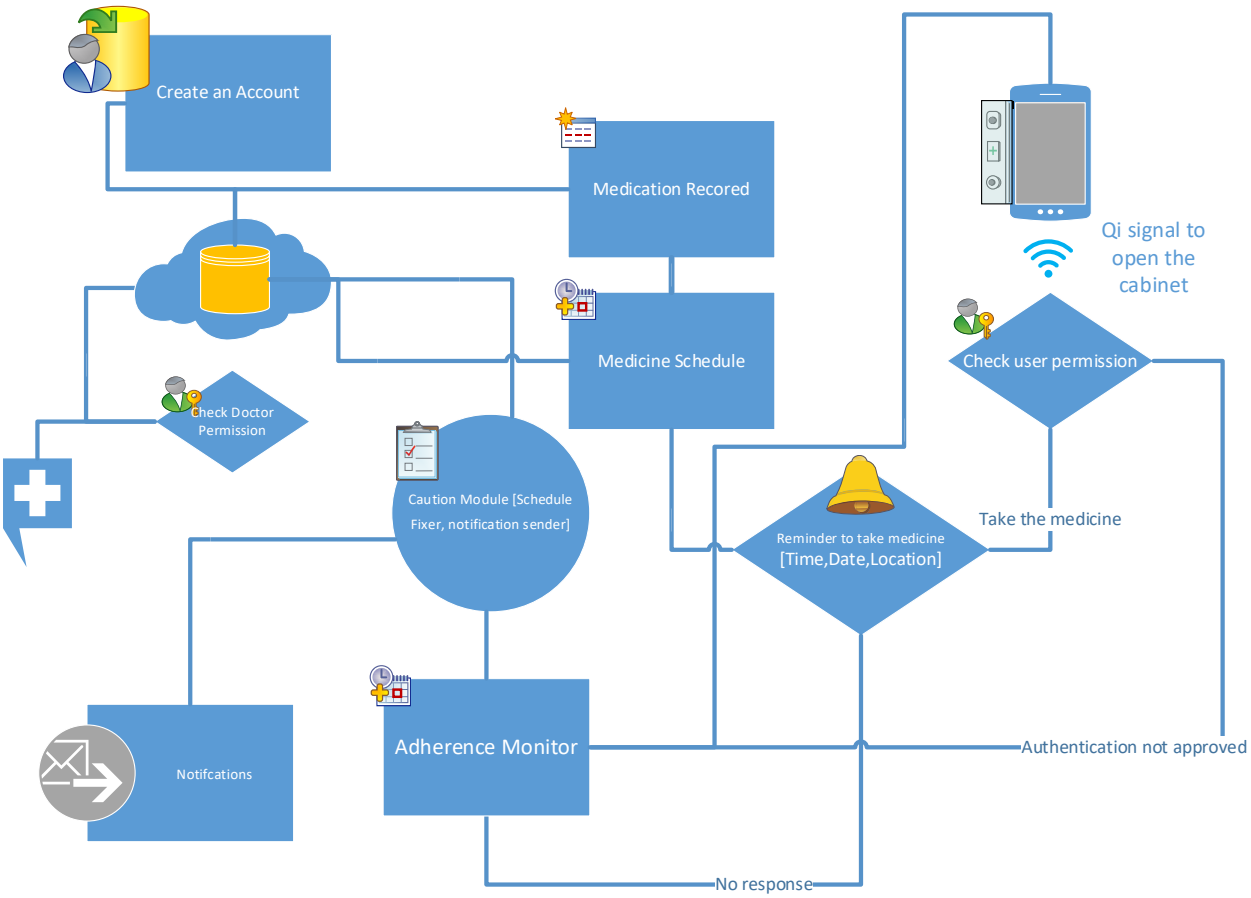
Figure 5. Design disintegration



A Use Scenario

1. Setup the Medicine: for the first time, the user will need to download the application and create an account, login, granted the prescriber to access the account. When a user purchases medicine, the pharmacist or prescriber uses a prescription to insert the medications in the cabinet and sets medication directions for the user, generating a schedule in the dispenser application.
2. Normal Operations: after set up, the application will have filled one or more of the cabinets with medicine. The Medication scheduler specifies the time immediately: referred to as dose times; and dose sizes of medications to be taken. A few minutes before each scheduled dose time, the dispenser sends an alarm to fetch and take medication(s). In response to the alarm, the user will access the phone and complete software verification (providing fingerprint, pin code, or even doing a face detection) after which the dispenser and user picks up a dose from the cabinet and the software screen shows the dose size to be taken at the time. After the user close the cabinet the dose is updated. The user will need to repeat this process in case of more medication(s) being scheduled at the time.
3. Whenever the user misses any medicine, a caution module will be reported by the adherence module, then it computes and adjusts the medication schedule based on the constraints given by the prescribing medical officer or performs a non-adherence notification of any delay to the user's registered family member – the urgency of the notification is able to be indicated.

Figure 6. Software modules Operations.



Conclusion

In this paper, a simple design of Mobile Medication Dispenser based on IoT technology has been presented. Senior users, especially those with chronic diseases or/and memory deficiencies, and those taking multiple medications, will find it much easier to increase their medicine compliance which will save their lives and assure a better treatment.

Some functions can be added to the application to connect with sleeping, Heart rate and other sensors can improve its timing effectiveness. The current prototype does not support the capture and use of user preferences. Finally, mobility and simplicity are intuitive, the dispenser is low cost and easy to carry and can be used by seniors.

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