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Design and development of Portable Smart Medicine Dispenser

Samhitha S, Srinath N.K.
Department of Computer Science and Engineering, RV College of Engineering, Bangalore, Karnataka, India

ABSTRACT

The consumption of prescribed medicine on time has become the most important requirement in day-to-day busy life. The adherence to the schedules of medicine dosage becomes critical with the problem or disease, which is being treated. Therefore, the importance of it varies from person to person. To overcome the problems of the adherence to medicine dosages, many products and designs of medicine dispenser have been proposed. In this paper, the prototype of Portable Smart Medicine Dispenser has been discussed, which overcomes the problems of many of the existing designs and provides the improved characteristics in it. Android has been used as the GUI for the system and NodeMCU ESP8266, a microcontroller with inbuilt Wi-Fi module, has been used. The Xcluma 28Ybj-48 Stepper motor is used to rotate the container of medicine. The history has also been setup, which shows the list of alarms, which have been successfully alerted and container is rotated. The medicine, if not taken within a specified time, the alert is sent to the caretaker in the form of notification of the Android App. Another improvement in this design is that the Firebase, which is a real-time and NOSQL database has been used, which helps in quick synchronization of the data from the Android app to Firebase and vice versa.

Keywords : Medicine Dispenser, Microcontroller, Android, Firebase, Nosql, Stepper Motor, Load Sensor, Nodemcu Esp8266

I. INTRODUCTION

Medication is the most important aspect in everyday life. Medicines are prescribed by doctors either to treat an ailment or to provide supplements to the body. Few type of medicines are expected to be strictly taken on schedules, before or after food, as per doctors' prescription, where as few can tolerate a level of irregularity in schedules. However, the best practice is to maintain a regular schedule. This practice becomes difficult, if the patient is very busy with the work or if the person is either aged or dependant on others for his/her daily activities. The Medicine dispenser, which would be smart enough to dispense the medicines at the scheduled time is the much needed device in such situations. Also, the portability and ease of use of dispenser also matters, as the people travel frequently in today's busy life and wants the dispenser to be as simple as possible.

To list down the required characteristics of a Medicine Dispenser, one can consider the following points: (1) Smart – Smart enough to dispense medicine on time set through Alarm and also indicate the shortage of medicines in the dispenser at the right time, (2) Portable – Easily carriable to any place through travelling, thus necessarily being as small as possible, (3) Ease of Use – Easy to use the component to perform operations like – to set an alarm or refill the medicines; thus both Hardware and Software must be designed to be easily usable and user interface should be user friendly, (4) Cost Effective –

The dispenser if built very costly, does not encourage all economic class of people to invest their money onto this device and (5) Personal – User should be able to feel it as his personal device, and should not be a one which can be shared among many. The prototype of the Portable Smart Medicine Dispenser (PSMD), which covers all the above characteristics, has been designed and discussed in this paper.

II. Related Works

It has been found out that many patients forget to take medicine on time [1]. Particularly, patients who have been prescribed multiple medications, are those who forget or get confused with the medicine dosages which might lead to critical situations; even death in some cases [2]. According to as survey, Indian patients who are suffering from cardiovascular issues are those who have least adherence to the medication schedules [3].

There are many existing medicine dispenser proposals, which have different technologies and ideas involved in them. Wedjat, a mobile phone based medicine in-take reminder is an application used to remind the patients of their medication schedule, along with the facility to alter the dosages based on food-drug reactions as well as rescheduling of dosages if missed [4]. This is purely a mobile based application.

Another prototype explains about a robotic medicine dispenser with database management system. The Robotic arm is used to dispense three different medicines at three different locations. Microcontroller is used to control DC motor and SQL database along with the GUI based on Visual Basic is used to allow the doctor or nurse to direct the dispenser to desired patient to dispense the medicine [5].

The prototype discussed in [6] talks about the usage of Infrared sensor and Arduino microcontroller to control the medicine dose dispense. Also, it is mentioned that Alarm is sent using popup notification on users smart phone. In the prototype proposal for Smart Medicine Dispenser, the Smart phone application is used as GUI and SQLite and Mysql on 000.webhost.com to store the data of alarm and history [7].

The design of another prototype exists which is completely based on the hardware. The beep sound along with the LED light indication is used in this design to alert the user about the medicine dipense [8].

III. Methodology

The methodology of the proposed prototype involves two major parts: (1) Software and (2) Hardware. The steps can be further divided as (1) Android GUI , (2) Firebase DB, (3) Microcontroller and (4) Stepper Motor along with the medicine container. Fig.1 explains the Data flow Diagram of the proposed prototype.

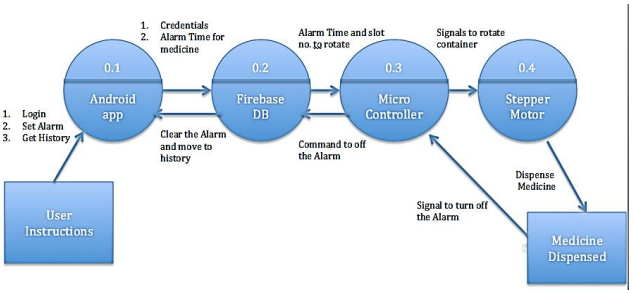

Fig. 1. Data Flow Diagram of Smart Portable Medicine Dispenser

Android GUI - Graphical User Interface

Android has become the major part of the everyday life of all, since Android Smart phone is being used for every task like setting Reminders, making Notes, Operating Smart devices through IOT, browsing,

video conferencing, etc. other than the very purpose of calling and messaging.

This prototype uses the Android on Smart Phone as the interface to the dispenser. The Android Application has been developed for the user to operate the dispenser through it. The Major task is to set the Alarm on the Application, which finally triggers the medicine to be dispensed on the Alarm time set.

Fig.2 shows the Alarm list as it appears on app and Fig.3 shows the history of alarms with different statuses.

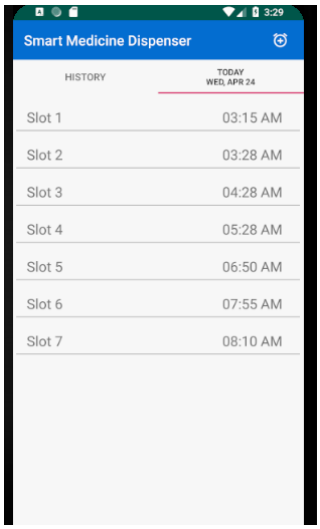

Fig. 2. Alarm List

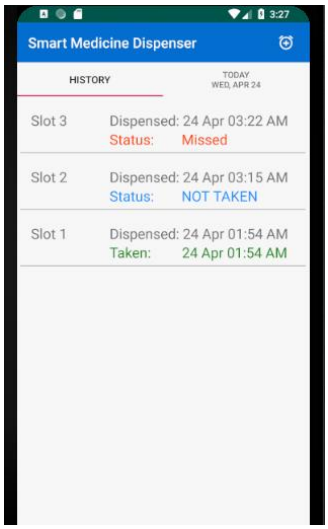

Fig. 3. History of Alarms

Firebase DataBase

Firebase provides NoSQL and Real-time Database, which is available on cloud. This is very suitable for Internet-of-Things Applications, since

- it allows for real-time sync of json data
- can collaborate among multiple devices
- supports offline use and syncs data when online
- data is secured.

The Firebase NoSQL database has been used to store the pill details and Alarm time entered from Android App. This information inturn is sent to the microcontroller by the Firebase at appropriate time to trigger the stepper motor.

MicroController- NodeMCU ESP8266

The NodeMCU ESP8266 is a microcontroller based on Arduino core, which has in-built Wi-Fi module in it. The Amica NodeMCU ESP8266 has been used in the prototype. The Wi-Fi is used here to connect to the microcontroller to the FireBase Database, which in turn connects to the Android. Without a cloud Database being used in between, it is difficult to directly connect the microcontroller to the Android App, since it would take a new IP for each connection of Wi-Fi.

Also, a clock server has to be connected to the microcontroller, for the system to get the time running on it.

Stepper Motor and Container with Slots

Stepper Motor holds the container of medicines, which has slots on it. The Motor rotates the container when it receives the instruction from Microcontroller. The container is circular in shape and the prototype uses 7 slots, which can be extended in future to any number of slots as per requirement of the dispenser. Xcluma 28Ybj-48 Dc 5V 4 Phase 5 Wire Stepper Motor has been used in the prototype.

The container into which the medicine is dispensed, can be optionally fit with a Load Sensor. This can detect presence of the medicine on it based on the weight and can automatically send signal to the microcontroller to turn off the Alarm, once the medicine is picked from it.

The Light Dependent Resistor (LDR) has been used for the purpose in this prototype, that has a varying resistance depending upon the light intensity that falls on it. Thus, it sends voltage drop, when a

medicine falls on it and blocks the light entering into it. When there is no medicine, it sends high voltage, since light falls on it, without any obstacle.

Development of PSMD

This section deals in detail with the development of the PSMD using the pseudocode and control flow diagrams.

Pseudocode

Step 1. Connect both Android and NodeMCU ESP8266 to the Internet.
Step 2. Connect them to each other via Firebase to have a fixed IP allocation always.
Step 3. Login into the Account using credentials on Android. Android will retrieve the History and Alarm details for the account from the Firebase.
Step 4. Change or Add the Alarm.
Step 5. The data gets updated on the Firebase DB.
Step 6. The instruction is passed on to NodeMCU ESP8266 microcontroller
Step 7. The NodeMCU ESP8266 microcontroller will instruct the stepper motor to rotate the container at the Alarm time set
Step 8. Stepper motor rotates the container to the angle at which it is programmed and medicine gets dispensed
Step 9. The alarm at which medicine is dispensed is moved to history in both firebase DB and Android App.
Step 10. The dispensed medicine if taken or not taken is detected by the Light Dependency Resistor(LDR) and signal is sent to the NodeMCU ESP8266 microcotroller.
Step 11. The dispensed medicine if taken, the history is updated with the time of medicine taken. Step 6 to step 11 repeats until the machine is up and running
Step 12. The medicine if not taken, the history is updated that the medicine is not taken and the dispenser is stopped, to avoid futher rotation.

Prototype

The Fig.4 and Fig.5 are the images of the working prototype. There are 8 slots in the upper part containing medicines out of which, one slot is open at the bottom and is used for dispensing medicine.
The bottom part is the housing for stepper motor, and microcontroller, along with the small slot to hold the dispensed medicine. Also, the LDR is attached below the slot which holds dispensed medicine and is painted with black to keep the light from around, not entering into it.

Fig. 4. Top View

Fig. 5. Profile View

Flow Chart

The Fig.6 explains the control flow in the system. Initially the WiFi connection check is done based on which the next process can take place. After

successfully connecting to Firebase, the microcontroller can get access to all the alarms set and take decision to dispense based on them. Also, the history is updated accordingly.

There can be four scenarios based on which the history is updated.

Scenario 1: If the previous dispensed pill was not taken from the dispenser, then the current alarm should be added to the history with status “Missed”, but the dispenser should not rotate to dispense any medicine.

Scenario 2: If the previous dispensed pill was taken, the dispenser should rotate to dispense medicine. Every time the dispenser is rotated and a pill is dispensed, the status “pill_dispensed_at” should be added to history along with the time at which medicine was dispensed.

Scenario 3: After rotating and dispensing the medicine, if the pill is not taken before a certain fixed time, the status “pill_not_taken” should be sent to the history.

Scenario 4: After rotating and dispensing the medicine, if the pill is taken before a certain fixed time, the status “pill_taken_at” should be sent to the history along with the time at which pill was taken from the container.

The complete system works based on only these four scenarios. However, the “missed” tablets cannot be re-dropped into the drop container as the complete schedule of all the alarms change. The user should handle the situation in order to refill the containers and reset the alarms again.

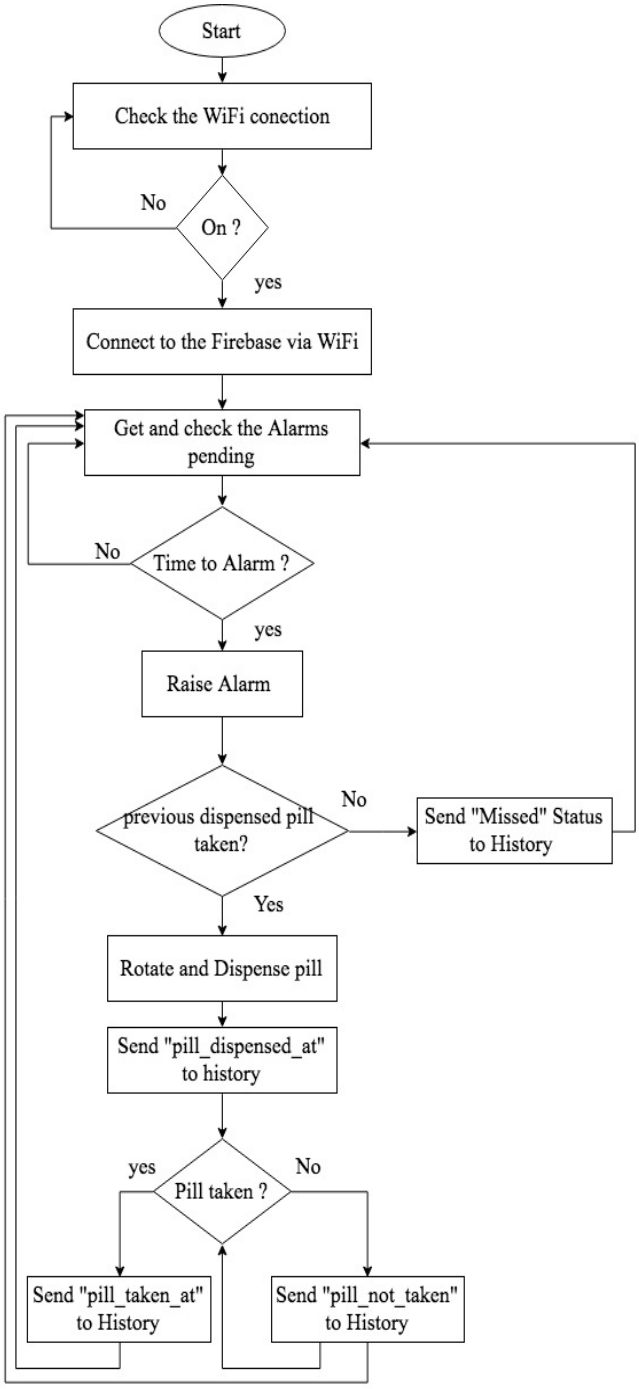

Fig. 6. Flow Chart of PSMD

IV. CONCLUSION

This paper has summarized major aspects about the construction and working of a Portable Smart Medicine dispenser. The prototype has aimed at easy to carry and easy to use medicine dispenser, which helps out the patients who need assistance. The prototype which currently has dealt with 7 slots of

medicine dispensing container, can also be constructed to accommodate more slots as per the requirement in the market. And the system can still be retained as compact as possible.

V. Acknowledgment

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