IEEE QP Winter '20

Automatic Pill Dispenser

FILO Penguins

QP Team 6:

Mike Liu

Travis Davis

Ethan Spraggon

Mon Morera

IEEE
UC San Diego Branch

TABLE OF CONTENTS

INTRODUCTION

Goals & Objectives

As part of IEEE UCSD's Quarterly Projects (QP), the theme for Winter 2020 is "Personal Productivity". Have you ever felt more sick or tired because you forgot to take your medication? For those on prescription medicine for consistent and daily problems, missing even one dosage can make a huge difference in how they feel the rest of the day. Sometimes, they would even have to wait until the next dosage time due to warnings from doctors and pharmacists. For instance, after waking up in the morning and getting ready for work, wouldn't you want an easier way to remember to take your medicine without interrupting your morning routine?

Our group has chosen to design and build an automatic pill dispenser and reminder with an interface directly on the machine to limit the need for a phone or web application. This project serves to create an easier way to dispense medication for those "computer-illiterate". Our objective was to create a working prototype within ten weeks. The prototype should be capable of dispensing at least two different medications at various times set by the end user.

Design Requirements

CRITERION	REQUIREMENT
Functionality	Mechanism should dispense correct amount and type of medication at the correct time based on user input
Desirability	Project should make end users want to have a more efficient pill reminder
Usability	Interface should be easier to use than a phone or web application Instruction set should be simple
Feasibility	Project should utilize current knowledge or require some research to implement
Affordability	Budget is limited to $50
Flexibility	Interior mechanics should be able to handle most types of medication, regardless of size or shape

MOTIVATION

Problem Statement

People on medication, especially the elderly, need an efficient way to remind and dispense medication at the right time because medication non-adherence is a widespread prevalent issue.

Background & Context

When it comes to drugs, whether prescription or over-the-counter, the consequences of medication non-adherence can be dangerous, especially for the elderly. The most common problem occurs when a person forgets to take their medicine. This is called unintentional medication non-adherence, which can be defined as the "passive process in which the patient may be careless or forgetful about adhering to treatment regimen".[1] They may "use more or less than the prescribed treatment or use their medication at the wrong time. They may also discontinue treatment prematurely".[2] This can result from a number of potential patient-related factors or treatment-related barriers. Some patient-related factors can include forgetfulness, internal impairment, lack of motivation, and lack of medicine knowledge such as how to take it and adverse effects.[3]

The different ways health providers address this issue is "simplifying the regimen, reminding patients to take their medication, and supporting patients in making the intake of medication part of their daily routine".[2] Our project serves to focus on this current solution and enhance it. The pill dispenser simplifies the medication process by allowing the user to set their medication setting once and letting the machine do all the work. When the time comes for them to take their medicine, the correct pills are dispensed. With a buzzing sound to remind the user that the medication is ready, it becomes a part of the daily routine without any extra work, allowing them to keep a productive day without worrying about missed medication.

TIMELINE

Week 4:

After a week of brainstorming possible ideas for our project, from a habit tracker to a portable printer/scanner to a schedule reminder, we decided on a medication dispenser/reminder. We created a word document listing project specifications such as design requirements for both the hardware and software sides and potential barriers we may come across during the testing phase.

Week 5:

We researched possible concept ideas for how the mechanics of the pill dispensary would work. We came up with three potential design concepts and created a pro/con list for each concept. We prototyped the mechanics using cardboard and tic-tacs in order to simulate how it would work realistically. After several iterations, our final design was a mix of two concepts.

Week 6:

Once we received the parts we had ordered, we began writing the Arduino code for the LCD screen. We also created possible SolidWorks sketches for the wheel to be used in conjunction with a DC motor to dispense the medication.

Week 7:

We started writing the Arduino code for our particle sensor and DC motor while continuing debugging the code for the LCD display. We accomplished getting the sensor to sense objects within 6 inches.

Week 8:

After running into several issues with the DC motor, we switched to using a stepper motor with a driver. We also added a DS1302 RTC module to make it easier to keep track of time rather than using the internal clock on an Arduino Mega. We started writing Arduino code for these two new objects.

Week 9:

We merged all the arduino code together and began final debugging and testing on our project. Using the cardboard and other materials, we built a casing for our dispenser.

HOW-TO-USE

Button Settings:

First Button - OK/Confirm.
The button does nothing when on the current time and date screen. When on the alarm screen, it confirms the alarm and returns the user to the time and date screen.

Second Button - Minute.
When on the alarm screen, the button alters the minute at which the alarm will be set.

Third Button - Hour.
When on the alarm screen, the button alters the hour at which the alarm will be set.

Fourth Button - Alarm.
When on the current time and date screen, the button switches the user interface to the alarm setting screen.

Steps:

1. The funnel accepts one type of pill of any size larger than 1cm and less than 3cm, fill it by it with any amount that is available.
2. On the OLED and series of buttons, set the alarm timer by pressing the Fourth Button (as many times as needed) it goes into a screen that requests hour and minute. The Third Button sets the hour and Second Button sets the minute (careful if the button is held down the count continues up). Set the hour and minute on the time you want the pill to be dispensed (note this is not a countdown timer but a timer that checks the current time).
3. Press the top button (OK/confirm) to set the alarm.
4. The dispensing will begin. Once the pill drops, take it from the side hole.

TEAMMATE CONTRIBUTIONS

Mike Liu:

As part of the hardware team, I was tasked with testing and designing the sensors and motor control. During the project we ran into trouble with outputting to the LCD screen so we rerouted to OLED functions that I setup and tested for screen output. In the Arduino aspect, I contributed to most of the base code around the sensor and screen output along with early portions of timekeeping settings. General mechanical testing was carried out by the hardware team as well as the major portion of the wiring.

Travis Davis:

As part of the software team, I was tasked with creating the alarm system that regulates the dispensation of pills. I contributed a majority of the alarm system code and created the circuitry of the alarm system. I also contributed greatly to the OLED display. I was also tasked with debugging the project's code, making sure that the proper information was displayed onto the project screen.

Ethan Spraggon:

I was part of the software team. In it, I made sure the code was robust and fit our specifications. I helped with getting the code to use the clock sensor we have to display its information to the OLED screen. We included the time, the date, and day of the week. We implemented buttons to set the alarm time and to switch between setting the alarm and viewing the time. The code was tested for quality to make sure it works with at least a 30 second margin of error.

Mon Morera:

As part of the hardware team, I was tasked with designing and testing the mechanics of the project. I helped brainstorm concept designs for how the dispensing would work. Using these ideas, I designed the pill mechanism using SolidWorks. I wrote Arduino code for the pill mechanism to work with a stepper motor and stepper driver as well as the code for the buzzer. I assisted with overall testing of the project.

REAL-WORLD APPLICATIONS

The automatic pill dispenser is designed around set schedules to remind users to take their pills. We imagined the targeted use will be for the elderly and patients that need frequent medication intake at home that either tend to forget to take the pills or difficulty in sorting the pills. This function of reminding and immediately ordering the pills into servings that can be taken immediately instead of further sorting is especially useful for elderlies that tend to forget what medication at what time and patients with Alchimers that remind them or their families to take the set medication. In industry this type of dispenser could also be applied in larger sized units for nursing homes tailored to individuals or larger groups that have similar medication needs. In small pharmacies it can also be used for scaled packet sorting (per serving) that is normally manually done in by hand.

DIFFICULTIES/CHALLENGES

One of the biggest challenges we had during this project was the mechanism for the pill dispensary. We prototyped the different concepts we had designed during our brainstorming phase using cardboard. The difficulty is dropping only one pill at a time for pills of various sizes with a uniform set of wheels that tend to clump the pills together when more than one is stuck inside the wheel slot. Although our solution isn't ideal, we believe it is the best working concept possible for our group.

Another challenge we faced was finding a way to ensure that the medication does get dispensed and finding a way to track it. We looked at different types of sensors, from photo to sound, and decided on a particle sensor. Although it can sense the medicine drop within a certain distance, we had trouble using it in conjunction with other working parts such as the stepper motor. The solution is using a sensitive IR sensor that can detect minute differences in the environment at each minute turn of the motor because the stepper motor steps inside its own loop when it is turning.

IMPROVEMENTS/ENHANCEMENTS

This project is currently a prototype and can be improved in the future. If our group had two more weeks, we would have liked to implement more features and allowed for more space. Being limited to two trays for medication, it makes it difficult for people who take more than medication to use. Studies have shown that at least 20% of the population take five or more medications daily, so we would have liked to store at least five different medications, more if it would be used for a family. Additionally, we would print up a casing for the machine rather than use cardboard. Having 3D printed coverings would make it more aesthetically pleasing for end users.

CONCLUSION

At the end of this project, we realized we achieved a lot from this seemingly simple medicine dispenser. We were able to display clock information onto an OLED screen, code a buzzer to go off at a set time, and build a wheel which deposited medicine at that set time. Our biggest achievement was merging all the individual aspects of this machine together. Specifically, getting the motor to spin once the alarm had gone off. This required that we get all of our hardware on one arduino board to ensure that the communication was as simple as possible. We were able to get the motor to spin, which rotated a wheel with divots. These divots would take a pill of medicine dropped from the top and deposit it for the user. This works with most pill types but takes one pill type at a time. This is an important achievement because it means we were able to deposit medicine at a designated time indicated by the user. The user is meant to have control over their preferred time of day to get their medicine when they want it.

As a whole, the QP process was initially intimidating. Getting everything together appeared daunting but once we got going, the process went more smoothly. It definitely sped up as we got closer to the deadline since we had all the parts and the ability to bring it all together. We feel that the process was fairly streamlined. We got what we wanted to get done despite having to change our original plan several times to accomodate for the allotted time.

REFERENCES

[1] Ho, P., Bryson, C., , & Rumsfeld, J. (2009). Medication adherence: Its importance in Cardiovascular Outcomes. Circulation, 119(23), 3031.

[2] Hugtenburg, J. G., Timmers, L., Elders, P. J., Vervloet, M., & van Dijk, L. (2013). Definitions, variants, and causes of nonadherence with medication: a challenge for tailored interventions. *Patient preference and adherence*, *7*, 675–682. https://doi.org/10.2147/PPA.S29549

[3] Kleinsinger F. (2018). The Unmet Challenge of Medication Nonadherence. *The Permanente journal*, *22*, 18–033. https://doi.org/10.7812/TPP/18-033