

Capstone Proposal

Automatic Pill Dispenser

Group 11

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Technical Approach

Objective

The objective of our project is to provide individuals with a complex medication regimen and automated device to simplify their medication management process. Our device will be able to intake multiple medications and will generate a dispensing schedule based on the instructions provided on the prescription. It will then automatically alert the patient and dispense the medication at the designated time in the recommended dosage.

Motivation

The motivation behind this project began during the pandemic. It was well known that the health care system was severely overwhelmed at that time. It was difficult for nurses to calmly check up on each patient. We wanted to focus our project on a device that can help relieve nurses of a small task within their busy day so they are able to focus on other matters. After speaking with individuals who worked within the healthcare industry, we decided to create something for retirement homes. Considering there are few nurses staffed at nursing homes who are responsible for complex medication schedules for numerous elderly patients, we decided to create a pill dispensing device. This project will involve features that require us to explore various engineering concepts including image processing, microprocessor coding, digital communication systems, etc.

Design Modules

The pill dispenser has various components, each performing specific tasks that work towards the main goal. The project will be divided into design modules according to these components. Below are the modules that will need to be completed:

- **Scanning**
 - Scan dosage instructions on pill bottles with a camera and computer vision software (OpenCV). The device's software will take that information and create a schedule for the device to follow.
- **Screen and GUI**
 - The device will have a screen in the front with a graphical user interface. This screen will display the schedule of the pills and will allow the user to make any changes as necessary (if the instructions are not parsed correctly from the pill bottles). There will also be an 'add' button to start the process of adding a new set of pills and schedule to the device.
- **Storing**
 - To add a new set of pills, the pills will be poured from the original bottle into an opening at the top of the device to be stored in a compartment inside the device. The holding compartment will have multiple slots, and each time a new pill is added, it will be added

to a vacant slot in the holding compartment. Sensors will be present to track the approximate amount of pills remaining in each slot.

- **Dispensing**

- Dispense the correct number of pills at the scheduled time and notify the user that pills have been dispensed. A mechanism will be present to adjust the size of the nozzle based on the size of the pill to ensure they are released one at a time from the holding compartment. Sensors will be used to confirm that the right number of pills have been dispensed.

- **Tracking**

- SaaS (software as a service) application to track and manage data from multiple pill dispensers. Data includes factors such as pills in need of refill or pills that have been dispensed but not consumed. The application will have a user interface displaying all pill dispenser devices being tracked and displays the data for each one. New pill dispensers can be connected to the system by this application.

Integration

This project requires the integration of principles in hardware and software design. The various components will be tested individually to ensure complete functionality. Once the initial testing phase has been completed, we will begin testing components together to test the limits and identify weak points to redefine the needs of each component if required. In terms of hardware integration, we will need to test physical rigidity of the dispenser's mechanical components (nozzle, spout, chassis etc.) while maintaining a focus on its interaction with electrical components (sensors, LCD, motors etc.). Furthermore, software integration will be upheld using key principles in software design where needed. To ensure version control between differing models, we will maintain a repository on GitHub. Additionally, we will modularize software components to help troubleshooting and ease of user control to make modifications. Finally, we will be regression testing our final project early on to identify any additional problems.

Resources

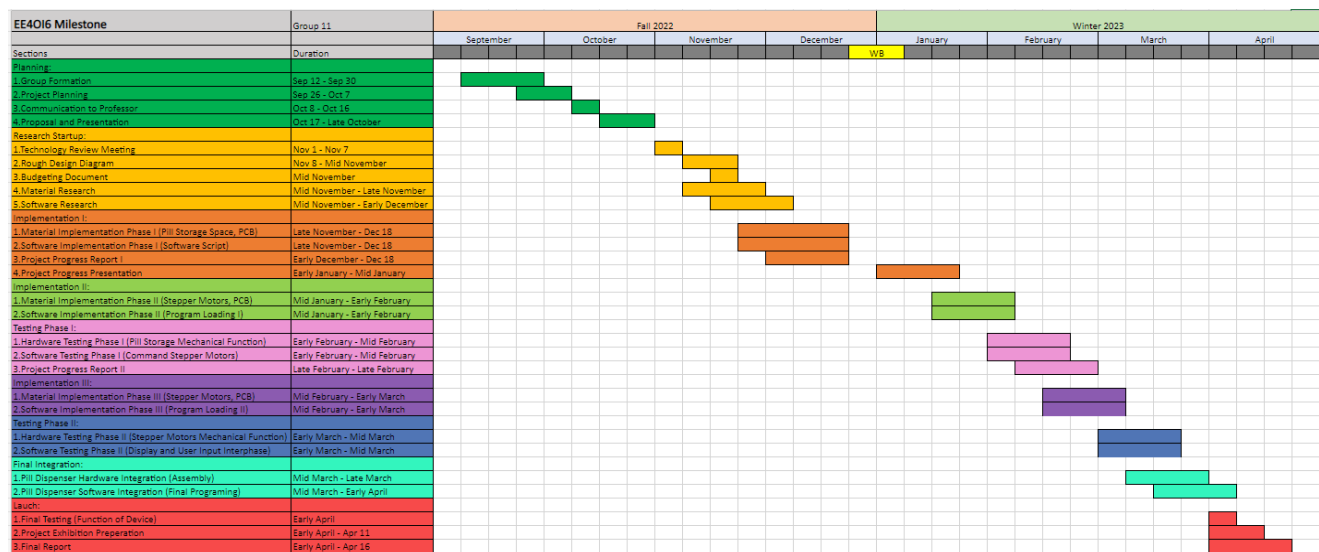
Over the year, we will be taking advantage of multiple resources to create a fully functioning automatic pill dispenser. In terms of hardware design, the project implements our knowledge of motors, sensors, and physical design. We intend on using Thode Makerspaces or Lyons's free 3D printing services to prototype our initial designs. Considering time constraints, we have broken our timeline to complete the project into phases. Regarding the software aspect of our project, we intend to make use of Arduino's free IDE to develop general functionality for the project. As we build further, we will use our prior knowledge in web application development to create a system to track pill inventory in each dispenser. The hardware components will be developed in person and the size of the project allows it to be easily portable. We will be using GitHub to track our progress on the software side of this project. We hope to use online resources to learn new skills while

developing the pill dispenser. The following table outlines the components required for our preliminary design of the automatic pill dispenser:

Component	Budget
Servo Motors	\$20.00
Arduino Nano	\$25.00
GUI LCD Screen	\$20.00
Physical Casing	Free
Webcam	Free

Schedule of Activities and Milestones

The schedule of activities is shown in the Gantt chart below, the schedule is divided into different sections and phases. The month is divided into 4 sections for us to better manage the approximate completion date of each task in each phase.



Risks and Alternatives

Risks	Original Plans	Alternative Plans
The way of campus access may change as we are still facing some uncertainties after the pandemic. Due to the possible pandemic	Meet in the library or meet in Lecture Hall.	Meet in someone's home or meet virtually online.

restrictions, we can no longer meet on campus.		
There are many uncertainties regarding our project materials. We might face the issue of the late arrival of our materials when we book them online.	Buy materials online (Amazon...etc.), or book materials through private firms.	Find the other available sellers and alternative material to buy from. Or find available materials at home or borrow available materials from friends.
There are possibilities that our design might break or get lost due to unintentional factors. (Cold winter, rainwater, overheated and burned, stolen by strangers).	Follow the original milestone schedule we planned.	Try to achieve at least one purpose of our design by using available materials. For example, we can alternatively just make the device take and dispense the pills given and remove the displays
The result might not work as we expected it to be, and the group is facing technical issues. None of our group Members have medical, life science, health science background, and we are not familiar with different PCBs and their functions.	Follow the milestone and achieve the design purpose as we expected.	If we find out our results are not working properly as we expected, we can instead choose to sort only one kind of pill instead of multiple different kinds of pills

Deliverables

Bronze Deliverable

A device in which the user can store multiple tablet/pill medications. The device will then dispense the appropriate dose/number of pills at the correct times as specified by the schedule. When a pill is dispensed there will be a light and audio notification indicating that a pill has been dispensed for the user to take. The schedule can be entered manually into the device.

Silver Deliverable

Instead of manually entering a dosage schedule, there will be a component added to the device which uses computer vision to scan and parse information from the text on the pill bottle to automatically extract the dosage instructions. The pill dispenser will then follow those instructions to dispense the pills.

Gold Deliverable

In addition to the aspects of the silver deliverable, the gold deliverable will incorporate a SaaS (software as a service) application which can be used by the staff of medical/care facilities

employing the use of multiple pill dispensers for each of their patients/residents. The primary focus will be retirement homes. Each resident in the home will have their own pill dispenser, and the SaaS application will track data from all the dispensers. The data will include information such as if each resident is taking their pills on time, and if the pills in a specific resident's device need to be refilled.

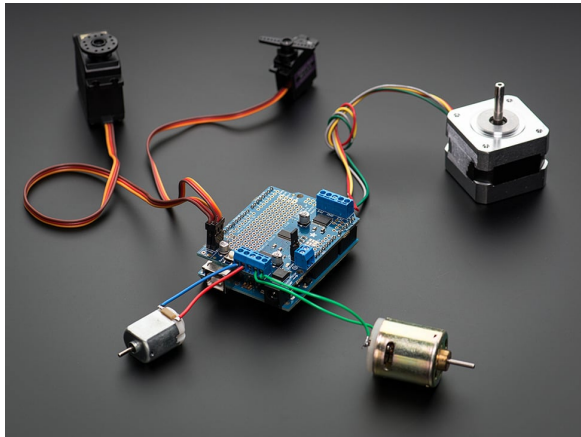
Summary

Our project is a fully functional pill dispensing system which will use a camera to read the prescription, intake the medication, and dispense the correct dosage throughout the day. The goal of the project is to relieve nursing home staff of one of their many daily responsibilities. Once completed we will have a deeper understanding of computer vision software, creating graphical user interfaces, sensor utilization, and other relevant concepts.

Reference:

Adafruit Motor Shield V2.3 Motor/Stepper/Servo Shield for Arduino (Assembly Kit) Stepper motor and PCB example reference (Dec 2 2013). Adafruit.

<https://www.adafruit.com/product/1438#technical-details>



28BYJ-48 DC 5V Reduction Step Motor Gear Stepper Motor 4 Phase Step Motor + ULN2003 Driver Board For Arduino Diy Electronic Kit for Alternative choice and reference. We actually have this module from the previous course. Eiechip, AliExpress.

<https://www.aliexpress.com/i/32756856488.html>



Technical Approach of how to use Arduino as a 28BTJ-48 Stepper Motor Controller with a ULN2003/2004 drive board. (March 4 2019).

<https://www.seeedstudio.com/blog/2019/03/04/driving-a-28byj-48-stepper-motor-with-a-uln2003-driver-board-and-arduino/>