University of Central Florida

Department of Electrical & Computer Engineering

EEL 4914

Senior Design I Group 16

Divide and Conquer Version 1.0

Automated Pill Dispenser

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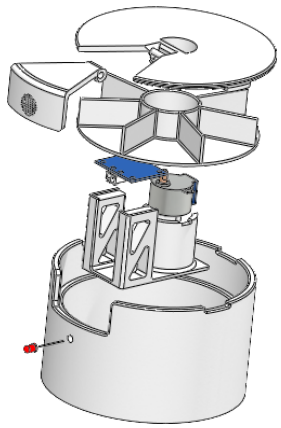
Project Narrative

One of the biggest problems in the medical industry is the inconsistency with which patients follow their doctor's instructions. Incorrect dosages, forgetfulness, and substance abuse are among the issues that surround prescription medication and greatly affect the health of millions of patients around the world. These issues are especially prevalent in elderly patients and those with cognitive diseases where it can be difficult for them to remember if they've taken their medicine, or even how much they're supposed to have. This project seeks to create a tool patients can use to accurately track prescription dosage, timetables, and that will dispense the correct amount of medication according to the information given.

Incorrect or complete lack of consumption of prescription medicine is one of the leading causes of adverse clinical outcomes. In the United States, non-adherence rates for chronic conditions like diabetes are as high as 50%, and can cause around 125,000 deaths per year. To help alleviate these issues, there are many devices in the market available to help patients keep track of prescriptions, such as plastic pill containers that are separate by weekday, or automatic pill dispensers that are refilled via pharmacy delivered trays. These devices, while helpful, still have issues, primarily of which is the price. The two readily available market models revolve around monthly subscription payments for access to an app or a one time purchase of a device.

To solve these issues, this device will be affordably produced, not requiring expensive components or costly server maintenance. This device will strive to deliver a streamlined setup and refill experience that makes it both simple to maintain and easy for patients or caregivers to operate. A smart refill compartment makes adding new medication a breeze, and a built in tracker will alert patients when a prescription is running low. The sleek design helps to minimize fault points making it reliable, and the app interface provides any relevant information about the current prescription at the click of a button.



Competitors

Hero Pill Dispenser found at https://www.herohealth.com/

Hero's business plan is an initiation fee with monthly payments, which provide a way to turn down consumers. Having a lower upfront with monthly payments of $30 can steer away customers who don't want what Hero considers a "assisted living" device. There are plenty of consumers who don't want this as a necessity, but also want to be able to use it for pills such as vitamins, supplements, but also prescription medicine.

For our project, we would only require an upfront cost to cover the price of the device. There is no need to have a subscription service as people don't always want this as an assisted living device.

Med-E-Lert™ Premium Locking Automatic Pill Dispenser found at
https://www.amazon.com/LertTM-Premium-Locking-Automatic-Dispenser/dp/B087JXZ7ZR

Med-E-Lert works on a daily or on intervals throughout the day. This, although would be a competitor, is a slightly different design than what we plan to make. Our design would require a schedule set on an app that would independently dispense pills. A downside to this design is that it is not customizable and requires you to manually fill each day when you run out. Although this is only every 28 days, if you take pills twice a day this cuts the length this would last down to 14 days. As you have to take pills more often through the day it cuts down how long each cycle would last.

Another downside to their design is that there is no way to notify the user without them currently being in the room. If someone is out of their home, this would be ringing constantly until someone is able to come back and turn it off. In the case of this device, it would ring, no one would hear it, and then the user would never actually go back to check to take their pills for the specified time. This is counter-intuitive and would result in someone not taking their daily pills.

Medacube found at https://www.medacube.com/

Medacube has a great design, notification system, and schedule setting interface and all with a lack of a subscription service. However, their product is about $1800 which is extremely overpriced for what the device does. We plan to make a product very similar to Medacube, but instead a cheaper alternative. They do not have an app, so setting your schedule is a little more difficult as you have to be present at the device. It is the same with all the configurations.

Specifications

Hardware:

- The device occupies a space within 1 cubic feet
- The device will cost less than $200 to produce
- The device will contain 30 days of medication for up to 3 prescriptions sized at 14 mm
    - Device will contain 15 days of medication for prescriptions bigger than 14 mm
- The device will be powered via USB cable
- The device will contain a microcontroller
    - Used to manage in device systems
        - Time
        - Notifications
        - Mechanical interfaces
- The device will contain a speaker for audio cues
- The device will contain a screen for visual information and cues
- The device will contain 3 weight sensors, one for each prescription
- The device will contain an apparatus to dispense medication
- The device will have a sensor that can tell there is a cup to dispense the medicine

Software

- The device will connect to a phone app via wifi
- The app will send push notifications when medication is dispensed
- The app will send push notifications when prescription is 2 weeks away from running out
- The app will will send push notifications once it time for the user to take the medication
- The app will display data about prescription
    - Remaining amount by
        - Weight
        - Approximate days left
        - Number of pills
    - Dosage
        - Amount taken per day
        - Time taken
        - Number of pills per dose

Constraints

Price Point: Most single purchase competitors with similar features market their products for significantly more than what this device is planned to cost. Other competitors offset the cost with a monthly subscription model that this device will not use. As such, this device seeks to be the one of the most advanced for its price class. This may cause issues with components needed for specific features. This devices will seek to avoid these issues by smart use of less expensive components while still maintaining quality and reliability

Size: This device will ideally be large enough to hold a sufficient amount of medication while not being cumbersome to move or fit into a home setting. The size limit of 1 cubic foot will allow, with good use of internal space, for the device to meet the capacity requirements while not taking up excess counter space. This may cause other issues to arise and limit the types of components that can be used internally and externally. To solve one of these issues, no internal power supply will be added, with the device instead being powered through a USB cord.

Interactivity: This device is designed to be connected to a home wifi network and for prescriptions to be entered through a companion smart phone application. As such, it will not operate in environments where wifi is not available. While this is an issue, most environments where this device may be set up are likely to have both a wifi connection and a smartphone device with which to interface.

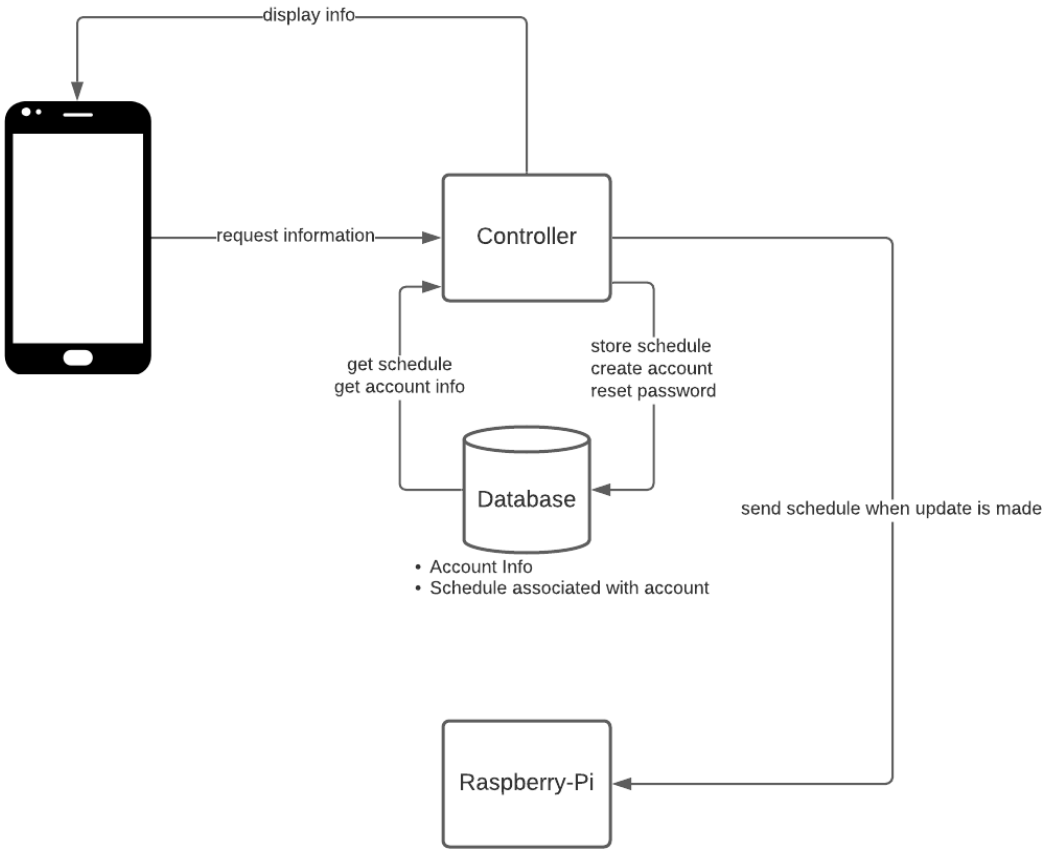
Types of Prescription: One issue of dispensing prescriptions or other supplemental pills is the large variety in shapes and sizes that are commercially available. This makes it difficult to create a “one size fits all” measuring and distribution device. In regards to measurements, the device will weigh the total amount of pills, and divide it by the user entered number of pills, thus obtaining an estimate of the weight per pill. This weight can then be used to monitor medication levels and distribution weights.

Technical Error: An issue that may arise would involve the device losing power and having to restart causing it to lose all of the information stored. In order to combat this difficulty, the app on the user's smartphone will need to store the information that was inserted and sync it with the device in case the user encounters this kind of situation.

Child Safety Lock : Majority of these kinds of products deal with safety issues due to the nature of accessing these medications easily. Ideally the device could have a passcode or lock to avoid kids or any unauthorized user to access the patient medication.

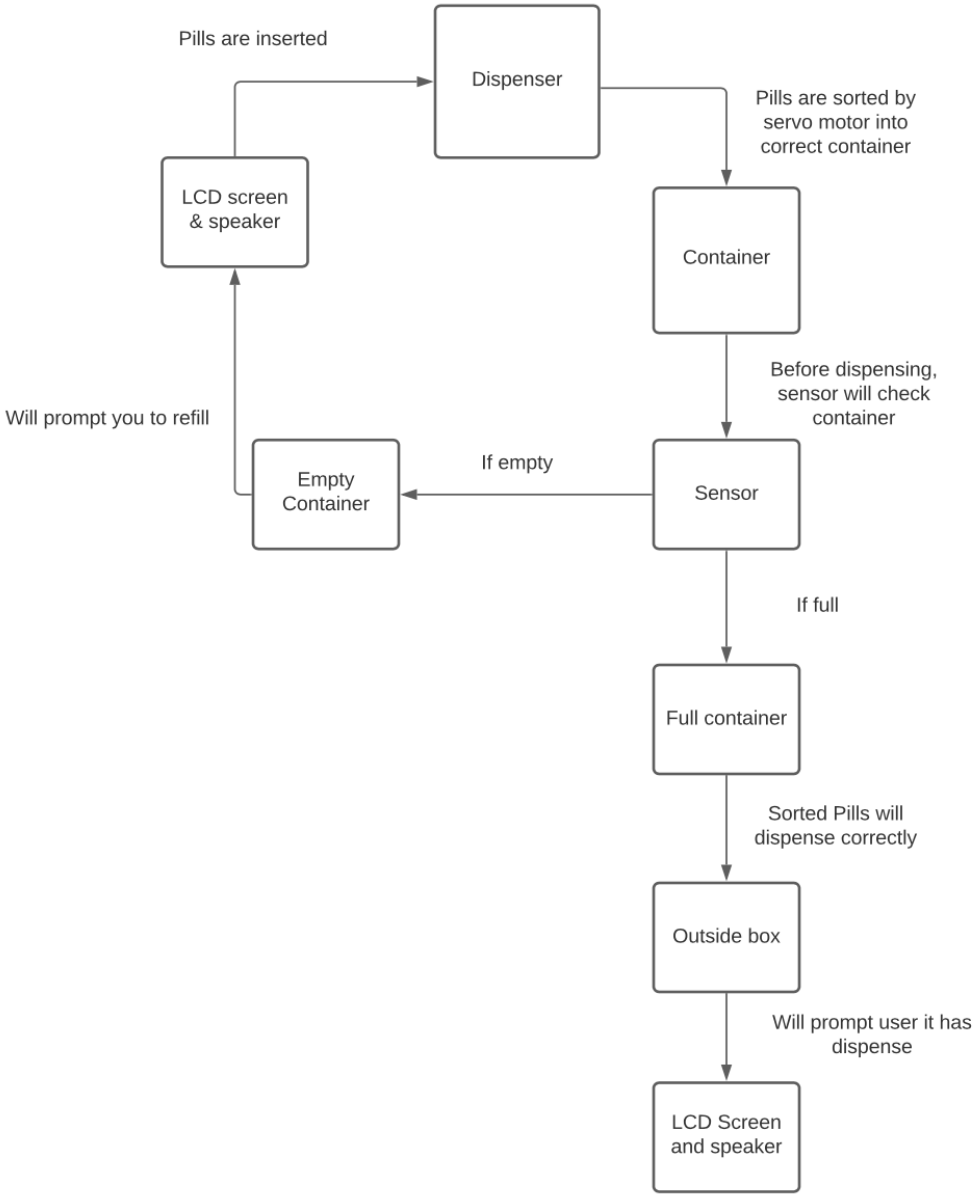
Block Diagrams

Software



Block Diagrams

Hardware



Project Budget and Financing

The budget for this project will be self-funded, the idea is to build a product that is not too expensive for the general public. The majority of these components are affordable. The highest expense might be the main components such as the custom PCB or the Raspberry Pi we decide on using. Below we can find a cost estimate for each of the components that are predicted for our project as well as the total cost of it.

Component	**Quantity**	**Pricing (each)**
Raspberry pi	1	$5 - $100
LCD Display	1	$5 - $50
Power Source	1	$5 - $20
PCB	1	$0.5 - $300
Weight sensor	3	$0.5 - $40
Dispenser	1	$20 - $30
Speaker	1	$0.50 - $20
Discrete components (resistors, capacitors, etc)	10	$0.50 - $5
Total	19	$37 - $565

The total cost of the project falls in a very wide range since it will really depend on what materials we use and the quantity, the table above is more a reference of the main things we might use for the project, in reality the project alone should have a total cost of around 200$ as it was previously discussed in the specifications.

Schedule

Week	Description
1	Initial project idea brainstorming
2-3	Solidifying project idea and organization of group roles
4	Initial divide and conquer documentation, creation of project specifications, creating of project box diagrams
5-6	Discussion and research of internal components, acquiring of initial build components
7-8	PCB design, 3D CAD model
9-10	Initial testing of microcontroller and smart phone app communication
11-12	Print PCB design, initial printing and assembly of external components
13-15	Finalization of report
	END OF FIRST SEMESTER
16-17	Assembly of first prototype and creation of app prototype
18-19	Testing of first prototype, initial adjustments
20-21	Major rebuild of prototype (IF NEEDED)
22-23	Stress testing
24-25	Finalization of product and app interface
26-27	Finalization of report and presentation preparation
TBD	Final report, peer presentation, final presentation

https://www.uspharmacist.com/article/medication-adherence-the-elephant-in-the-room

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6045499/