ECE 445: Senior Design Laboratory

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Autonomous Pill Dispenser

Project Proposal

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1 Introduction

1.1 Objective

Our product will help those who have medications and vitamins that they need to take on a daily basis. It can be quite difficult to remember what pills to take when and how much the correct dosage is. To overcome this difficulty, the pill sorter will be able to take in a full month's worth of several pills, sort them into the correct dosage, and dispense them at the correct interval. This takes the potential for error each day and moves it upstream to a single task: correctly inputting the prescription information into the pill sorter. Now instead of 30 or 31 opportunities for a mistake to be made, there is one. This method decreases the opportunity for error and makes it easier for the end user because all they have to do is open their hand and the correct medication will be dispensed.

This problem has been tackled in the past. However the solution that others have come up with tends to resemble an alarmed box, still requiring manual sorting by the user, or a bulky countertop box without direct user interface, requiring a somewhat high technical knowledge to operate. Our solution will overcome both of these common pitfalls with an intuitive user interface so even those with limited computer and technical knowledge can fully utilize the system and a simple design that avoids oversized motors, actuators, and containers. The end product will be a low cost solution to an everyday problem. [1]

1.2 Background

According to a study by NPR, 119 million Americans take prescription drugs. In addition to that group, our target population includes any person who takes over the counter allergy medication, pain relievers, and vitamins routinely. As figures 1 and 2 show below, there is a significant population between the ages of 0-18 and 65+ years old that take both prescriptions and over the counter medicines routinely. The Kaiser Family Foundation found that on average those who are 0-18 years old purchase medication 4.3 times each year and that those who are over 65 years old that number jumps to 23.9 times per year in the United States. People between the ages of 19 and 64 purchase 12.7 medications annually. We are gearing towards helping those between 0-18 and over 65 because these are the age groups that typically require extra help whether it be from parents, guardians, or caretakers. Removing the task of counting out and alerting these groups to take their medication could preserve the autonomy of aging users and give children a sense of autonomy as they are able to take their medication without having a parent watch over them once the dispenser is programmed. [2]

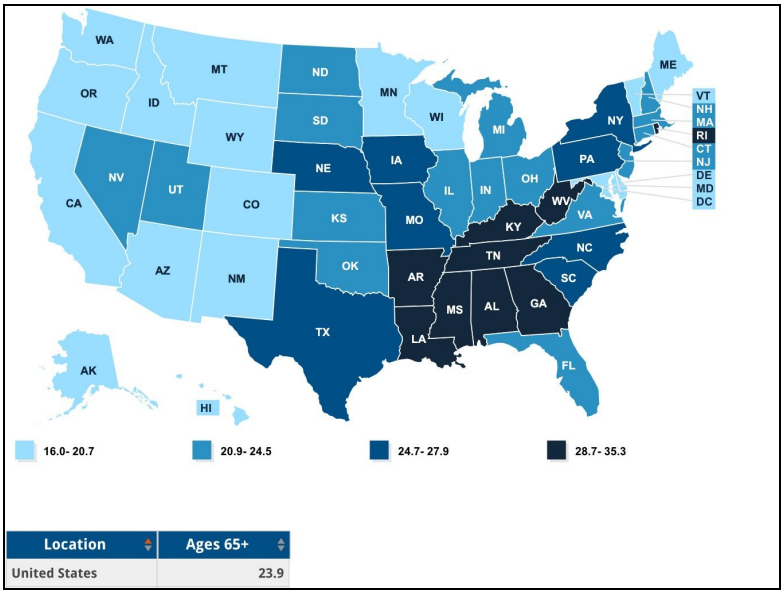

Figure 1: Retail Prescription Drugs Filled at Pharmacies (Annual per Capita Ages 65 and Up) [2]

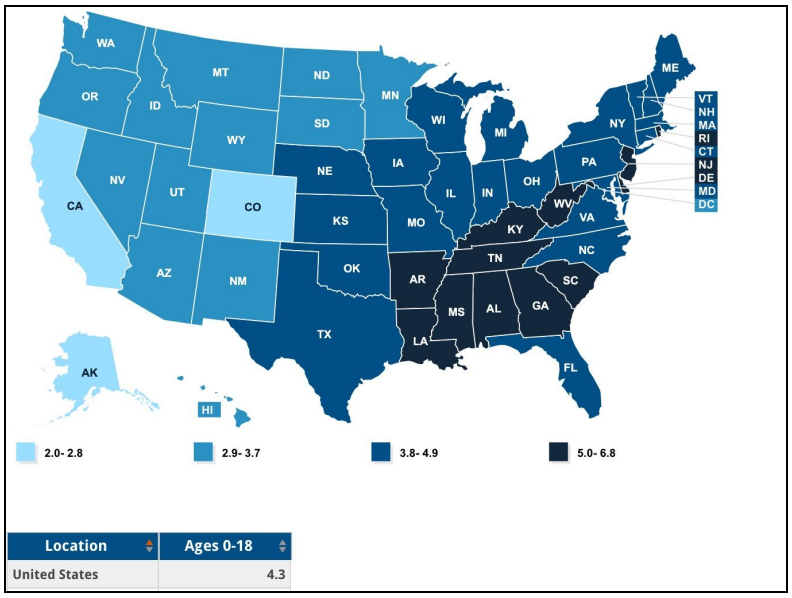

Figure 2: Retail Prescription Drugs Filled at Pharmacies (Annual per Capita ages 0-18) [2]

1.3 High-level Requirements

1. The machine will sort and properly dispense one pill at a time for any given pill.
2. The machine will be able to dispense medication at specified times.
3. The machine will audibly alert the user that it is time to take medication.

2 Design

2.1. Block Diagram

Our dispenser will require five separate sections: a power supply which will turn the 120VAC 60Hz to 5VDC; a control unit featuring a microcontroller and sensors to properly alert and dispense medication; a user interface to program the proper dosage; a couple of motors (one per type of medication) to dispense a single pill; and most importantly, a system of alerts to the user that it is time to take the medication.

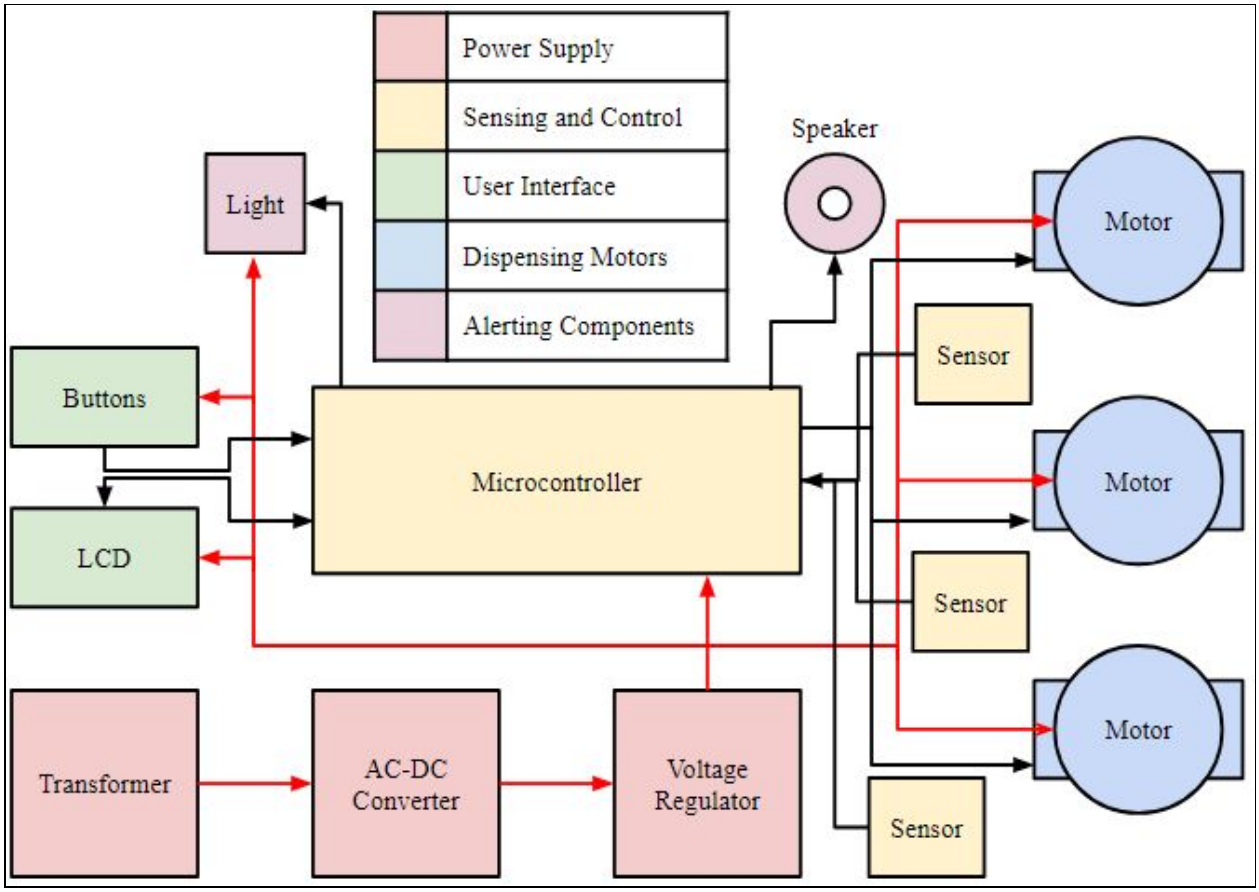

Figure 3: Block diagram

2.2. Functional Overview

2.2.1. Transformer

A transformer is one of the three power supply components. Our board needs a reliable DC voltage supply to power the dispenser's circuit components, however, we desire this device to plug into the wall for accessibility. As a result,

our circuit requires a transformer to step down the wall voltage of 120VAC to 12VAC.

2.2.2. AC-DC Converter

Also a part of the power supply, the AC-DC converter will change the 12VAC input voltage to 12VDC.

2.2.3. Voltage Regulator

The last part of the power supply is the voltage regulator. Our voltage regulator will buck the 12VDC input to a steady 5VDC input; this constant direct current is critical to supplying the digital components the power they need.

2.2.4. Microcontroller

A microcontroller (MCU) is necessary for our circuit to function, for we have multiple control input and output peripherals. This MCU will have to accept the user's designated medication time while properly keeping track of the current time. That way, the controller can then control the motors to dispense the pills while sensing whether one came out.

2.2.5. Sensors

These sensors will work in tandem with the microcontroller to sense the proper dispensing of the pills; meaning, only the desired number of pills are administered.

2.2.6. LCD

An LCD is required to aid the user's programming of the designated medication time.

2.2.7. Buttons

These buttons will allow the user to enter information.

2.2.8. Dispensing Motors

We will be using compact stepper motors to precisely turn the pill dispensing tumbler. The motors must be finely controlled, so that the correct dosage of medication is dispensed.

2.2.9. Alerting Components (Audio/Visual)

A light and a speaker will be used to alert the user when to take their medication.

2.2 Physical Design

Our device will use precisely controlled motors to spin a hopper. When desired, the pills will trickle down into a common tube and out to the medication cup. An early sketch of the pill hopper is shown in Figure 4.

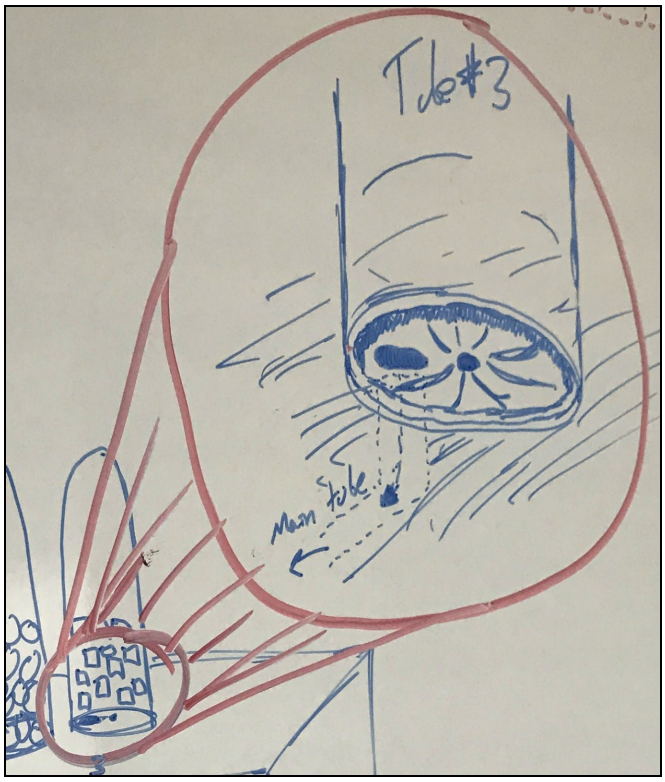

Figure 4: Pill Hopper Sketch

2.3 Risk Analysis

The main concern we have while thinking about and designing this circuit is the improper dispensing of medication by the machine. We must assure that only the proper dosage will be administered. Additionally, we assure that our machine will alert and dispense the medication at the correct time. Currently, we have one faux pas; we cannot assure who takes the medication. In our design, we only have one user. We may implement a keycode to enter a PIN number, and definitely will if we have extra time and expand the number of users.

When building a circuit to be in the center of someone's home, one needs to make sure the circuit is safe and stable. A faulty circuit risks starting on fire. We must ensure that our circuit and housing come together to create a reliably safe device.

3 Ethics and Safety

The potential costs of delivering incorrect doses or medications from the dispenser are extremely high. It would not be outlandish for this error to result in a hospital visit or death. With the correct automation and double checking, these mistakes could be avoided with our system. As spoken about above, if used correctly this product takes 30 potential opportunities for error each month and shrinks it into one step. While there is more importance put on the programming of the machine, it is much easier for a parent, guardian, or caretaker to set aside the proper amount of time once to set the correct dosage and timing information than it is for them to set daily reminders to set up, count out, and provide medication to the patient.

We intend to set up some sort of identification system to verify that it is actually the intended patient receiving the medication. Our current methods are a simple four digit PIN number, a typed password, RFID sensor, or fingerprint. These can all be added as a peripheral so the central sorting and dispensing mechanism of our design will not be affected should these methods not work. As a whole, the proper use of this system does not cross any IEEE and/or ACM ethics codes as its intended use will streamline the lives of those taking multiple medications each day.

4 References

[1] R. Harris, "Federal Survey Finds 119 Million Americans Use Prescription Drugs", *NPR.org*, 2017. [Online]. Available: http://www.npr.org/2016/09/08/493157917/federal-survey-finds-119-million-americans-use-prescription-drugs. [Accessed: 22- Sep- 2017].

[2] "Retail Prescription Drugs Filled at Pharmacies (Annual per Capita by Age)", *The Henry J. Kaiser Family Foundation*, 2017. [Online]. Available: http://www.kff.org/other/state-indicator/retail-rx-drugs-by-age/?activeTab=map&currentTimeframe=. [Accessed: 22- Sep- 2017].