Pill Pal: A Medication Tracker and Dispenser

Team 42

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1 Introduction

1.1 Background

Modern medicine allows us to alleviate the ailments that come with advanced age and has consequently allowed us to extend our life expectancy well beyond limits decades ago. As expected, reaping the benefits of old age requires us to maintain regularly scheduled medication intake. Older generations have an especially difficult experience keeping track of pills taken and they may have many different pills to take at different times of the day. With growing numbers of an elderly population in the United States[2], it is anticipated that there will be more elders than caregivers in the coming years. Thus, it may be seen that overall control of specific medication taken at a time and the remembrance of taking such batches of medication proves to be a challenge for the elderly. Complications with medication, whether it be overdosing, underdosing, or mismanagement, are potentially dangerous.

1.2 Problem and Solutions Overview

Efforts by commercial manufacturers on today's market effectively dispense medication of different types with configuration options possible, but at high price points and fail to track the taking of medication. We propose an automated pill dispensing system that will inform users when to take their pills and indicate whether the pill(s) has/have been taken or not. Caregivers will be able to survey the medication intake of patients without 24/7 attention, and will free up time for greater volumes of patients or other issues, without the mundane chore of manual dose control. Additionally, to prevent overdose, the dispensing system would be able to lock and only dispense medication at the right time of day and when the single user has not already taken the pill(s). This will alleviate the need for 24/7 attention and manual dose control. There will be an interface for caregivers to configure and show the frequency of intake for specific pills. This will be configured on the interface such that pills with specific frequencies will only dispense should the time to take them be ready. Alerts and notifications should also be supplemented with the device to remind users to take the batch of medicine. Former groups implemented a number of new and related solutions without success of control over the number of pills dispensed. To circumvent this technicality, we will be working closely with the ECE Machine Shop to implement a horizontally sorting pill counter with the use of an IR sensor much like automatic pill counters seen on markets today[3]. We believe that this will be a greater improvement on a vertical gravity-based pill drop dispenser. Our project models on existing solutions, to motivate greater chances of success on dosage control.

1.3 Visual Aid

This is not to scale, but the dispenser will have an opening just for the cup that holds the pills. Below the cup is the load cell that weighs the changes in the cup to track whether the patient has taken the pills or not. The LED on the front of the dispenser will serve as an indication: green for pills taken, red for pills not taken, and yellow for pills dispensing/dispensed. The buzzer/speaker will play a noise when the pills have been dispensed in order to alert the patient to take the medication. The phone application is for the caregiver to specify how many pills to take, at what time to take them, and any other important information. The caregiver will also be alerted about the status of the medication intake and whether or not to refill the pill dispenser.

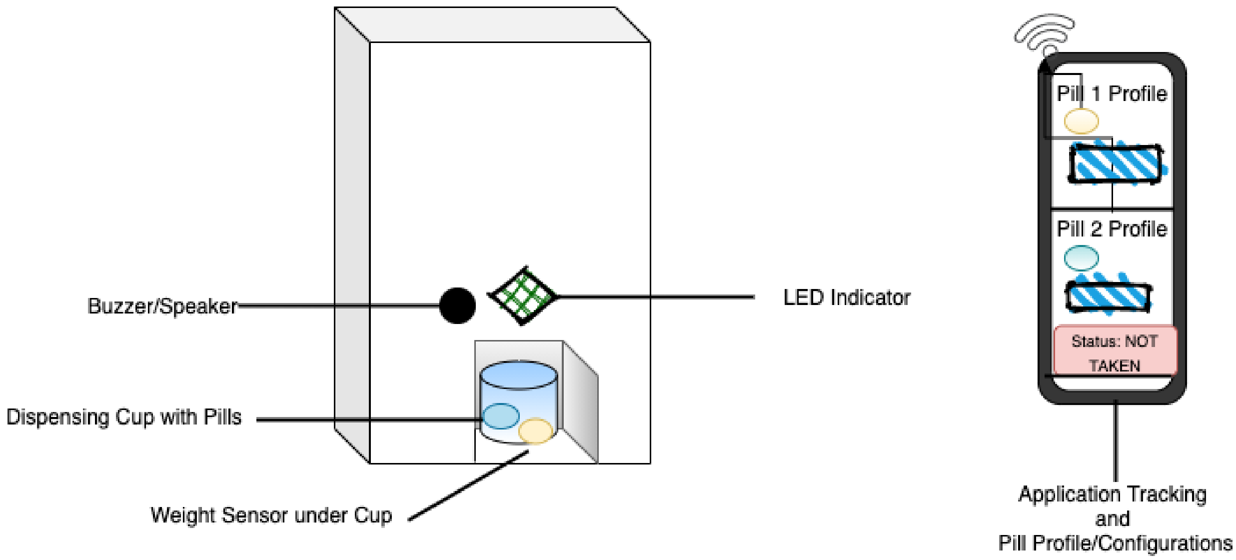

Figure 1.1.
Visual Aid

1.4 High-Level Requirements

1. Caregiver inputs the prescription specification of the medication into the mobile application. This information includes the number of pills to take and at what time of day. The dispenser should run with a scheduler and should dispense dose within a minute (60 sec) of inputted time. The dosage must be outputted based on application specifications 99% of the time.
2. Track whether the pills have been taken through application interface of caregiver. User's profile should show whether or not the medication was retrieved and receive an update on status, within 3 minutes, about retrieval from the dispenser. This is maintained through a weight sensor capable of 0 - 100g precision needed for mg weight of pills. Additionally, warning about pills not taken will show up on the application 5 minutes after dispensing.
3. Configure dispenser remotely from mobile application by allowing caregiver to input the type of medication put into the dispenser, the number of pills to take, and at what time the pills should be dispensed. There will also be an update when the pills must be refilled on the application so the caregiver can unlock the dispenser on the app and then refill the medication.

2 Design

2.1 Physical Design

The design of our pill dispenser uses the pill counting design from modern machines to output pills based on a specified amount. There are two pill dispensing plates to allow for two separate types of medication, but both output to the same cup at the bottom of the machine. The rotating discs use the motors to turn when prompted and the pill size corridor control ensures that pills leave in a line so only one pill passes the IR sensor at a time. This allows the sensor to send the data to the control unit to track the number of pills dispensed. The weight sensor below the cup is used to track whether the pills have been taken from the dispenser or not and can be updated on the mobile application. On the front door of the dispenser, there is the EM "Fail-Secure" Lock to deter patients from breaking into the machine. The small door at the bottom allows the user to take the cup and the pills from it. The WiFi unit and control unit are placed in the bottom at the back in order to have as much space as necessary. Finally, the mobile application connects to the mechanism using the WiFi unit and can help control the machine with when to dispense the pill, if the pill has been taken, or if it is necessary to refill.

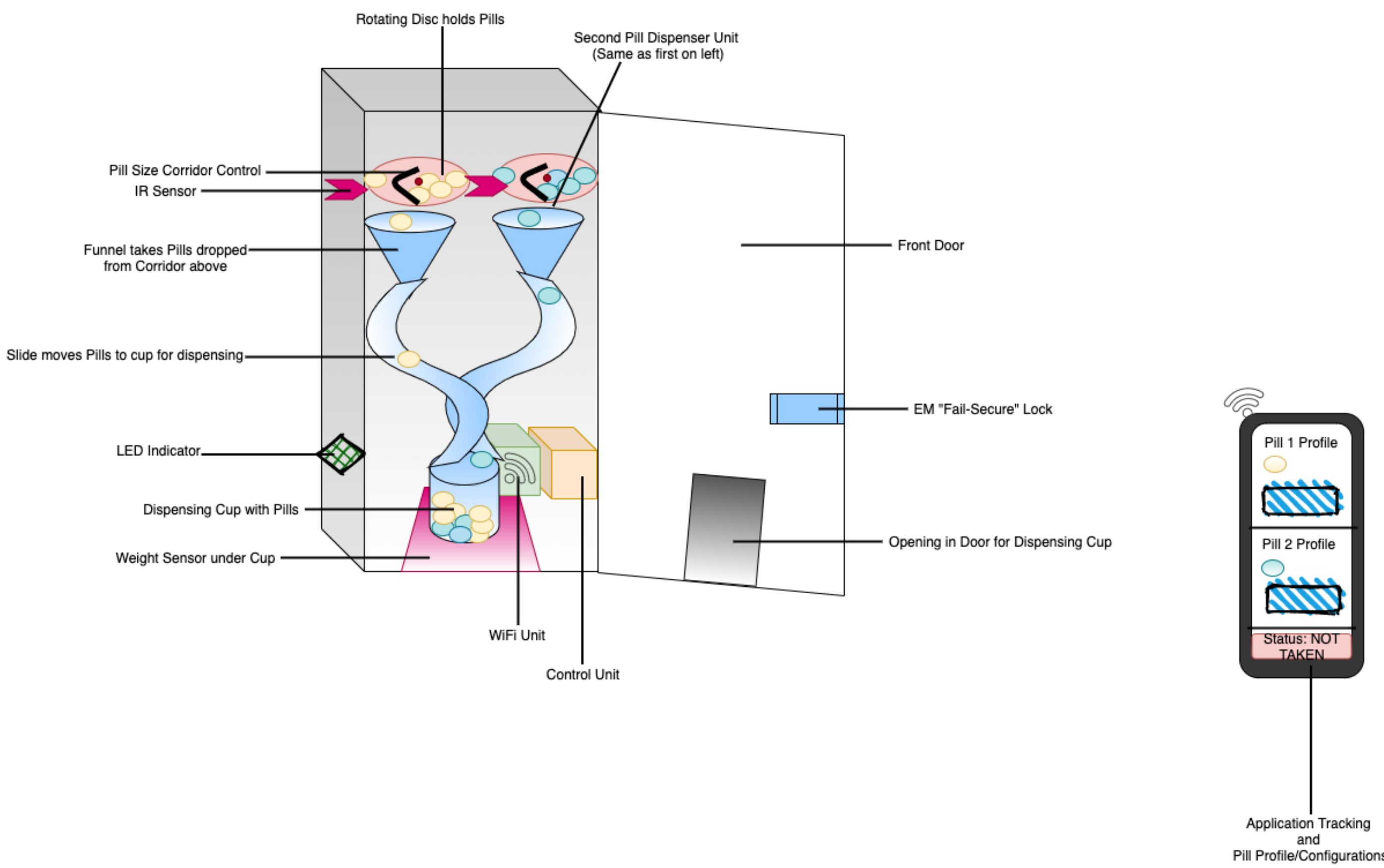

Figure 2.1. Physical Diagram

2.2 Block Diagram

This pill dispenser requires seven sections for correct operation: power supply, microcontroller, WiFi module that connects to a server and an application, safety mechanism, sensors, motors, and an indication system. The power supply ensures that the microcontroller, sensors, lock, WiFi module, motors, LEDs, and speaker can be powered with the proper 5V. The control unit contains a microcontroller to interface with the sensors, motors, LEDs, speaker, and WiFi module. Thus allowing the microcontroller to dictate when each item's data will be used, or when it should be deployed. A WiFi module connects this control unit to a standard IEEE 802.11b/g/n WiFi network. This is so that the connected server module can interface between the mobile application and the microcontroller. The safety mechanism is connected to the microcontroller to be locked or unlocked by the microcontroller. The sensors and motors are in order to dispense a pill and are connected to the microcontroller so a specific time to run can be configured. Finally, the indication system, consisting of LEDs and a speaker, is also connected to the microcontroller to change which LED is lit and when the speaker will output noise to alert the user.

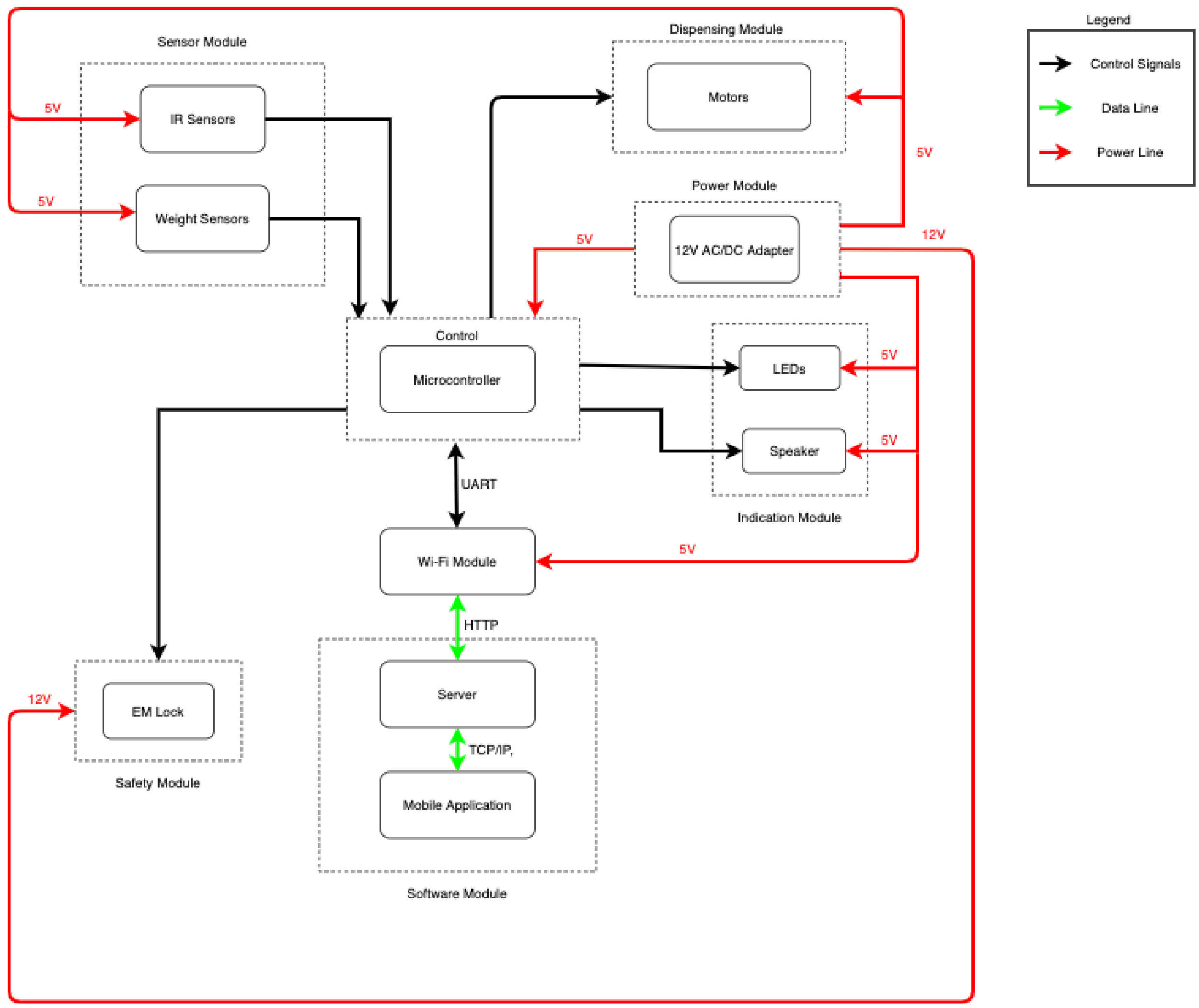

Figure 2.2.
Block Diagram

2.2.1 Power Module

A power supply is required to keep the microcontroller, sensors, motors, LEDs, speaker, EM Lock, and WiFi module working.

2.2.1.1 12V AC/DC Adapter

Power supply will be connected to the microcontroller, regulated for 5V for most of the other modules and then distributed where necessary. For the EM Lock, we will need to take the power from the microcontroller, but not regulated for 5V, instead it should stay at the 12V. The power will be plugged into an outlet for easy access and less replacement, therefore we need to convert the high power output from the outlet to the 12V that our system needs. The input to the adapter is the AC power from the wall outlet and the output the adapter gives is DC voltage rated at 12V.

Requirement	Verification
1. Must output 10.5 ± 1.5 VDC and 2.95 ± 0.05 A at an error range of 0 - 25%	1. a. Use a multimeter to check voltage drop of power supply over a 1KΩ resistor to test that 10.5 ± 1.5 VDC and 2.95 ± 0.05 A is outputted using Ohm's law.

2.2.2 Control

A control unit manages all the separate parts of the dispenser and allows them to react or deploy given specific requirements. The motor, sensors, EM lock, LEDs, and speaker need to be run at specific times to ensure that a pill is dispensed correctly and at the right time.

2.2.2.1 Microcontroller

The microcontroller, chosen to be an ATmega328PU, handles memory allocation for the cache. It communicates with the WiFi chip via UART. The inputs to the microcontroller are the IR sensors, the load cell, the 12V coming from the AC/DC adapter, 5V coming from a linear voltage regulator, 3.3V also coming from a linear voltage regulator, and the UART connection from the ESP8266-01s WiFi IC. The outputs from the ATmega328PU are control signals to the EM (solenoid) lock, L298N motor drivers that control the step motors, LED, piezo buzzer, and the UART connection to the ESP8266-01s WiFi IC.

Requirement	Verification
1. Microcontroller should take at least two analog inputs from the sensors 2. A digital output HIGH should be produced when the sensor provides a 1 and a digital output LOW should be produced when the sensor provides a 0 3. Must sink or source 10mA on each of the two GPIOs at 3.3V +/- 5%	1. Test connections using driver codes a. Connect 3.3V to VCC to power the board b. Upload the driver code c. Set PE sensor output to 0 and check if the corresponding output pin voltage is low (approx. 0V) d. Set PE sensor output to 1 and check if the corresponding output pin voltage is high (approx. 3.3V) e. Check that the amperage can reach 10mA and expected values should be within +/- 5%

	of expected value

2.2.3 Dispensing Module

The dispensing module consists of the motors used to control the plates that allow only a few pills into the limited channel and to lessen the flow of pills outputted. This ensures that only the correct number of pills are dispensed.

2.2.3.1 Motors

The motor is a step motor that will control the plate that holds a maximum of 20 pills at a time. This will interact with the microcontroller to know when to turn on to dispense the pill. The input to the motor is a high or low voltage that is regulated by the L298N motor drivers which start and stop the motor when necessary. The motors are connected to the plates where the pills sit and therefore the output of the motor would be to turn the plates at the rpm specified.

Requirements	Verifications
1. Must operate at 5.0 ± 0.2 VDC 2. Must rotate 360° for a minimum of 0.07 ± 0.01 sec/60° 3. Must be able to turn 360° for a minimum of 0.07 ± 0.01 sec/60° with a load of 0.58 ± 0.05 oz attached.	1. a. Use a multimeter to check voltage drop over the step motor. Ensure the drop is 5.0 ± 0.2 VDC. 2. a. Place a marking on the base of the motor and attach a piece of colored tape to the rotating piece where the starting location of the tape coincides with the marking. Starting from 3.5V to 6V, test in 0.5 volt increments to count the number of times the tape passes the marking in a minute. b. Weigh a piece of plastic or a CD such that it is 0.58 ± 0.05 oz. Attach the item to the motor and connect the motor to the power supply to see if it can still work with the additional weight.

	3. a. Attach a disc of maximum diameter 140mm to the motor. Place a marking on the disc and a marking exactly below on the base of the motor. Check that the disc's marking passes the marking on the base in 0.42 ± 0.06 seconds. b. Place an item on top that is 0.58 ± 0.05 oz. Do the above test while the object is on top of the disc.

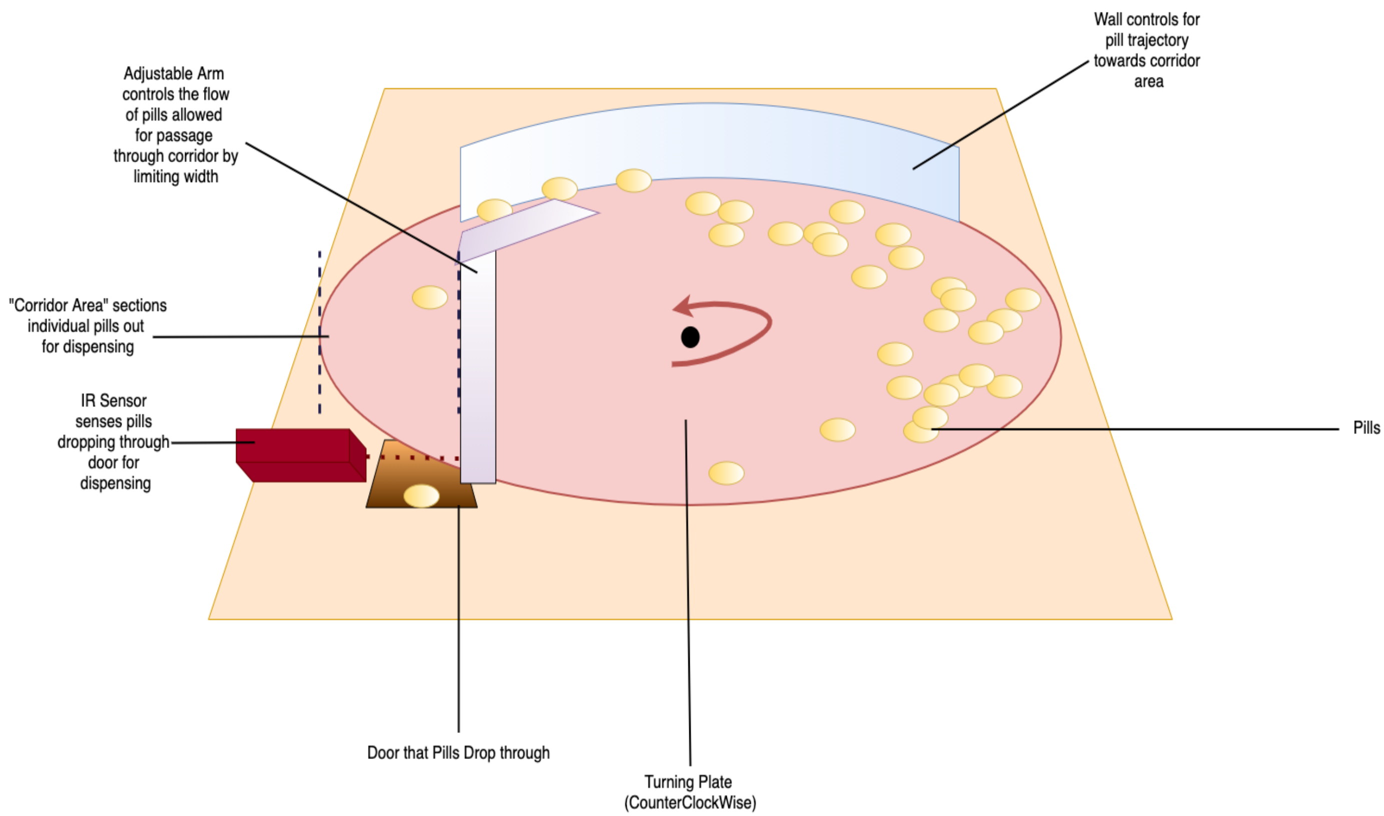

Figure 2.3. Magnified View of Plate

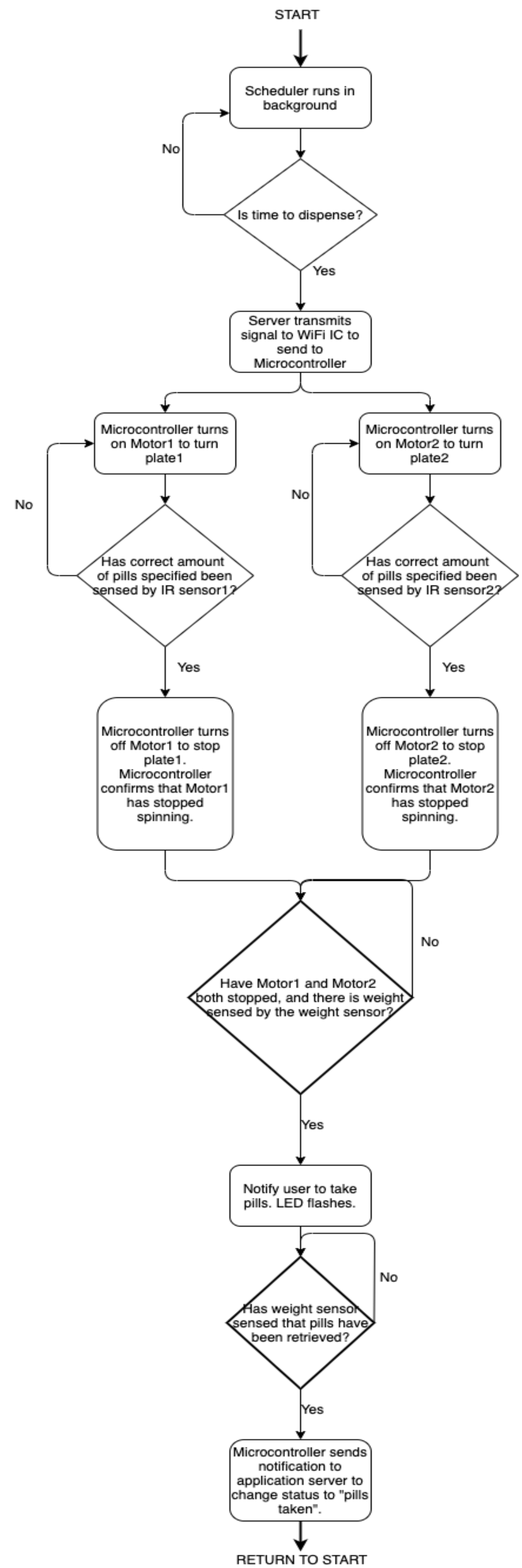

Figure 2.4. Pill Dispensing Flowchart

2.2.4 Sensor Module

The sensor module is made up of IR sensor(s) and a FX292X-100A-0100-L load sensor which keep track of how many pills leave the plate at the top and whether the pills are actually removed from the bottom.

2.2.4.1 IR Sensors

The IR sensors are located where the pill exits the rotating plate to keep track of the number of pills that exit to the cup. This is to ensure only the prescribed number of pills are dispensed. The input to the IR LEDs are 5V from the linear voltage regulator and ground from the linear voltage regulators, the output is the infrared light the LED emits. The inputs to the IR sensors are 5V from the linear voltage regulator and ground from the linear voltage regulators, the output is a voltage reading (between 0.000V to 0.8000V) that is sent to the microcontroller.

Requirement	Verification
1. Must operate at 4.1 VDC ± 1.4VDC 2. Must be able to detect a pill when it crosses a beam of maximum distance 100mm, minimum distance 12.5mm, range of 10° above or below the sensor 3. Must be able to detect different sizes of pills minimum of 6mm to maximum of 12mm	1. a. Use a multimeter to check voltage drop over sensor when in circuit is 4.1 ± 1.4 VDC 2. a. Set up the IR LED on one side and the IR sensor on the other side at 12.5mm b. Use a small object (10mm or less) and guide it through IR pair's beam c. Check the voltage change through multimeter, change should be 0.3V or greater d. Set up the IR LED on one side and the IR sensor on the other side at 100mm e. Use the same small object (10mm or less) and guide it through the IR pair's beam f. Check the voltage change through multimeter, change should be 0.3V or greater 3. a. Use a small 6mm pill within the range of detection and use a multimeter to check output

	voltage from the IR sensor. Check to see if voltage changes by 0.3V or greater. b. Use a medium 9mm pill within the range of detection and and use a multimeter to check output voltage from the IR sensor. Check to see if voltage changes by 0.3V or greater. c. Use a large 12mm pill within the range of detection and use a multimeter to check output voltage from the IR sensor. Check to see if voltage changes by 0.3V or greater.

2.2.4.2 Weight Sensors

The FX292X-100A-0100-L load sensor is located below the cup where the pills will be dispensed to. This sensor detects the weight and therefore can tell the difference between weight when the pill is dispensed and once it has been removed by the user. The input to the load sensor is 5V from the microcontroller and ground from the microcontroller. The output from the load sensor are two wires that give a voltage output which is sent to the microcontroller. The difference between the voltage output wires gives the weight reading.

Requirement	Verification
1. Must operate at 5 ± 0.25 VDC 2. Need to be accurate in deciding when pills are in the cup and when they are not. 3. Must be able to differentiate between when the cup has no pills and when it does have pills (through difference of weight measurement voltages). A tolerance threshold of up to 75% a dosage weight will be allowed, such that we say pills have been retrieved once a 25% → 24% threshold change in voltage is crossed.	1. a. Use a multimeter to check voltage drop over sensor when in circuit is 5.0 ± 0.25 VDC 2. a. Place a 1oz plastic cup on top of the weight sensor and use a multimeter to check the voltage drop. Add 6mm, 9mm, or 12mm, or all three pills and check the voltage drop over the weight to see if it has changed from the previous measurement. Then take away pills and cup to see if the 75% threshold is crossed. If so, this

	is a good mark for detecting pills or a lack thereof. 3. a. Place a 1oz plastic cup on top of the weight sensor and use a multimeter to check the voltage drop. Add 6mm, 9mm, or 12mm, or all three pills and check the voltage drop over the weight to see if it has changed from the previous measurement. Then take away pills and cup to see if the 75% threshold is crossed. If so, this is a good mark for detecting pills or a lack thereof. b. Try the above test with different numbers of 6mm pills, 9mm pills, and 12mm pills. Repeat until dose detections are perceptible.

2.2.5 Safety Module

The safety module is meant to deter overdose of pills or tampering with the system.

2.2.5.1 EM Lock

The 1528-1191-ND EM Lock will be used to ensure that the front of the mechanism is locked at all times unless specified to be unlocked through the app. The microcontroller will maintain control over the lock. The input to the EM lock is the 12V or less than 9V and ground that comes from the microcontroller and the output of the lock is whether the lock is engaged or not. This is determined by the ATmega328PU, based on if the voltage sent is high (unlocked) or low (locked).

Requirement	Verification
1. Must remain locked in its natural state when under 9 VDC is applied. 2. Must unlock when 10.5 VDC ± 1.5 VDC is applied to lock.	1. a.. Use a multimeter to probe the voltage entering the EM lock at increments of 0.5 volts, starting from 0 VDC. The lock should remain locked.

	2. a. Use a multimeter to probe the voltage entering the EM lock at increments of 0.2 volts, starting from 8.8 VDC to 12 VDC. The solenoid should retract when 9 VDC is reached and remain unlocked until a value larger than 12 VDC is reached.

2.2.6 WiFi Module

Data from the control module (microcontroller) is sent via UART to be accessed on a WiFi network. A WiFi SoC (System-on-a-Chip) operates off SPI flash program memory and uses an antenna for both receiving and transmitting.

2.2.6.1 WiFi IC

We have chosen our WiFi IC, the ESP8266-01s, with cost in mind. This chip includes a 32-bit microcontroller and WiFi transceiver. This was chosen since it allows for easy information relay to and from a local server created from the WiFi module. It operates at 160MHz (overclock) and has data input communication with the ATmega328PU microcontroller via UART. Both input and output communication through UART is sent to the microcontroller. Since the WiFi chip is hosting the web server, all the other input and output connection is coming from and sending to the mobile application.

Requirement	Verification
1. The WiFi IC must be able to communicate with microcontroller on pill dispensing at 10% of total timeout of pill dispensing process of 5 minutes.	1. a. Connect voltage to the microcontroller and wifi modules b. Upload a sketch using the Arduino to the ESP8266-01s c. Connect the wifi module to the microcontroller using TX/RX pins and send variable data through ESP8266-01S program. d. Check that the maximum timeout time when no data is sent is 30 seconds. Look at output logs and print

	statements to verify that ESP8266-01S program runs in 30 seconds.

2.2.7 Software Module

Data from the WiFi IC is sent to the software module through the server. The PIC32 with the microcontroller is able to communicate to the server that will receive and send the data to the application.

2.2.7.1 Server

The server design will consist of a microcontroller, a cellular receiver, and a WiFi dongle. The main function of the server is to send and receive data to/from the mobile application. The web server takes input from the microcontroller, by the ESP8266-01s WiFi IC, and the mobile application. The output from the web server goes to the mobile application or the WiFi IC to send to the microcontroller.

Requirement	Verification
1. Must be able to establish port connection for host-client transmission of data from microcontroller to application 2. Use POST and GET requests for transferring data, interface between microcontroller to application 3. Must establish WiFi connection	1. a. Create a web server using the Arduino IDE using given code b. Add in credentials and test the web server by entering the ESP IP address into a web browser 2. a. Using the created web server, connect LEDs with simple web server code and test that LEDs can turn off and on by command on the web browser through IP address. 3. a. Using LED and web browser testing, if successful, then WiFi connection is established.

2.2.7.2 Mobile Application

The main function of the application is to allow the caregiver to put in details of the pill intake and keep track of when the pill has been taken and when to refill. This will serve as the main interface for any adjustments to the pill dispensing. The input and output from the mobile application are from and sent to the web server hosted on the ESP8266-01s WiFi IC.

Requirement	Verification
1. Must be able to connect to the server by WiFi and access updates from the server. 2. Must allow the caregiver to successfully unlock the machine for medication refill and be updated on the status of pill dosage and dispensing. 3. Should allow the caregiver to input prescription details to change the mechanical environment such as dispensing the appropriate medication and locking and unlocking the dispenser to add in more medication.	1. a. Echo statements between WiFi point and server ports. Send a statement between the host and client to confirm that the connection has been made. 2. a. Verify that the application is connected to the server and WiFi IC first with Requirement 1. Then, use print statements to verify that the correct data is sent when selected by caregiver on User Interface. Use print statements when debugging on microcontroller to show that output voltage to control EM lock turns HIGH. 3. a. Use print statements to verify user input is received correctly as raw strings then converted to correct types after processing and storing.

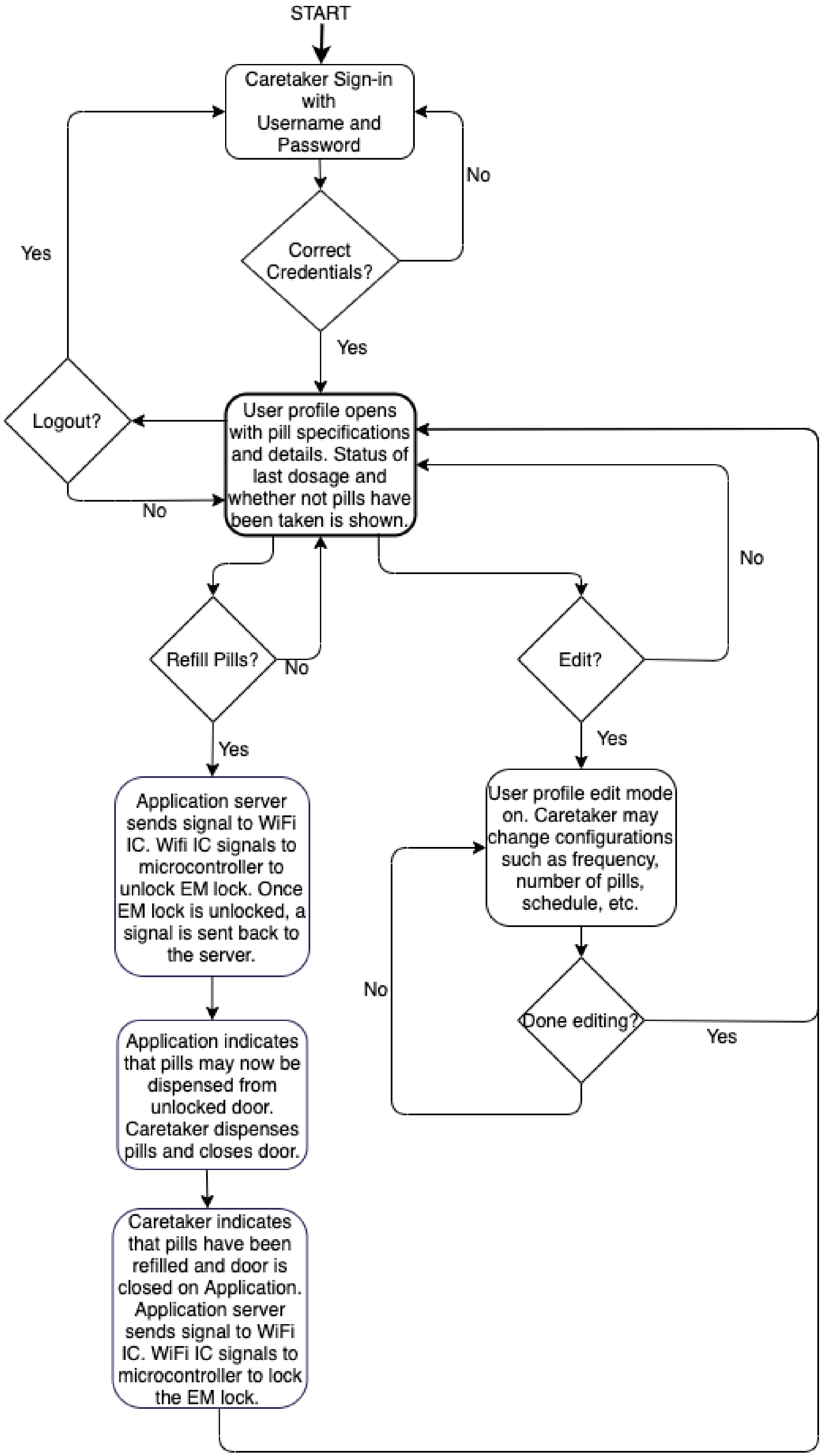

Figure 2.5. Caretaker Application UI Flowchart

2.3 Schematic

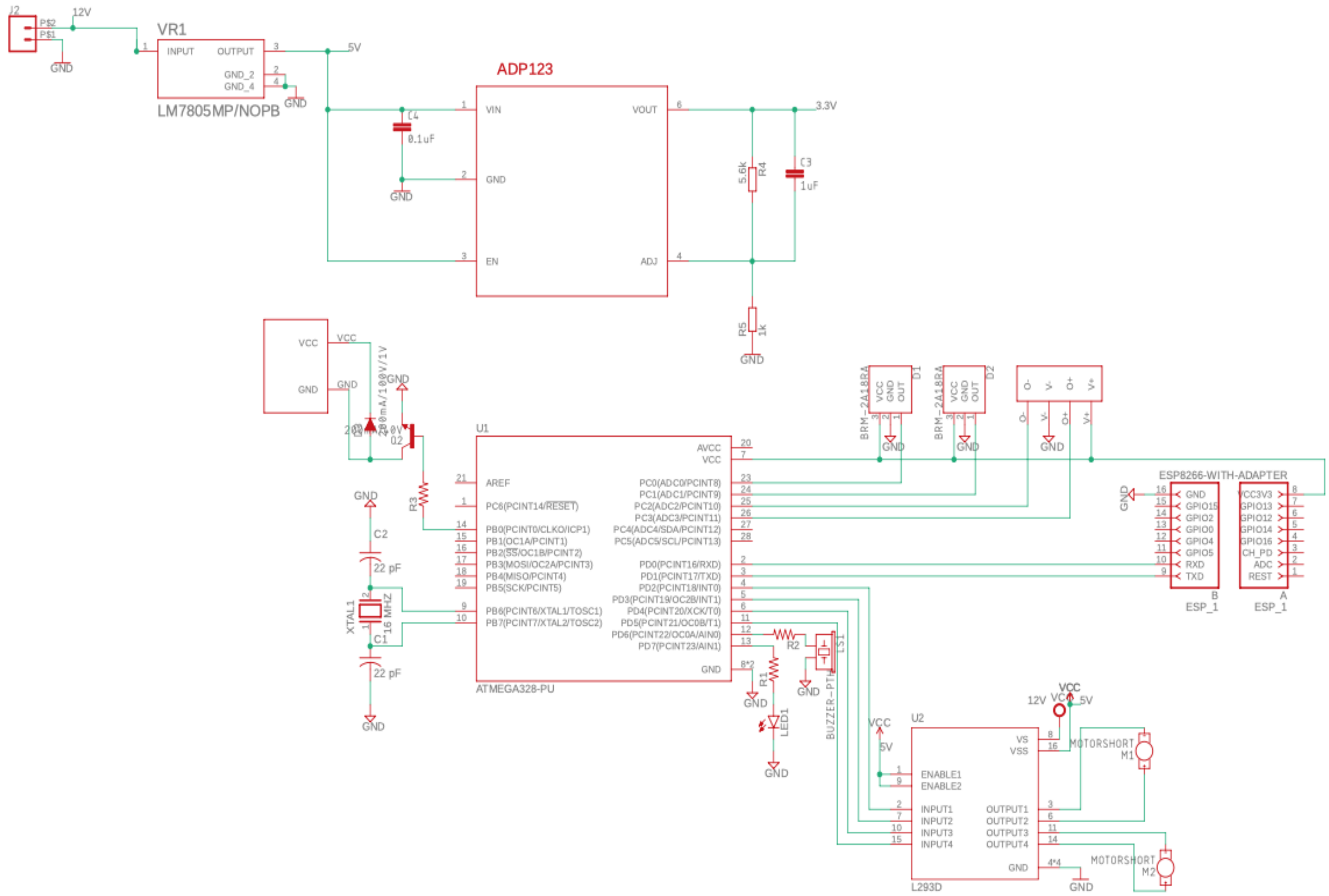

Figure 2.6. Schematic of components

2.4 Tolerance Analysis

As modern medicine continues to improve, lifespans are potentially extended through medications and pill dosages to address health issues. However, most people who have to take medication to maintain their quality of life tend to be of the older generation and will forget what pill to take, when to take it, and how many they have to take. There are many caregivers who will be responsible for keeping track of this information, but it can become quite difficult when caring for many different people.

An important factor for the success and proper functioning of our pill dispenser is ensuring that that correct number of pills are dispensed. In order for us to ensure the correct dosage is dispensed each time, we use an IR sensor to detect when a pill is ready to be dropped and we keep a count in the microcontroller using the output of the IR sensor. Once the correct count of pills has been reached, the motor for the disc, which the pills sit on, must stop immediately to prevent further pills from being dispensed.

The IR sensor must be able to detect a pill in the range of 50mm to 200mm. Based on the graph below, different photodiodes yield a different range of Analog-to-Digital voltage output. The output is sent to the microcontroller in order to make the decision to stop the motor. Thus, the photodiodes in the IR sensor must be sensitive enough to detect the pill at the aforementioned distances.

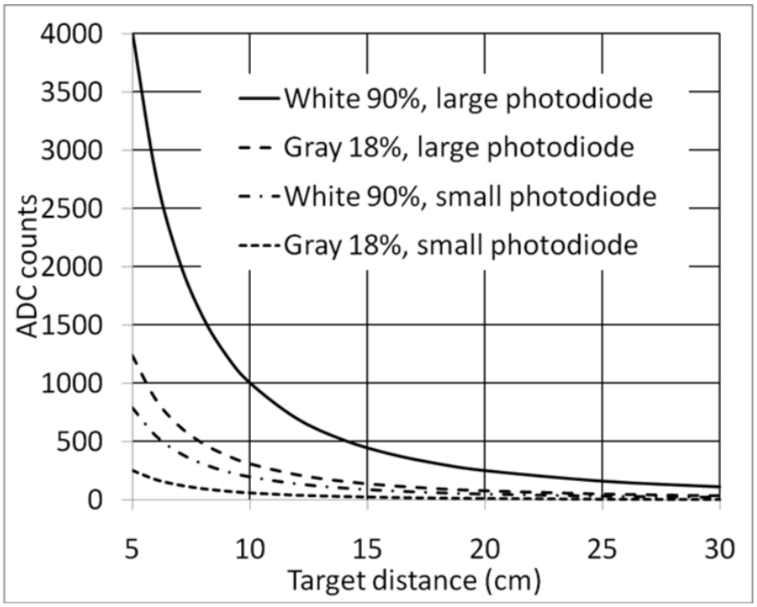

Figure 2.7. Proximity Response Using Kodak Gray Cards, PS_RANGE = 0, PS_ADC_GAIN = 0 (Single 25.6 µs LED Pulse), 22.5 mW/sr, No Overlay (Preliminary)

Given a diameter of 140 mm, the plate should rotate such that pills passing through the corridor have sufficient space in between. An estimated 100 mm will be the length of the arm. Thus, the pills will have a runway of 100 mm before dropping down. This length of runway should have an IR sensor placed enough in advance to sense a pill, forward the signal to the microcontroller, send a signal back to stop the motor, and physically stop the rotations before it is sensed by the IR sensor. With an average weight of 500mg, the average pill's velocity must reach termination before the IR sensor; in turn, the motor must spin the plate such that the pill's velocity will reach termination before the IR sensor. This factor assumes that the IR sensor operates optimally according to the reception of IR light and propagation of signals to the microcontroller.

In addition to the delay caused by the propagation of signals from the IR sensor to the motor, it is important to account for the pill sliding after the disk has stopped spinning. The extra distance traveled by the pills will be the sum of the distance traveled because of the propagation delay and the distance the pills slide after the plate has stopped. Accounting for both of these, we can determine how much of a time error can be tolerated to allow for only the pill we want to dispense to be dispensed without extra pills falling as well. The time error accounts for the time from when the IR sensor is triggered to when the motor is stopped. To calculate what error can be tolerated we find the distance traveled by the second pill on the disk after the first pill has dropped. To stop the second pill from being dispensed as well we want the disk to stop no later than half the distance of the radius of the pill.

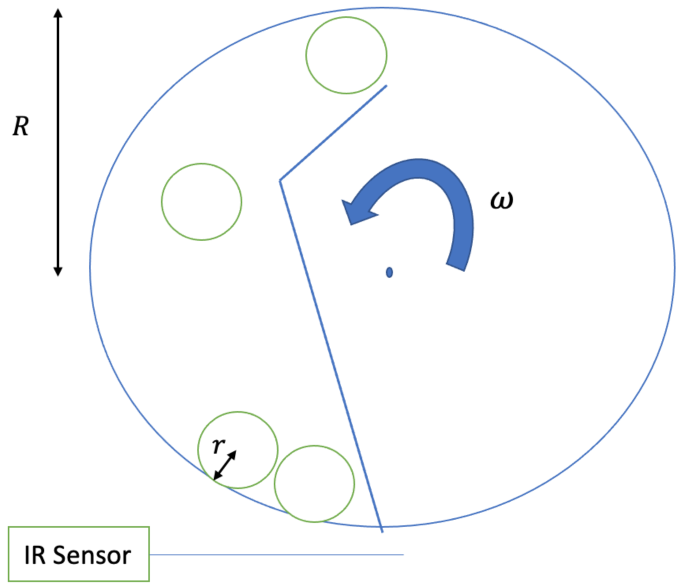

Figure 2.8. Rotating Plate used for Calculations

We first add the distance traveled by slipping then we account for the additional time because of the delay.

$$distance\ traveled\ by\ pill = \frac{v^2}{2\mu g} + v\Delta t\ ,\ where\ v = (R - r)\omega \qquad \textbf{EQ (1)}$$

R = radius of disk
r = radius of pill
v = velocity of plate
Δt = change in time (seconds)
μ = coefficient of friction
g = acceleration due to gravity constant
ω = angular velocity of the plate (rpm)

This can be manipulated to find the maximum tolerated time delay for a single pill to be dropped:

Change in time must be defined by this equation:

$$\Delta t < \frac{3r}{2(R-r)\omega} - \frac{(R-r)\omega}{2\mu g} \qquad \textbf{EQ (2)}$$

Δt = change in time (seconds)
R = radius of disk

r = radius of pill
μ = coefficient of friction
g = acceleration due to gravity constant
ω = angular velocity of the plate (rpm)

Assuming our disk has a radius of 0.07m and the radius of the pill is 0.006m, we can solve for the maximum tolerated time delay of a pill on different surfaces with different coefficients of friction. We found the coefficient of friction of pills on different surfaces in a paper investigating the sliding coefficient between pills and different surfaces [5]. Taking the coefficient of friction of Aspirin 325mg film coated tablets on different surfaces, we found what the maximum tolerated time delay would be on our mechanism at different speeds.

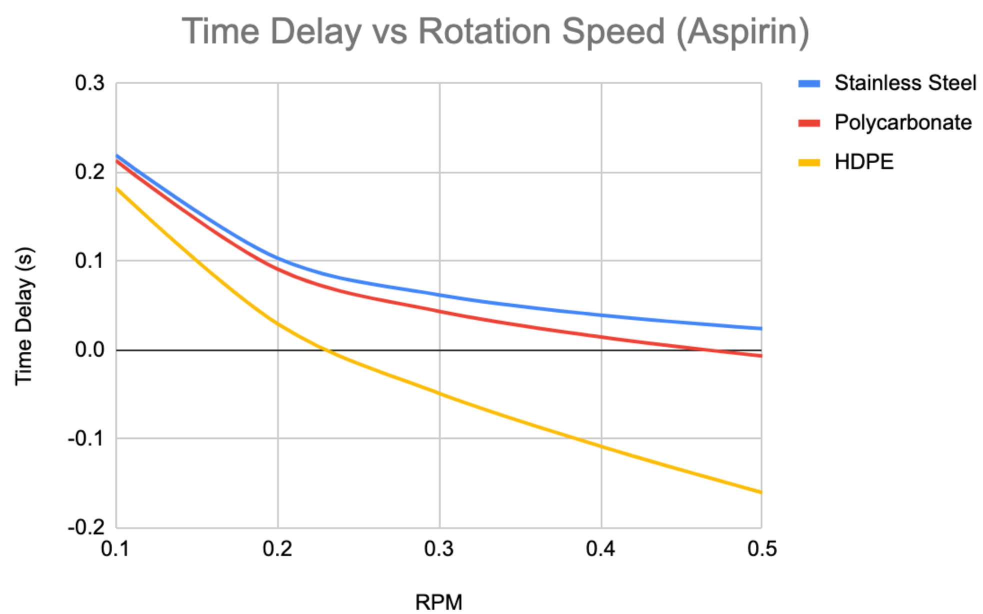

Figure 2.9. Plot of Time Delay vs. Rotation Speed of pill on disc

Using this information, we can see the difference in using different materials as the disk. Another important factor is that we will need to run the motor quite slowly if we don't want to dispense more pills by mistake.

Should more pills drop due to mechanical failure, it should be considered that the number of excess pills be reported to the application interface, and consequently, the caretaker. This requires a tight enough IR sensor feedback loop.

The average pill is around 500mg, and so the load cell must be sensitive enough to sense the 0.5% difference of its sensitivity range of 100g. This may be modeled with a linear regression analysis of larger weight points from 0 to 20 grams, with a granularity at 0.25g intervals. This would provide a base analysis that checks the detection of up to approximately 40 pills with half-pill increments. The voltage will be adjusted as needed with a bridge to model a linear F(x) = mx + b. From there, the microcontroller may be programmed to detect differences between lower gram thresholds and changes on the load cell to no weight, when the pills have been retrieved. A scheduler should run on the server to update retrieval status and notify for tighter control.

3 Cost and Schedule

The cost of development can be calculated assuming 10 hours per week of work for 16 weeks for 3 team members. We will assume an average salary of an electrical/computer engineer of $35 an hour.

$$3\ people * \$35/hour\ * 10\ hours/week\ *\ 16\ weeks\ * 2.5 = \$42{,}000$$

3.1 Cost Analysis

Description	Manufacturer	Part Code	Quantit y	Cost
EM Locking Mechanism	Adafruit Industries LLC	1528-1191-ND	1	$14.95
Motor Driver	STMicroelectronics	L298N	2	$9.72
Load Cell (0-100g)	Phidgets Inc.	CZL639HD	1	$7.00
Stepper Motor	Twotrees	Twotrees 17HS19-2004S1	2	$35.99
WiFi IC	MakerFocus	ESP8266-01	4	$12.99
RGB LED	SparkFun Electronics	COM-00105 ROHS	1	$2.05
Microcontroller	Microchip Technology	ATmega328-PU	1	$2.30
Power Supply AC to DC converter	BINZET	HM-01831	1	$15.49
Linear Voltage Regulator	Texas Instruments	LM7805	1	$1.40
Linear Voltage Regulator	Analog Devices Inc.	ADP123	1	$1.22

Buzzer	Adafruit Industries LLC	485-1536	1	$0.95
IR Sensor	Vishay Semiconductor Opto Division	TSOP34438	2	$2.66
Transistor	Adafruit Industries LLC	TIP120	1	$2.50
TOTAL COST:				**$110.26**

Section	Cost
Labor	$42,000
Parts	$110.26
Total	**$42,110.26**

3.2 Schedule

Week	Jerry	Deonna	Pallavi
3/8	Talk to Machine Shop, Order Parts	Talk to Machine Shop, Order Parts	Talk to Machine Shop, Order Parts
3/15	Testing EM Lock	Testing IR Sensor	Testing Load Cell
3/22	Setup Application Interface, Test Motor	Verify PCB design, Test Motor	Setup port-to-port server control
3/29	Solder on standard parts, continue Application Interface	Solder on Microcontroller, fix mechanical pill dispenser into frame	Solder on standard parts, fix mechanical pill dispenser into frame
4/5	Test Pill Dispenser with application	Test Pill Dispenser with motor and IR	Test Load cell with application interface

	interface and load cell	sensor detection	
4/12	Debugging Application Interface	Make last hardware adjustments and Microcontroller tweaks	Debugging Motor Controller
4/19	Mock Demo	Mock Demo	Mock Demo
4/26	Demo/Final Paper	Demo/Final Paper	Demo/Final Paper
5/3	Demo/Final Paper	Demo/Final Paper	Demo/Final Paper

4 Safety and Ethics

There are a couple of potential safety hazards with our project. This is mainly regarding the control of a microcontroller, sensors, motors, EM Lock, and a WiFi module with medicine. This is because there could be the issue that the microcontroller stops working or sends wrong information about the amount of pills to dispense. If it is too many pills, an overdose can cause fatal or potentially lethal side effects such as internal bleeding, bruising, poisoning, etc. If the sensors and modules overheat, this could negatively affect the medication as pills become ineffective over 86°F [4].

Pill storage based on FDA regulations requires the pills to be stored at adequate lighting, ventilation, temperature, sanitation, humidity, space, equipment, and security conditions [6]. The recommended temperature for most pills 59°F to 86°F. [7] The regulated relative humidity level for most pills is 60% or lower with good ventilation in the storage location and an odor-free environment. [8]

Another large safety concern is if the outlet adapter does not work properly, it could allow too much amperage and cause a fire or short circuit the system. To safeguard against this, we will thoroughly test the adapter to ensure it works as expected and double check the connections of the subsystems and modules to ensure they are not receiving more current than they should be. This will lessen the likelihood of a fire. To mitigate the possibility of a short circuit, we will have to double check how we connect power and ground to all of our sensors and modules.

We develop this project in firm belief of IEEE Code of Ethics 1.1 “to hold paramount the safety, health, and welfare of the public”[1] at the heart of our project. This solution proposes to accept the growing elderly population and help assuage the inevitable need for more precise caregiver control. Thus, we also consider safety lock features in case of potential abuse of our product by addicts.

We also seek “to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies”[1] by giving control of the drug distribution to medical caregivers instead of engineers. This technology is being developed for health fields in hopes of improving coverage with accessible innovation. Should there be mechanical failures in the control of pill drops, we will have an alert for the caretaker and the physical alert system, the LED and Buzzer, should not signify to the user that pills should be taken. This will control for possible incongruities in dosage, for the caretaker’s own discretion.

Furthermore, we earnestly acknowledge the use of prior developed technologies in our modeling of the dispensing system as 1.5 states that we must “be honest and realistic in stating claims or estimates based on available data, and to credit properly the contributions of others.”[1] The aforementioned mechanical complexity we model and alter our dispensing system after seeks to make for a safer and more accurate system for patients.

5 Citations

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