

NEEDS ASSESSMENT

Client/Customer Definition

It's common to have diseases as ages grow. Remindicine aims to serve for those patients who need to take various medications several times in a day. For instance, patients with uremia are usually required to take more than six types of medications daily [1]. However, many elderly people have difficulty taking pills due to impairments in memory and the large amounts of medication issued [2].

48.6% of the U.S. population, approximately 328 million people [3] in 2015-2018 have had at least one prescription drug in the recent 30 days when they were surveyed [4] and more than 80% of patients usually miss their prescription [5] which amounts to approximately 262 million people that could be our target audience.

However, we will primarily focus on middle class patients in Waterloo Ontario at the age 65+, which is the 91,295 people in the most recent population census [6].

Competitive Landscape

Senior Support Groups and Communities - Social

Senior services hosted by the City of Waterloo [7] have a senior centre and a variety of senior programs for people in the community to connect and provide mutual support in areas including medication management.

How it Addresses the Challenges:

Memory: Members can share strategies for improving memory and help each other remember to take their medications.

Large doses of medication: Members can provide tips on organizing and managing multiple medications effectively.

Shortcomings:

Limited Expertise: While these groups can offer valuable peer support, they may not have access to professional medical expertise for personalized advice.

Memory: Seniors with bad memory might just forget the advice they receive on improving memory immediately after receiving it.

In-Home Caregiver Services - Economic

Getting trained caregivers who assist seniors with activities of daily living, including medication management.

How it Addresses the Challenges:

Timing: Offers personalized support, ensuring that the right medications are taken at the right times.

Memory: Provides human interaction and supervision, which can be comforting and beneficial for individuals with cognitive impairments [8].

Shortcomings:

Financial: Can be costly and may not be financially accessible for all individuals.

Emotional: Reliance on external caregivers, which may not always be available or consistent.

Medication Management Apps - Technological

Individuals track and manage their medication schedules, set reminders, and receive notifications for when to take their medications.

How it Addresses the Challenges:

Memory: The app provides timely reminders and notifications to help users remember to take their medications.

Large Amounts of Medication: Users can input detailed information about their medication regimens, helping them stay organized.

Shortcomings:

Accessibility: Some elderly individuals may face challenges in using or navigating smartphone apps, especially those with visual or cognitive impairments.

Accuracy: Software apps cannot ensure that medication has been taken out, it can only assume based on the input of the user (unlike Remindicine which will use a light sensor to ensure that pills have been taken).

Requirement Specification

1. **LED Brightness and Blink Frequency Requirement**: The red LED used for indicating the active pill compartment must have a brightness of at least 5 lumens and blink in a frequency of 30 times per minute.
2. **Weight Tolerance for Pill Compartments**: Each pill compartment must be designed to support a minimum load of 100 grams (g) to accommodate a range of pill sizes and quantities.
3. **PIR Motion Sensor Detection**: The PIR motion sensors must detect movement within a radius of 5 centimetres from the smart pill box.
4. **Audio Output Volume**: The speaker must produce sound at a minimum volume of 70-90 decibels (dB) to ensure that audible reminders are clearly heard by the user demographic (elderly)
5. **Timer Precision**: The LCD 7-segment display must allow users to set the timer with a precision of at least 1 minute in a range of 24 hours, using the joystick for control.

ANALYSIS

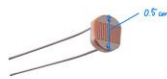
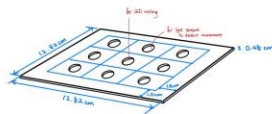
Design

② Pill box compartments



- material: 3D printed, wall width is 0.5cm
- dimensions need to contain pill bottle, thus 0.5cm larger than dimensions of pill bottle and 0.5cm between
- $2.0 + 0.50 + 0.50 = 3.00\text{cm}$
- thus length: $3.00\text{cm} + 3.70\text{cm} = 6.70\text{cm}$
- height needs to be tall with pill bottle height (because there's no bottom): 6.1cm

③



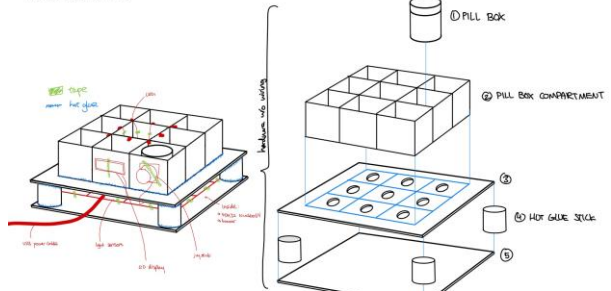
- material: 3D printed, thus height is 0.48cm
- dimensions need to encompass two glue sticks and the pill box compartments
- $\rightarrow 10.50 + 2(1.1) = 12.70\text{cm}$
- holes diameters need to equal light sensor diameter, 0.5cm. Could be done with needles/needles

④



- material: 3D printed
- dimensions are the same as ③

REMINISCE (V3)



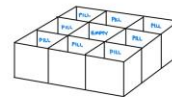
*Note: connection between parts are hot glued/taped

DETAILS

① Pill box



X 8



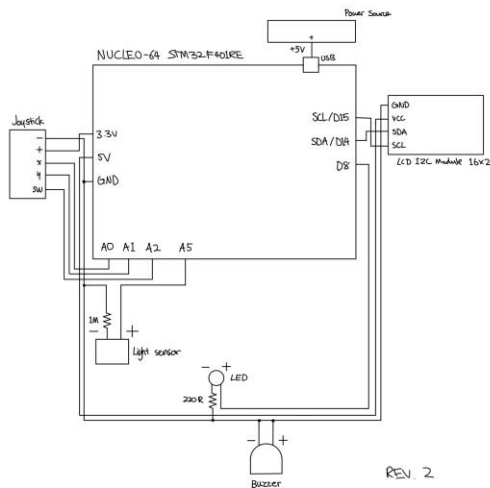
② Hot glue stick



X 4 (2 glue sticks)

- height has to be 0.25cm taller than PIR sensor
- $3\text{cm} + 0.25\text{cm} = 3.25\text{cm}$
- each standard glue stick is 10.16cm long
- $3.25\text{cm} \times 4 = 13\text{cm}$, thus 2 standard glue sticks

CIRCUIT BOARD LAYOUT



REV. 2
Date: Nov 19, 2025

Scientific or Mathematical Principles

Luminance:

$L = (d\Phi) / (d\Omega \cdot dA \cdot \cos\theta)$ [9], where L is luminance, Φ is luminous flux, Ω is solid angle, A is area, and θ is angle. Luminance is a measure of the intensity of light emitted or reflected from a surface in a particular direction.

Incorporating luminance measurements through a light sensor will enable the system to detect whether a pill has been taken from the box. This principle ensures accurate monitoring and adherence to the medication schedule.

Application:

1. The application of luminance principle is demonstrated by incorporating luminance measurements through a light sensor. It enables the system to detect whether a pill has been taken from the box and ensures accurate monitoring and adherence to the medication schedule.
2. It is applied while calculating the luminance of those mini light bulbs which is used to indicate which pill should be taken. It is necessary to find the appropriate luminance so that the indicators can not only direct the user to the correct section efficiently, but also avoiding hurting people's eyes especially the elders.

Sound Propagation:

$I = P/A$ [8], where I is the intensity of sound, P is the power and A is the area. The sound intensity (I) is also proportional to the square of the amplitude (A^2). Sound propagation refers to the way sound waves travel through different mediums [10].

Application:

1. This principle will be applied while designing the alarm section of our product. It enables us to determine the most appropriate intensity of sound for customers.
2. With different potential materials of container, we apply this principle to choose the best one which allows the sound propagating most efficiently.

Ohm's law:

$V = IR$ [11], where V is voltage (in volts), I is current (in amperes), and R is resistance (in ohms). Ohm's Law describes the fundamental relationship between voltage (V), current (I), and resistance (R) in an electrical circuit. It states that the current flowing through a conductor between two points is directly proportional to the voltage across the two points and inversely proportional to the resistance between them.

Application:

1. Ohm's law is used in calculating power consumption and energy efficiency of our product to make sure it doesn't surpass the project requirements. In the context of voltage and current measurements, it helps quantify the power usage of electronic components and systems.
2. After calculating the power needed by applying the Ohm's law, we can estimate the approximate the lifetime of the product. This helps us choosing the material for other components according to expected use time of this product.

COSTS

Manufacturing Costs

- Light Sensors x8: \$0.00 (self supplied)
 - Component Manufacturer: ELEGOO
 - Geological Location: Shenzhen, China
 - Vendor/distributors: Amazon
 - Geological location: Amazon Fulfillment Centre-YYZ1, 6363 Millcreek Dr, Mississauga, ON L5N 1L8
- STM32F401RE Microcontroller: \$34.99
 - Component Manufacturer: Manufacturer and designers are STMicroelectronics.
 - Geographical Location: Headquarters of STMicroelectronics are located in Geneva, Switzerland. Manufacturing factories are located in Agrate Brianza and Italy, Crolles, Rousset, Tours France, Singapore
 - Vendor: Wstore Waterloo University
 - Geographical Location: South Campus Hall University of Waterloo, Waterloo Ontario
- Through-hole LEDs x8: \$0.00 (self supplied)
 - Component Manufacturer: ELEGOO
 - Geological Location: Shenzhen, China
 - Vendor/distributors: Amazon
 - Geological location: Amazon Fulfillment Centre-YYZ1, 6363 Millcreek Dr, Mississauga, ON L5N 1L8
- Speaker: \$0.00 (self supplied)
 - Component Manufacturer: ELEGOO
 - Geological Location: Shenzhen, China
 - Vendor/distributors: Amazon
 - Geological location: Amazon Fulfillment Centre-YYZ1, 6363 Millcreek Dr, Mississauga, ON L5N 1L8
- Breadboard: \$0.00 (self supplied)
 - Component Manufacturer: ELEGOO
 - Geological Location: Shenzhen, China
 - Vendor/distributors: Amazon
- LCD 7 segment display screen: \$0.00 (self supplied)
 - Component Manufacturer: ELEGOO
 - Geological Location: Shenzhen, China

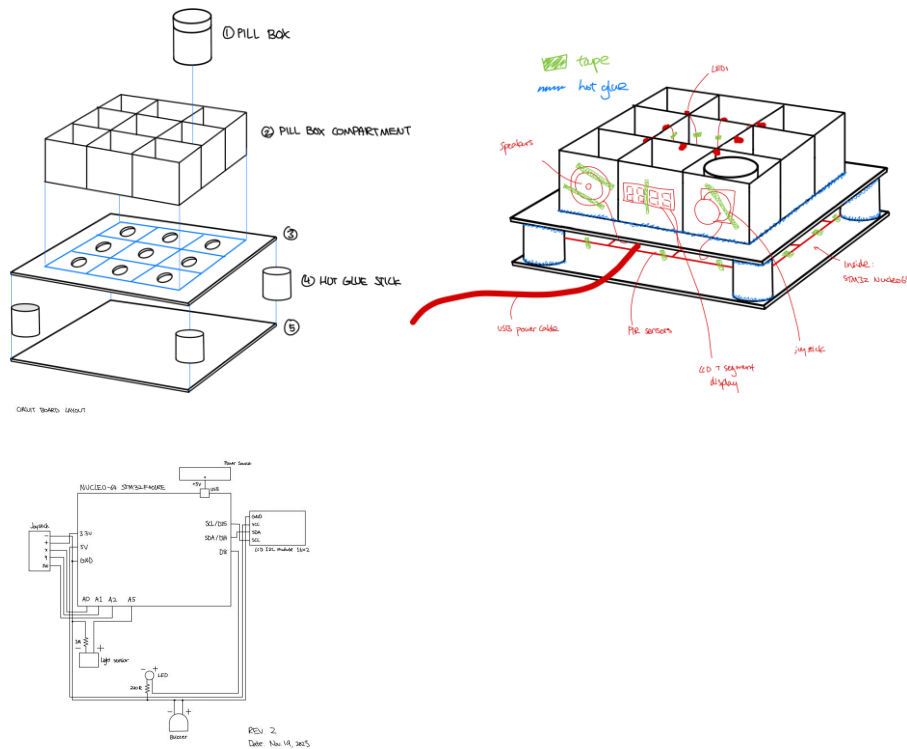
- Vendor/distributors: Amazon
 - Geological location: Amazon Fulfillment Centre-YYZ1, 6363 Millcreek Dr, Mississauga, ON L5N 1L8
- Joystick: \$0.00 (self supplied)
 - Component Manufacturer: ELEGOO
 - Geological Location: Shenzhen, China
 - Vendor/distributors: Amazon
 - Geological location: Amazon Fulfillment Centre-YYZ1, 6363 Millcreek Dr, Mississauga, ON L5N 1L8
- 220 Ohm resistors x8: \$0.00 (self supplied)
 - Component Manufacturer: ELEGOO
 - Geological Location: Shenzhen, China
 - Vendor/distributors: Amazon
 - Geological location: Amazon Fulfillment Centre-YYZ1, 6363 Millcreek Dr, Mississauga, ON L5N 1L8
- Wiring: \$0.00 (self supplied)
 - Component Manufacturer: ELEGOO
 - Geological Location: Shenzhen, China
 - Vendor/distributors: Amazon
 - Geological location: Amazon Fulfillment Centre-YYZ1, 6363 Millcreek Dr, Mississauga, ON L5N 1L8
- 3D Printer: \$0.00 (available for free use)
 - Component manufacturer: Stratasys
 - Geographical Location: Headquarters are in Rehovot, Israel.
 - Vendor/distributor: University of Waterloo Rapid Prototyping Center.
 - Geographical Location: E7 Design Bay, University of Waterloo.
- 3D Printing Filament: \$12.00 (\$4.00/inch³, volume is approximately 3 inch³)
 - Name: ABS-M30 plastic, 0.013"
 - Component Manufacturer: Stratasys
 - Geological Location:
 - Vendor/distributors: Headquarters are in Rehovot, Israel.
 - Geological location: E7 Design Bay, University of Waterloo. 3D printing Filament
- Pill bottles x8: \$0.00 (self supplied)
 - Component Manufacturer: Wiseorbent Technology LLC
 - Geological Location: 11 E Stow Rd, Marlton, NJ 08053, United States
 - Vendor/distributors: Amazon
 - Geological location: Amazon Fulfillment Centre-YYZ1, 6363 Millcreek Dr, Mississauga, ON L5N 1L8
- Hot glue gun: \$0.00 (self supplied)
 - Component Manufacturer: Magicfly
 - Geological Location: US
 - Vendor/distributors: Dollarama
 - Geological location: 600 Laurelwood Dr, Waterloo, ON N2V 0A2
- Hot glue sticks x2: \$0.00 (self supplied)
 - Component Manufacturer: Magicfly
 - Geological Location: US
 - Vendor/distributors: Dollarama

- Geological location: 600 Laurelwood Dr, Waterloo, ON N2V 0A2
- Tape ~1m: \$0.00 (self supplied)
 - Component Manufacturer: Nadco Tapes and Labels, Inc.
 - Geological Location: 2240 72nd Terrace E. Sarasota, FL 34243
 - Vendor/distributors: Dollarama
 - Geological location: 600 Laurelwood Dr, Waterloo, ON N2V 0A2
- Development in Blender software: \$0.00
 - Component Manufacturer: Blender Foundation, community
 - Geological Location: Globally (developers contribute online)
 - Vendor/distributors
 - Geological location: Amsterdam, Netherlands

Total Estimated Implementation Costs (with HST): \$206.69

Implementation Costs

Installation Manual:



1. Attach 2 and 3 by hot glue, 2 is centred in 3.
2. Attach STM32 Nucleo 64 board to the center of 5 by tape.
3. Tape the 8 LEDs on to each edge of the individual compartments closest to the middle box in 2.
4. Attach the PIR motion sensors by hot gluing them on to 5 directly under the holes in 3.
5. Attach 3 and 5 together by mounting 4 using hot glue on the edges of parts 3 and 5.
6. Attach joystick to front of 2 by tape.
7. Attach LCD 7 segment display to front of 2 beside the joystick by tape.

8. Attach speakers to front of 2 beside other parts by tape.
9. Power the STM32 Nucleo 64 board by USB to standard Windows laptop, reaching the cord in-between 4 which is contained by 3 and 5.

User Guide:

- Set alarm for medication schedule using joystick, first two digits are for hours and last two are for minutes. The valid time ranges from 0:00 – 23:59. The set alarm will repeat daily unless changed.
- Place Remindicine on nightstand or any surface for easy access (preferably away from children).
- Wait for the alarm to sound through the speakers.
- Once alarm sounds, access the pills in each pill box container by taking the cylindrical pill bottle out of the square pill box compartment, unscrew the cylindrical pill bottle, and take appropriate amount of medication as prescribed. The process of taking the pill bottle out will stop the alarm from sounding.
- After taking the prescribed dosage, put the pill bottle back and refill it if it's empty or less than prescribed amounts for the next dose.
- Place Remindicine back on to dedicated surface (nightstand) and wait for the next daily dosage reminder.

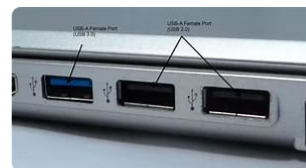
Energy Analysis

- We are using a laptop with a standard USB port so the power level would be: $5V * 0.9A = 0.45W$, with less than 500mA of current.
- Evidence:

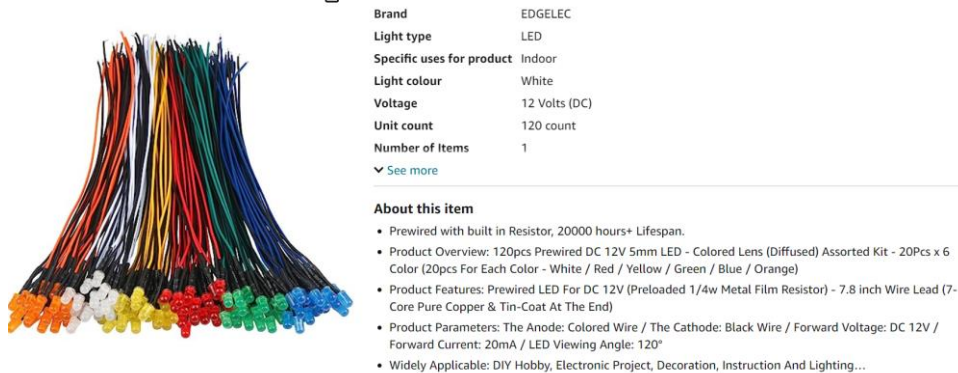
Usb voltage output

Average Power Output The average power of a USB port is about 5 volts. Your USB device will be able to draw out a maximum of 500 milliamperes (mA), but most default to 100 mA until prompted to provide more power by the device software.

Usb voltage output



- Indicated by the specification of the Led light we are going to use, it is 12V with 20mA, which means our power supply would not overload it.



- Since there is no mechanical and chemical energy included in this project, the max total energy would all be in the form of electrical energy, and can be calculated by the power level of the supply, which is 0.45 W.

Risk Analysis

- If used as intended: If some special users are sensitive to intense red lights which we apply on the product, the light would probably irritate them.
- If used incorrectly: If users take it as a weapon and throw it onto somebody else's face, it has the potential to hurt others.
- If misuse it: If users use it as an alarm for waking up instead of reminding them to take the medicines, users may break it while reaching for it from the bed with eyes closed, as it has larger dimensions than a normal alarm, which makes them have higher chance to fall from the edge of the nightstand.
- There are several ways the design may malfunction, such as the alarm does not ring when it is supposed to ring, or the light is not indicating the correct pill type. These malfunctions may lead to severe consequences because not getting medicine on time could potentially deteriorate the situation of disease.

TESTING AND VALIDATION

Test 1: LED Brightness and Blink Frequency Requirement

Test setup: STM32 board is connected to laptop, alarm set to default, LED light is off at the beginning

Environmental parameter: The lighting in the test room should be a color that's not red, which lets us determine the LED light's luminance correctly.

Test inputs: An action command towards the STM 32 control letting the Led light blink. The stopping command will be given later.

Quantifiable measurement standard:

- Luminance of the LED light.
- Frequency of the LED light's blink.

Pass criteria: The LED light is turned on after receiving the command, with minimum 5 lumen. It should blink until receiving the stop command. Each blink should last one second and has one second interval in between.

Test 2: Weight Tolerance for Pill Compartments

Test setup: The empty pill tube is clear; objects that has the weight of 120 g

Environmental parameter: The pressure level in the test room should be normal – around 101.325kPa

Test inputs: Put the objects into the pill tube.

Quantifiable measurement standard: The weight of the objects

Pass criteria: The pill tube can hold 100 grams of objects without any sign of breaking on the appearance.

Test 3: Motion Sensor Detection

Test setup: The cylinder pill tube is placed on the motion sensor which is at the bottom of the rectangular container; LED lights and alarm are turned on.

Environmental parameter: The room temperature of the location where the test takes place.

Test inputs: The lighting in the test room should be bright and can't be dark as the motion sensor needs to sensor the change in lighting to take action.

Quantifiable measurement standard: The area of the place that the test tube covers.

Pass criteria: When the cylinder pill tube is taken up, the motion sensor takes action which turns the LED light and alarm off.

Test 4: Audio Output Volume

Test setup: STM32 connected to laptop, alarm turned on

Environmental parameter: The test room needs to be relatively quiet so we can measure the decibels made by the speaker.

Test inputs: Set the alarm to the next minutes

Quantifiable measurement standard: The decibel of the sound.

Pass criteria: The alarm should ring when the minute arrives, with decibels that's higher than 40 decibels.

Test 5: Timer Precision

Test setup: STM32 is connected to the laptop; display and joystick is connected through the breadboard.

Environmental parameter: A correct time calibration should be set aside (can be pulled up from the internet) to ensure there is no delay when responding.

Test inputs: Changing time command is inputted by pushing up and down the joystick; switching between setting hours or minutes is inputted by pushing left and right the joystick.

Quantifiable measurement standard: The lowest precision is minute; the maximum range is 24 hours.

Pass criteria: When the alarm is set to the next minute, the system should respond correctly when the minute arrives, which means the LED light and speaker are turned on.

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