# Steady Dose: A Compact Device for Accessible and Precise Dispensing of Liquid Medicine Dosages

CEO Yerin Kim, CTO Vikhaash Kanagavel Chithra, CIO Shaina Premraj, CFO Vishal Balagani

# Problem Statement and Motivation

- The hassle to accurately measure liquid medicine is made extremely difficult for individuals with diseases that hinder their hand manipulation skills, as well as busy parents with sick children(Overdose Prevention, n.d.).
    - Lack of fine motor skills
        - The risk for drug overdose due to incorrect dosage measurements is made more likely to occur (Parkinson's Disease - Symptoms and Causes, n.d.).
    - Families
        - The stressful environment created due to the child's whining for medicine to feel better, as well as finding the correct dosage cups for each child can contribute heavily to these incorrect dosage administrations.
        - Further, even small increases in medicine dosages can have deadly effects on infants due to their small body size.

# 01

# Requirements

# Requirements (Level 1)

## Functionality

- The device shall support a multitude of medicine in various viscosities.
- The device shall dispense medicine within 0.5 milliliters of the specified dosage.

## Usability

- The device shall be easy for users to understand and operate.
- The device shall be portable.

## Safety

- The device shall be constructed from materials safe for medical use.
- The device shall have a secure and internal leak-proof design to prevent spills and maintain medication integrity.

# Requirements (Level 2)

Functionality

- The device should be battery powered.
- The device shall be durable.
- The device shall dispense medicine in 30 seconds or less.

Usability

- The device should be designed for easy cleaning.
- The device should offer a comfortable and ergonomic design for ease of handling.
- The device should have a user-friendly interface.

Size

- The device shall be no larger than 12" x 12".

Accuracy

- The device should be capable of dispensing any user-specified dosage that is not limited to standard doses of the Over-the-counter (OTC) medicine.

# Requirements (Level 3)

## Functionality

- The device may be charged using a USB-C charger

## Usability

- The device may offer connectivity features for remote monitoring and management.
- The device may incorporate features for tracking medication usage and providing usage reports.
- The device may include features such as automatic refill reminders.

## Physical

- This device shall incorporate a way to minimize wires.

## Cost

- The device shall cost no more than $30.

02

# Designs

# PDR Design #1

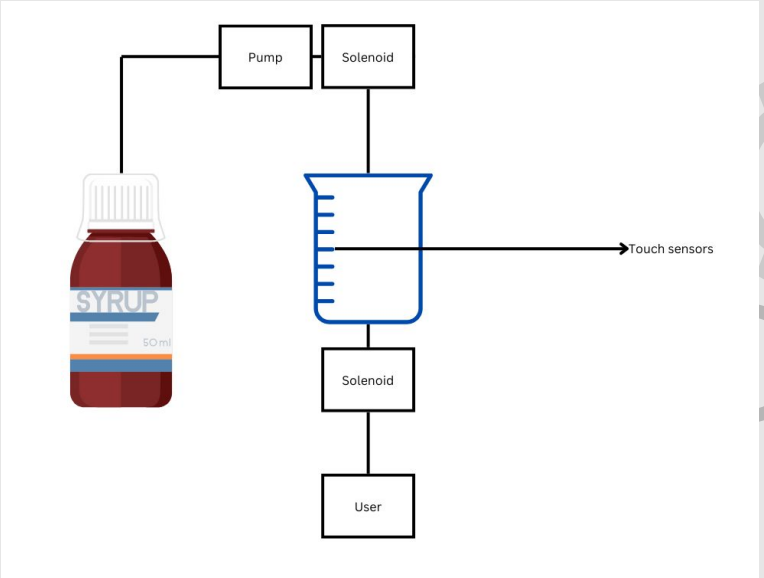
**Touch Sensors at Each Dosage**

Pros:

- Can dispense medicine with any viscosity
- Can be very accurate with each specified dosage increment

Cons:

- Many different systems- higher chance of malfunction
- Inefficient in the overall building process



# PDR Design #2

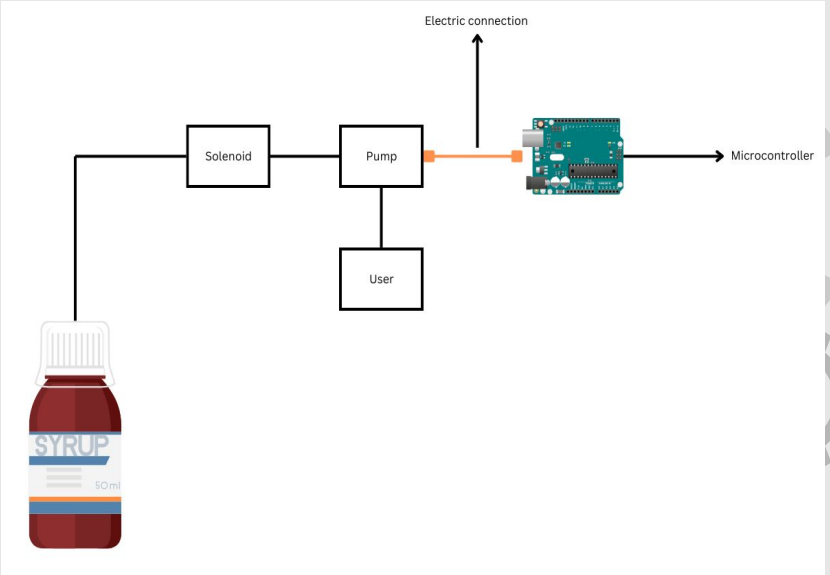
**Microcontroller With Time Control**

Pros:

- Simplest design
- Flexibility in adjusting dispensed volumes
- Easier integration with other WiFi and IoT systems

Cons:

- Cannot dispense medicine with different viscosities accurately



# PDR Design #3

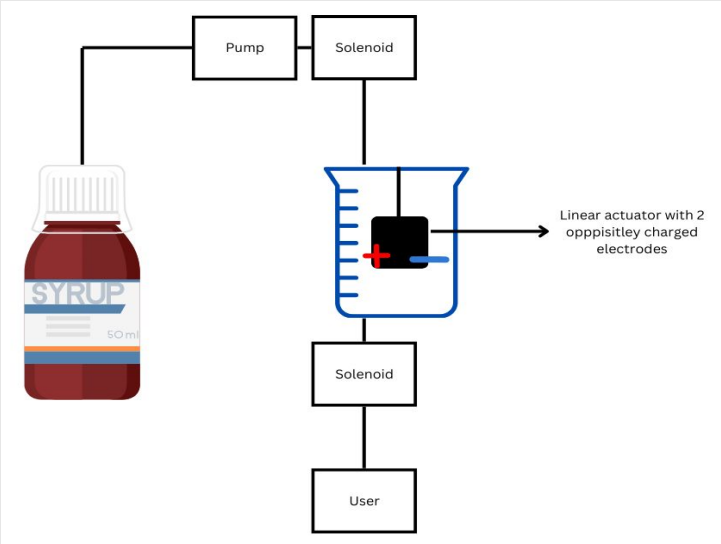
**Linear Actuator Adjustments**

Pros:

- Precise volume measurement
- Compact design

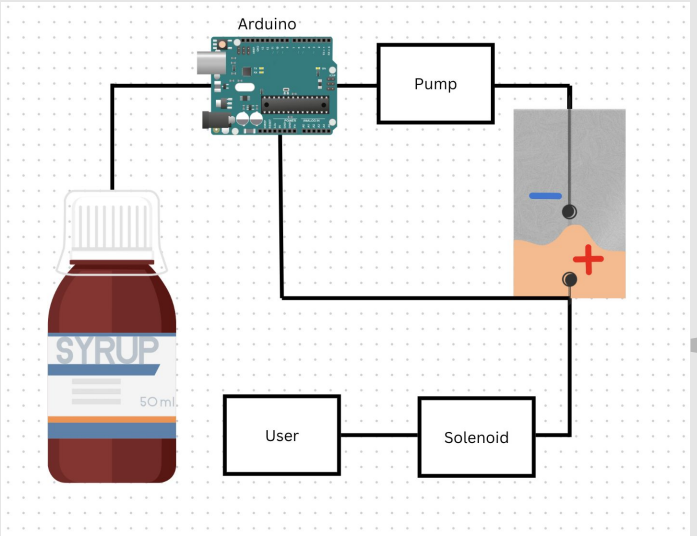
Cons:

- Many different systems which can increase the chance of an error
- Residual medicine might remain in the container



# CDR Design #1

- The current design utilizes an Arduino, peristaltic pumping motor, linear actuator, and solenoid.
- When the wire on the linear actuator comes into contact with the positively charged liquid, then the Arduino is triggered and the liquid stops pumping.
- The Arduino allows for the keypad functionality



# 03

# Design Studies

# Design Study #1

**Container Dimension Testing**

- Finding the ideal dimensions of the device when reading and dispensing the user inputted dosages of liquid optimized precisions and adequate volume storage
- Varies dimensions of the TMSU
- Conclusion: The ideal dimensions of the container would be 21 by 21 mm for the base, as well as 56.7 mm for the height.

# Design Study #2

**Device Accuracy Testing**

- Tests the accuracy of the device when measuring and dispensing liquids of different viscosities
- Varies input dosages in increments of single, half, and quarter milliliters
- Conclusion: The device dispensed within 0.5 mL of the specified dosage each time for 1-20 mL doses

# Design Study #3

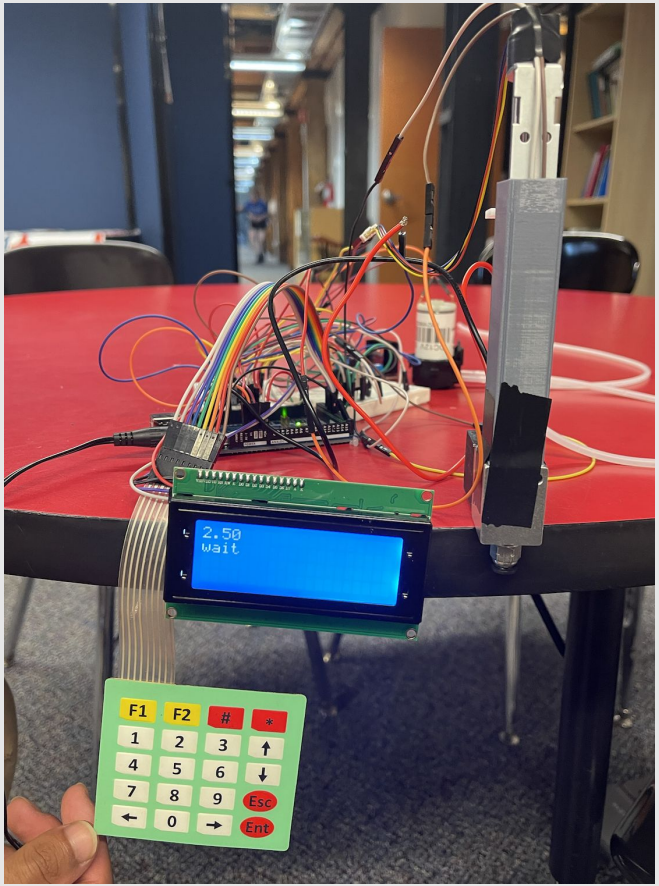
**Flow rate resting**

- Identify the fastest rate at which the device can dispense the user-specified dosage for liquids of different viscosities.
- Varies rpm of peristaltic motor
- Conclusion: For realistic dosages, the device will take from 20-47 seconds to dispense, increasing in time as the dosage amount also increases

04

# Final Prototype

# Final Prototype Picture



# Final Prototype Details

- Linear actuator for precise measurements
- Peristaltic motor pump for liquid movement
- Keypad with ability for decimal measurements
- Solenoid valve to dispense medicine
- Temporary measurement and storage unit (TMSU)

# Final Requirements

| Level | Requirement | Status |
|---|---|---|
| 1 | Easy for users to understand and operate | Pass |
| 1 | Made from medically safe materials | Pass |
| 1 | Support different viscosity medicines | Pass |
| 1 | Portable | Pass |
| 1 | Leak-proof design | Pass |
| 1 | The device shall dispense medicine within 0.5 milliliters of the specified dosage. | Pass |
| 2 | Not limited to integer doses | Pass |
| 2 | Can be easily cleaned | Pass |
| 2 | Ergonomic design | Pass |
| 2 | User-friendly interface | Pass |

| Level | Requirement | Status |
|---|---|---|
| 2 | Battery powered | Pass |
| 2 | Able to withstand travel (durable) | Fail |
| 2 | No larger than 12” x 12” | Pass |
| 2 | Dispense medicine in 30 seconds or less | Fail |
| 3 | Connectivity features for remote monitoring | Fail |
| 3 | Features for tracking medication usage and usage reports | Fail |
| 3 | Automatic fill reminders | Fail |
| 3 | Charged with USB-C | Fail |
| 3 | Cost no more than $30 | Pass |
| 3 | Minimizes exposed wires | Fail |

# Future Work

- Implement PCB plate to minimize heavy density of wires being used
- Cloud incorporations to dispense liquid through virtual assistant
- Pill department to make device a dual medicinal device that can be used for all types of medicine

# Lessons Learned

- Adaptiveness
- Arduino IDE
- General circuitry
- PCB
- Challenges
  - Not triggering the linear actuator to reverse the liquid dispensing
  - Preventing leakage
  - Ensuring wire connections were connected at all time

# References

*Overdose Prevention*. (n.d.). Global Health Advocacy Incubator. Retrieved April 27, 2024, from https://www.advocacyincubator.org/overdose-prevention

Parkinson's disease - Symptoms and causes. (n.d.). Mayo Clinic. Retrieved March 23, 2024, https://www.mayoclinic.org/diseases-conditions/parkinsons-disease/symptoms-causes/syc-20376055