

# SmartPills

EE149/249 Final Project Presentation

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# SmartPills

- Detect the number of pills in the bottle, based on high-precision weight measurement combined with an accelerometer.
- Send usage information from the bottle to an Android App, and Configuration commands/data from the App to the bottle
- Unlock the bottle based on fingerprint scan.

# Component Breakdown

- Processor
  - mbed LPC1768
- Sensors
  - Accelerometer (ADXL345)
  - 100g Load Cell
  - Fingerprint Scanner (GT-511C3)

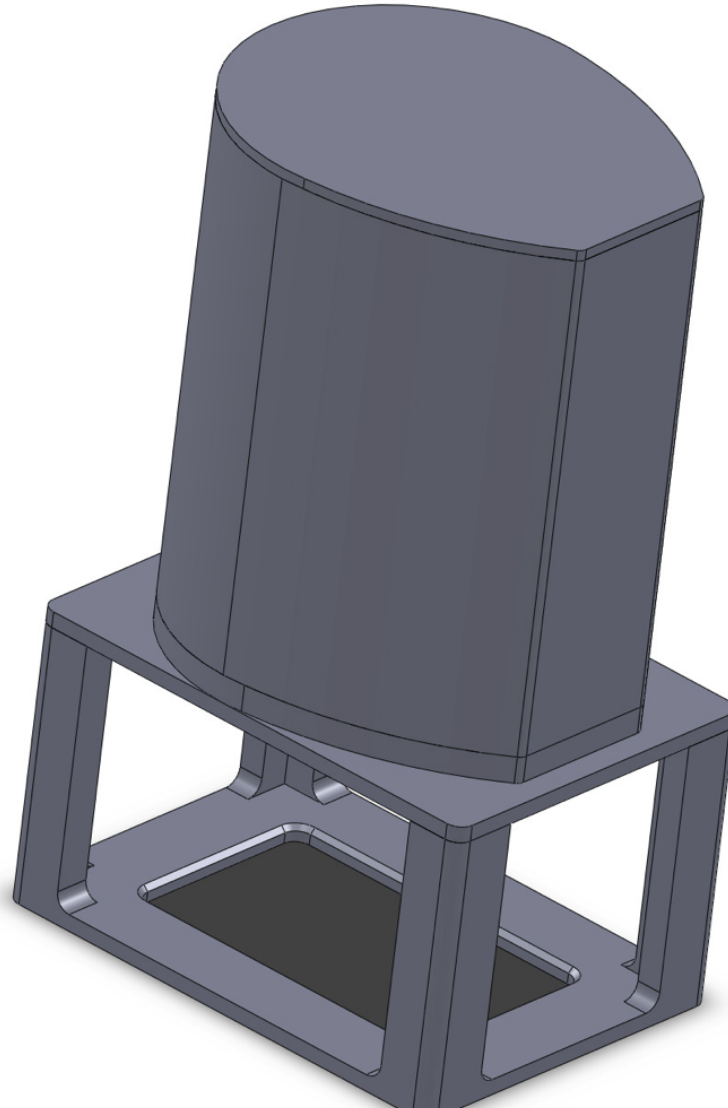
# Component Breakdown

- Actuators
  - Servo for locking mechanism
- Communication
  - BLE BlueSMiRF Family

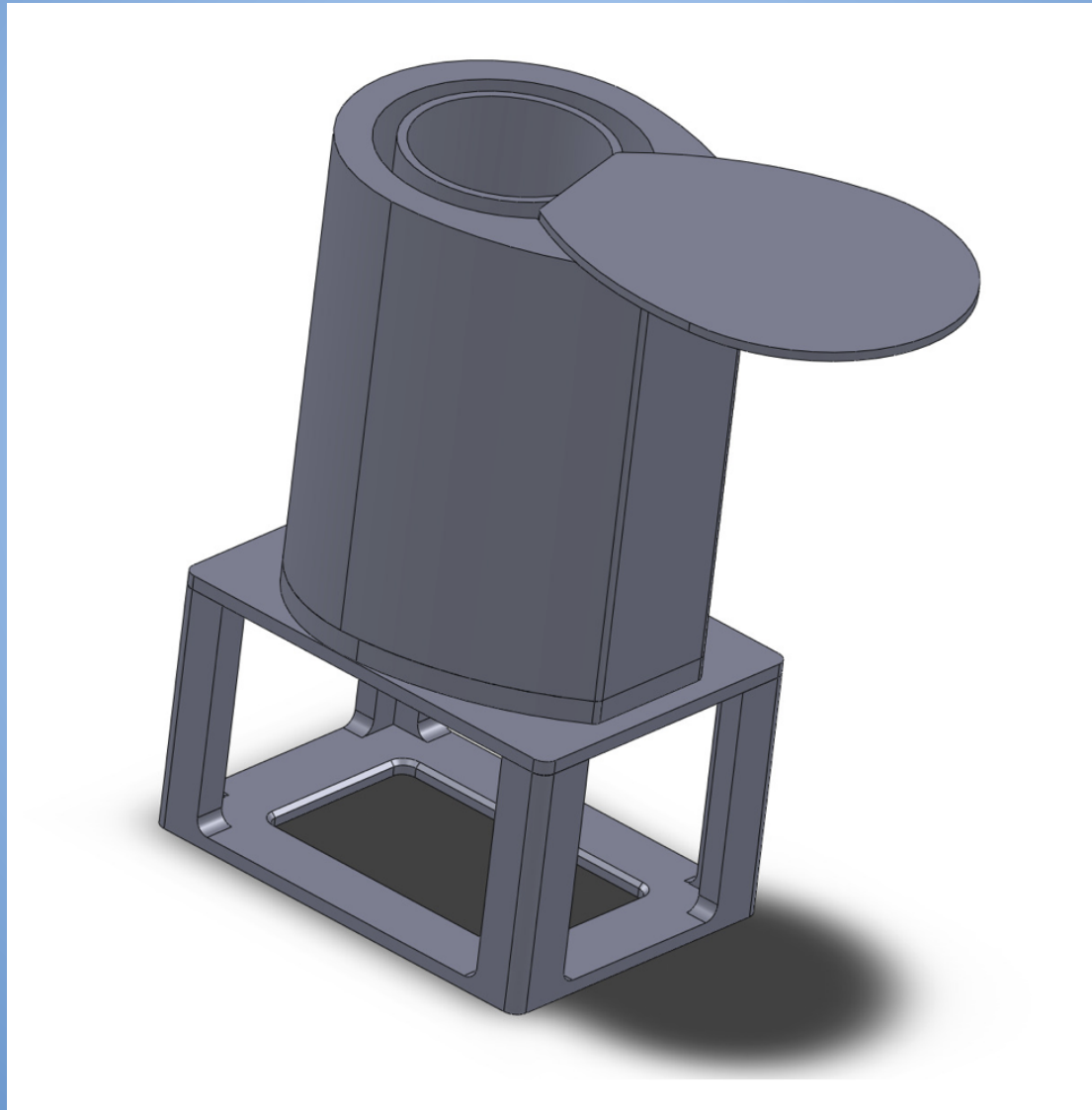
# Module Breakdown

- Mechanical structure of the bottle and hardware integration (Josh/Parsa)
- Number of pills detection (Josh/Parsa)
- Bottle safety (locking/fingerprint scanning) (Gil)
- Software architecture (Gil/Vicenc)

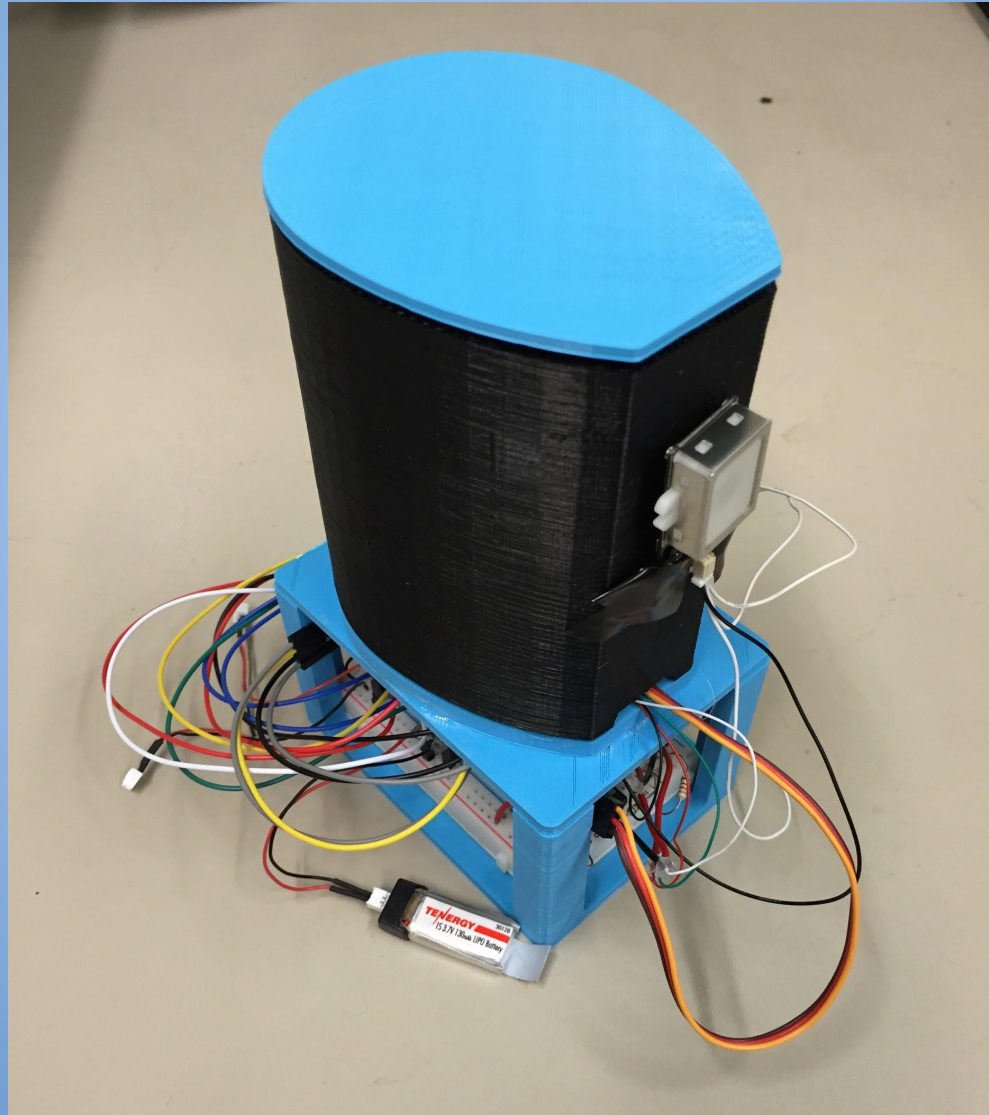
# Mechanical Structure



# Unlocked Bottle



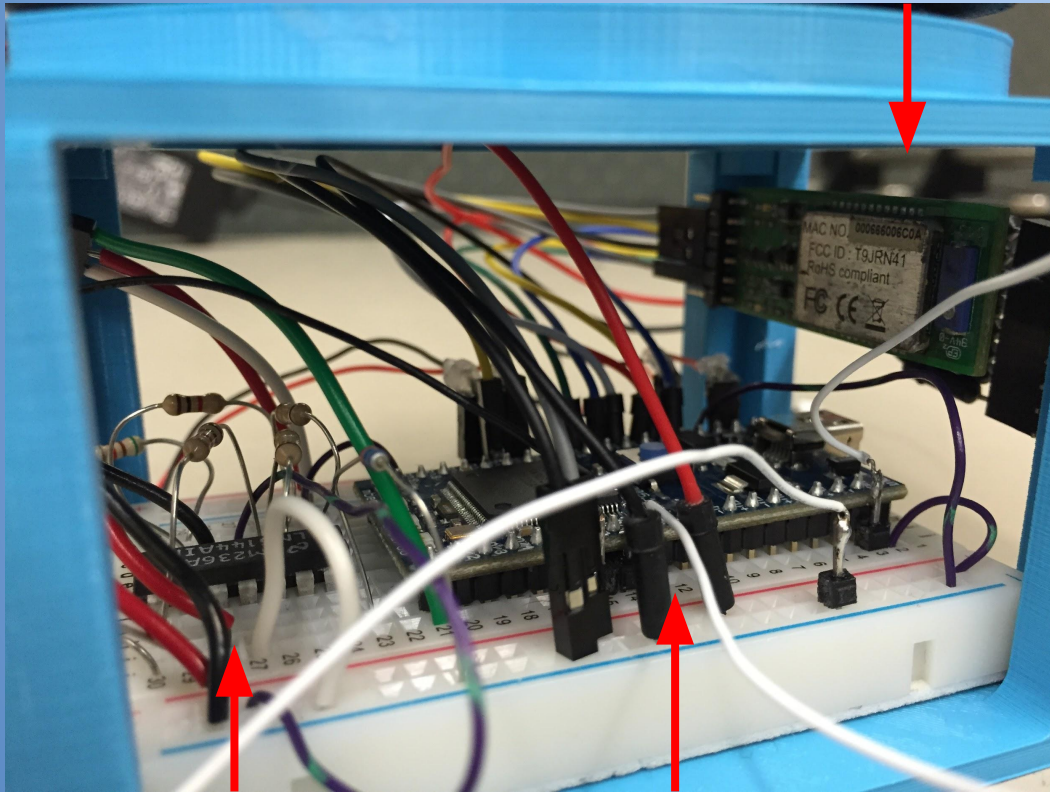
# 3D Printed Prototype





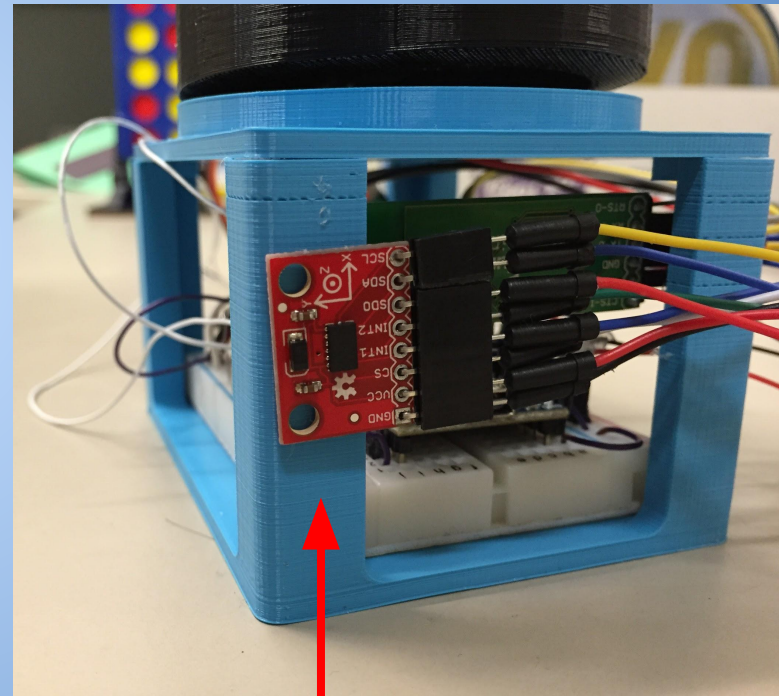
# Enclosed Circuits

BLE



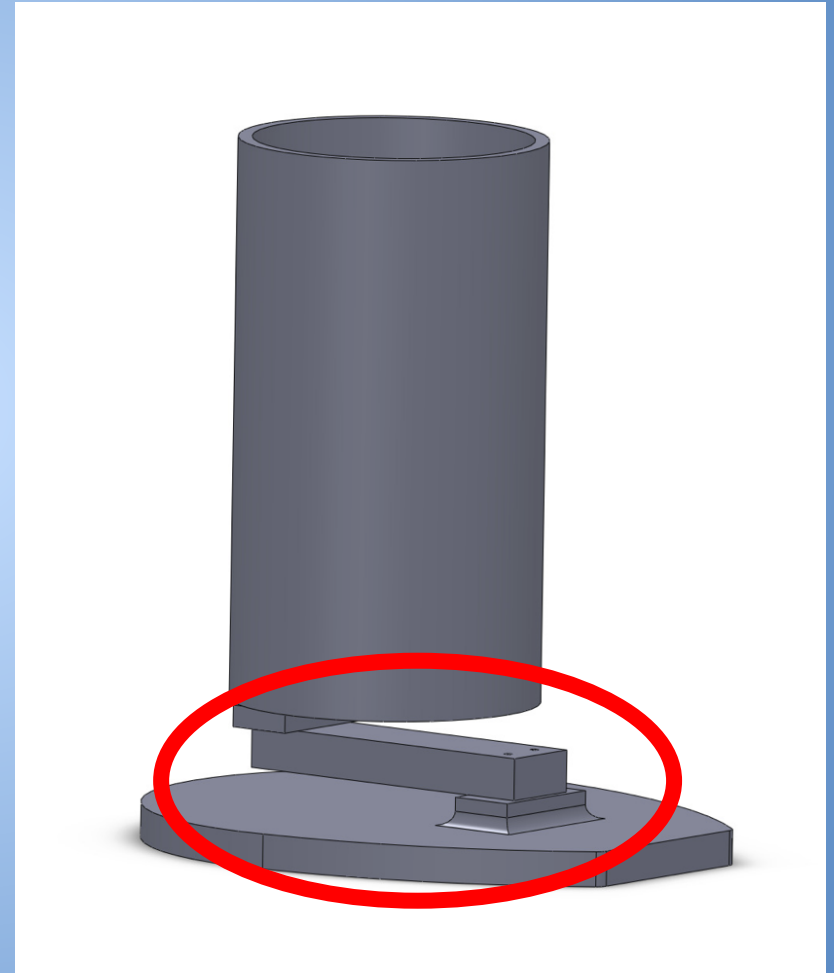
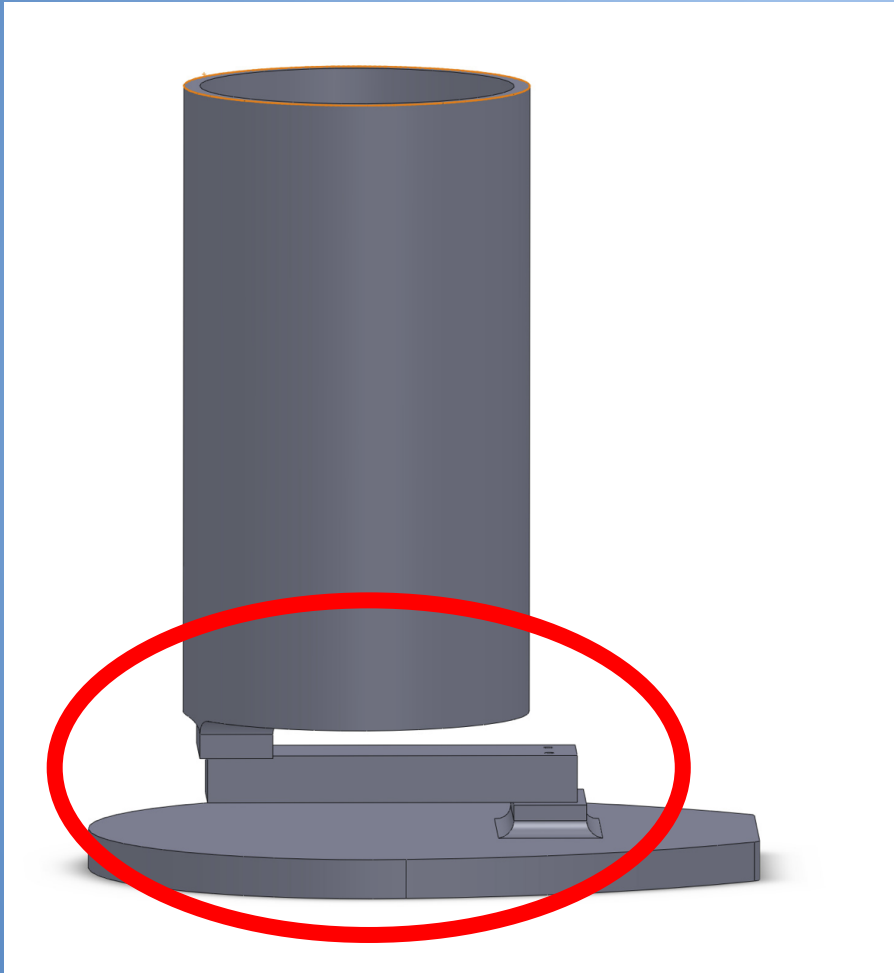
Amplifier

mbed

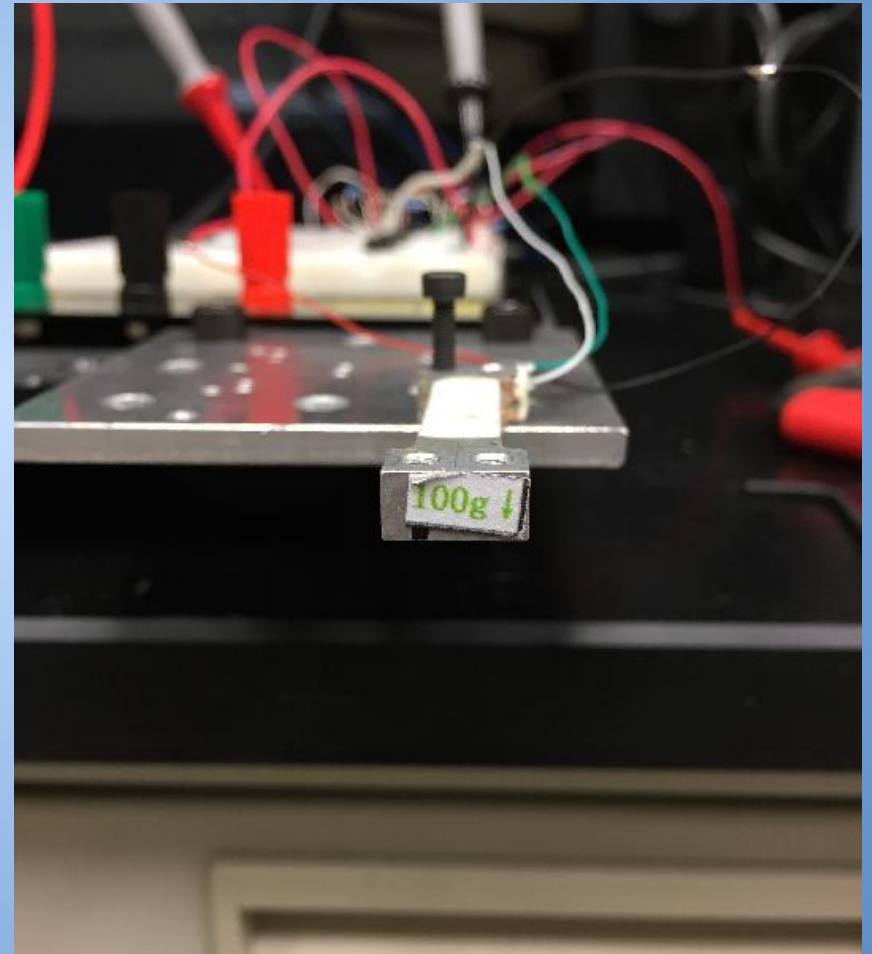
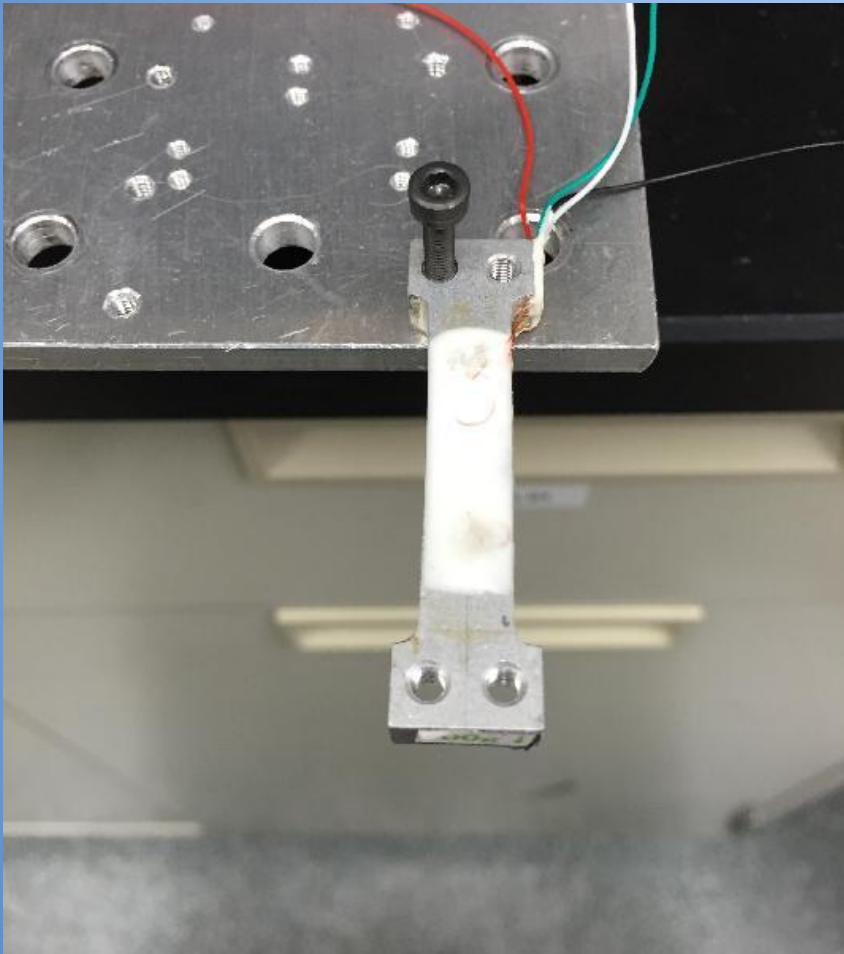


Accelerometer

# Load Cell

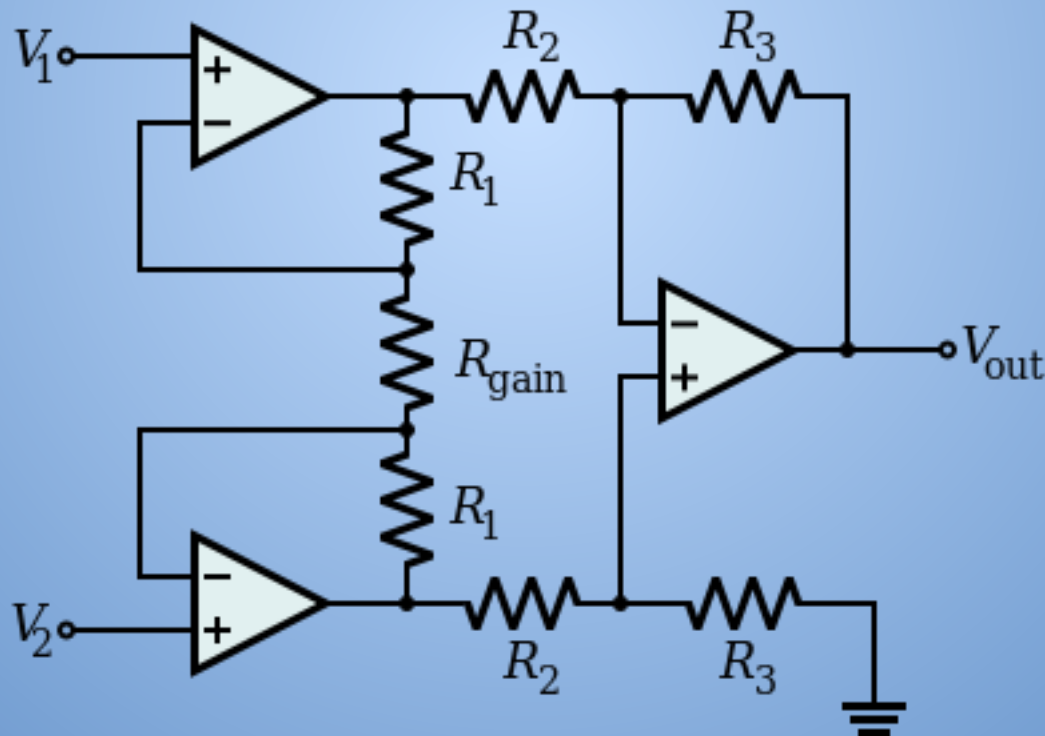


# Load Cell

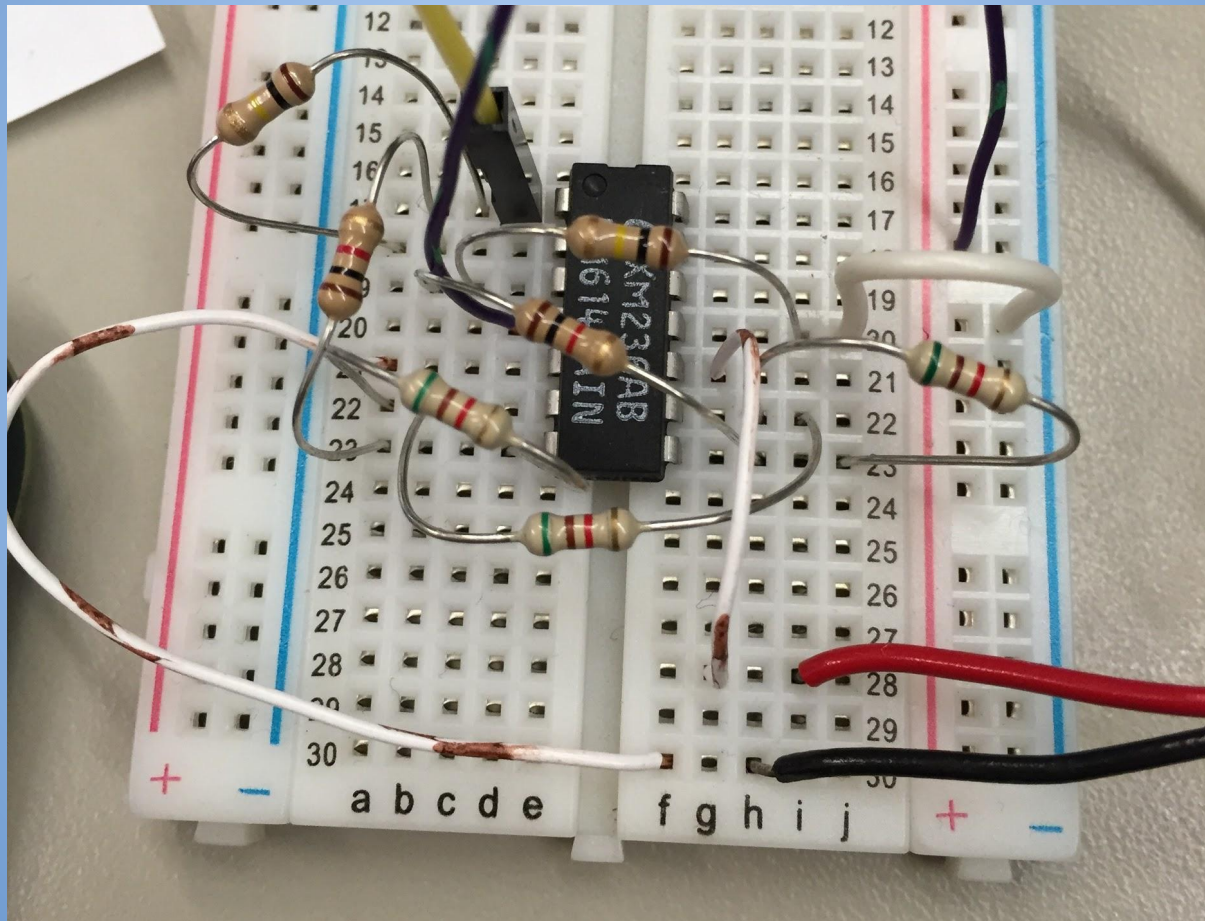


# Amplifier

- Instrumentation amplifier to measure voltage difference between outputs of load cell



# Amplifier



# Load Cell Summary

- Load cell is much more repeatable than FSR
- There is no creep like with the FSR
- We tuned the gain of the instrumentation amplifier to get the dynamic range necessary to measure individual pills
- Pill weighs about 770mg, 12-bit ADC can measure differences of 0.8mV
- Currently amplifying to about 48 mV/gram = 36mV/pill = 45 adc-units/pill

# Bottle Safety

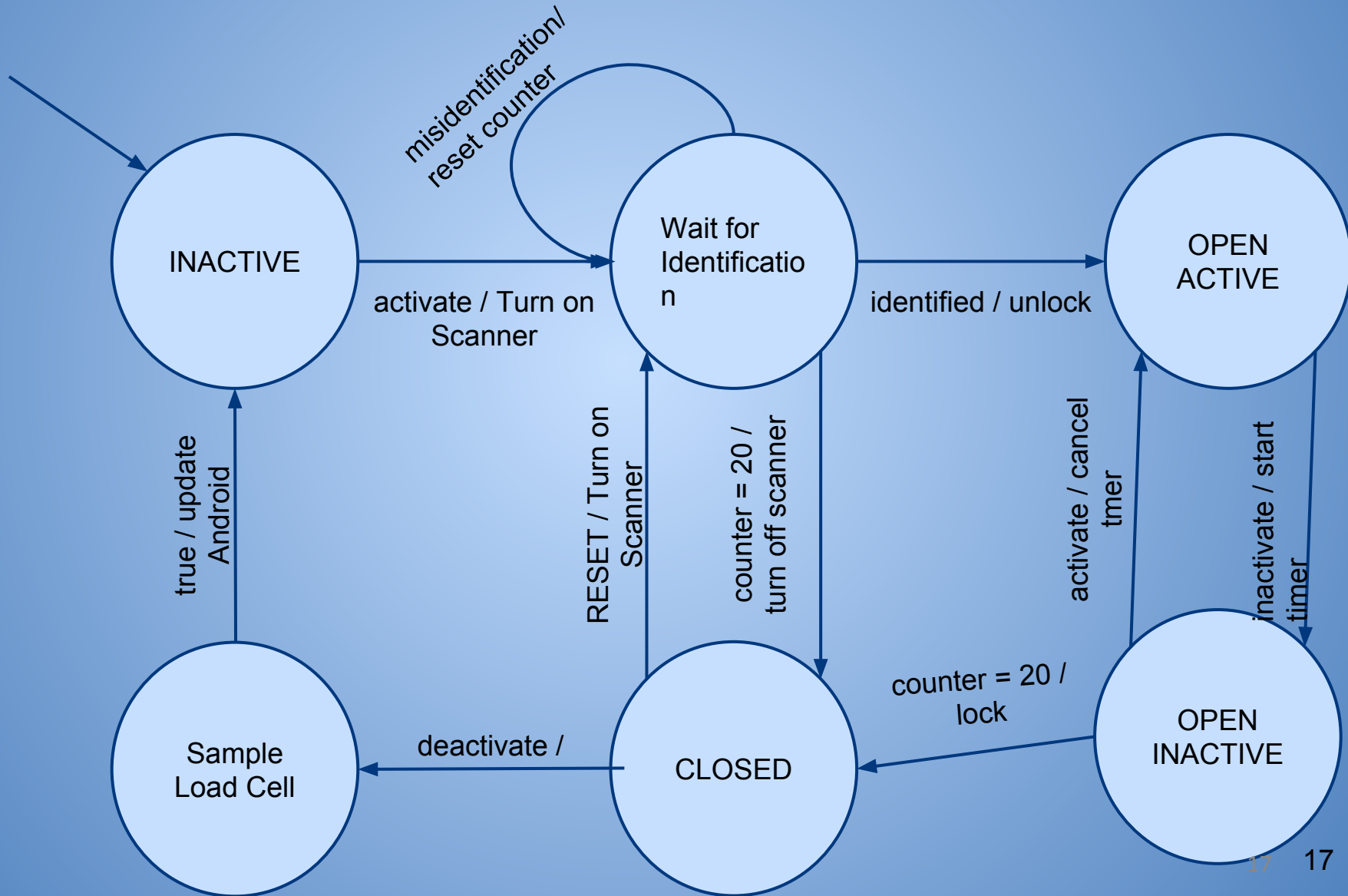
- Only authorized users allowed access to the pill bottle.
- Bottle is locked until a verified fingerprint scan is detected.
- Servo attached to the cap of the bottle, automatically opening after successful identification.

# Bottle Safety

- GT-511C3 only responds to commands, must be periodically polled to check if finger is pressed.
- Bottle only “wakes up” the fingerprint scanner after an interrupt from the accelerometer/button wakes it up.
- Fingerprint enrollment initiated by command from Android app



# Controller FSM



# Software Architecture

- Leverages the mbed-rtos, based on the RTX implementation of the CMSIS-RTOS API.
- 3 threads - Controller, BLE communication, GT-511C3 scanner
- Communicating via RTOS queues.
- All threads are based on a common FsmThread class, implementing an event loop that demultiplexes events in sub-classes.

# Software Components

- ScannerFsm (fingerprint sensor), based on a GT-511C3 library by Toshihisa T.
- AdxlModule (accelerometer control), based on the ADXL345 library by Aaron Berk. This module programs the ADXL to drive ACTIVATE/INACTIVATE interrupts.
- Servo module, based on a library by Simon Ford.

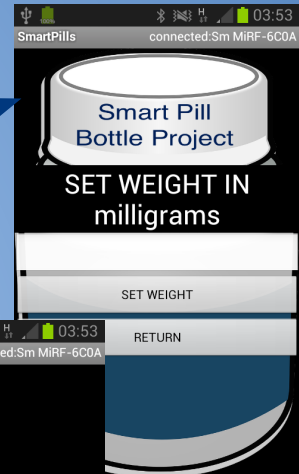
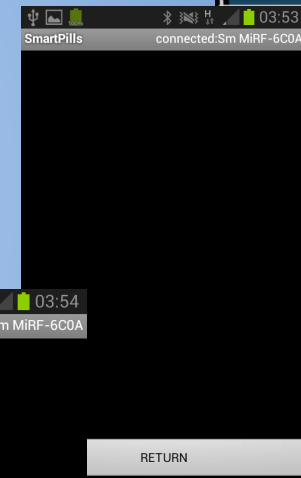
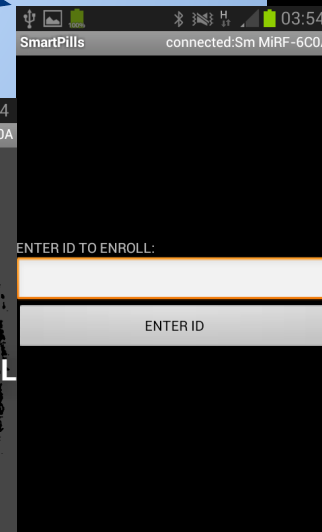
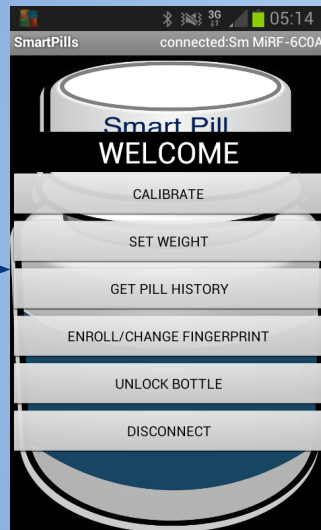
# Software Components-LoadCell

- Calibrated once on empty by measuring the last voltage bias.
- During each ADC measurement doing average of 10,000 samples.
- Saves history of measurements, sends it to the Android when it pairs.

# Android Application

- Android code:
  - Modified version of BluetoothChat sample code provided in Eclipse IDE.
  - Code distributed under Apache License v2.0.
  - Usage compliant with License.

# Android Application



# Communication

- Message Structure:
  - 1.) Header = 4 bytes (0xCCCCCCCC)
  - 2.) Type = 4 bytes
  - 3.) Length = 4 bytes
  - 4.) Payload = (Length) bytes [mult. of 4]

# Communication

- **Message Types From Android to MBED:**
  - 1.) RequestCalibrateMessage
  - 2.) RequestEnrollMessage
  - 3.) SetWeightMessage
  - 4.) RequestUnlock
  - 5.) RequestHistory



# Communication

- Message Types From **MBED** to **Android**:
  - 1.) NewSampleMessage
  - 2.) AcknowledgeEnrollMessage
  - 3.) RequestRemoveFingerMessage
  - 4.) RequestPressFingerMessage

# Things that could be improved...

- Noisy load cell measurements
- Fingerprint sensor is not very reliable
- With a PCB, we could drastically reduce the size of the mechanical design
- Android App could have enhanced user interface
- Add pill usage metrics

# Demo

[Watch our demo on youtube!](#)

**Thank you!**  
**Any questions?**