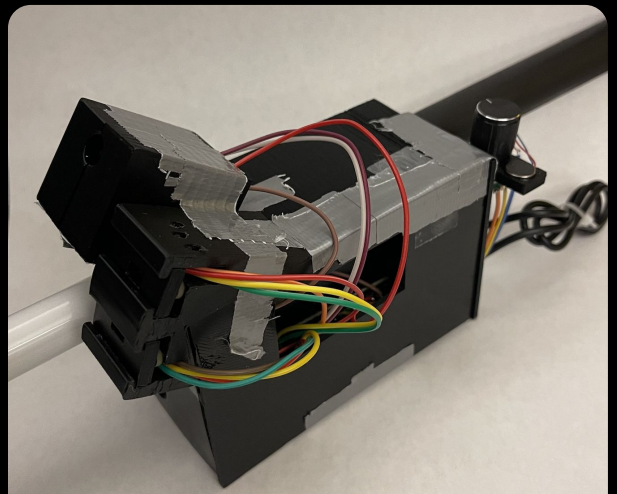
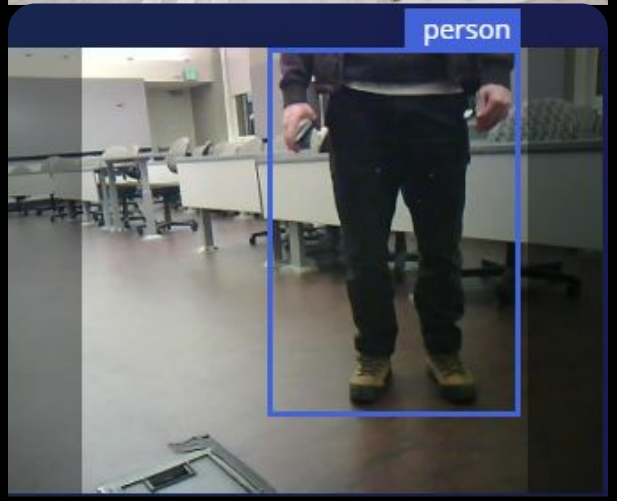


December 5th

Haptic Cane Module

Jaden Le David Mok Kandai Shimada Bingan Chen



Motivation

- Improve accessibility for visually impaired
- Extend distance detection of a white cane
- Classify and name objects detected

Key Features

- Object Detection
- Adjustable Sensor Threshold
- Haptic Feedback
- Modular Design
- Ergonomic

Distinctions

On-device ML image processing

Using device as a way of detecting objects and moving around

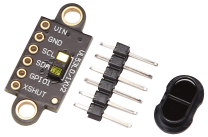
Live demo with TA using it

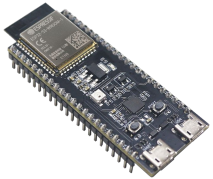
Project Breakdown

3D Modeling

Prusa Slicer

Embedded HW/SW



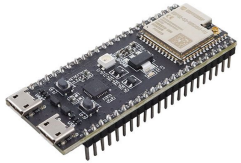


Machine Learning

TensorFlow

Embedded HW/SW

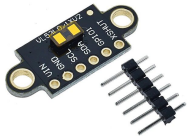
Esp32 s3 devkitC



Rotary Encoder

ESP32 s3 Sense

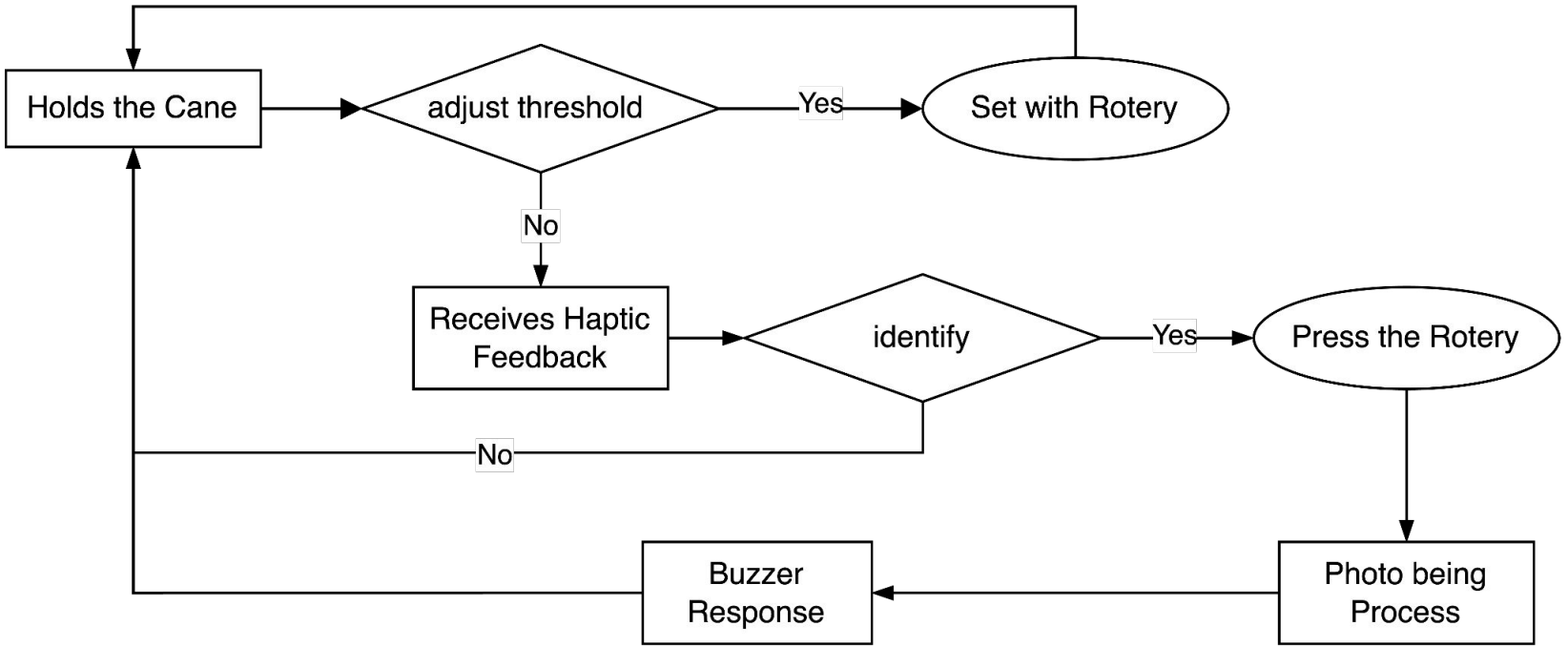
ToF VL53L1X sensors



Vibration motors

+Battery

Flow


Holds the Cane
adjust threshold
Yes
Set with Rotery
No
Receives Haptic Feedback
identify
Yes
Press the Rotery
No
Buzzer Response
Photo being Process

PIO Home | platformio.ini M | main.cpp M

src > main.cpp > loop()

```
#include <Wire.h>
#include <VL53L1X.h>

VL53L1X sensor;

// define allocates to Flash Memory (non-volatile)
// #define PIN 38 // RGB
// #define NUMPIXELS 1

// Set SCL and SDA pins
#define SCL_PIN 9 // Set pin 9 as SCL pin
#define SDA_PIN 10 // Set pin 10 as SDA pin

#define btnPin 11
#define DT 12
#define CLK 13

#define picturePIN 6
#define vibrationPIN 7

BfButton btn(BfButton::STANDALONE_DIGITAL, btnPin, true, LOW);

int counter = 0;
int angle = 0;
int aState;
int aLastState;

//Button press hanlding function
void pressHandler (BfButton *btn, BfButton::press_pattern_t pattern) {
  switch (pattern) {
    case BfButton::SINGLE_PRESS:
      Serial.println("Single push");
```

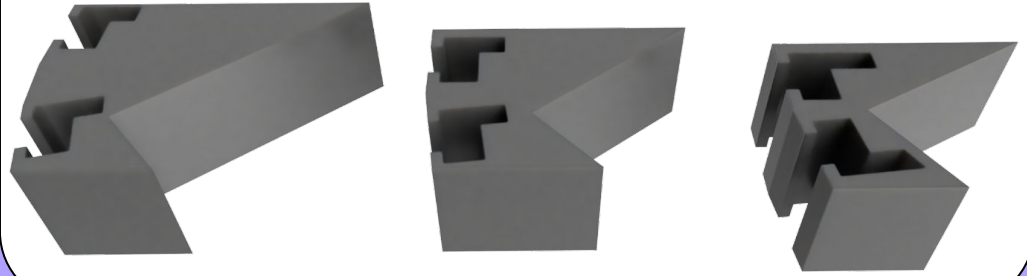
PROBLEMS OUTPUT TERMINAL GITLENS COMMENTS

TERMINAL

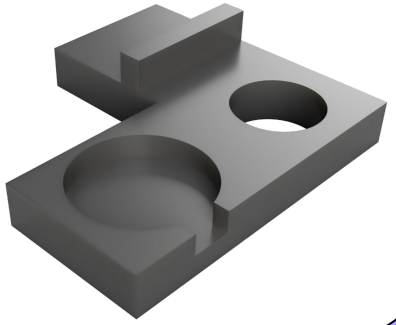
```
Writing at 0x0005122b... (100 %)
Wrote 282160 bytes (157579 compressed) at 0x00010000 in 1.8 seconds (effective 1256.9 kbit/s)...
Hash of data verified.

Leaving...
Hard resetting via RTS pin...
========================= [SUCCESS] Took 5.66 seconds =========================
*  Terminal will be reused by tasks, press any key to close it.
```

3D Modeling

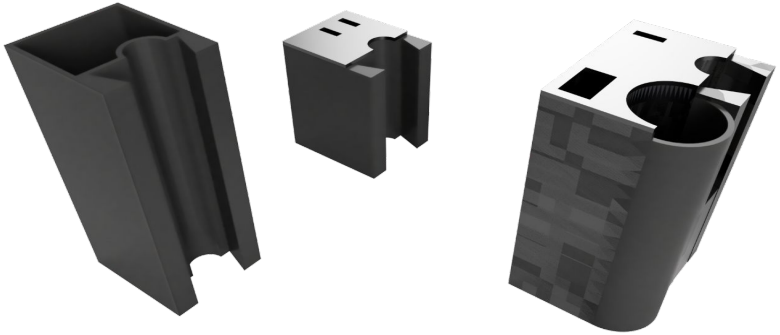
Sensor Mounts



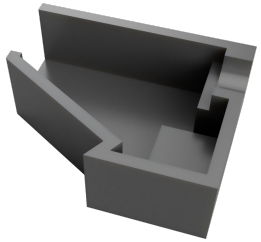
Rotary and Haptic Mount



Housing Module



Camera Mount



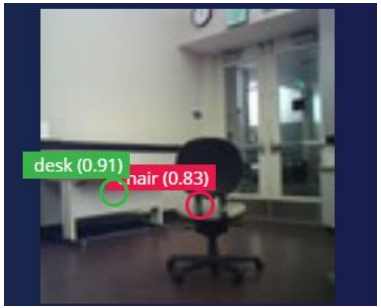
Machine Learning Training Flow

roboflow

collect/label images

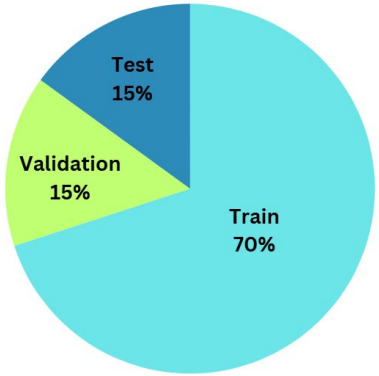
- Blur
- Rotate
- flip

Training/ hyperparameter tuning

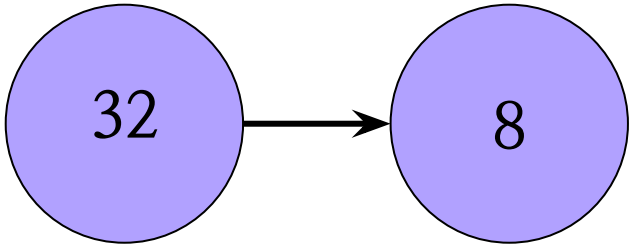


Testing

Machine Learning Statistics



Data Splits



Quantization

Test Dataset

ACCURACY
86.84%

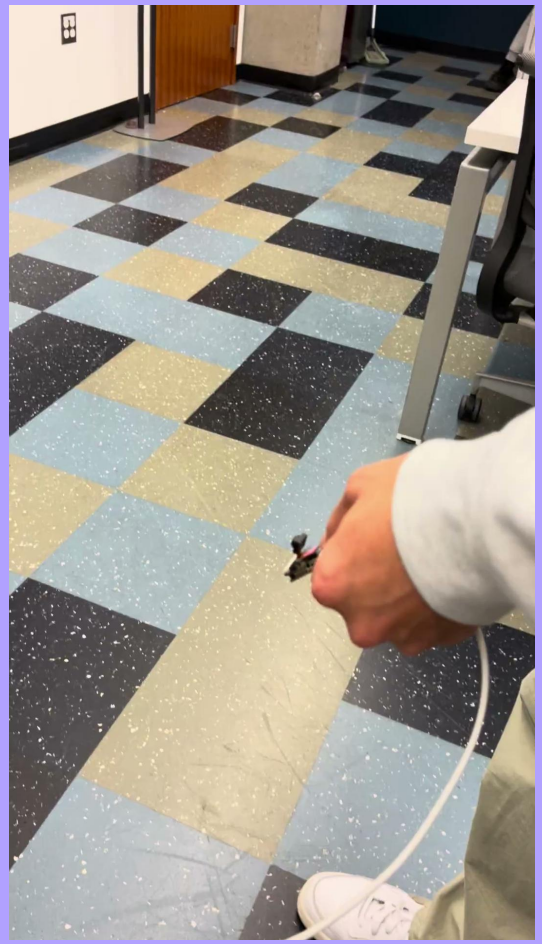
Metrics for Object detection

METRIC	VALUE
Precision (non-background)	0.89
Recall (non-background)	0.98
F1 Score (non-background)	0.93

Hyperparameters

- Lr = 0.0005 ~ 0.001
- Batch size = 8 ~ 16
- 60~70 epochs

Demo Videos



Future Improvements

- Improving the design to hide protrusions (sensors, camera, wiring)
- Ambidextrous design
- ML improvement (overfitting, data collection)
- BLE speech audio feedback to user device