UMassAmherst
The Commonwealth's Flagship Campus

Final Project Review:

Intelligent Screw Organizer - ISO

Team 20
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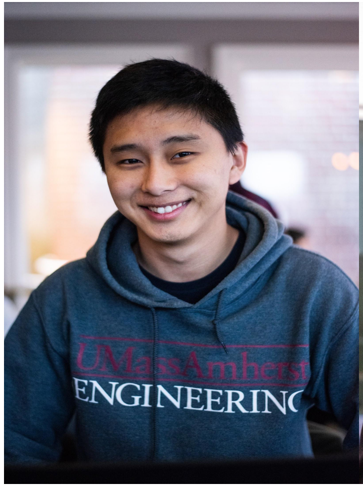
April 22, 2019

Advisor: Professor Eslami

ISO Team:



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CSE

Jordon Balskus
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The Problem

- Many people and machines shops have loose screws laying around and do not want to invest the time and effort in sorting them. They also don’t want to spend the money in an industrial sorting machine

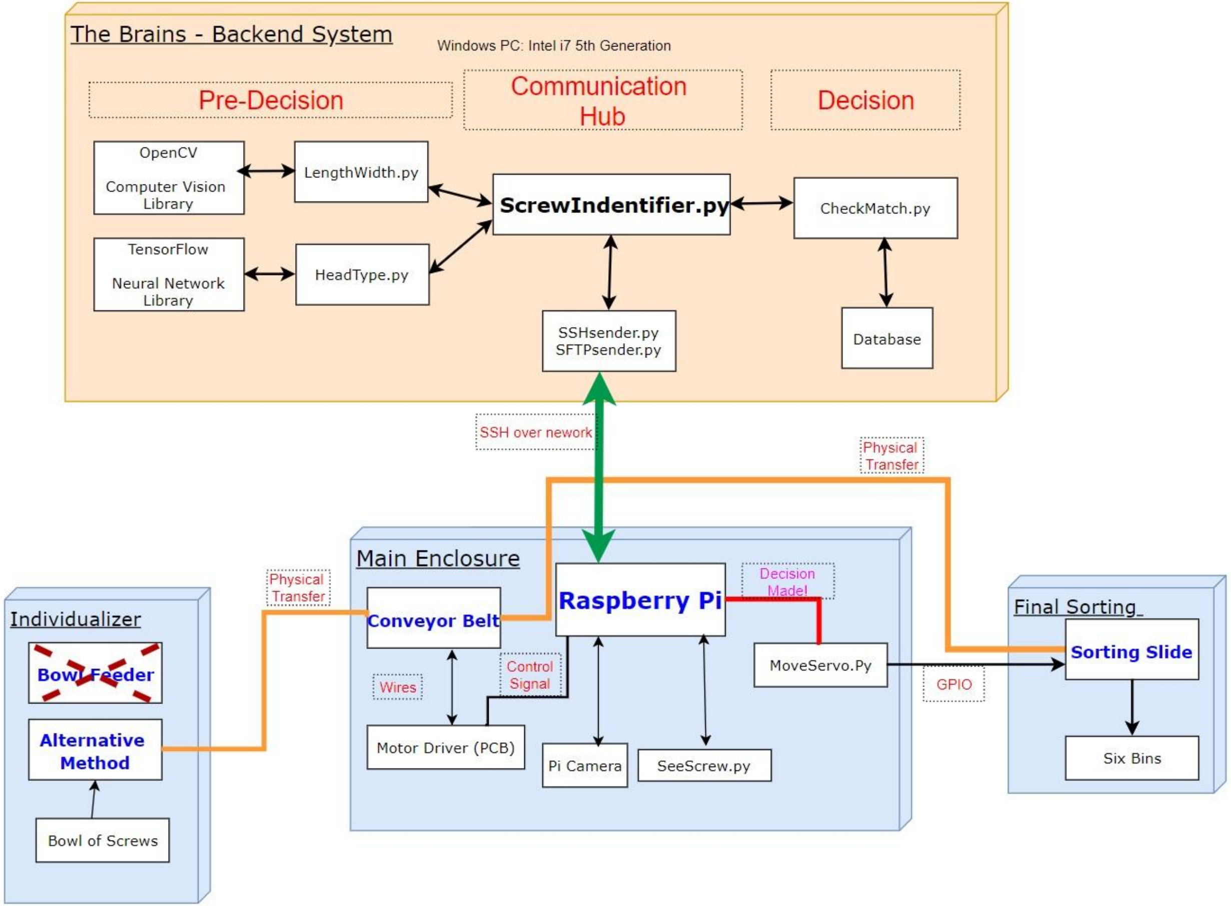
- Throwing them out would be a waste of materials and only contribute to the growing trash problem our planet has.

We have a quick and low-cost solution for the problem: ISO

Mechanical Requirements & Specifications

Specification	Goal	Actual
Screw Length	0.5 inch - 3 inch	0.5 inch - 2.25 inch
Screw Type	5	5
Sorter able to deposit screw into correct bin	6s	6s

Block Diagram



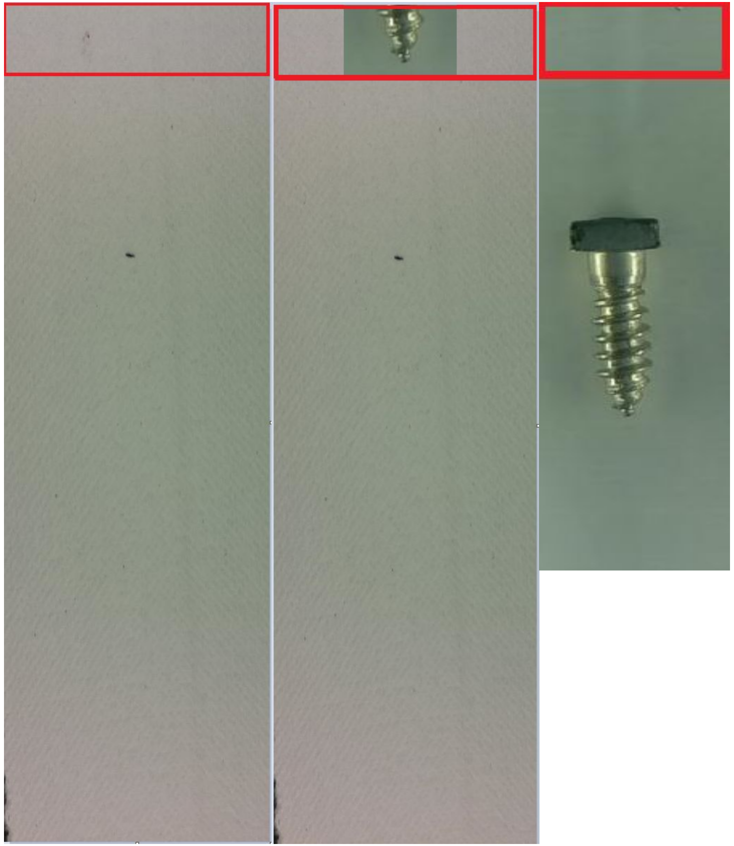
Backend Brains - Summary

- Communicates with Raspberry Pi over SSH and SFTP
- Orients image then determines screw height and width
- Compares with tensorflow model
- Checks database to see if there is a match
- Sends command (over SSH channel) to move sorting slider into proper position

Backend Brains - Detect Screw

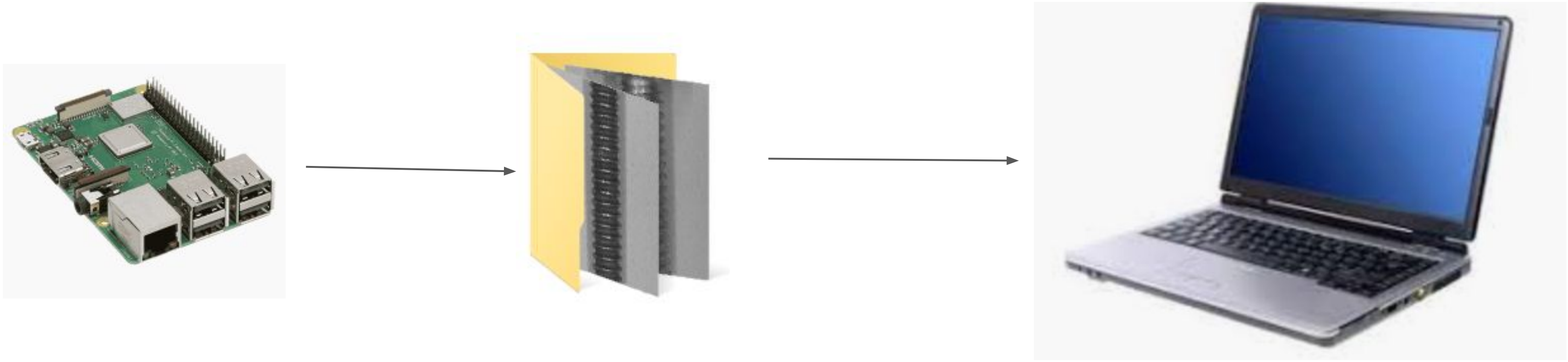
- Look for difference in top of frame
- Once threshold is reached
  - First part of screw is detected

- Wait until difference gets under threshold (back to white)
- Screw fully in frame now
- Pause conveyor to take picture
- Save image to file for sftp
- Restart conveyor



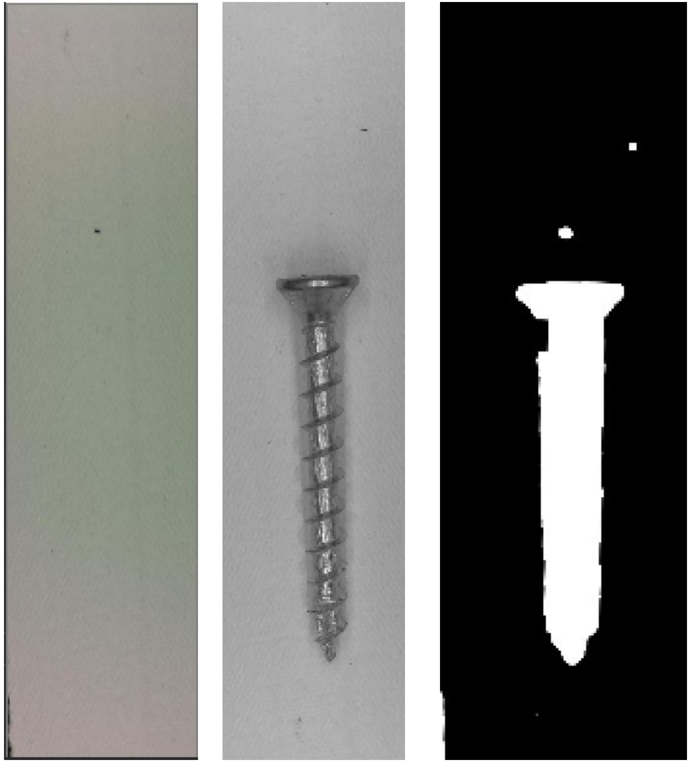
Backend Brains - SFTP

- Send image to the computer for processing
- Save in correct directory for reading
- (Conveyor is now running)



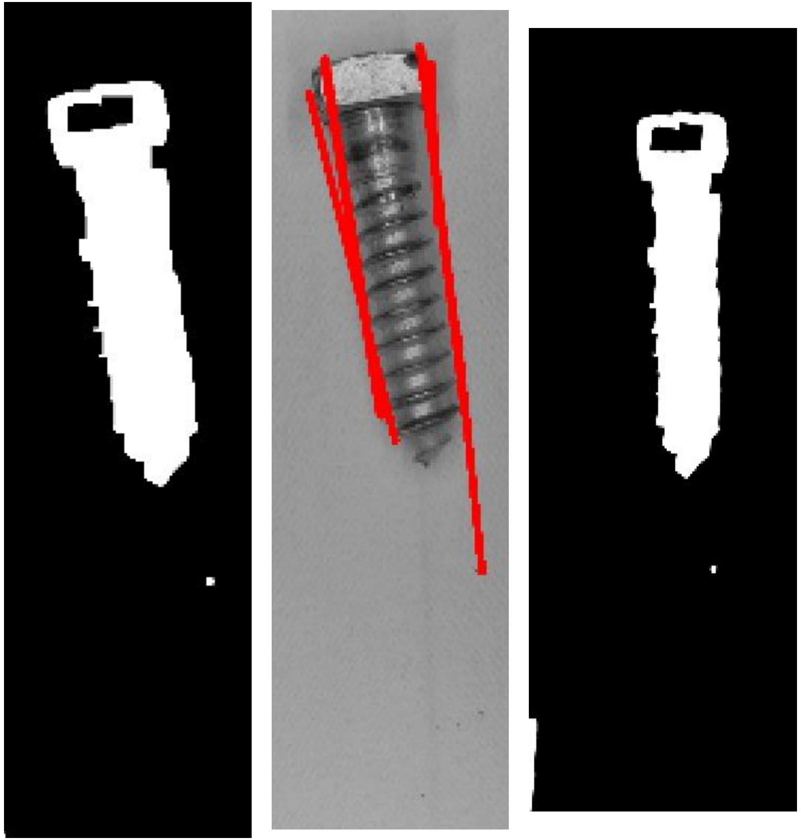
Backend Brains - Processing

- Use picture of background
- Compare with picture of screw
- Find the difference



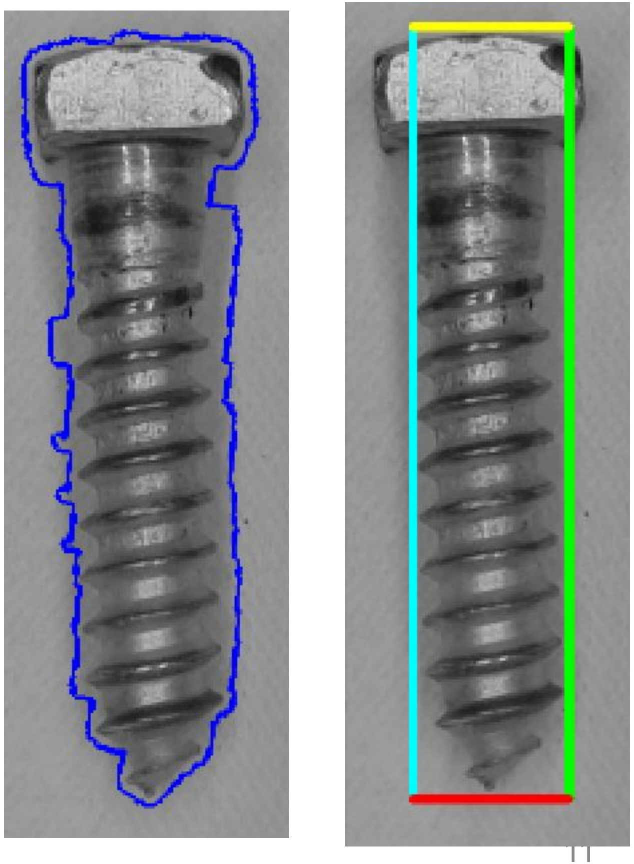
Backend Brains - Line Detector

- Use line detector to get direction of screw
- Turn image based on the average slope for better length and width detect
- Return this image to detect contours



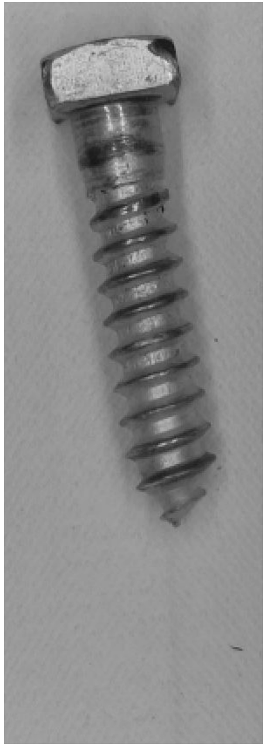
Backend Brains - Detect L/W

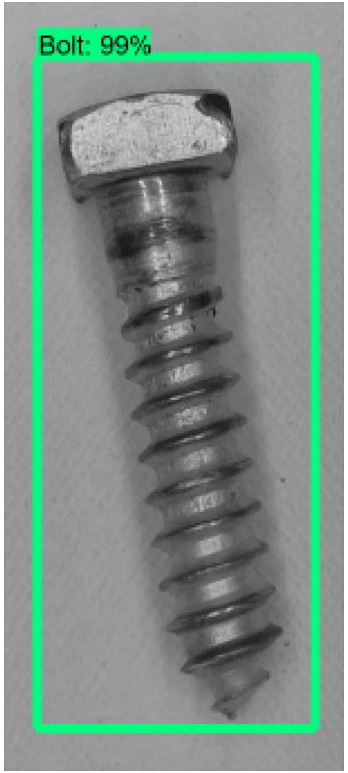
- Contours are found using opencv detector
- Using contours averages are calculated for the top, bottom, left, and right of screw
- Difference of these averages are used to diagnose length and width



Backend Brains - Tensorflow

- Grayscale screw is sent to the tensorflow model.
- Model outputs the object with percentage of correctness.
- Use this percentage to decipher how to use the data
- Combine length, width, and head-type data to compare with previous screw and make a decision





Backend Brains - Error Handling

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- If the first part of a screw is seen but takes too long to get under the camera error will be thrown : bad_detection
- If the screws length/width is outside our specified range error will be thrown : bad_id
- If the code errors out during runtime, error will be thrown : id_ error
- All thrown errors will cause the servo to dump screw in position six
- Outputs the total errors for a run after completion

Enclosure - Conveyor and Raspberry Pi

- Conveyor System
  - Feeds screws into enclosure system
  - Powered by driver which is controlled by Pi command

- Raspberry Pi
  - Turns on via SSH command from PC
  - On program inception, turns on conveyor belt via control signal and runs continuous ScrewDetection.py script
  - On detections, send image to PC via SFTP
  - Receive servo position detection decision via SSH and make the move

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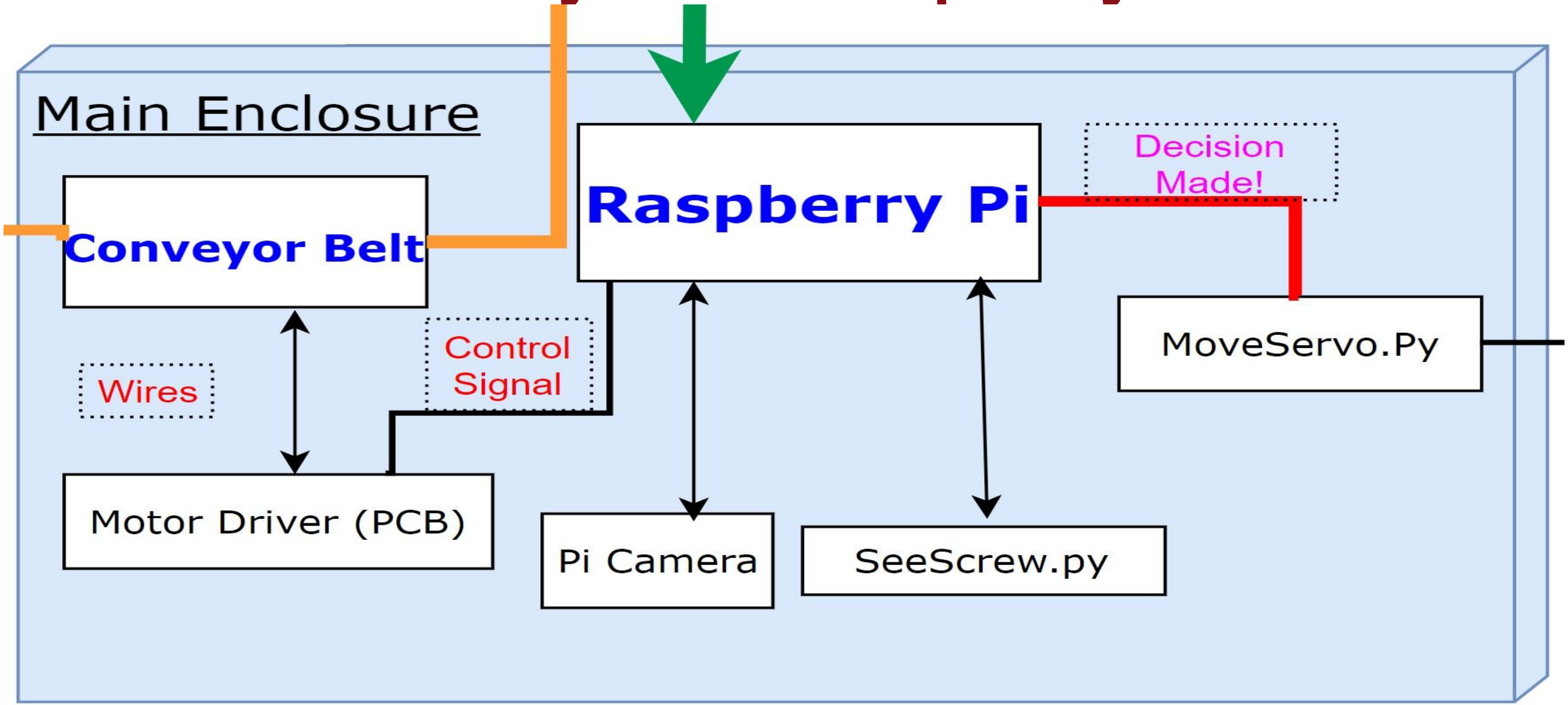
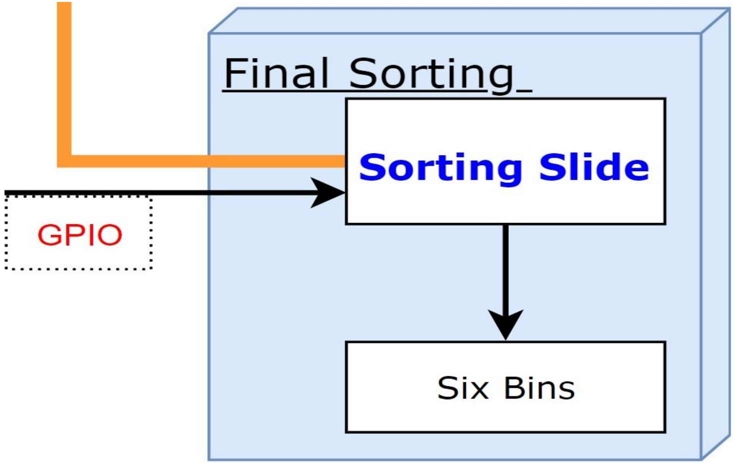


Sorting Mechanism

- Conveyor belt feeds into mouth of slide sorter
- Raspberry Pi sends commands via GPIO pins to servomotor
- 6 different bins will hold screws (5 being similar screws with 1 being miscellaneous)



Proposed FPR Deliverables

- **Motor Driver PCB** - Jordon B
  - Conveyor Belt gear motor needs a variable speed driver and power supply.
- **TensorFlow Model Creation** - Jordan G
  - Implement machine learning model for head type detection
  - Incorporate head decision into current detection algorithm
- **Optimize Software Suite** - Andrew M.
  - Get detection code to work as flawlessly as possible
- **Aesthetic Improvements** - Rajesh S.
  - Upgrade enclosure structure and add professional touch
- **Final Prototype Completion** - All Members
  - Have final ISO system completed and working by FPR

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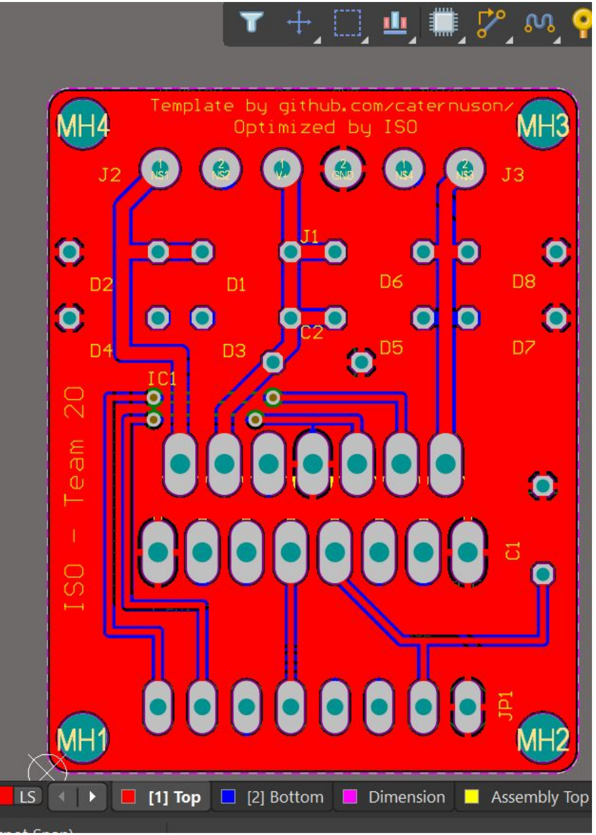
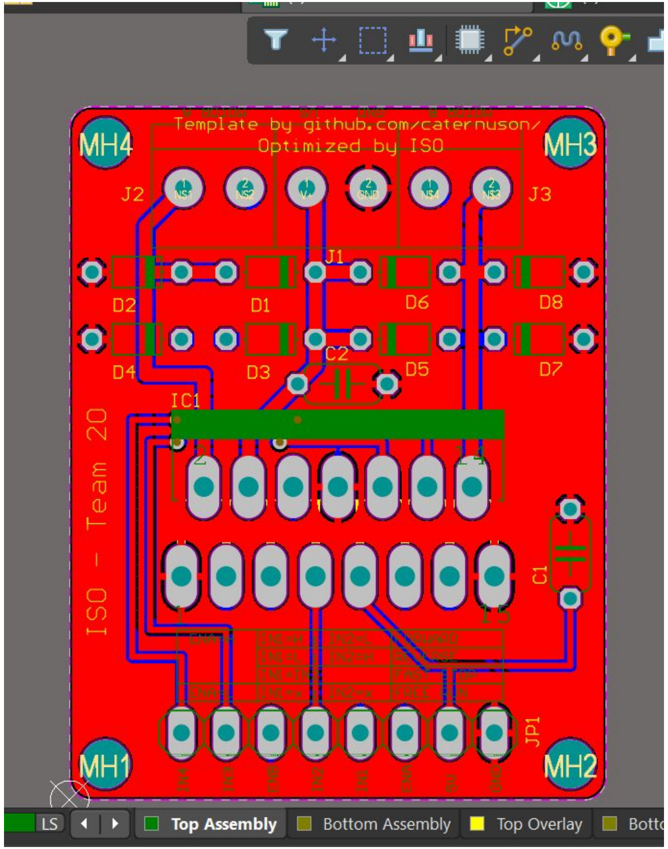
PCB Dilemma


Template by github.com/caternuson/
Optimized by ISO
MH4
MH3
MH1
MH2
J2
J3
J1
D1
D2
D3
D4
D5
D6
D7
D8
C1
C2
IC1
JP1
ISO - Team 20
LS
[1] Top
[2] Bottom
Dimension
Assembly Top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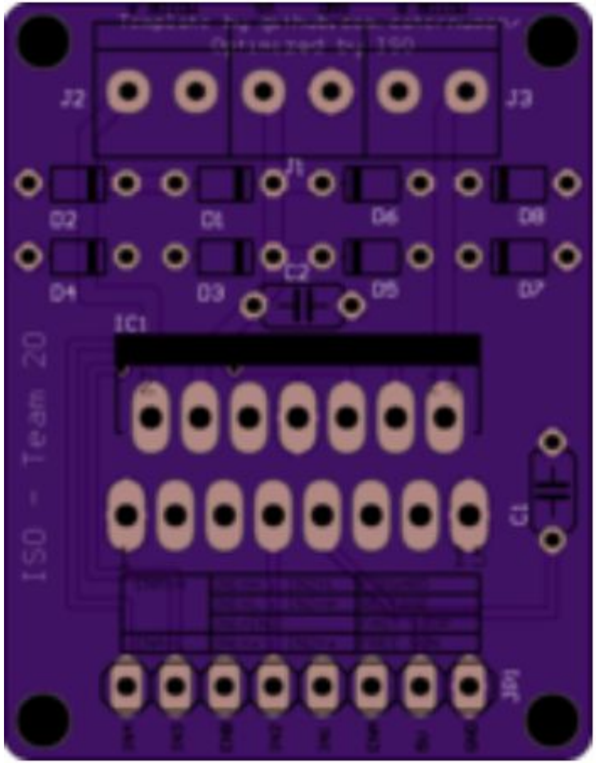
D3
D4
D5
D6
D7
D8
C1
C2
IC1
JP1
ISO - Team 20
LS
Top Assembly
Bottom Assembly
Top Overlay
Botto


J2
J3
D2
D1
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D7
C2
C1
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What Went Wrong?

- The Top Assembly text was interpreted as a mechanical layer and **printed with conductive material**. Thereby shorting our entire board.

- Text should have been placed as a Top Overlay layer

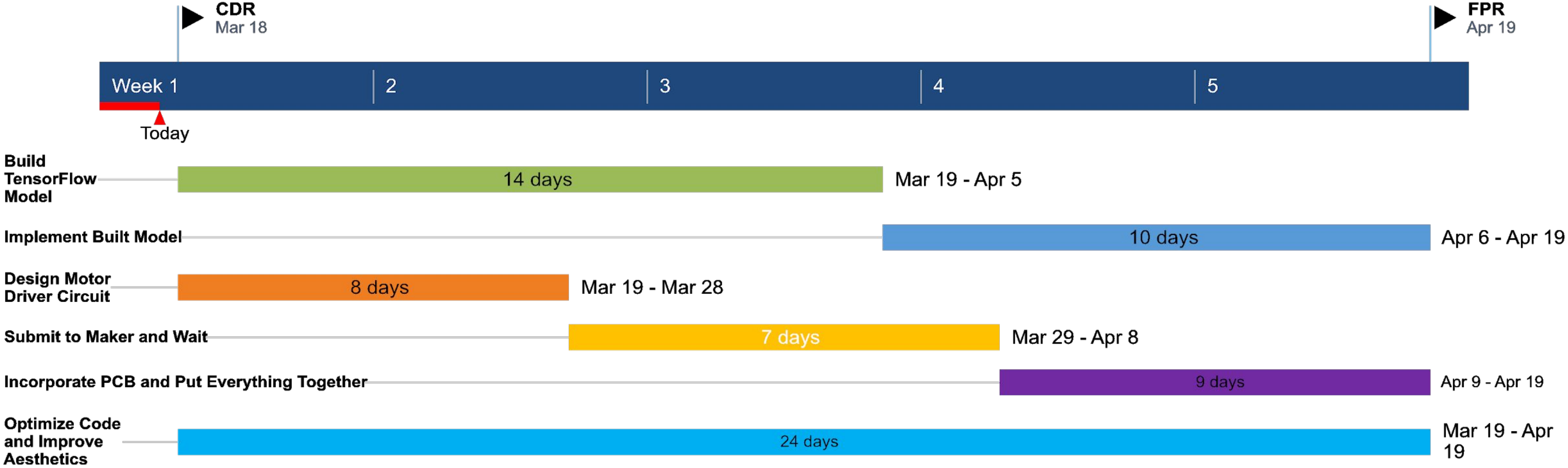
- With more time, this issue could have been fixed with a simple layer fix

- <u>Nothing wrong with the actual circuit design of PCB.</u> Breadboard currently mirroring this functionality

Material Costs

Device	Model	Unit Cost
Conveyor structure	Bruder Conveyor belt	$35
Belt	Inner Cycle Tube	$10
Raspberry Pi	Pi model 3B	$25
Camera	ArduCam 5	$30
Motor driver	uxcell 12V DC 200RPM Gear Motor	$20
PCB + Components	PCB, diodes, wiring	$15
Miscellaneous Components	Gaffer’s Tape, Electric tape, Motor mount	$20
Total		$155

Final Gantt Chart



Lessons Learned

- Make the best mechanical system from the start
- Delineate tasks better
- Start earlier

DEMO

Thank you

Questions?