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Team 12

ECE / MAE 148

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Proposed Goals

What We Promised

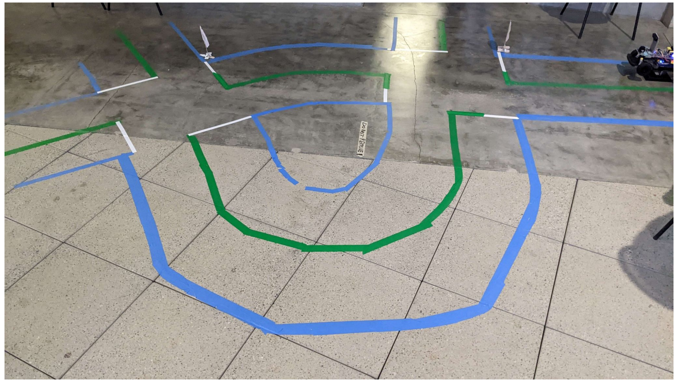
- Staying between lines
- Stopping at stop signs
- Wait for user input
- Autonomously traverse intersection

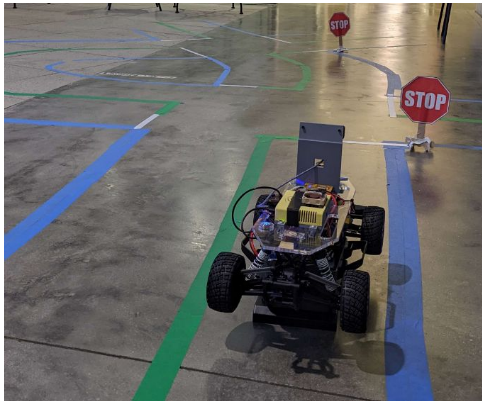
Nice to Haves

- Handling right-of-way
- Obstacle detection

How is it different

We combine autonomous lane-finding and traffic sign recognition to stop at an intersection and await user input.





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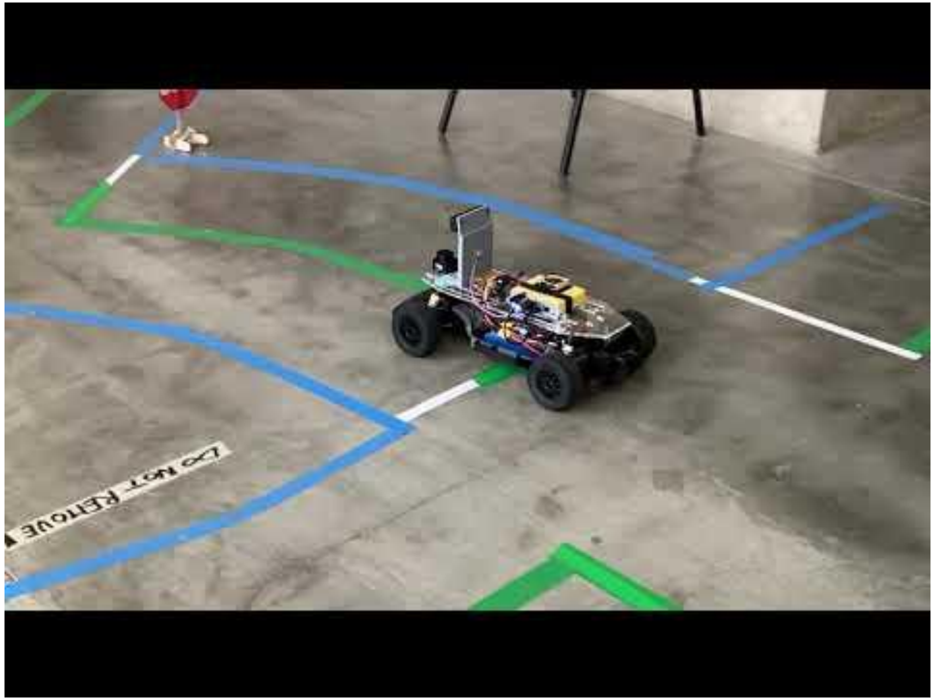
Demo Video



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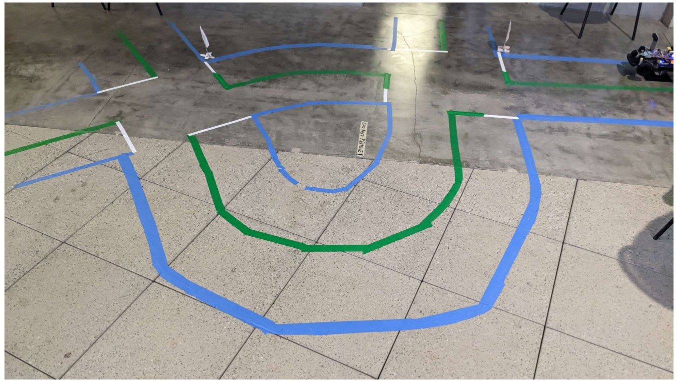
What We Have Done

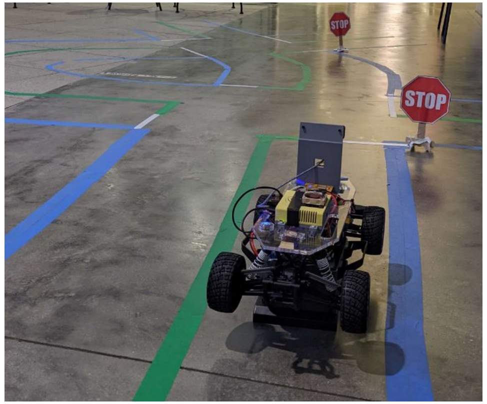
What Worked

- Staying between lines
- Staying in the right lane (mostly)
- Stop sign recognition
- Stopping at the line
- Traversing the intersection

It's harder than it looks

- Glare
- Daytime vs Nighttime
- Narrow camera FOV
- Inaccurate depth perception





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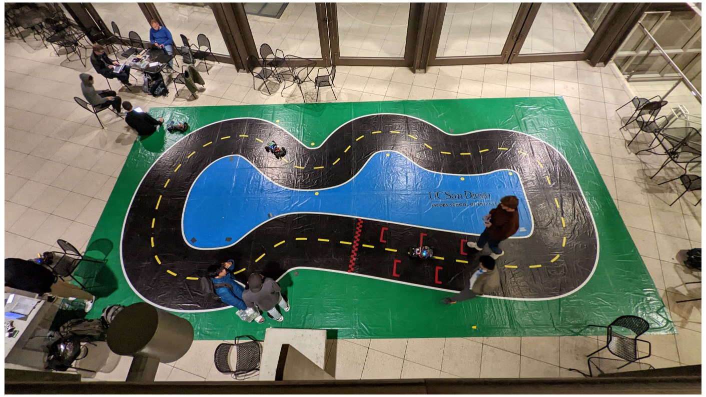
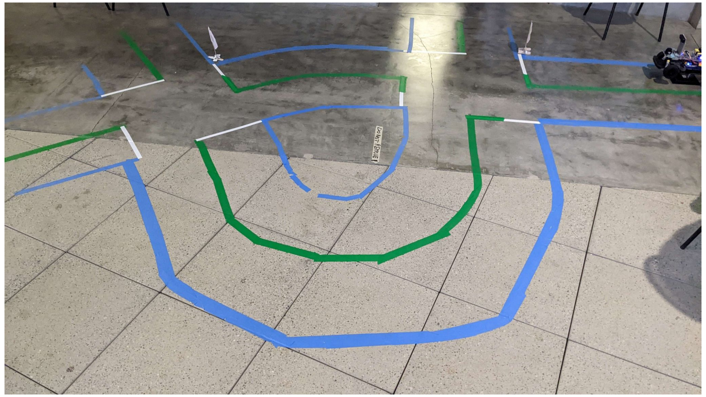
Staying in the Lines

Initial Attempts

- **Canny and HoughLines**
  - Managed 2 laps
  - Easily ruined by glare/shadows
- **White filtering + Canny and HoughLines**
  - Narrow camera FOV
  - Can't differentiate left vs right lines
- **Blue-green filtering**
  - Filter for greens and blues
  - Count green/blue pixels
- **Red-green filtering**
  - Blue difficult to filter at night
  - Objects are red too (people, stop signs)


Credit to Team 7 for the image above



How Blue-Green Filter Worked

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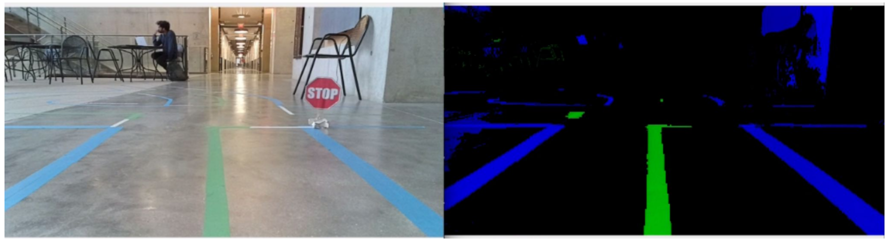
Steps

1. Filter for blues and greens
2. Crop the image
3. Count blue and green pixels
4. Subtract the the two
5. Center/clip the range

Benefits

- Easily filters out glare
  - Cropping
  - Blue/green filter
- ***Can handle lanes***



Blue = 100px, Green = 200px
200 - 100 = 100

Right turn

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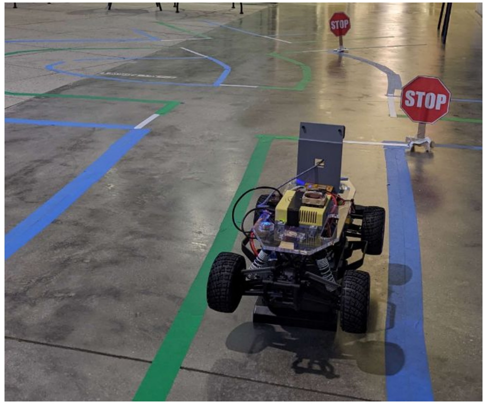
Stop Sign Detection

Initial Attempts

- **Tiny-Yolo (on OAKD)**
  - Off-center bounding-boxes
  - Multiple boxes for same object
  - Can't average boxes (multiple signs)
- **Size of Bounding Box**
  - Distance using bounding box area
  - Boxes on edge of frame
  - Boxes not on a stop sign (Tiny-Yolo)
- **OAKD Depth from Tiny-Yolo**
  - Bounding boxes not centered
  - Where to sample depth?
- **OAKD Depth from Cascade Classifier**
  - Trained using XML file from internet
  - Drew perfect bounding boxes



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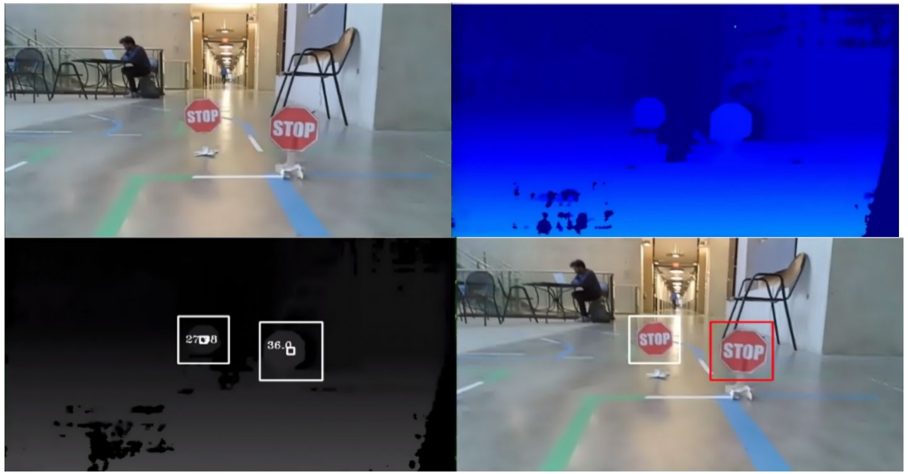
Stop Sign Detection

How it Worked

1. Read depth map from OAKD
2. Run cascade classifier on RGB frame
3. Compute center of bounding boxes
4. Average depth in a radius around center
5. Select closest stop-sign

Benefits

- Handles multiple stop signs
- Usually returned good depths



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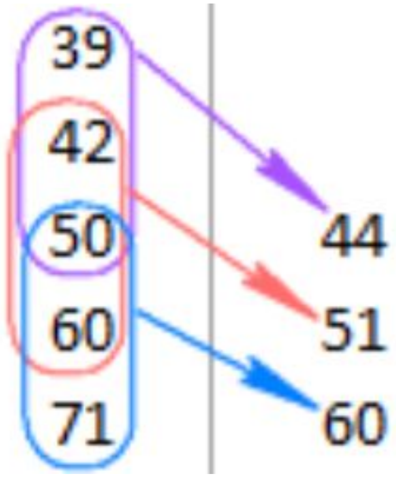
Inaccurate Measurements

Problem

- Stop signs occasionally returned bad depths
  - Early stopping
- VESC flicking back and forth
  - VESC crashes
  - Bad for stop sign detection

Solution

- Use the average of the last n values
  - Stop sign distance
  - Servo angle



Stopping at the Line

Problem

- What happens after seeing the sign?

Initial Attempt

- Keep going in the same direction for a second
  - Sharp corrections caused crashes

Accepted Solution

- Continue line following for n seconds
  - Works well most of the time
  - Fails if a *major* correction occurs at the end
- Reset VESC's running average once stopped

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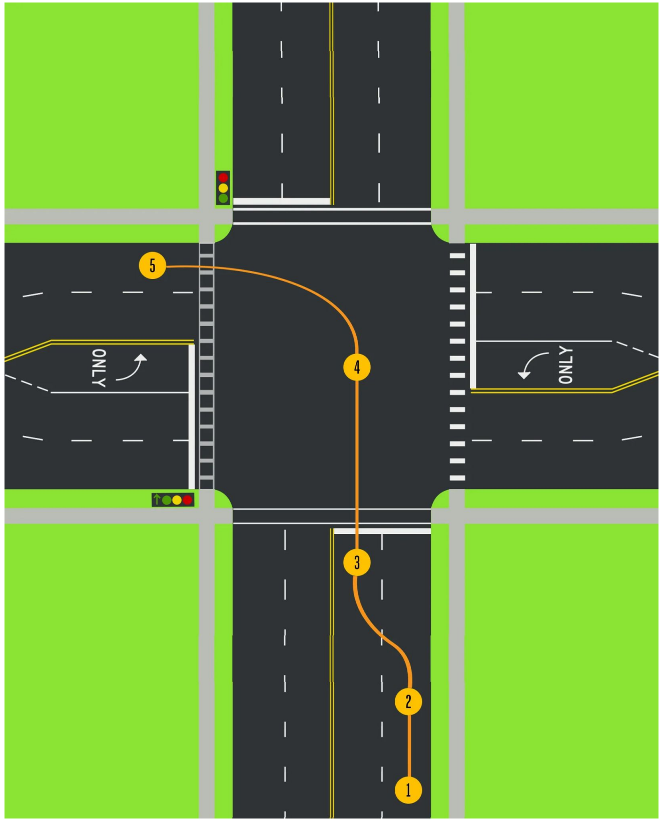
Traversing the Intersection

Problems

- Cross intersection where there are no lines
- Turns happened too fast
    - Running over stop sign
    - Turning into wrong lane

Solutions

- Hard coded parameters
    - Throttle
    - Servo angle
    - Move in time
    - Turn time
- Move into intersection first, then turn



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Given Another Week

Proposed Changes

Test lidar obstacle detection

- Identify other cars
- Handle right of way

White line detection for stopping

- Detect white lines
- Stop perpendicular to the line

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Thanks for Listening