Improved Motion Primitives

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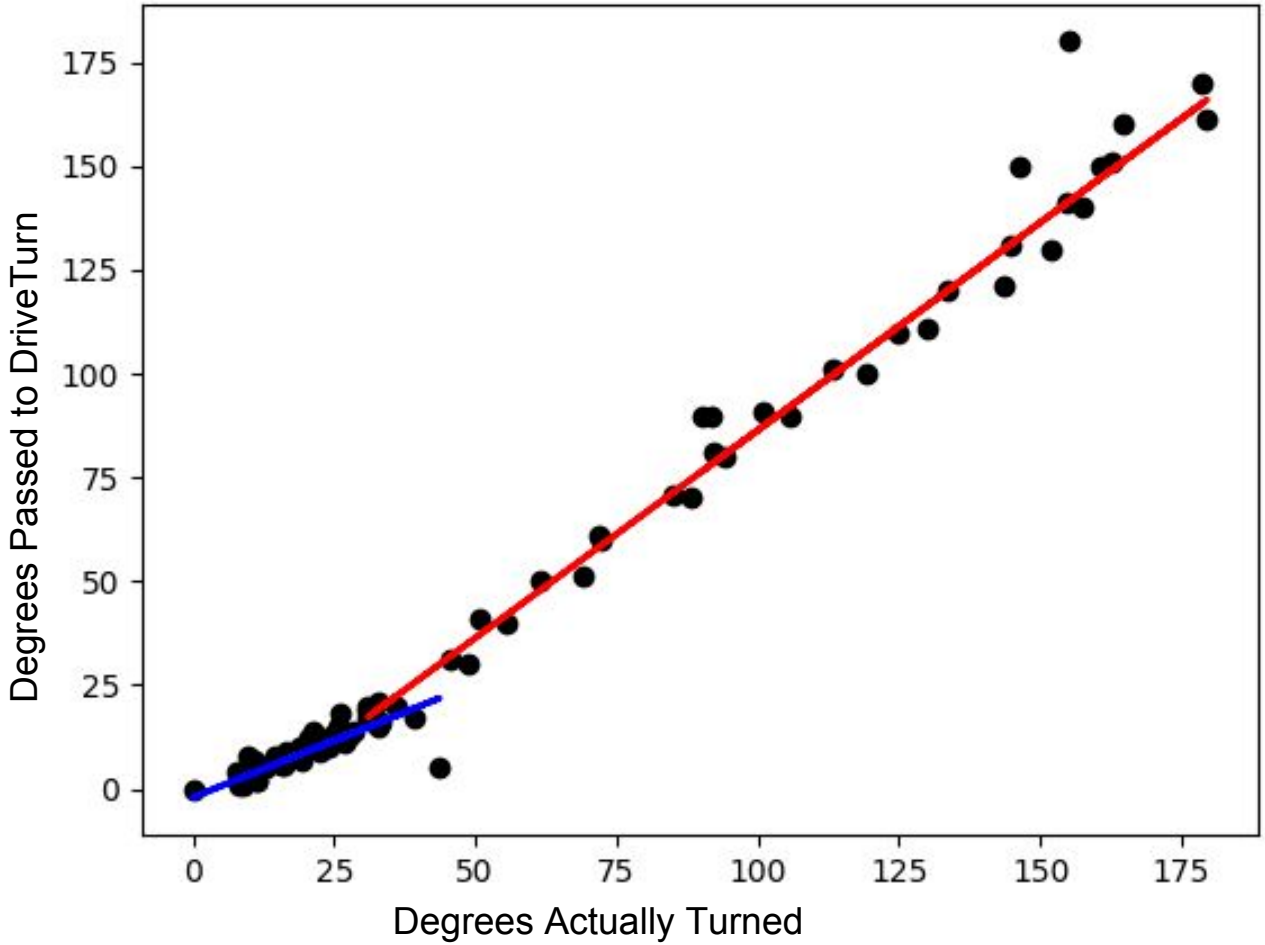
Machine Learning to Self-Calibrate Turn Actions.

- Turn node is slow, but DriveTurn is inaccurate
  - DriveTurn doesn't account for momentum
  - Use machine learning to figure out how early to stop DriveTurn and make it accurate
- Used SKlearn for machine learning
- Used 2 ridge regression models
  - One for small turns (<20 degrees), one for large turns
- The SmartTurn node only uses machine learning after acquiring 5 data points
- TurnOnCalibration node causes SmartTurn to not use machine learning
- TurnOffCalibration node causes SmartTurn to use machine learning
- Models can be saved with the Save node and loaded with the Load node
  - Both nodes are initialized with a path to the save location
- CalibrateSmartTurn node trains the model


Degrees Passed to DriveTurn
Degrees Actually Turned
0
25
50
75
100
125
150
175

Improved Approaching and Picking Up Cubes

- Cozmo's way of approaching cubes is slow and inaccurate
- We made it more direct and reliable
  - Compute the closest side of the closest cube
  - Pilot to a point a fixed distance from the cube
  - Make small adjustments to center the cube, and then do a final approach
- With the improved approach, the cube is essentially always picked up without failure

Object Tumbling Operations

- Native tumbling uses the old approach cube code
- We reimplemented tumble using our approach cube code
- We also created an approach and tumble node for the custom cardboard cubes
  - This is hard because the cubes are slightly too large to grab with the lift
  - Slightly shrinking the cubes or changing the design would make this work

What was hard?

- Doing the geometry to calculate the point lined up with the correct side of the cube to pilot to
- Deciding what machine learning algorithms to use and how to tune them
  - We tried various linear models, and different kernels
  - The data is still noisy enough that there's significant error, especially at low angles

What was neat?

- The fact that two linear models with a cutoff right around 20 degrees best fit the turning data
  - This became clear once we drew the plot
- Working out how robust our cube approach can be
  - As long as the robot is generally facing the cube after the pilot phase, it can reliably pick it up

What's next?

- Cardboard cubes can be adjusted
- Pushing cardboard cubes
- Possibly testing out other machine learning models for SmartTurn