Path Planning and Tracking for Autonomous Cars

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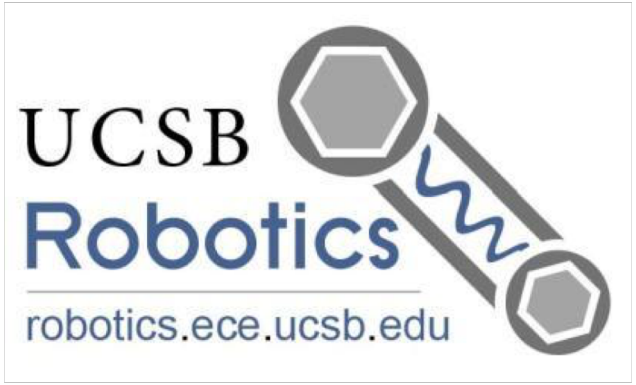
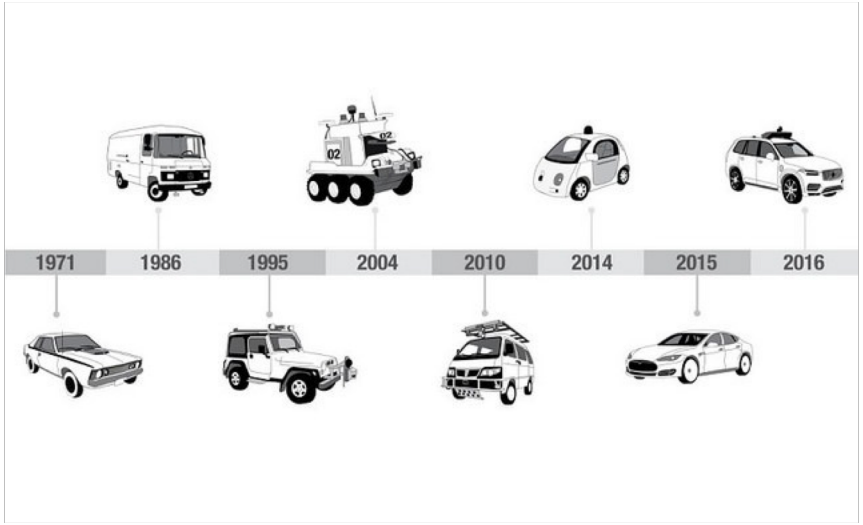


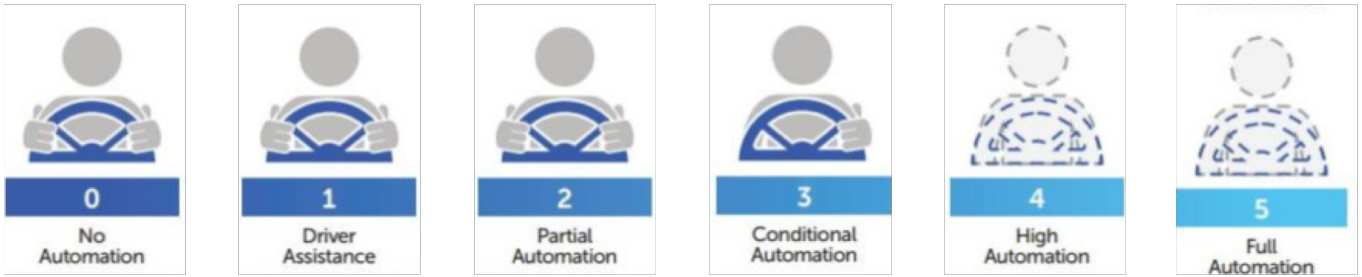
Autonomous cars are the future of transportation

-safety (reduce human error)

-energy efficiency (optimized trajectories waste less fuel/battery)

-speed (quicker routes than can be planned by a human driver)

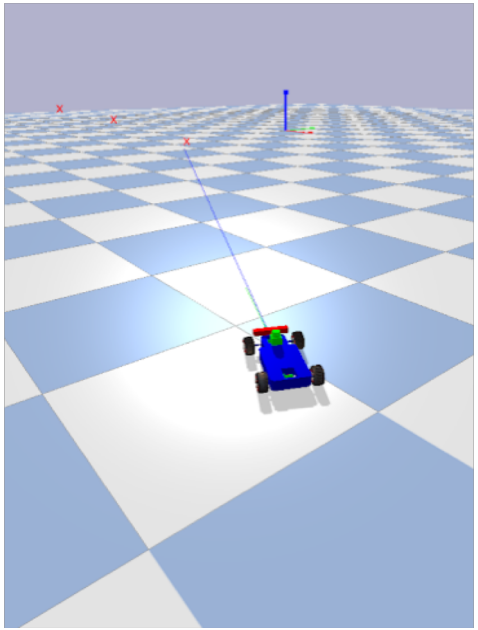




Use model based techniques for dynamic car maneuvers

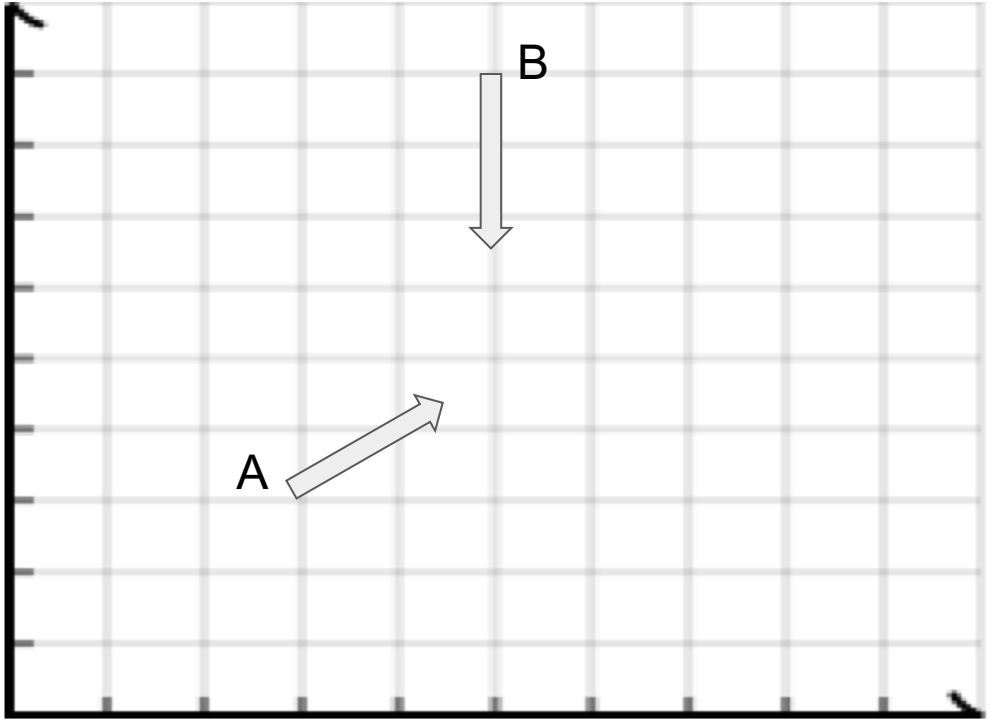
-avoid or exploit wheel slipping

-translate simulations onto real life small car model



Our Coordinate System

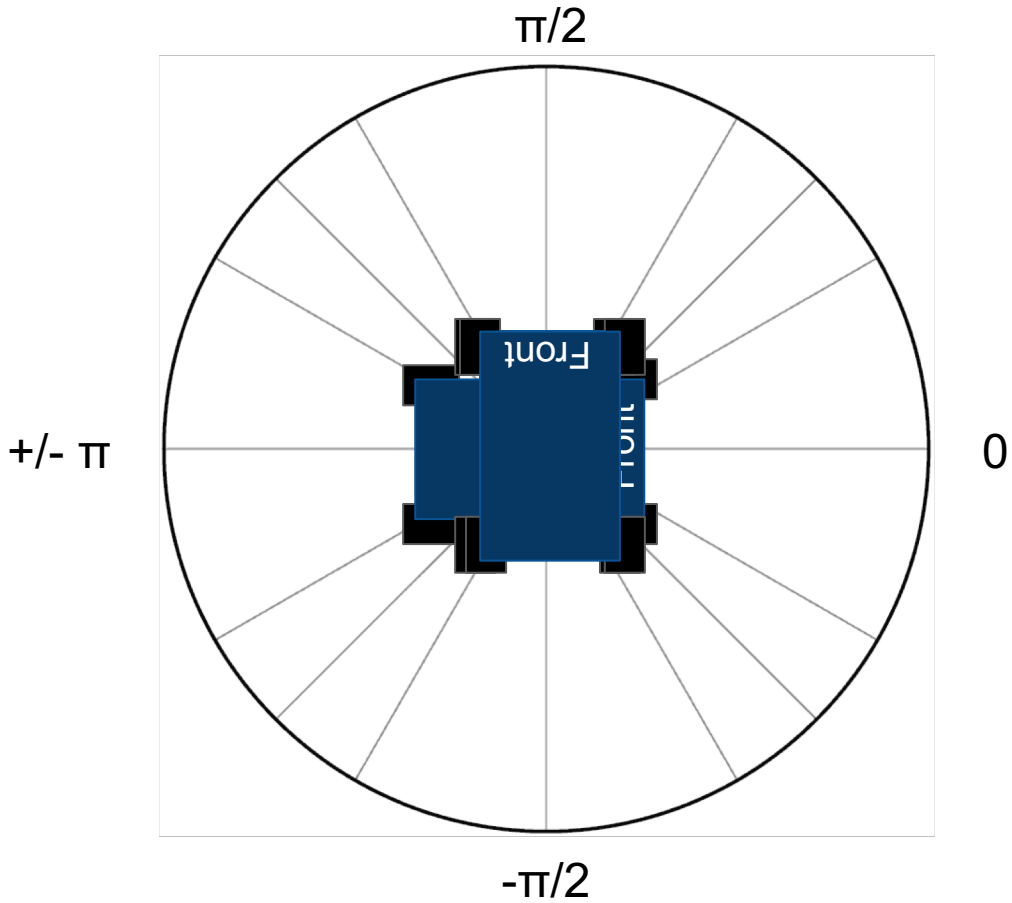
-to reference position: (x-value, y-value, orientation)



A (x-initial, y-initial, theta-initial):
(3,3,π/6)

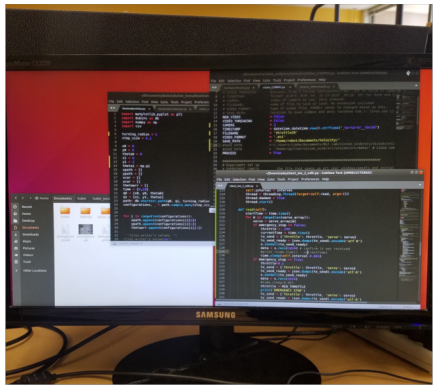
B (x-goal, y-goal, theta-goal):
(5,9,-π/2)

Understanding Orientation

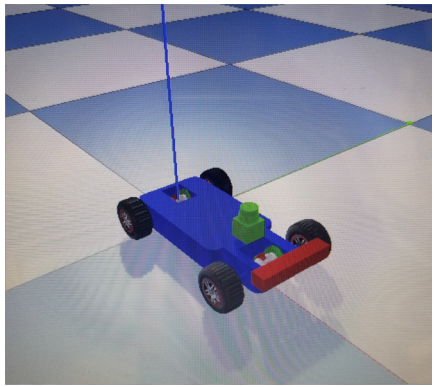


The process

Path Planning



Simulation Tracking

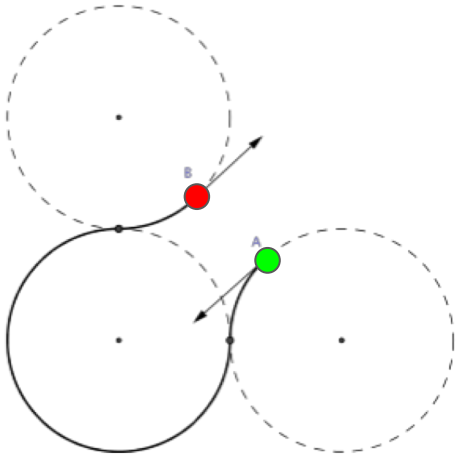


Hardware Tracking

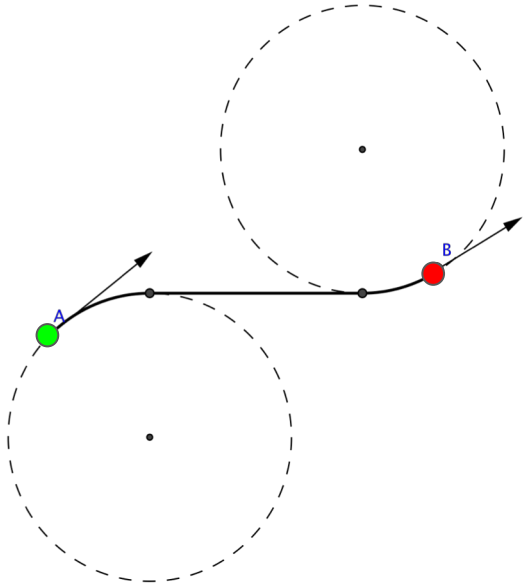
Path Planning

-use a Dubins path to find the shortest way to reach a target with a fixed turn radius

-Dubins Path uses a combination of curves and lines



CCC Path



CSC Path

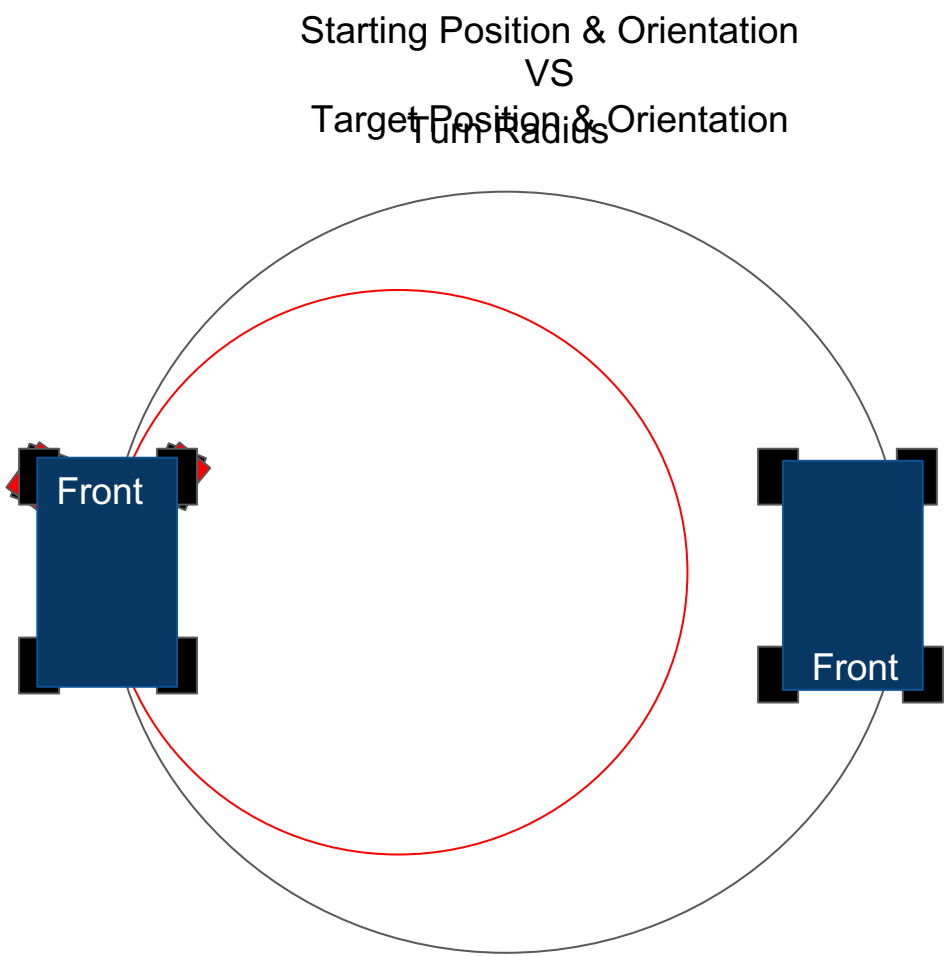
Dubins Path Basics

Inputs:

1. Turn Radius

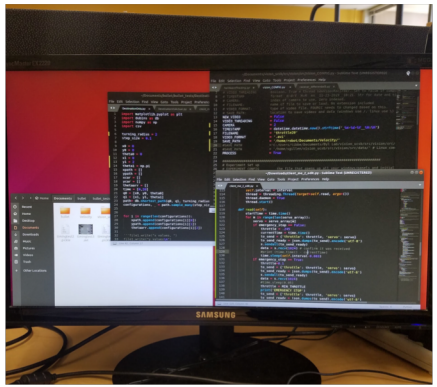
2. Starting position & orientation

3. Target position & orientation

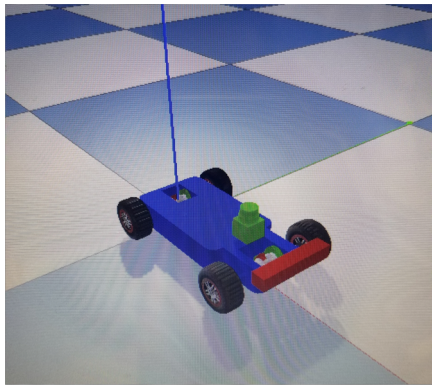


The process

Path Planning



Simulation Tracking

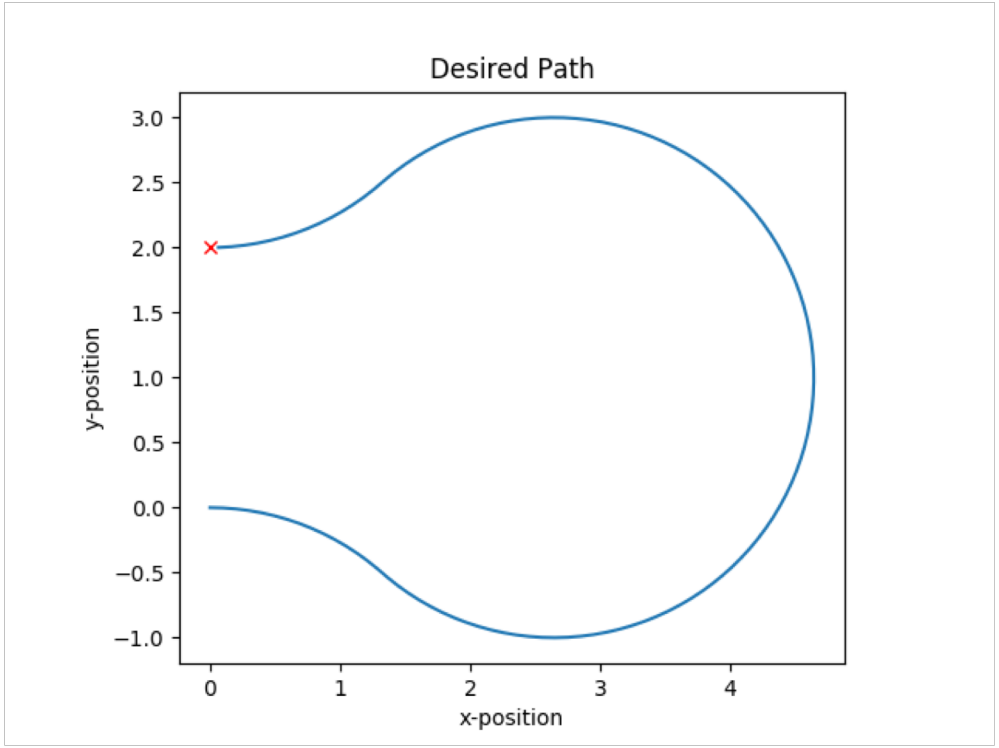


Hardware Tracking

Path Tracking in Pybullet Simulator

-Compare current car position and heading with the next point in the Dubins path

-Adjust the turn angle to steer the car towards this next point



Simulation Car Tracking

Simulation result

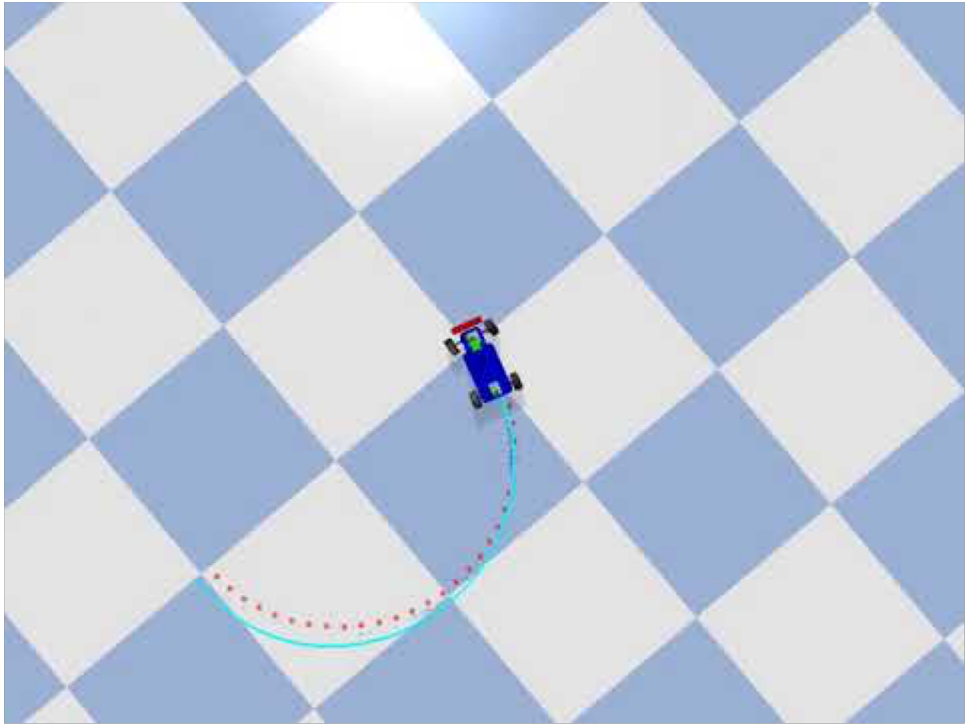
Input values:

-turn radius= 1.0m

-velocity=~1.5(m/s)

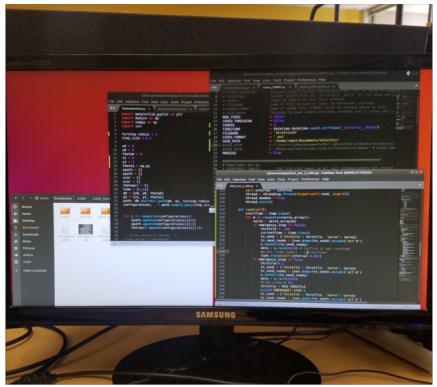
- Starting Coordinates:(0,0,0)

-Target:(0,2,π)

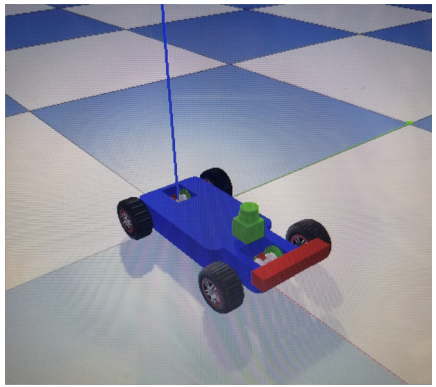


The process

Path Planning



Simulation Tracking



Hardware Tracking

Actual Car Tracking

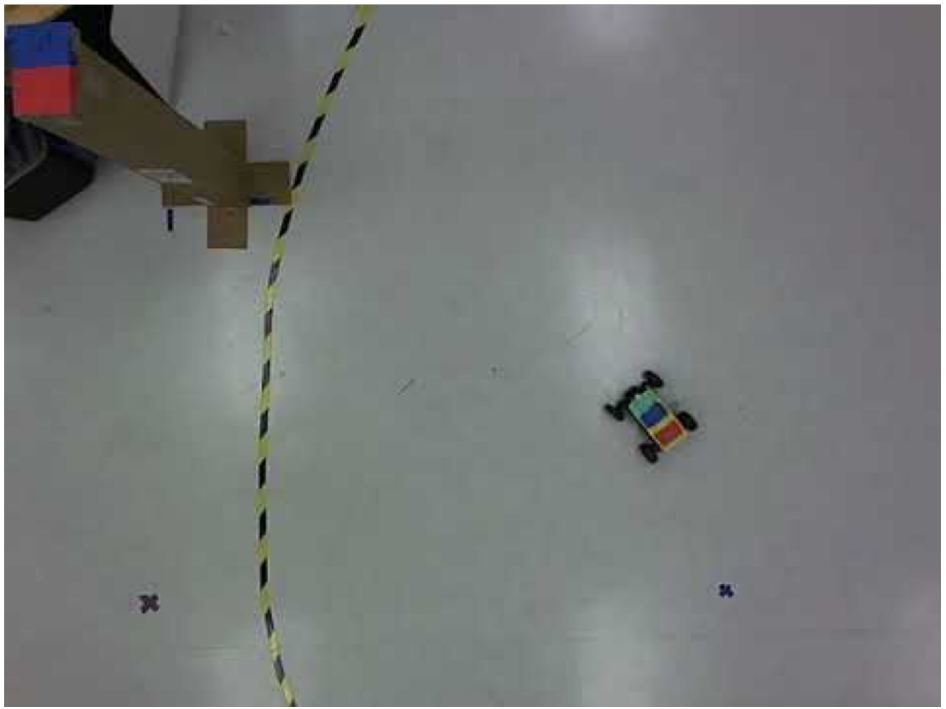
Starting coordinates: ~ (0,0,0)

Target: (0, 2, π)

Turn radius: 1m

Speed: ~0.70(m/s)

Real World result

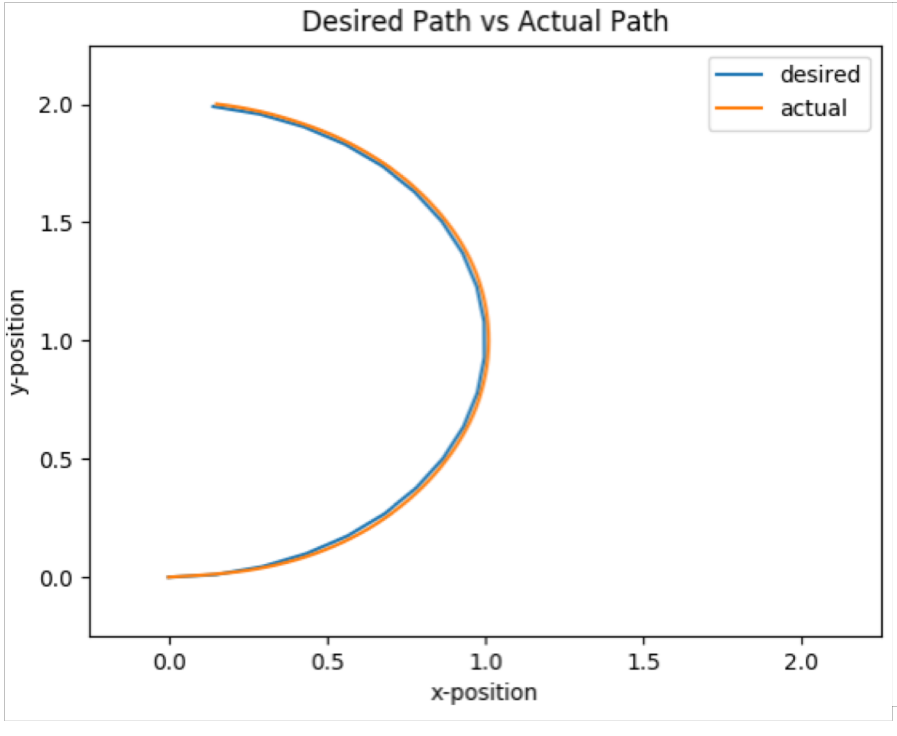


x-axis

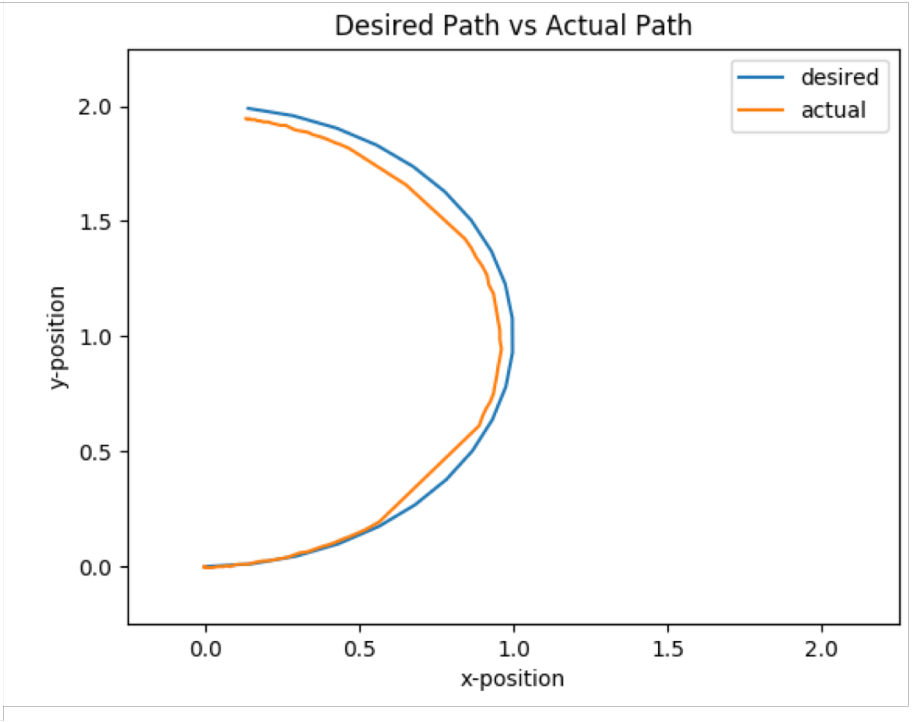
y-axis

Comparing simulation and real world trials

Simulation



Actual Car



Factors responsible for differences between simulation and real world tests

1. Car dynamics differ between simulation and real world

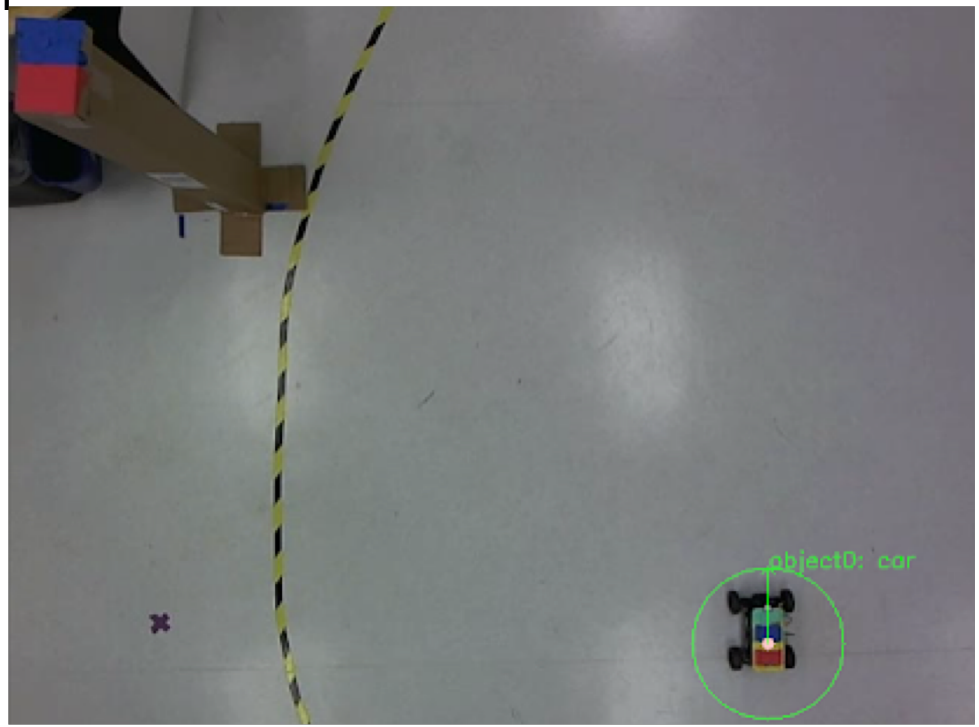
2. Simulation has “ideal” conditions (i.e. known friction, no disturbances or uncertainty, perfect sensing, etc.)

Further improvements yet to come

-use multiprocessing to improve real-world tracking

-update simulation car to be proportionally accurate with actual car

-use LEDs to better track the orientation of the car



Conclusion

-Path Planning: utilize Dubins path to reach goal from starting point

-Path Tracking: implemented proportional controller to accurately track the car’s path in simulation and hardware

-Analyzed data to track accuracy and improve conditions to get more accurate results in the future

Acknowledgements

Sammy Davis

Guillaume Bellegarda

Timnit Kefela

CSEP

UCSB Robotics
robotics.ece.ucsb.edu