FROM MOTORCYCLE TO CHEVY BOLT:
A JOURNEY WITH MATLAB IN AUTONOMOUS VEHICLES AND ROBOTS RESEARCH

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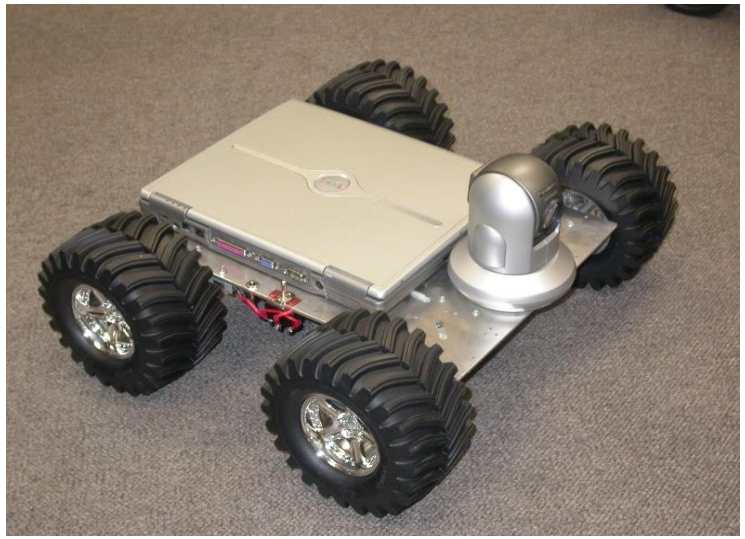
FIRST ENCOUNTER WITH MATLAB - 1993

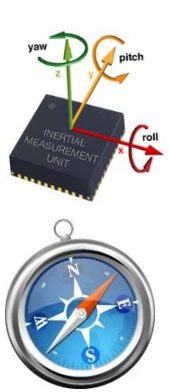
VAX Terminal:

MATLAB 3?

OUTLINE


Raytheon
AMD




yaw
pitch
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INERTIAL MEASUREMENT UNIT

km
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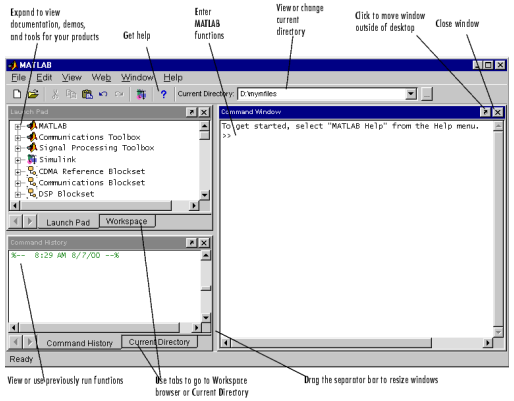
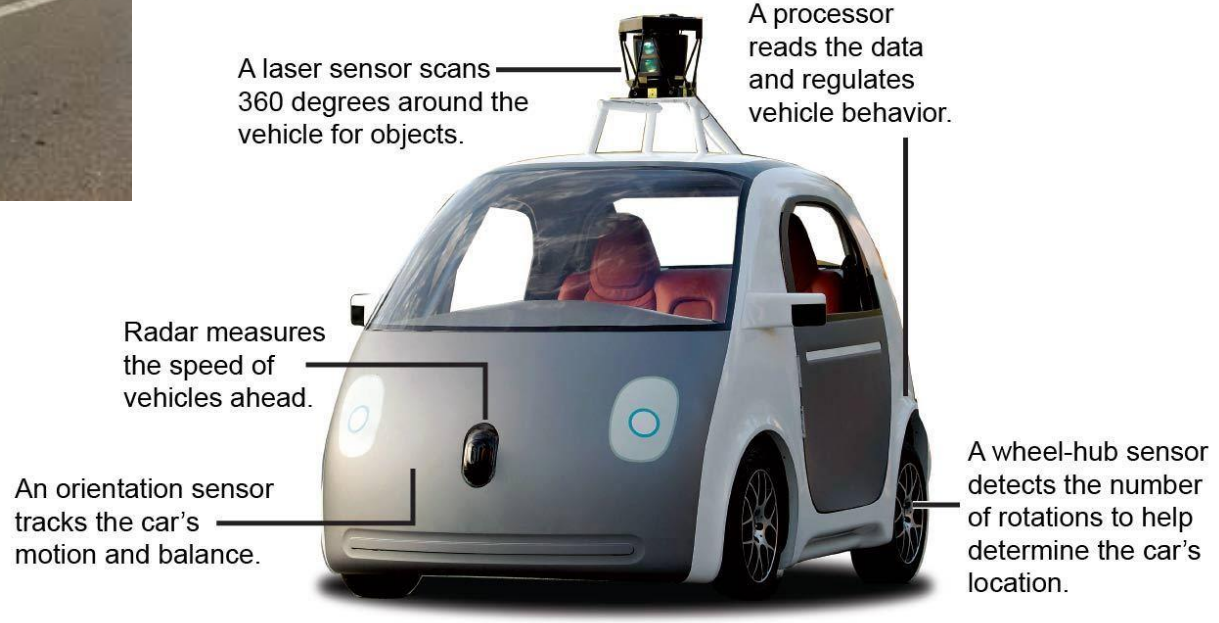
DARPA GRAND CHALLENGE 2005

AUTONOMOUS MOTORCYCLE &MATLAB VERSION 6.0





Source: Google

Raoul Rañoa / @latimesgraphics

OUTLINE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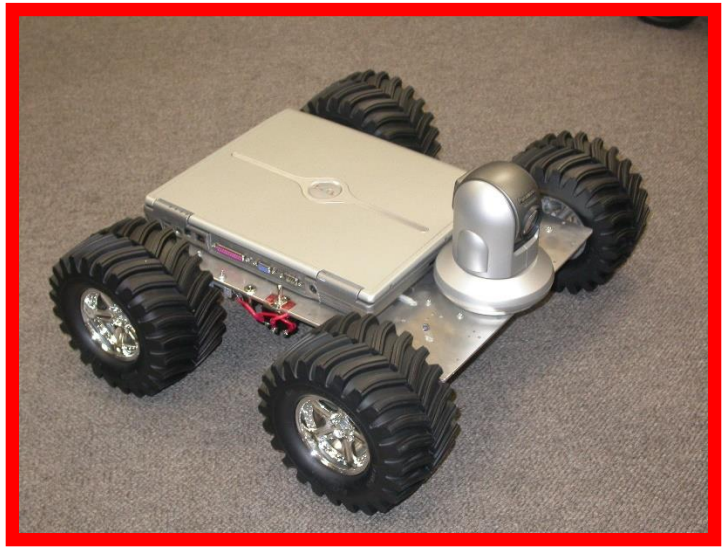

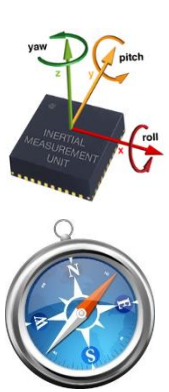
yaw
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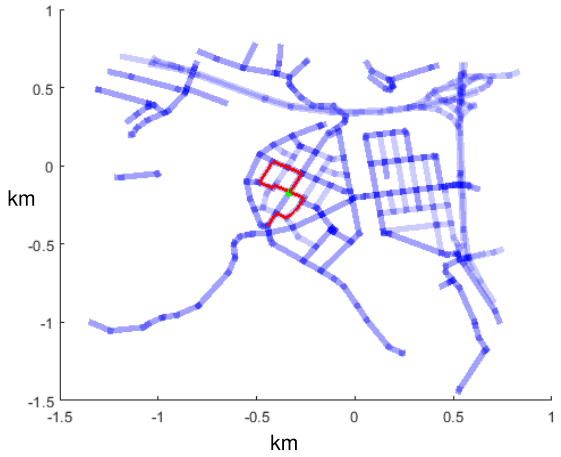
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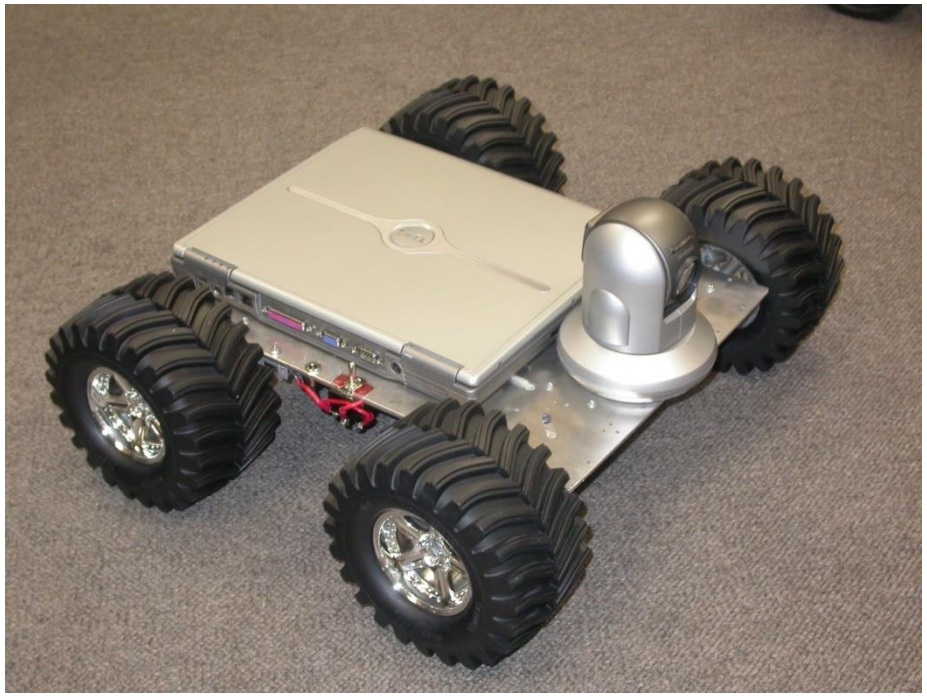
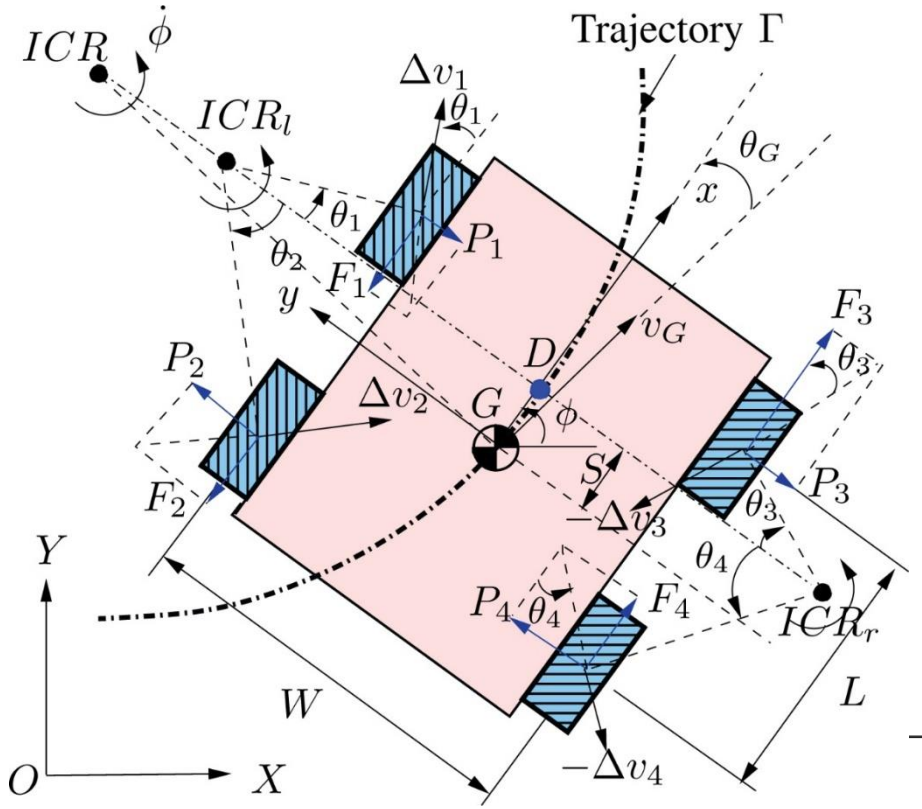
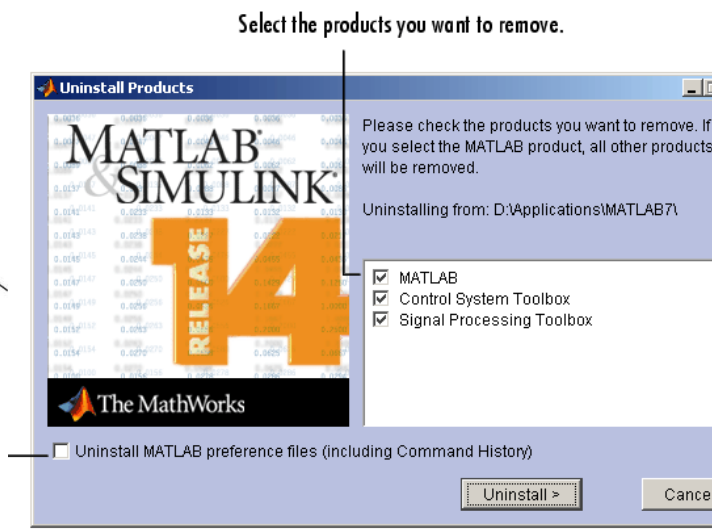
SKID-STEERED MOBILE ROBOTS

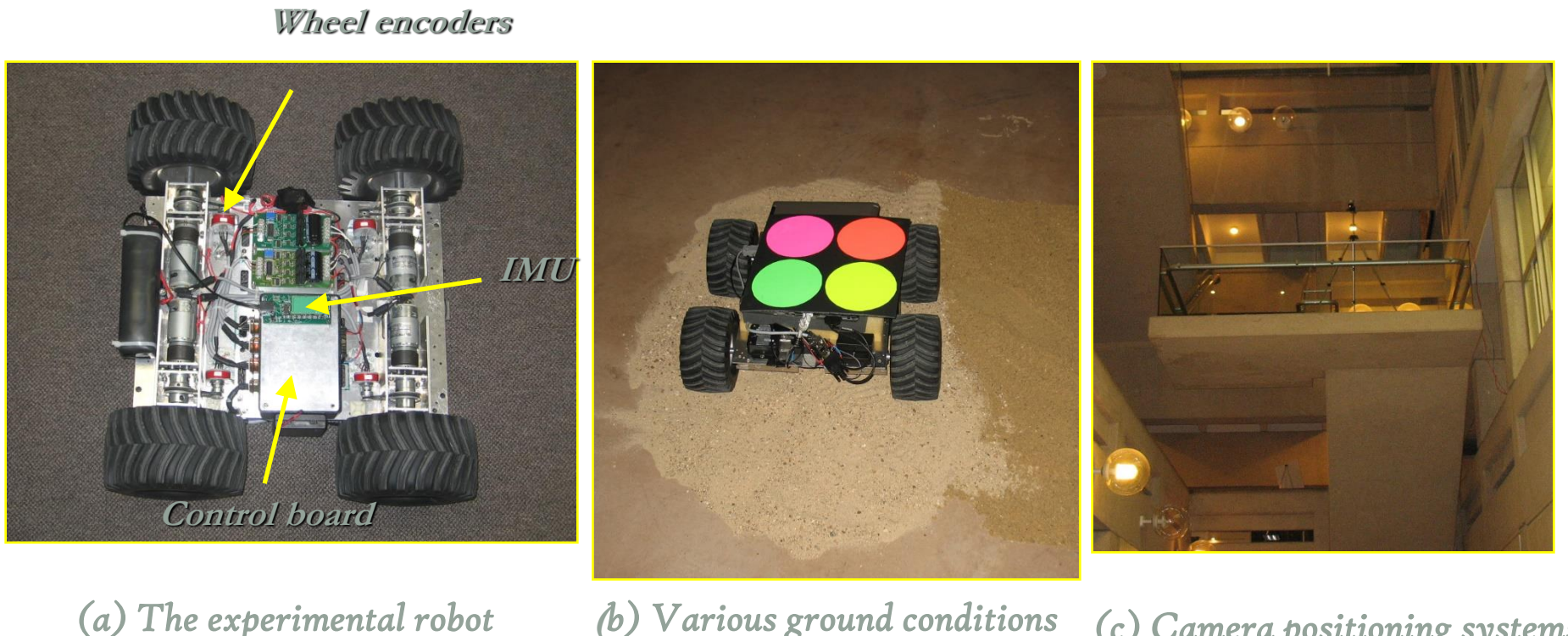






EXPERIMENTAL SETUP

- On-board control systems and a sensor suite
- Vision-based computer localization as the global location reference



(a) The experimental robot (b) Various ground conditions (c) Camera positioning systems

OUTLINE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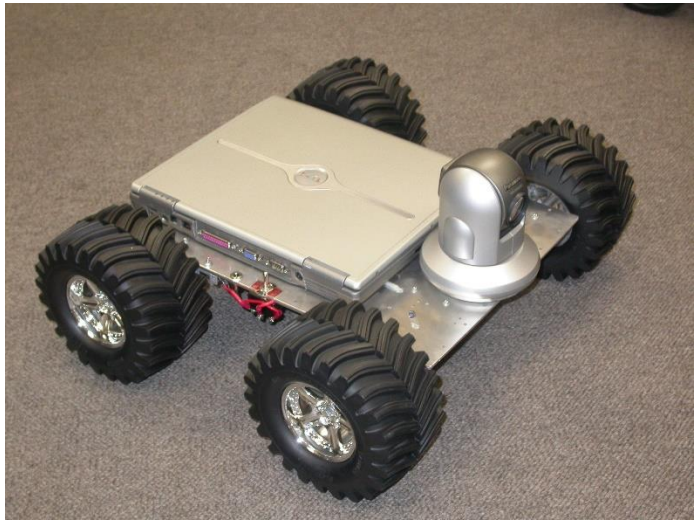
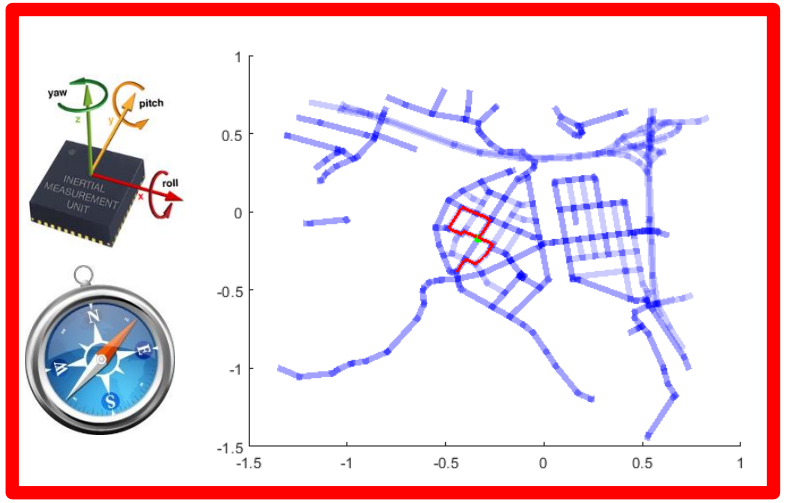
AMD




yaw
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INERTIAL MEASUREMENT UNIT
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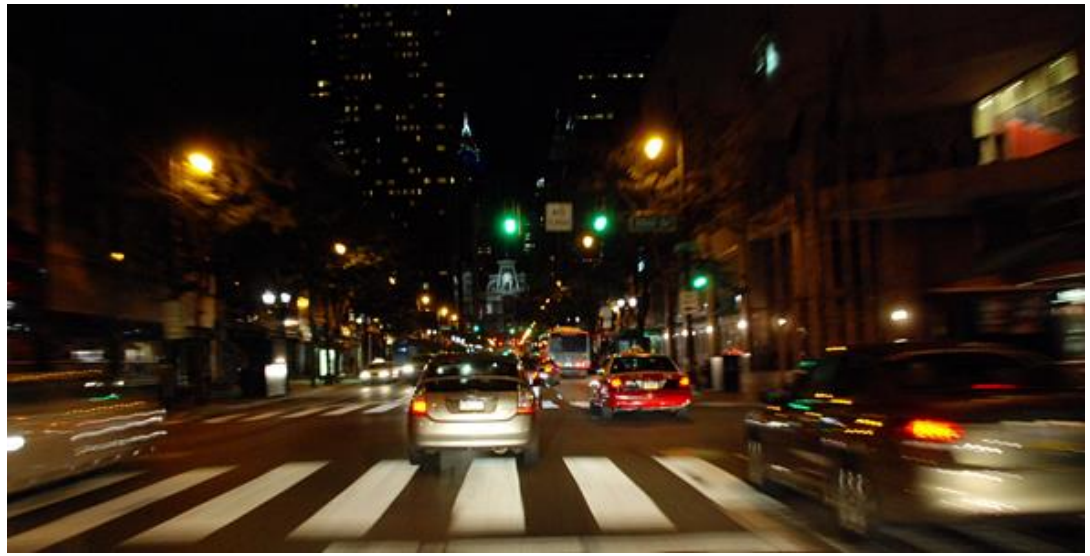
INTRODUCTION

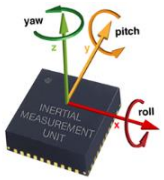
- Localization Scenario
  - Bad weather and poor illumination conditions
  - High-rise buildings block GPS signals



PROBLEM DEFINITION

Problem 1. *Given* $\mathcal{M}_p$, $\mathcal{R}$, $\omega_{0:t}$ *and* $\phi_{0:t_\phi}$, *localize the robot after its heading changes.*

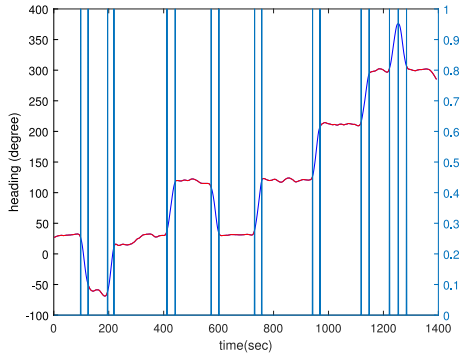
IMU



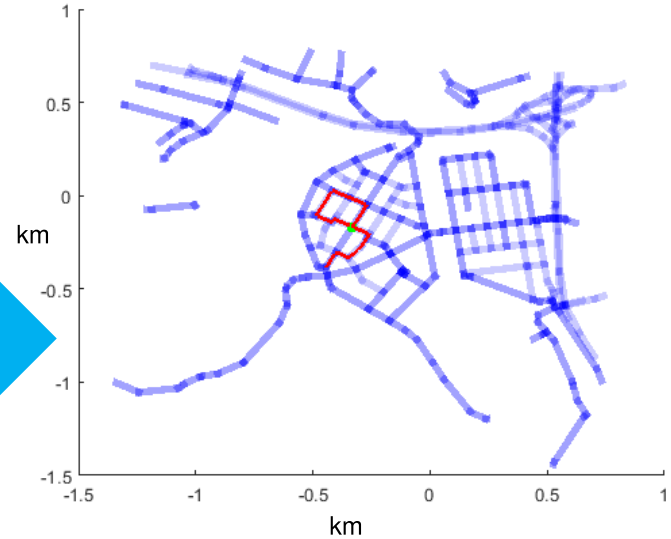
Compass

Prior Map

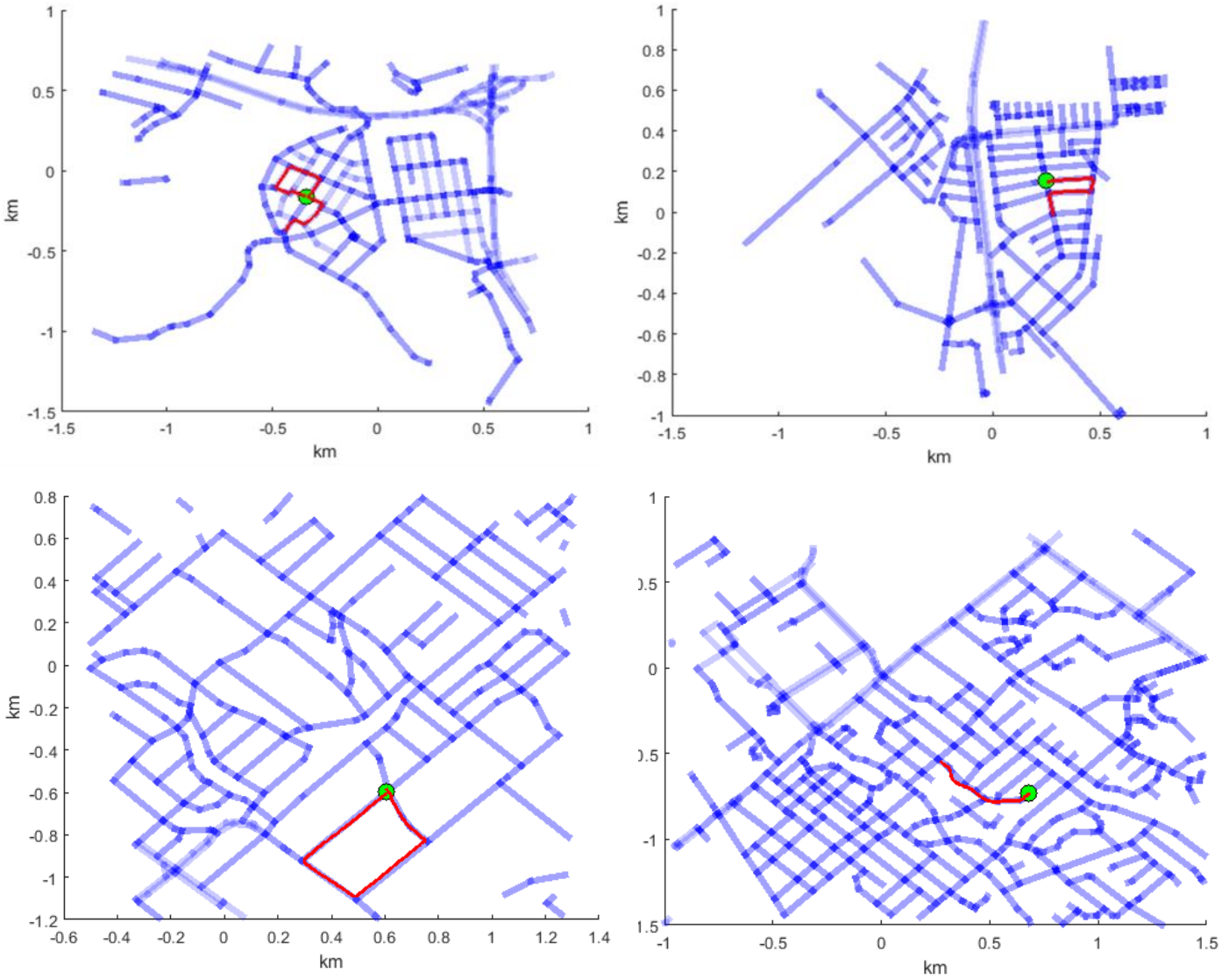
EKF

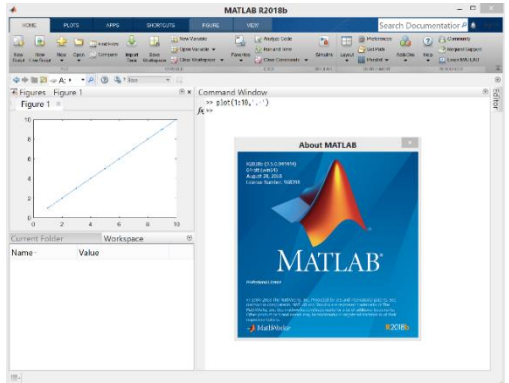


Localization



EXPERIMENTAL RESULTS: SAMPLE





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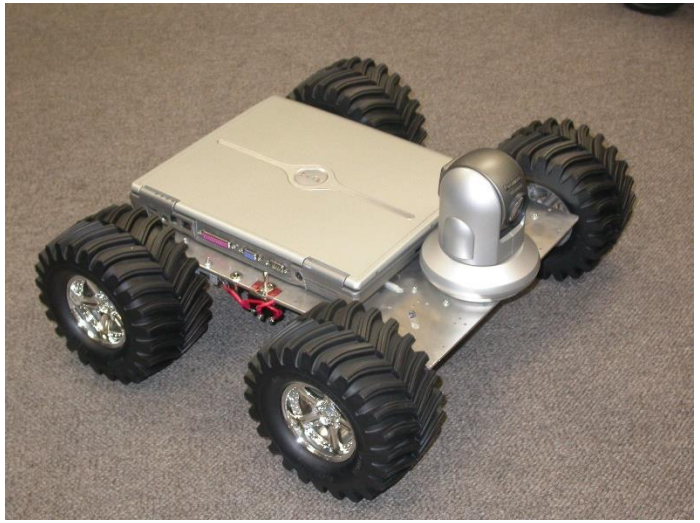

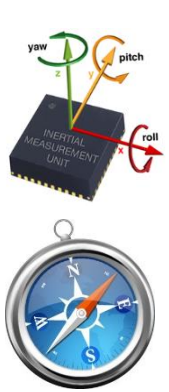
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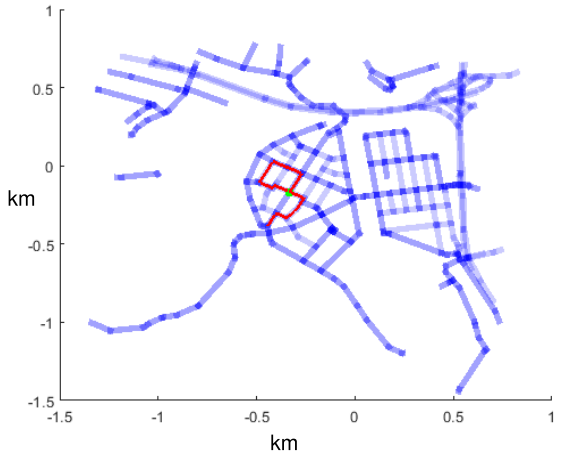
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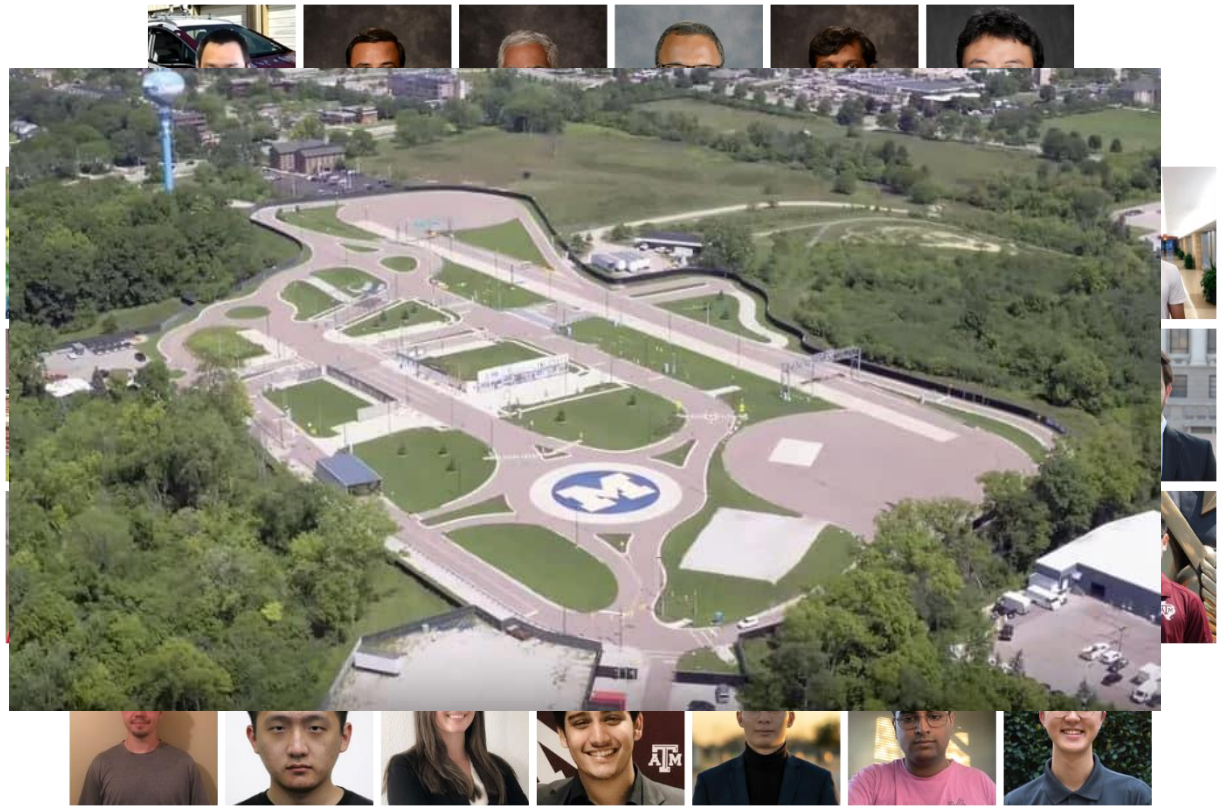
GM/SAE AUTODRIVE CHALLENGE 2017-2021



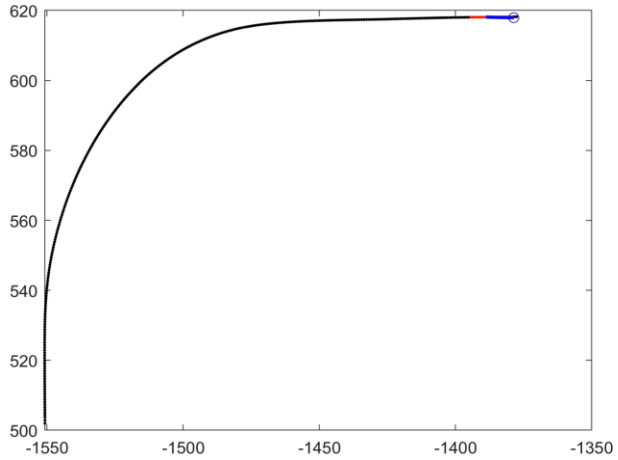
Year 4

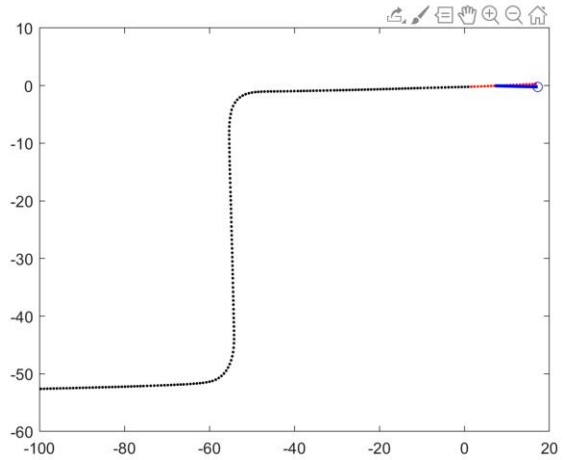
How MATLAB Helped Our Team

- Vehicle Control
- Sensor Calibration
- Perception Testing
- Planner Testing

LATERAL CONTROLLER ANALYSIS

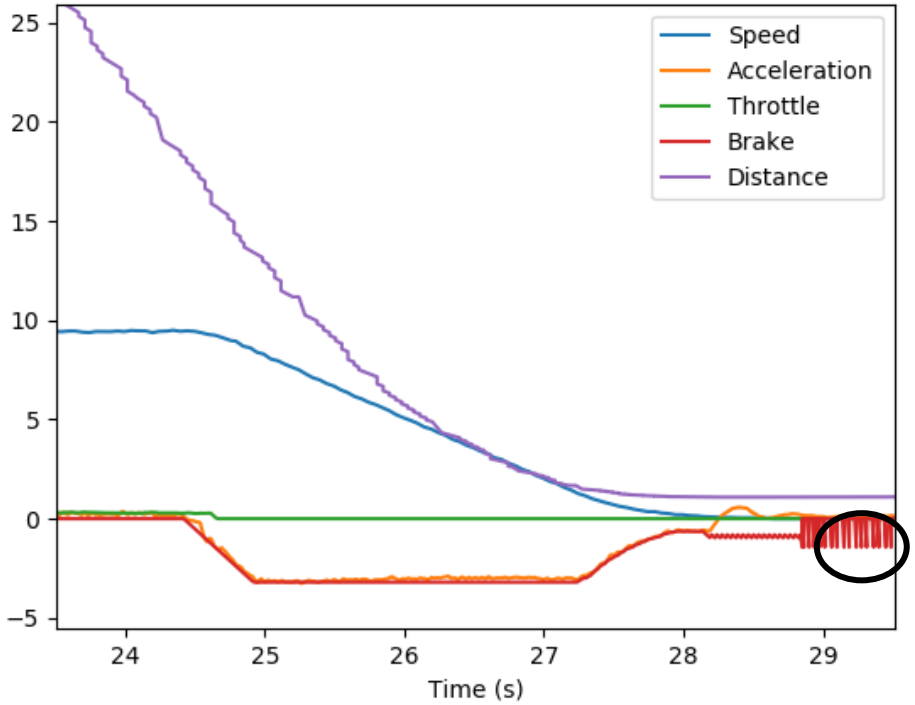
X: detected waypoints at turning : vehicle position : vehicle trajectory



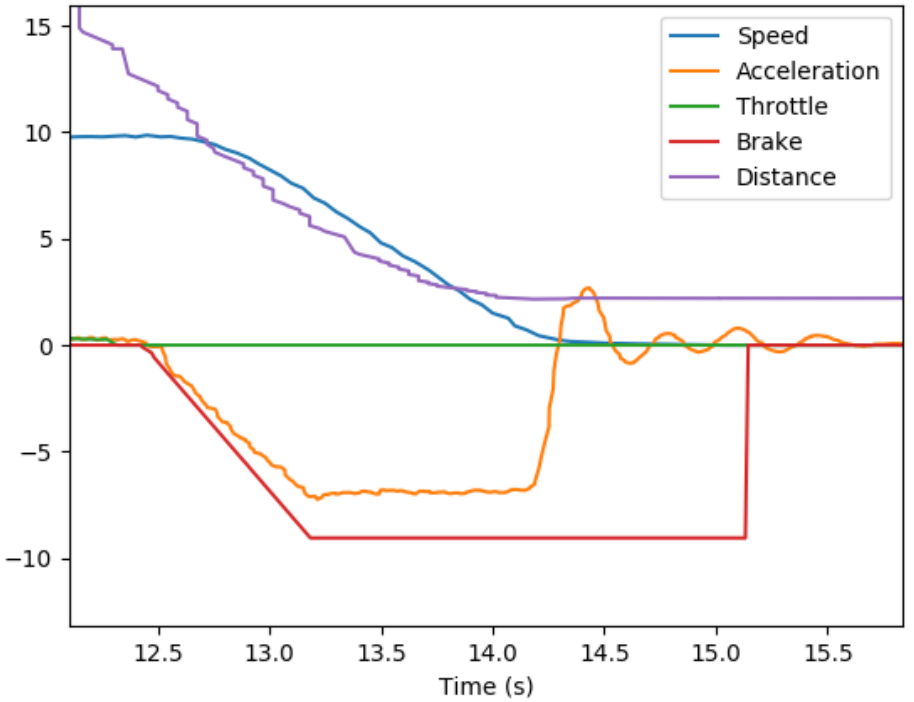


LONGITUDINAL CONTROLLER ANALYSIS

- Mimic human driving in designing controller behaviors
- Visualize the CAN bus output



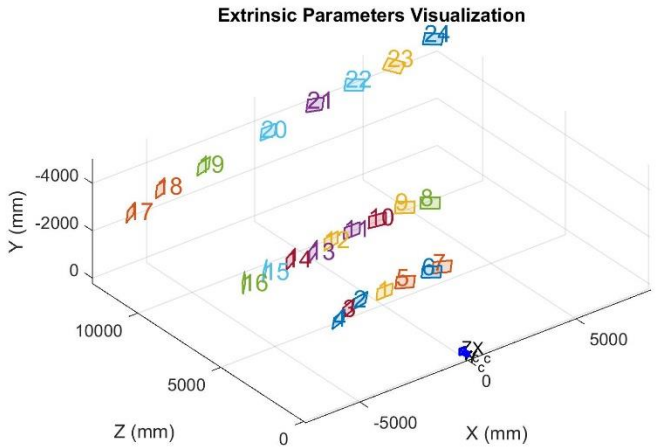
(a) Trembling brake (See black circle) happens since the numerical issues and solved after adding the filtering.

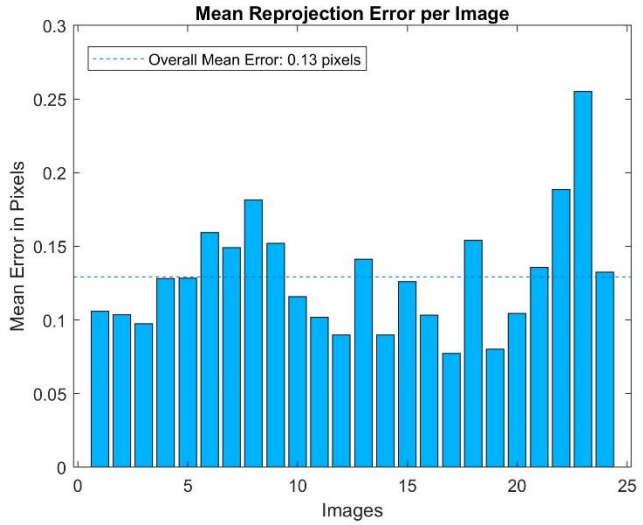


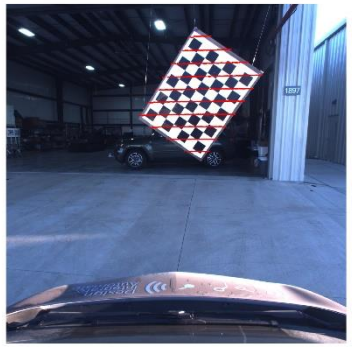
(b) Maximum deceleration analysis when emergency brake happens.

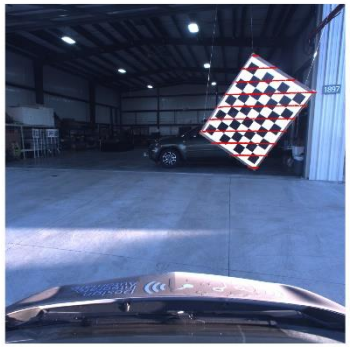
SENSOR CALIBRATION

- Computer Vision Toolbox
- Verify the calibration accuracy using visualization

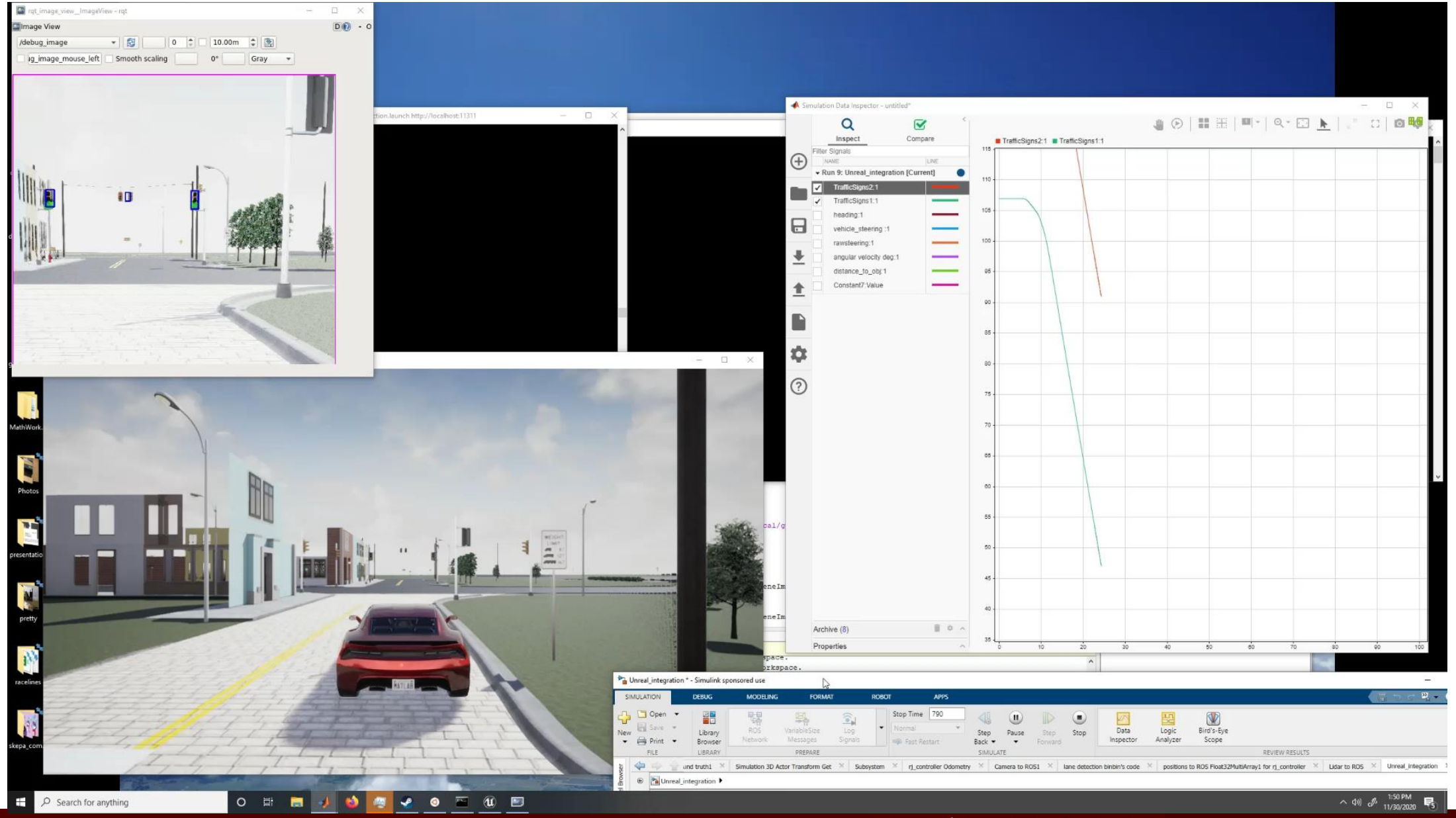




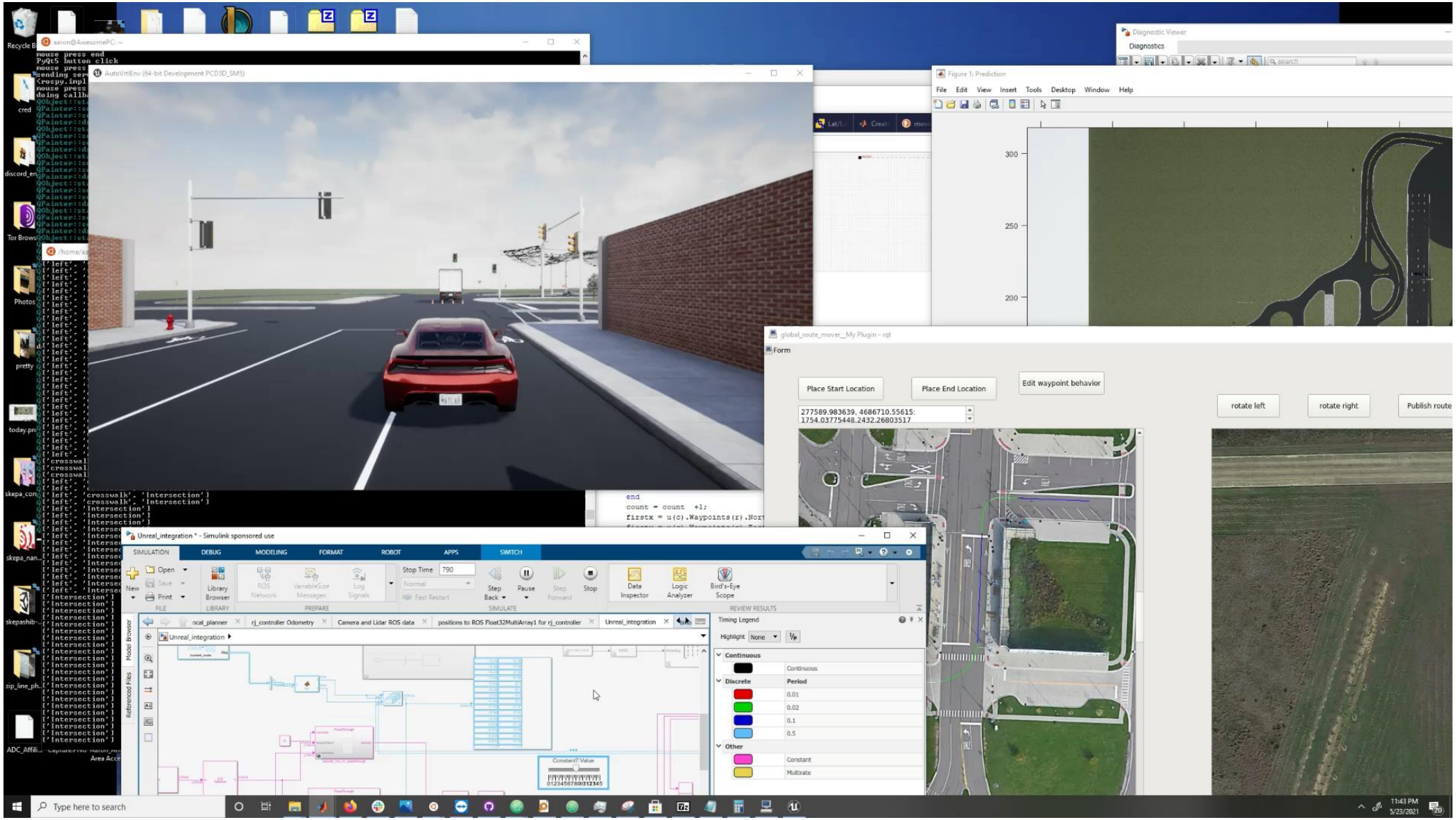




PERCEPTION TESTING – TRAFFIC LIGHT



PLANNER TESTING



THANK YOU!

- This is a long journey with my
  - current grad students: **Shu-hao Yeh, Aaron Kingery, Aaron Angert, Di Wang, Shuangyu Xie, Fengzhi Guo, Yingtao Jiang, and Chengyuan Qian**
  - former grad students: **Drs. Jasmine Cheng, Binbin Li, Jay Chou. Yiliang Xu, Wen Li, Yan Lu, Joseph Lee, Chang Young Kim, Hyunnam Lee, Qin Ni, Ji Zhang, and Mr. Qiang Hu**
  - collaborators: Prof. Ken Goldberg (Berkeley), Prof. Jingang Yi (Rutgers), Prof. Swaroop Darbha (TAMU), Prof. Sivakumar Rathinam (TAMU), Prof. Jian Tao (TAMU), Prof. Debjyoti Banerjee (TAMU), Prof. Swaminathan Gopalswamy (TAMU), Prof. Alireza Talebpour (UIUC), Prof. Ivan Damnjanovic (TAMU), Prof. Hongpeng Wang (Nankai Univ.), Prof. Jingtai Liu (Nankai Univ.), Prof. Haifeng Li (CAUC), Dr. Gaofeng Li (CAS), and Mr. Anthony Levandowski
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