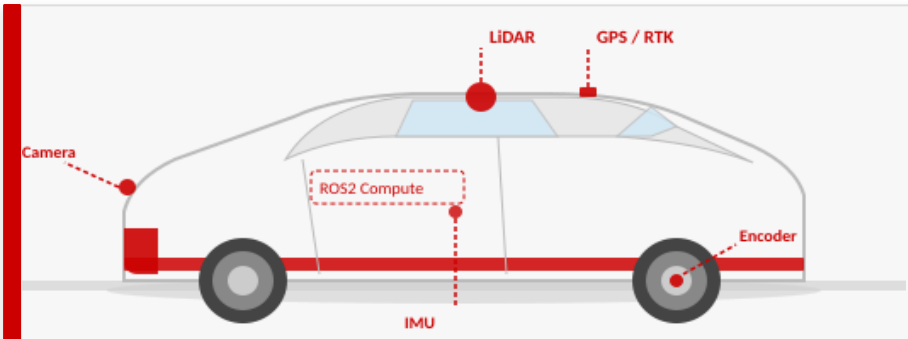
NORTHEASTERN UNIVERSITY

EECE 5554

Robotics Sensing and Navigation

4 Credit Hours

Sense the World. Navigate It. — Real Sensors, Real Data, Real Roads.



Ford Mustang Mach-E

Outdoor Data Collection Platform

- LiDAR · GPS/RTK · Stereo Cameras
- IMU & wheel encoders onboard
- ROS2 compute for live data logging
- Drive real Seattle-area routes

Sensors & Algorithms

- GPS & RTK Positioning
- IMU — Accel, Gyro, Magnetometer
- Camera Calibration & Vision
- LiDAR & Sonar Range Sensing
- Odometry & Dead Reckoning
- Real Field Data Sets in ROS2

Navigation Theory

- Kalman Filter & EKF
- Particle Filters for SLAM
- Localization & Pose Estimation
- Simultaneous Localization & Mapping
- Visual Inertial Odometry (VIO)
- Coordinate Transforms & Geometry

Lab Sequence

- Lab 1 · GPS & Serial Parsing
- Lab 2 · RTK & DGPS Corrections
- Lab 3 · IMU Dead Reckoning
- Lab 4 · Camera Calib & Panorama
- Lab 5 · Mach-E Outdoor Dataset
- Final · Full Navigation System

What You Will Do

- Mount and configure GPS, IMU, and camera sensors on the Mustang Mach-E platform
- Implement Kalman and particle filters for real-time localization from live sensor streams
- Build a SLAM pipeline fusing LiDAR, GPS, and IMU data from the Mach-E drive sessions
- Collect outdoor navigation datasets driving real routes around the Seattle campus
- Calibrate cameras and build panoramas from overlapping image sets using Harris corners
- Present an individual design project and a team-based final navigation system

Team Final Project — Full Navigation System

Teams use the Mustang Mach-E to collect a multi-sensor outdoor dataset, then build and evaluate a complete navigation stack — fusing GPS, IMU, LiDAR, and camera data into a coherent localization and mapping solution demonstrated on real Seattle-area driving data.

Deliverables: Lab reports · Individual design project · Team final project & demo

Prerequisites

MATH 3081 or EECE 3468 + EECE 2160 or EECE 2210
or graduate program admission

Who Should Enroll?

ECE, CS, or ME graduate & senior undergrad students
Anyone working on autonomous vehicles or field robotics