Michigan Alliance for Greater Mobility Advancement

Course Title: Autonomous Vehicle Positioning Systems

Course Length: 1 day, in-person

Time in Class per day (hours): 8 hours of in-person instruction

Delivery Options: Company site or at provider

Class Size: Minimum 8 / Maximum 25

Price Per Student: $1,195.00

Location: Oakland County *or* Company Site

Course Description:

This seminar addresses vehicle positioning and navigation systems. The first part of the seminar provides an overview of the Global Positioning System (GPS) since it is the main location technology enabler for automotive location-based applications. The following topics will be discussed: coordinate reference frames, satellite constellation, signal structure, ranging observables, ranging error sources, error mitigation techniques, position velocity and timing (PVT), accuracy and availability for different modes of positioning that include open-loop, differential GPS (DGPS), real-time kinematic GPS (RTK), GPS dead-reckoning, augmentation of GPS with wheel speed sensors, inertial measurement units and compasses. Sensor fusion using a Kalman filtering technique will be included. GPS accuracy and availability performance in automotive driving environments, GPS vehicle installations (antenna, RF cable and GPS receiver), and bench-level and vehicle-level methods to evaluate GPS will be covered. An introduction to automotive navigation systems will be presented. Topics such as map database sources, route guidance calculations, and graphical user interfaces will be covered.

Course Learning Objectives:

Upon completion of this course participants will be able to:

- Specify the performance of GPS receivers and navigation systems
- Evaluate the performance of GPS receivers and navigation systems
- Integrate the GPS with other sensors via a Kalman filter to improve navigation availability
- Select the appropriate implementation of a vehicle navigation system based on your application requirements

Course Content/Syllabus:

Overview of GPS and Navigation Systems

- Coordinate reference frames
- GPS Satellite Constellation

- GPS signal structure
- Code and carrier ranging observables
- GPS ranging error sources and mitigation techniques

Position accuracy dependence on satellite geometry and range error

- GPS Modes of Positioning
- Open Loop GPS positioning with C/A code
- Differential GPS carrier phase positioning with C/A code
- Kinematic GPS positioning with C/A code and/or L1/L2 carrier phase
- GPS performance examples in typical automotive environments

GPS/INS Integration for Vehicles

- IMU modeling and vehicle dead-reckoning errors
- Introduction to the Kalman filter
- Ground vehicle dynamics
- Ground vehicle models
- Estimation of vehicle navigation states
- Estimation of vehicle parameters
- GPS/INS simulation examples

GPS Integration with other sensors

- Digital Compass
- LIDAR
- UWB
- Wheel speed sensors
- Application examples

MAGMA short courses are held on a rolling basis, based on industry demand. Please complete this **short form** to express interest for yourself, or your organization.