MAGMA
Michigan Alliance for Greater Mobility Advancement

Course Title: Connected Vehicles: V2X Communications

Course Length: 2 days with a prior online component, online and in-person

Time Online: 6.5 hours

Time in Class: Day 1: 6.5 hours, Day 2: 7 hours (includes labs)

Time in lab: Day 1: 2 hours, Day 2: 2 hours

Class Size: Minimum 7 / Maximum 12

Price Per Student: $2,385.00

Location: Genesee County *or* Company Site

Course Description:

Traditionally, the perception system of autonomous vehicles is composed of an array of sensors that include vision cameras, radar, LiDAR, and ultrasonic. Although not a sensor per se, wireless communications can significantly enhance the perception system of automated vehicles thus leading to the concept of "connected vehicles" as an enhancement of traditional autonomous vehicles perception system. This course will cover V2X, a family of wireless protocols for autonomous vehicles while emphasizing DSRC and safety messages.

Lab Projects Description:

Lab Project 1: Sending and receiving DSRC Basic Safety Messages.

Lab Project 2: Calculating and displaying autonomous vehicle path history.

Course Learning Objectives:

- Differentiate the various forms of V2X communications
- Describe the architecture, protocols, and use cases of DSRC
- Configure and develop experimental test plans for experimental work
- Perform experiments according to test plans
- List and briefly describe the main standards behind DSRC
- Send and receive various SDRC safety messages using wireless transceivers
- Calculate and display autonomous vehicle path history

Course Content/Syllabus:

Online Component (throughout one week):

The course begins with a one week online component to be completed prior to classroom instruction. On this week, you'll take a Pre-Assessment to get a baseline of your understanding of the course material. After detailed information on the course, you will get an introduction to wireless networks and DSRC. This is followed by a description of DSRC protocols, use cases,

and devices. You will spend time on generating your own ideas about the role of V2X communications in autonomous vehicles. This component will end with a comprehensive assignment to be completed before the classroom instruction.

Topics:
- Knowledge Pre-Assessment
    - Welcome, Course schedule, Course collaboration tools, Learning objectives, Course syllabus.
    - Instructor, Training and delivery methodology, Assignments, Laboratories, Grading and completion criteria.
    - Introduction to course
    - Introduction to wireless networking
    - Introduction to V2X
    - DSRC Stack: J2945, IEEE 1609.3 (Transport), 1609.4 (Link), 802.11p (Physical)
    - Use Cases (Main applications)
    - DSRC devices: transceivers, host vehicle remote vehicle, OBE, RSE, DVI
    - OFDM
    - DSRC network characteristics (speed, wiring, bandwidth, antennas, etc.)
    - Tools: Hardware, software

Graded Assignment
- Detailed set of questions on main DSRC protocols and architectures, use-cases, characteristics, and tools.

Day 1:

On day 1 we review the online content material, answer your questions and discuss the graded assignment of the online component. You will get an in-depth coverage of DSRC architecture while concentrating on V2V safety messages. You will then be exposed to appropriate SAE standards including crash scenarios and safety applications. Day 1 will end with a comprehensive assignment and completing a laboratory experiment.

Topics:
- Review of V2X: V2V, V2I, V2P
- Review of DSRC

- V2V Architecture
- J2735: Data Encoding
- J2945: Safety communications
- Crash scenarios, safety applications
- V2V Safety Message exchange

Graded Assignment
- Prepare a summary of J2945.

- Preparation and discussion of a test plan to perform lab project 1.

Laboratory Project 1
- Sending and receiving DSRC Basic Safety Messages.

Day 2:

On day 2 we review the day 1 material, answer your questions, and discuss the graded assignment and lab project of day 1. You will then get exposure to GNSS receivers and how to perform calculations of path history and path prediction. You will then work on a graded assignment and complete lab project 2. Day 2 will end with a course summary, main takeaways, a post assessment, and a course assessment.

Topics:
- GNSS receivers
- Path history (PH), path prediction (PP)
- Tools/Services: Testing, simulation, certification

Graded Assignment
- Research and report on DSRC tools & services.
- Preparation and discussion of calculation procedure for lab project 2.

Laboratory Project 2
- Calculating and displaying autonomous vehicle path history.
- Course Summary and Wrap-up
- Course Takeaways

Knowledge Post-Assessment
- Course Assessment

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.