Michigan Alliance for Greater Mobility Advancement

Course Title: Introduction to Virtual and Augmented Reality (VR/AR) for Automated Driving

Course Length: 2 days

Time Online: 2 hours

Time in Class: 6 hours (Lab and Class) per day

Time in Lab: 4 hours (2 hours per day)

Class Size: Minimum 7 / Maximum 12

Price Per Student: $2,310.00*

Location: Company Site

Course Description:

Automated driving (AD) is not one technology, but rather a highly complex system that includes many sub-systems, including various algorithms and components involved in perception, decision, and action. It is costly and sometime impossible to evaluate either proposed algorithms or hardware in a real environment, Simulation environments such as virtual/augmented reality environments can be used to enable designers to simulate hazardous circumstances with various actors as a scenario. Using this scenario, they are able to develop their own methods and capture required data for the purpose of modeling and testing, all in a virtual environment.

This course provides the required theoretical and practical background to design and development of virtual/augmented realities (VR/AR) simulations for automated driving. Students learn to simulate automated vehicles and driving scenarios in a virtual environment using current VR/AR technology. This enables students to generate required data for modeling and validating automated driving algorithms and control methods. This course aims to cover basics of VR/AR through lectures and lab projects. Through lab projects, students acquire hands-on skills to create multimodal virtual environments for modeling and control of automated vehicles in various automated driving conditions. Topics include multimodal virtual and augmented reality, current VR/AR technology and devices, and simulation for automated driving. This course is suitable for individuals, who work in industry and want to enhance their knowledge as well as their hands-on skill in the application of VR/AR for automated driving.

Lab Projects Description

The main goal of lab projects is to provide students opportunities for acquiring hands-on skills and demonstrate the practical applications of the course topics. Two proposed projects are listed as follows:

* Price based on minimum enrollment, subject to change

Project 1:

In this project, students will learn how to design a virtual drivable area as well as design required actors such as vehicles and pedestrians with corresponding physical features. They will also work with behavioral parameters of objects and actors through the simulation in order to achieve required skills for designing scenarios that are more complex.

Project 2:

Having the skills related to projects 1, student will enhance their capabilities by learning how to design virtual sensors through the simulations. They will know how to equip actors with the virtual sensors and capture the requisite data. In addition, they will learn how to involve deep learning methods such as object detections in the virtual scenario. Eventually, they will be able to feed the object detection algorithm with the data emitted from virtual sensors and train it with the images of the virtual vehicle. Bounding boxes of detected vehicles will be the output of the project.

The completion of projects requires completing several potential tasks to create a simulated drivable area, design/develop scenarios through simulations with actors, and develop AI models for vehicle detection/tracking and implementation of control algorithms.

Course Learning Objectives:

Each student who receives credit for this course will have demonstrated the ability to:

- Explain essentials for creating virtual and augmented reality (VR/AR) applications
- Demonstrate familiarity with the several current hardware/software and physics simulation engines that are used in the development of automated driving VR/AR applications
- Use hands-on experience to model and develop multimodal virtual driving scenarios for modeling and testing automated driving algorithms
- Identify and recognize important aspects of VR/AR integration in various AD applications
- Capture requisite data from simulated scenarios by modeling virtual sensors and surrounding environments.
- Configure and develop experimental test plans for modeling and testing automated driving algorithms
- Perform experiments according to test plans
- Develop and evaluate artificial intelligent (AI) models in simulation environment.
- Describe various important factors in VR/AR simulation for AD.

Course Content/Syllabus:

This course will be offered in two days with a lab project in each day. In addition, it has an online material so that students should pass it prior to attend the face-to-face classes. The online material gives them an overview of topics, which are going to be discussed in the class.

Online course:

Students should complete the online materials one week prior to attending class. They will obtain an outline of all contents, which are going to be discussed in class. Topics include overview of Automated Driving's concepts and definitions, algorithms in AD, operating systems and hardware for AD, applications of creating AD scenarios in simulations. Student will complete a quiz after completing the online course and email their answers to instructor.

Day 1:

The online course will be followed by a successive two-day in-class presentation. In the first day, the instructor will enlighten those who have questions from contents of the online course. After that, students will obtain more information about simulations and their application in AD. It will show them process of developing a method for a specified problem through simulations. The instructor will discuss more about AD requisite equipment in the simulation and students will get acquainted with simulation's facilities such as sensors and virtual environments. At the end of this day, student will complete lab project 1.

Topics:

- Introduction to AR/VR simulations for AD.
- Review of simulations applications
- Simulated components for AD applications
- Designing actors in simulations (including ego cars)
- Designing drivable areas in simulations
- Designing sensors and equip actor with simulated sensors
- Developing a simple scenario in simulations

Day 2:

In the second day, the topics of the day one will be reviewed and questions related to both the class and lab will be answered. The instructor will talk more about essential algorithms for either detection or control purposes. Then, students will get familiar with compatible algorithms in available simulations. They will learn how to utilize the algorithms in simulated scenarios. In addition, they will learn how to compile data from simulated scenarios and model and evaluate them using aforementioned algorithms. The day will end with lab project 2.

Topics:

Introduction to essential algorithms and control in AD simulations

- Interaction between simulations and algorithms
- Designing more advanced scenarios using dynamic parameters
- Compiling data in simulated environments
- Modeling captured data for developing algorithms in simulations
- Evaluating AI models through simulations in real-time