CE 8930 AUTONOMOUS VEHICLE SYSTEMS
FALL 2019
GLENN DEPARTMENT OF CIVIL ENGINEERING

Instructor: **Mashrur "Ronnie" Chowdhury, Ph.D., P.E., F. ASCE**
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Class Hours: Tuesdays and Thursdays, 5:00 PM – 6:15 PM

Class Location: 115 Lowry Hall

Office Hours: Tuesdays and Thursdays, 4:00 PM – 5:00 PM, and by appointment

Course Description

Autonomous Vehicle Systems (AVS) use advanced in-vehicle and transportation infrastructure sensors and electronic controllers, wired and wireless communication (vehicle-to-everything (V2X)), human-machine interfaces, data management infrastructure and advanced analytics tools to enable the safe and secure longitudinal and lateral movements of autonomous vehicles. A substantially improved surface transportation system, in terms of both safety and efficiency, is the result. This course will provide students with a comprehensive overview of concepts and hands-on experience in various AVS component designs, operations principles and evaluation tools at different levels of vehicle automation.

Learning Outcomes

Students will demonstrate the attainment of the following outcomes after completing this course:

- an in-depth understanding on concepts of AVS design, deployment, operation, and evaluation;
- an ability to apply and evaluate the AVS concept in a high fidelity simulation platform.

Primary Text

Materials will be provided in the class.

Reference Texts

- Chowdhury, M., Apon, A. and Dey, K. eds., 2017. *Data analytics for intelligent transportation systems*. Elsevier.
- Deka, L. and Chowdhury, M. eds., 2018. *Transportation Cyber-Physical Systems*. Elsevier.

Final Grading

100 ⟵ A ⟶ 90 ⟵ B ⟶ 80 ⟵ C ⟶ 70 ⟵ F ⟶ 0

Grading Distribution

Description	Distribution
Class participation and in-class exercise	10%
Group Project: • Proposal • Presentation and demonstration • IEEE style paper	 10% 40% (10% for midterm update and 30% for the final) 20%
Final Exam	20%
Total	**100%**

Course Topics

- Introduction to autonomous vehicle systems (AVS)
- Cyber-physical systems (CPS) of Autonomous Vehicles
- Autonomous vehicle sensors technologies
- Sensor fusion, localization, and mapping
- Computer vision for AVS
- Vehicle trajectory/motion planning - longitudinal
- Vehicle trajectory/motion planning – lateral
- Automated vehicle control design aspects
- V2X communication technologies
- Data analytics for AVS
- Security of AVS
- Human machine interface requirements and technologies
- Evaluation of AVS
- Ethical issues for AVS
- Policy, laws and regulation for AVS

Class Breakdown

- Concepts (Every Tuesday - 5:00 PM – 6:15 PM)
- Applications (Every Thursday - 5:00 PM – 6:15 PM)

Final Exam

Date: December 12 (Thursday), 2019
Time: 7 PM – 9:30 PM

Notes

Final Exams:

See course outline for the final exams dates and times. Any changes will be announced in the class.

AVS Simulation Platform:

Each group will use the PreScan (https://tass.plm.automation.siemens.com/prescan) simulation platform for their AVS related project. One license of PreScan will be allocated to each group.

Group Project:

The project in this course has two goals. The first goal is to help you learn more about doing research in AVS in general. The second goal is to give you the opportunity to study particular areas of AVS in greater detail as shown below.

1. AVS trajectory planning: (i) longitudinal control (ii) lateral control
2. Cybersecurity
3. Sensor fusion of AVS
4. V2X Communication of AVS in a cyber-physical system (CPS)
5. Ethical issues

Therefore, you are expected to perform a substantial research project, which involves- i) selecting an open problem from the above AVS research areas, ii) reviewing the published related work, iii) designing, implementing, and evaluating a potential solution, iv) documenting your findings in an IEEE style paper, and vi) presenting and demonstrating your results in the class.

For your project, you need to pose a question/hypothesis, design a research framework/method to answer the question, conduct the research, and report your research results. There will be three deliverables for this project, which will count toward your final project grade: a project proposal (10%), class presentations and demonstrations (40%), and an IEEE style paper (20%). You need to give a project update at the beginning of each Thursday class.

Project proposal: Your project proposal should be about two pages in length. The project proposal should clearly state the goals of your project and the research question you are investigating. Describe why you think the project you are proposing is interesting, important and unique. Your research plan should include (i) a section on related work summarizing earlier studies, which will make sure that you are not simply reproducing someone else's earlier work; (ii) research hypotheses about the conclusions you expect to draw from the work; (iii) experimental setup describing your plan to conduct research and data collection; (iv) a description of software you will use for your research in addition to PreScan; and (v) a detailed schedule for your project including dates and milestones.

Project presentations and demonstration: Each group will give a proposal presentation in three weeks, which should be about 8 minutes long and about 2 minutes for questions afterward. During midterm, each group will give an update on their project progress. Final project presentation and demonstration should be about 15 minutes, with about 5 minutes for questions afterward.

IEEE style paper: Your paper should be roughly 8 pages in length in IEEE format, including graphs, diagrams, and citations. You should complete the writing early enough to improve your writing quality and critique it with the same rigor that you applied in reviewing other papers for the course. You shall have a comprehensive literature review based on your research project. You shall sufficiently explain experimental results and findings. You shall also state the shortcomings/limitations of your work. You shall discuss future research directions and possible follow-up projects.

More details on the project topics and deadlines will be provided in the class.

Policies

The project deliverables must be submitted on the due dates. **Any late submissions will be penalized**.

Class attendance is strongly recommended, but not required. I highlight important points in class. Also, the materials for each topic will be provided in the class.

Students are expected to present and demonstrate their project at the scheduled time and date. Only in exceptional circumstances, changes will be made.

Students can leave the class if the instructor is late for more than 15 minutes.

Laptop Policy

Students are required to bring a laptop in all application classes.

Academic Integrity

Students are expected to perform class activities in keeping with standards outlined in the Clemson University Statement on Academic Integrity. Appropriate action will be taken towards any student suspected of violation of the following statement:

"As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

Acknowledgment

This course is developed through the Center for Connected Multimodal Mobility (C^2M^2), which is a Tier 1 USDOT University Transportation Center and headquartered at Clemson University, Clemson, South Carolina, USA. Course materials will be publicly available on the C^2M^2 website (https://cecas.clemson.edu/C2M2/).