SECS Senior Design
Winter 2025

Autonomous Driving Demonstration and Competition

Sponsors: Michael Latcha, Phd, (latcha@oakland.edu), Mohamad Zohdy, PhD (zohdyma@oakland.edu), Edward Gu (ygu@oakland.edu), Simo Meskouri (meskouri@oakland,edu)

The project for the Winter 2025 semester, for all sections and students in Senior Design, is an autonomous driving demonstration and challenge.

Recent changes:

- 10 Jan 2025 – Distance from stop line to intersection increased to 250-mm
- 10 Jan 2025 – Not all corners will be 90°, some may be less than 90°, and there may even be some gentle curves in the "straight" portions. All intersections will be 90°.
- 10 Jan 2025 – Option to develop directional devices added
- 12 Jan 2025 – Rule clarifications for 4 types of intersections

Vehicles:

Each design team will design, build, test and compete with a fully autonomous, line-following vehicle:

- The vehicle may move around the competition course in many ways - roll on 2 to 4 wheels, or on two tracks, or even walk on legs. If a design group has another idea for locomotion, it must be approved by the instructors before moving ahead.
- The vehicle must have a footprint no larger than 25 cm x 25 cm.
- The operating speed of the vehicle must be between 100-mm/s and 200-mm/s
- The rear of the vehicle must have a 10-mm diameter red LED in the center that is 25 mm from the floor. The front of the vehicle must have a multicolor 10-mm diameter LED in the center and 25 mm from the floor.
- The front of the vehicle must be spanned by a "bumper switch" that, in the event of a collision, changes the front LED from green to red and switches off power to the drive motors, disabling the vehicle.
- The vehicle must not come closer than 200-mm to any vehicle or obstacle in front of it.
- The vehicle must closely follow a strip of 3M® 1-in wide blue painter's tape both in straight lines and in making 90° right and left turns.
- The vehicle must be capable of operating continuously for at least 120 minutes.
- All circuits must be assembled on PCBs (preferred) or soldered perfboards, no plug/push-in breadboards

- The maximum amount that can be used to develop, build, test and compete with the vehicle is $300.

Directional Devices

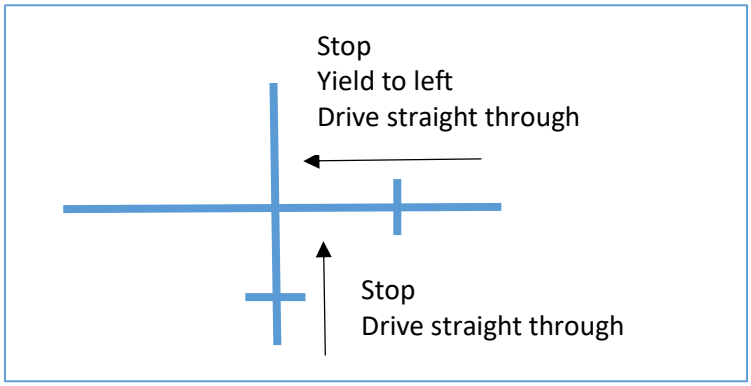
Each group will have the option of developing a directional device to direct vehicles through T-intersections. Directional devices that are proven reliable and incorporated into the competition will earn extra credit for their groups. Groups that declare in their Design Proposal that they intend to develop a directional device will be allowed an additional $50 in their budget, to be applied only to the directional device.

- Directional devices will be free-standing and consist of three horizontal 10-mm LEDs spaced 75-mm apart, 50-mm from the floor and 250-mm from the intersection, in line with the center of the T.
- The center LED will be yellow and always on, the two outside LEDs will be green.
- The outside LEDs will turn off/on to direct vehicles to the right and left, changing as each vehicle passes through the intersection.
- The devices must be independently powered and able to function for at least 300 continuous minutes.

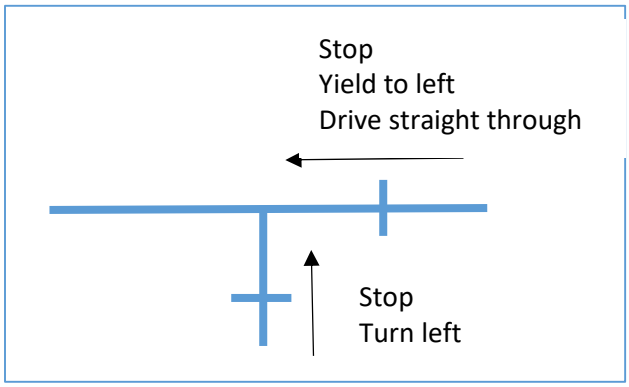
Intersections

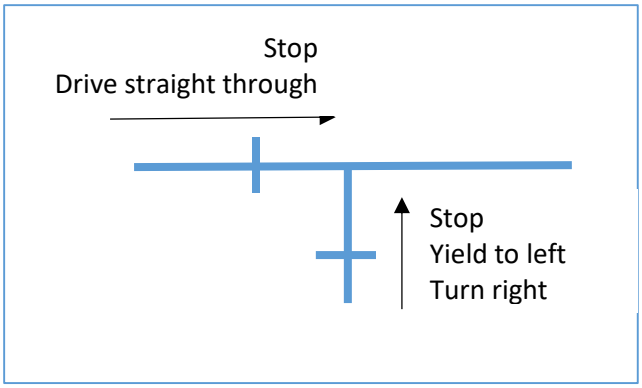
The following are the rules governing the various intersections of the course. Note that in all cases a vehicle must never approach within 200-mm of another vehicle or obstacle.

X-Intersections

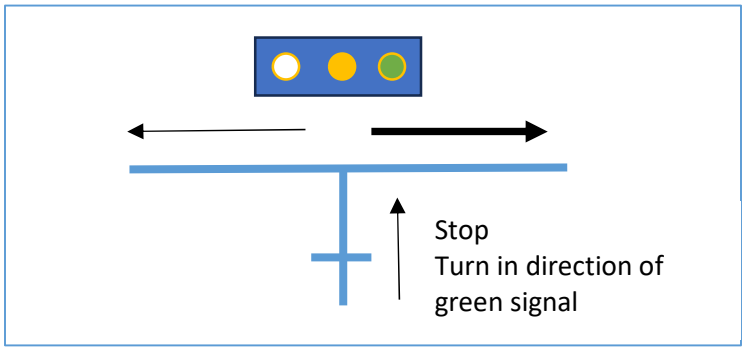


T-Intersections without directional device





T-Intersection with directional device

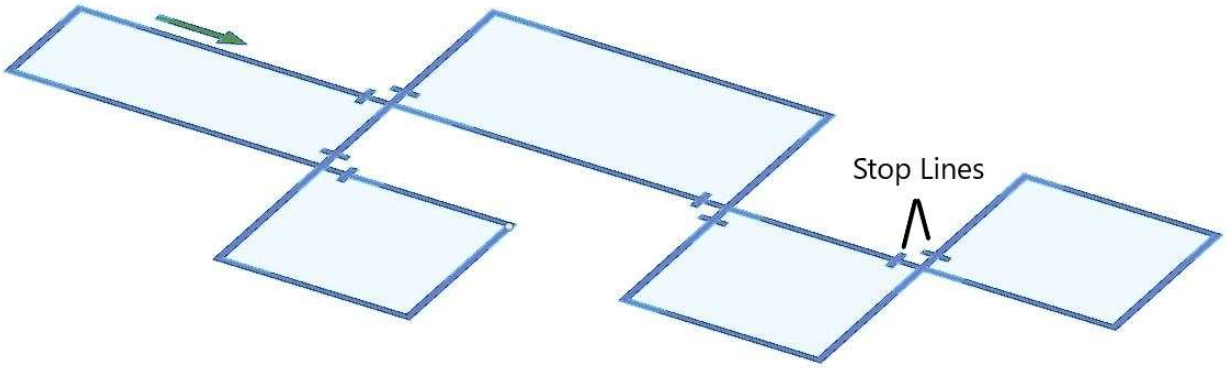


Competition – ***April 21, 2025, 10 am – noon in the EC Atrium***

The competition course will consist of a continuous loop of 3M® 1-in wide blue painter's tape applied to the floor of the EC Atrium. The course will have several straight lines and 90° turns and will cross itself several times.

At each intersection there will be a 100-mm long "stop line" located 250-mm from the intersection. As the vehicles approach the intersection, they must stop behind the stop line. If two vehicles are stopped at the same intersection, the vehicle on the left has the right of way, that is, the vehicle on the right must always yield to the vehicle on the left. After stopping and yielding all vehicles will move straight through all intersections.

The example course below is 4-m long and 2-m wide. It is anticipated that the competition course will be approximately 8-m square to accommodate approximately 26-28 vehicles.



- Vehicles whose outside wheels (or tracks or legs) touch or cross the tape line they are following as they move around the course will be removed from the competition.
- Vehicles that approach closer than 200-mm to another vehicle will be removed from the competition.
- Vehicles that collide with other vehicles will be removed from the competition
- Vehicles that fail to yield at intersections to other vehicles will be removed from the competition.
- Vehicles that are damaged or forced to be removed from the competition due to the actions of other vehicles will be allowed to return to the competition after repairs, if necessary.
- As vehicles are removed from the competition the course may be reconfigured to increase interactions between the remaining vehicles.

Note: As this project develops through the semester, these rules may change at the discretion of the instructors. Any changes will be distributed to all groups via the Announcements feature in Moodle.

Augmented Project Team(s)

Sponsor: Khalid Mirza (mirza@oakland.edu)

The Augmented Reality Center (ARC) will sponsor one or more larger Augmented project teams of students to work on the senior design challenge with additional objectives.

Additional Project Component and Dedicated Team Group

The Augmented Project Team includes 2-4 additional SECS students who will be the team's Augmented Reality Group (AR Group). The AR Group is assigned to develop a virtual version of the team's main autonomous vehicle. The virtual version must operate in sync with the physical vehicle developed by the rest of the team and enhance its operation with "virtual sensors" via communication with an AR headset. This must enable it to follow a secondary virtual path and respond appropriately to other digital cues and elements that cannot be "seen" by the other project teams' vehicles.

Interdisciplinary Collaboration Opportunity

Because immersive technology is a highly visual and dynamic digital experience, the AR Group will have the enhanced opportunity of working with a cohort of Art and Design students who have the expertise to design and help create the user experience and look of the virtual vehicle and environment. These students attend the College for Creative Studies, a Detroit-based university, and are part of the school's Immersive Technology Specialization educational track.

SECS Student Eligibility

The first consideration for the Senior Design Project AR Group participants will be students who:

- Have completed ECE 4510 (Machine Vision)
- Have completed the Augmented Reality Center (ARC) Intro to Unreal Engine 5 (UE5) and Immersive Application Development Training, or can demonstrate basic competencies with UE5, or are willing to complete the Intro to UE5 and Immersive Application Development Training through ARC in January.
- Are open to participating in an extra-curricular online module (approximately 10 hours)
- on fundamental user interface and user experience design principles (UI/UX).