

# **E11: Autonomous Vehicles**

**Fall 2011**

**Harris & Harris**

## **Final Project**

### **Introduction**

Welcome to Moonbase Epsilon! Once a tranquil plateau, the land is now the site of a fierce duel for mining rights. Moonbase Epsilon sits atop the universe's largest reserves of epsilonium, a rare compound useful in making very small things, such as microcontrollers, nanomachines, and hats for gnomes. You have been hired by either Green Industries or White Incorporated to stake their claim on this valuable land.

The contest revolves around epsilonium mining stations, which exist in 8 locations on the moonscape. Each team starts with four stations claimed. The stations around the edge are each worth 1 point. The two center stations are located on an especially rich deposit of epsilonium and are worth 2.4 points each. At the end of each two-minute round, the team that has claimed the most points of mining stations is the winner.

### **Locating the Stations**

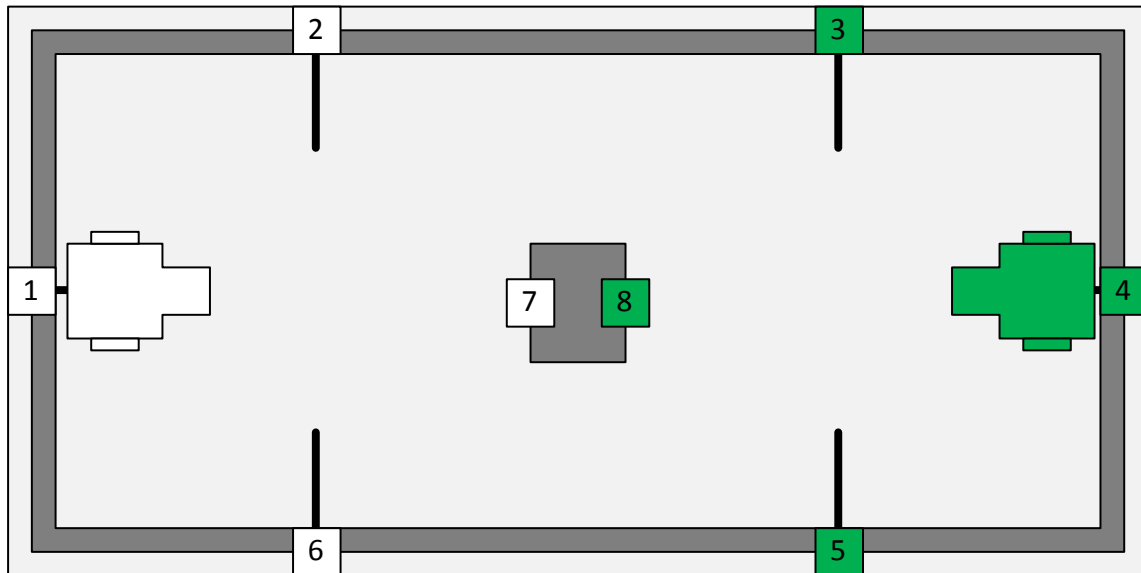
All of the stations are also broadcasting a unique binary code at 4 kHz as described in Labs 3 and 6. Beacons claimed by the Green team will flash the original code; beacons claimed by the White team will flash an inverted version of the code. This way, robots can identify both which beacon they are looking at and which team it currently belongs to at a glance.

Black roads also lead to the stations around the perimeter.

### **Claiming the Stations**

Each station has a bump panel on the front. To claim a station, a robot must ram into this bump panel. This will cause the station to switch ownership. The ownership LED on top of the station will change to reflect its new owner, and it will begin broadcasting the appropriate code (either inverted or uninverted) based on its new owner. A station cannot be claimed again until a two-second cooldown has passed.

## Map



The colored squares indicate the locations and initial owners of the stations, and the nearby numbers indicate the seed for the binary sequence generation. The starting positions of the robots are also shown. Black lines lead into the beacons.

## Game format

- Each team will position their robot in the starting box before the game begins.
- Each round lasts two minutes, and the team with the most beacons at the end of a round is the winner.
- In the event of a tie after two minutes, sudden death mode begins: the first team to claim a beacon wins.
- If no team appears capable of winning in sudden death, the referees will end the game at their discretion.
- If a robot appears likely to damage itself, the playing field, or the other robot, the referees will resolve the situation at their discretion.

From all of us at Green Industries and White Incorporated, good luck!

## Robot Requirements

“Stock hardware” is defined as the hardware that you built in the labs prior to the final project. Your vehicle must contain at least one modification to stock hardware such as a new sensor, a modified chassis, etc., and you must be able to provide a credible rationale of why the modification could improve the performance. Your modification must be operational at the time of the scrimmage.

You may add a maximum of \$40 of new hardware. See the E11 bill of materials for the cost of components obtained from the class supply bins. You may also redesign the chassis and print it again with the 3D printer, subject to a maximum distance of 7" between any two corners of the robot. Your team may have one new chassis printed for free, but are responsible for paying for 3D printing costs (\$10/in<sup>3</sup> of material) for additional printings.

You are encouraged to experiment with wacky ideas. When in doubt about the rules, contact your instructor. Josh Vasquez is the final arbiter for the rules.

## **Deliverables**

You and your partner are responsible for the following deliverables

- A prototype robot with a physical modification that can capture at least one flag during an in-class scrimmage
- A final robot to compete in Capture The Flag
- A presentation about your robot design
- A final report

## **Presentation**

Your team will make a 10-minute presentation to your classmates in your lab section in the final week. Your presentation should describe the novel features in your vehicle including the algorithm you used, any interesting issues in the software implementation, and any modifications to the stock chassis, sensors, and actuators. Your should be clear, lively, and interesting. Bring your presentation to class on a memory stick in PowerPoint or PDF or email it to the instructor in advance.

## Final Report

Your team will write a final report describing your robot. The report should not exceed 5 pages, excluding appendices containing source code. A classmate should be able to understand and replicate your robot based on the information in your report. Specifically, it should contain:

- An overview of your autonomous vehicle
- An explanation of your game-playing algorithms
- A description of your modification(s)
  - A dimensioned drawing of your chassis if you designed a new one
  - A description and bill of materials for any hardware you added
  - Schematics of any electronics beyond the stock hardware
- A summary of the robot performance, including how it did during your tests, the scrimmage, and the final game, discrepancies with the intended algorithm, limitations you have observed, and concrete recommendations for improvements.
- A summary of the main lessons you have learned from the project.
- An appendix listing your Arduino code

Bring a clean draft of your report to your lab section in the next to last week for peer editing. Turn in a final copy in class on 12/8.

## Grading

Your project score is based on the following:

Successfully captures at least one flag in the scrimmage	5%
Useful physical modification operational at the scrimmage	5%
Successfully captures at least one flag in the final game	20%
Operates reliably and repeatedly during Robot Design IV lab	20%
Modification to stock hardware	10%
Creativity	10%
Presentation	10%
Report rough draft ready for peer editing	5%
Final report	15%

In addition, you will receive 5% extra credit for each win accumulated in the final tournament.

If you feel that the work was divided unequally between you and your partner, please discuss the discrepancies with your lab instructor.