

# **E11: Autonomous Vehicles**

**Fall 2014**

## **Final Project**

### **Introduction**

Welcome to Moonbase Epsilon! Once a tranquil crater, the land is now the site of a fierce duel for mining rights. Moonbase Epsilon sits atop the universe's largest reserves of unobtanious-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 u-epsilonium mining stations, which exist in 9 locations on the moonscape. Some stations (stations 3 through 7) are claimed by physically touching them. The rest of the beacons are claimed by flashing or transmitting a gold code that they can read. The game begins with all flashable stations unclaimed, and the remaining standard touchable stations distributed equally between the two teams, and the goal of the game is to claim stations. Once a touch station is claimed, it switches color.

If held at the end of the match, Stations 1 and 2 are worth two points while all other stations are worth one point. Station 4 contains a radioactive supply of u-epsilonium. While this is a more valuable form of u-epsilon, it requires more investment of time to keep it under control. Station 4 begins the game unclaimed, and the first team to tag it will be awarded one point. When first changed from its unclaimed state, it will flip to a random team. Teams will need to be cautious to tap station 4 until their team claims it. Following this, for each consecutive thirty seconds the beacon is held, the team that held the station/beacon will be awarded additional points. If left untouched after each continuous 30-second interval, the station will destabilize to the state of an unclaimed beacon. At the end of each match, the team with the most points wins. (See map section for station numbers).

### **Locating the Stations**

Black roads lead from each of the corner stations to the center, and the center stations are within a colored circular field. The peripheral stations are located against the walls of the crater.

All of the stations are broadcasting gold codes corresponding to their number. Unclaimed stations will broadcast their number + 10 (In decimal). Note that the seed to the gold code is just the binary form of the beacon number.

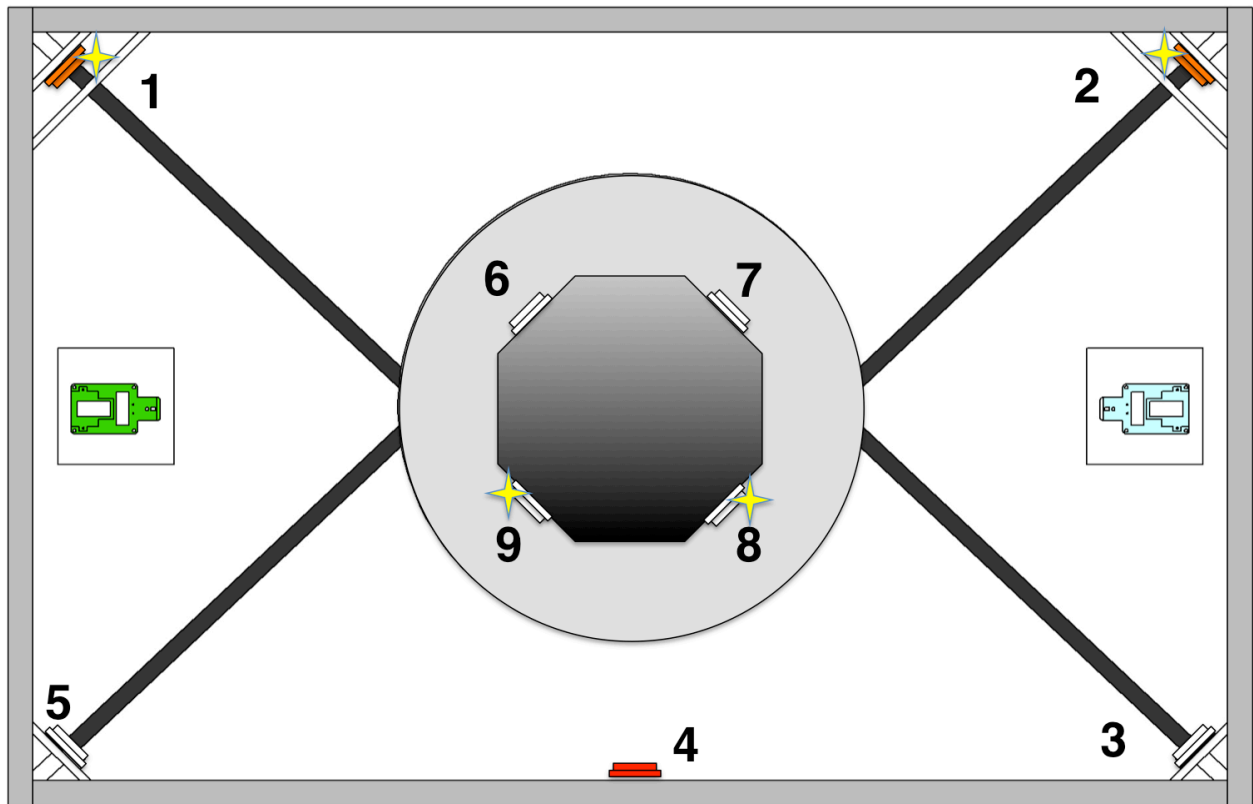
The beacons claimed by the White team will flash the original codes; beacons claimed by the Green team will flash inverted versions of the codes. This way, robots can identify both which beacon they are looking at and which team it currently belongs to at a glance.

### **Claiming the Stations**

Each standard station (**stations 3,4,5,6,7**) has a bump panel on the front. To claim a standard station, a robot must activate 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 cool down has passed.

Each flashable station (**stations 1, 2, 8, 9**) begins as an unclaimed station, and must be claimed from afar. To claim one of these stations, a robot must flash or transmit the station's gold code to the station. If the station receives its corresponding gold code (either inverted or uninverted), it will change ownership corresponding to the color that was flashed. All other characteristics are the same as for the remainder of the stations.

## The Map, The Map, The Map!



The two squares with robots at the east and west end of the board indicate the starting locations of the robots. Robots working for Green Industries begin at the west end, White Incorporated robots begin in the east end. The numbers correspond to the numbering of that particular beacon. The number of the beacon is also the seed of the gold code sequence emitted by that beacon. Beacons with stars are flashable beacons!

## Game Rules

### General rules

- Each match will last **one minute and ten seconds (1:10)**
- Each team will position their robot in the starting box before the game begins. All points of contact must be within the outer edge of the 7" square. Orientation of the robot within this boundary is not restricted. Immobile structures designed as launching platforms or blockades are NOT legal points of contact.
- In the event of a tie, the team, which first tapped the bonus beacon, wins.
- Points will be scored based on the state of the beacons at time = 0 at the referees 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.
- Teams that wish to remove their robot at any point in the match (i.e. to prevent robot damage) may do so however this will result in match forfeit.

- Robots must adhere to the restrictions as described in **Robot Requirements**

### Scoring

- Remote outer flashable beacons **(1,2)**: 2 points
- **Radioactive Bonus beacon (4)**: 1 bonus point awarded to the first team to tap this beacon (regardless if they claim it for the wrong team). An extra 1-point is then awarded for each continuous 30 seconds the beacon is held by that respective team. At the end of each 30 continuous seconds, the beacon will destabilize into an unclaimed beacon. (*Accidental claiming for the opposing team will reward the additional 30-second hold points to the opposing team!*)
- Other beacons **(3, 5,6,7,8,9)**: 1 point
- Robots in either of the starting squares (as measured by robot perimeter not wheel base) at the end of a game will earn **an additional bonus point**. Note that this point can only be earned once per team and once per square. In the event that two robots are in the same starting square, the robot with a point closer to the center of the square will be awarded the point.

## Competition Format

### Scrimmage

The scrimmage is designed to allow teams to test their robots in the harsh reality of competition. It may be in your advantage to not reveal your entire strategy at this time but keep in mind that relying on an untested mechanism is unwise. The results of the scrimmage will be used to determine the seeding for the final tournament.

### Final Competition

The competition will take the form of a double elimination tournament seeded by scrimmage results and winners.

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.

You may add a maximum of \$40 of new hardware, note that this total is calculated from the components used in the final robot. 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. Remember that your bot's footprint **must fit within the 7" starting square**, as mentioned earlier. You are responsible for paying for 3D printing costs (\$10 per cubic inch of material) for additional printings. Note that the stock price of any equipment that students already own or want to borrow will count towards the \$40 total.

You are encouraged to experiment with wacky ideas - the most memorable robots aren't always the winners. When in doubt about the rules, contact your instructor or the referees.

## **Deliverables**

You and your partner are responsible for the following deliverables

- A prototype robot with a physical modification that can capture at least one beacon during an in-class scrimmage
- A final robot to compete in The Unobtanium Epsilonium Duel
- 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 last week of the semester. 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 presentation should be clear, lively, and interesting! Bring your presentation to class on a memory stick in PowerPoint or PDF or email it to the section 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. The code should be readable, commented, and well formatted.

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 beacon in the scrimmage	5%
Uses physical modification effectively in the scrimmage	5%
Successfully captures at least one beacon 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 Capture the Unobtanium Epsilon tournament.

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