

E11: Autonomous Vehicles

Fall 2010

Harris & Lape with Keeter & Ong

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 Blue Industries or Yellow 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. At the end of each two-minute round, the team that has claimed the most mining stations is the winner. These stations are very valuable: not only do they mine epsilonium, but the fuel cells that power them produce water, a rare resource in the arid lunar environment.

Locating the Stations

Blue Industries and Yellow Incorporated have laid down black roads leading to one of the opponent's stations. A line-following robot should be able to follow the road and claim the first station. Beyond that point, things get a bit trickier.

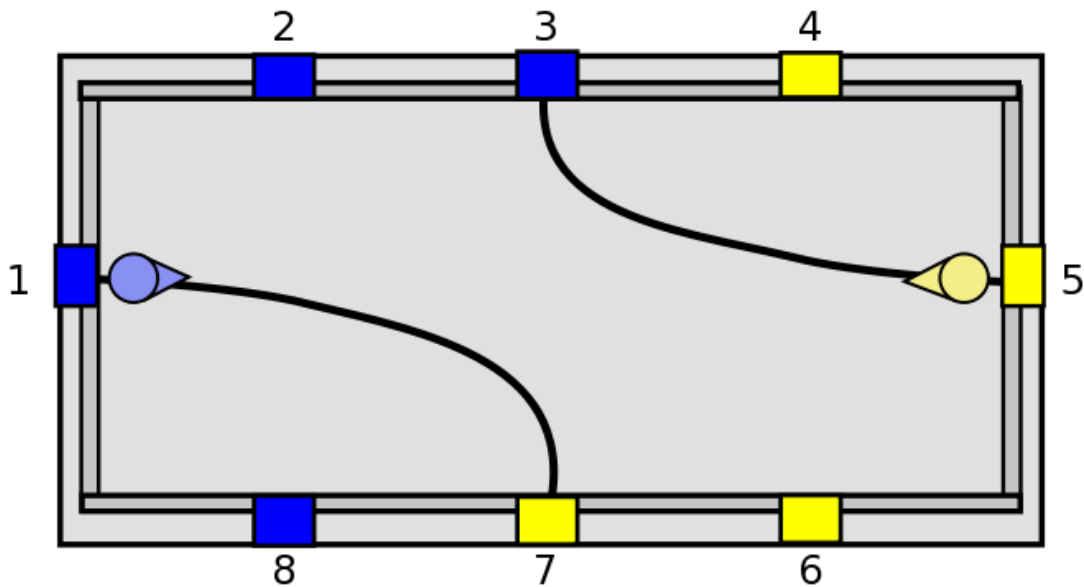
All of the stations are also broadcasting a unique binary code at 4 kHz. This code is generated by XORing two maximum length sequences. The first sequence is generated by a 5-bit linear feedback shift register with taps at 2, 3, 4, and 5, seeded with the value 1. The second sequence is generated by a 5-bit LFSR with taps at 5 and 3, seeded with the value shown in the map below.

Beacons claimed by the Blue team will flash the original code; beacons claimed by the Yellow 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.

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 circles with arrows indicate the starting position of the robots. Black lines lead from the starting positions to the first station; after that, it's all up to you.

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 Blue Industries and Yellow Incorporated, good luck!

The goal of the final project is to work with a partner to build an autonomous vehicle that can play Capture the Flag.

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. 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 two corners of the robot. You are responsible for paying for 3D printing costs (\$10/in³ of material), but these costs do not apply toward the new hardware budget.

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

Deliverables

You and your partner are responsible for the following deliverables

- A prototype robot 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 Week 14. 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 Week 13 for peer editing. Turn in a final copy in class on 12/6.

Grading

Your project score is based on the following:

Successfully captures at least one flag in the scrimmage and the final game	30%
Operates reliably and repeatedly during Robot Design III lab	15%
Modification to stock hardware	15%
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 Flag tournament.

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