CSCE 236 Embedded Systems, Spring 2016
Project Competition 2

Started: March 31, 2016
Checkpoint Wall Following: Thursday, April 14, 2016
Checkpoint Obstacle Avoidance: Thursday, April 18, 2016
Competition: Tuesday and Thursday, April 26 & 28, 2016
Written Report, Video, and Survey: Friday, May 1, 2016 at noon

1 Overview

For the final project your team will compete against other teams in a modified capture the flag-type environment. Each robot will start guarding an exit of a "room" and the goal will be to get out of the opposite exit before your opponent. Figure 1 shows an overview of the course. There will be a black line on the ground connecting the two exits that you can follow to the exit. There will also be walls at least 3 inches high surrounding the environment. Finally, there will be a randomly placed obstacle within the course environment. You are free to modify your robots, but please make sure all of the components I gave you are returned in working condition.

You will also create a 2 minute video that gives an overview of the project, submit a written report, and fill out a project and course survey.

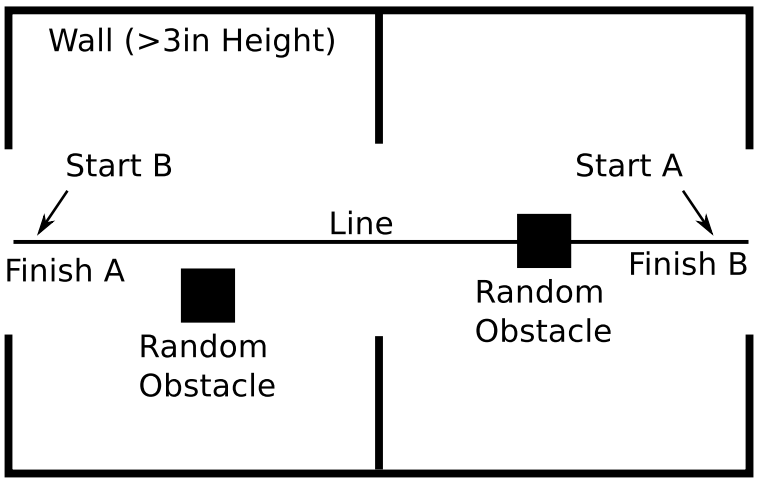

Figure 1: Course Overview

2 System Constraints

Below are a set of constraints on your robot. These are subject to change. If you have any questions regarding these constraints, please ask for clarification.

- **Your robot cannot be designed to intentionally damage or disable another robot.**
- You robot must be fully autonomous (no user input once a game has started).
- You can use servos/sensors/etc from up to 2 of the robot kits.

- You can use other passive mechanical devices, but no other electronics/sensors/etc. However, you are limited to at most $15 of additional components.
- The dimensions of your robot cannot exceed 22x14x14 centimeters and cannot be more than 500g (this includes the weight of the battery if you use a battery).
- You can power your robot from either the wall power I supplied or batteries; however, be aware if you draw too much power from either of these your robot may reset itself.

3 Wall Following Checkpoint

This is worth 10% of your project 2 grade and is due on Thursday, April 14, 2016. For this checkpoint you must use your range finder to follow a wall for 1 meter. You must do this at a distance between 4cm and 10cm. Full credit will only be given if you maintain a nearly constant distance and operate smoothly. When you get checked off 1 point will be deducted for each additional try you need.

4 Obstacle Avoidance Checkpoint

This is worth 10% of your project 2 grade and is due on Thursday, April 18, 2016. For this checkpoint you must follow a black line, except there will be an obstacle in your path. You must detect the obstacle, go around it, and then return to following the line. When you get checked off 1 point will be deducted for each additional try you need.

5 Competition

The competition will be held as a double elimination bracket and is worth 10% of your final grade. You will face at least two teams and hopefully more. To win a match against an opponent you must win 2 out of 3 runs against that opponent. You win a run if your robot passes out of your exit before your opponent. After 1.5 minutes, if neither robot has won then the robot closest to the exit (or out the furthest) wins. You will then have at most 30 seconds to reset your robot before the next run. The run will start with or without your robot present on the course. Once you put your robot down and the run is started you cannot touch or interfere with your robot; however the judges may choose to intervene (e.g. to prevent damage to a robot). The exception to this is if you robot gets stuck or flipped you can reset it at the start after 10 seconds. The competition will be held on Tuesday and Thursday, April 26 & 28, 2016.

6 Video Presentation

This is worth 10% of your project 2 grade. You should prepare a 2 minute video. You should give an overview of how you designed and built your robot and may want to give a description of the software architecture, the approach you used in the competition, and any additional information. You must email me a link to your video that is publicaly viewable[1] no later than **Friday, May 1, 2016 at noon**. Part of the final grades for the video presentation will be based on voting by the whole class.

7 Self, group, and video evaluation

This part should not be included in the report, but should be done by **each person individually** and is worth 10% of your overall project grade. Each member of your group should complete the survey (which

[1] You can upload your video to youtube, post it as a public file on box, etc. But make sure that this file will remain online for at least two weeks and that it is in a format playable by most browsers.

will be posted on the website) **before** you turn in your written report. The survey is on self, group, and video evaluation. Note that this will require watching and voting on your classmates' videos. In addition, you should complete the UNL class survey here:

`http://crseval.unl.edu/welcome/`

Both of these provide me with valuable information that will help me improve the course in the future and they will not take long to complete. They will also help me judge group dynamics and the contribution of different group members.

8 Writeup

Below are a set of questions you must answer as **part** of your final report for project 2. Overall the report is worth 50% of your project 2 final grade. Each group only needs to submit a single report.

This report should read as a coherent report with appropriate transitions between sections and an introduction and conclusion. In addition to answering the questions, you should also *describe* why the question is important and how the results impact your design decisions. Make sure to use complete sentences, paragraphs, and sections. Finally, make sure that any figures are properly labeled and are clear when printed (e.g. you can distinguish the different variables if you print it in black and white).

Writing may be less fun than coding (for me at least), but even if you end up in the most technical of jobs (perhaps as an assembly-level driver developer programmer for a mobile development phone company) you will still need to clearly describe and analyze system performance in written reports. There is no set page limit for this report (it is quality, not quantity), but I expect most will be between 8 to 12 pages (double spaced). Break it up among your group members, but make sure the overall report is consistent.

8.1 Introduction, Conclusion, Grammar, and Style (10 pts.)

Your report should include an **introduction** to the project that gives an overview of the project goals and describes what you aim to achieve. The introduction should also describe the remaining sections of the report. You should also have a **conclusion** that summarizes the report and what you learned. You may also lose some points if the overall flow, grammar, and style of the report are inadequate.

Make sure to also give your robot a name, since robots like to have names.

8.2 System Architecture (10 pts.)

In this section (perhaps with multiple sub-sections), you should describe the overall architecture for both the software and hardware you developed for this project. You should discuss the physical layout of your robot (include pictures), the sensors you used, where you placed them, etc. Make sure to explain why you made the choices you did and justify your choices with experimental data where appropriate.

You should also describe the overall architecture of your code. You can discuss, for instance, how and where you used interrupts, the code API for the main functions you implemented (e.g. a turning function, a driving function), and how you structured the main loop in your code (you may want to include and describe pseudo-code).

8.3 Range Finder and Sensor Characterization (10 pts.)

In this section you should characterize the performance of your range finder. You should at least include a *discussion* and analysis of the following:

- Describe how you interface with the range finder, the frequency at which you read it for the checkpoints and competition, etc.

- Characterize the range finder to determine which values correspond to different distances. Describe how you calibrated the range finder and how the results are similar or differ to those described in the datasheet.
- How does lighting impact the range finder? Does it produce the same numbers for a given range in different lighting conditions? Conduct and present experiments to analyze lighting.
- How does interference from other nearby range finders influence your range finder?
- Include a plot showing the range information as you follow a wall as you did in the checkpoint. Include indicators to show when you were turning or going straight.
- Include any additional information and discussion to help with the characterization and analysis of the range finder.

If you used the bump sensors also provide a characterization of their performance. Finally, for the line sensors, describe how you configured them and characterize how well they worked in this configuration. You can compare your setup now to the one used in project 1, but note that you should include a **detailed** characterization of these sensors.

8.4 Approach (10 pts.)

In this section, you should describe how you approached the competition **and** the two checkpoints. Did you end up using similar code during the competition? Did you learn anything from the checkpoints that helped you improve your system for the competition? Describe how your approach evolved over time, for instance you may want to include a description of how you initially planned to approach the competition. If your system had different states then include a control state machine diagram, if it didn't include other figures illustrating your control approach.

8.5 Performance Evaluation (10 pts.)

You should analyze the performance of your robot in the competition. Did it perform as well as you expected? How many wins did you have? How could you have improved the performance and how would you go about doing so? Make sure to discuss failures or successes in both the software and hardware during the competition. You might also want to discuss particular runs and why you won/lost against those opponents.

8.6 Code Handin

You must also turn in your code by visiting `http://cse.unl.edu/~handin/`. Only one person per group needs to do this. If you do not do this then 5 points will be deducted from your project grade.