CSCE 236 Embedded Systems, Spring 2013
Project Competition 2

Started: April 9, 2013
Checkpoint Wall Following: Tuesday, April 16, 2013
Checkpoint Obstacle Avoidance: Thursday, April 18, 2013
Competition: Tuesday, April 23, 2013
Presentation: Thursday, April 25, 2013 (slides emailed by 9:00am)
Written Report and Survey: Friday, April 26, 2013 at 4pm

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 give a short presentation on the final day of class, submit a written report, and fill out a project and course survey.

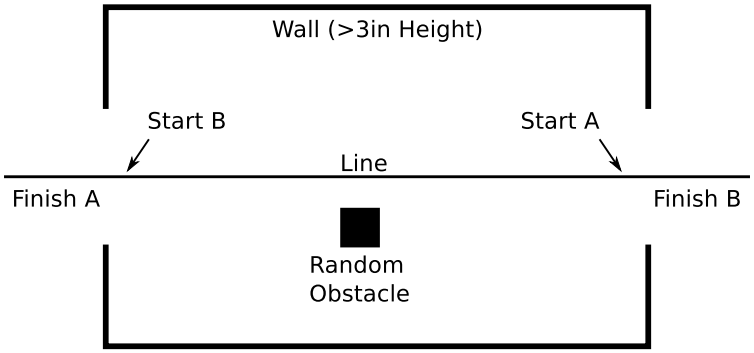

Figure 1: Course Overview

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 20x14x14 centimeters and cannot be more than 500g.
- 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 Tuesday, April 16, 2013. For this checkpoint you must use your range finder to follow a wall for 1 meter. You must do this at two different distances, 5cm and 10cm. Full credit will only be given if you maintain a nearly constant distance and operate smoothly.

4 Obstacle Avoidance Checkpoint

This is worth 10% of your project 2 grade and is due on Thursday, April 18, 2013. 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.

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 completely 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 bulk of the competition will be held on Tuesday, April 23, 2013, although the final 4 will do their final runs on Thursday, April 25, 2013.

6 Presentation

This is worth 10% of your project 2 grade. The presentation will take place in class on Thursday, April 25, 2013. You must email me your slides by no later than **9:00am** on that day. You should also bring your slides on a USB drive as a backup. I would highly recommend sending me a PDF of your slides, although powerpoint is also acceptable. Google docs won't work if you need to log in as we will not have time to log in, but if you send me a link I can have it open in a browser.

The presentation will have a strict 4 minute timeline to allow all groups to present. You should give an overview of how you designed and built your robot, a description of the software architecture, the approach you used in the competition, and any additional information. Make sure all members of your group talk during the presentation.

7 Writeup

Below are a set of questions you must answer as **part** of your final report for project 2. Overall the report is worth 60% of your project 2 final grade. Each group only needs to submit a single report. The exception is Section 7.6, which is a group and self evaluation that each member of the group must submit individually.

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.

7.1 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.

7.2 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).

7.3 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.

7.4 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.

7.5 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.

7.6 Self and group evaluation (10 pts.)

This part should not be included in the report, but should be done by **each person individually**. Part of your grade will also be based on self and group evaluation. Each member of your group should complete the survey (which will be posted on the website) **before** you turn in your written report. 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.

7.7 Code Handin

You must also turn in your code by visiting `http://cse.unl.edu/~cse236/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.