UNIVERSITY OF CALIFORNIA, SANTA CRUZ
BOARD OF STUDIES IN COMPUTER ENGINEERING

CMPE118/L: INTRODUCTION TO MECHATRONICS

"Slug Out at the OK Corral"
WINTER 2010

Purpose:

The purpose of this project is to provide an opportunity to apply all that you have learned in CMPE-118 to solve an open-ended problem. The task is to design an autonomous machine that will shoot two fixed targets off of a raised wall and a beer can off of your opponent's head, using the west's deadliest weapon: ping pong balls (or possibly foam balls).

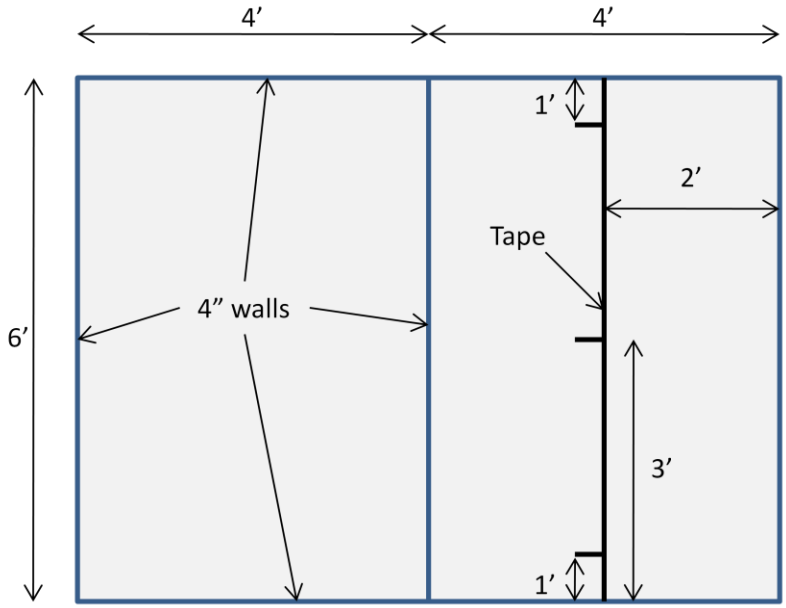

Figure 1: The Playing Field

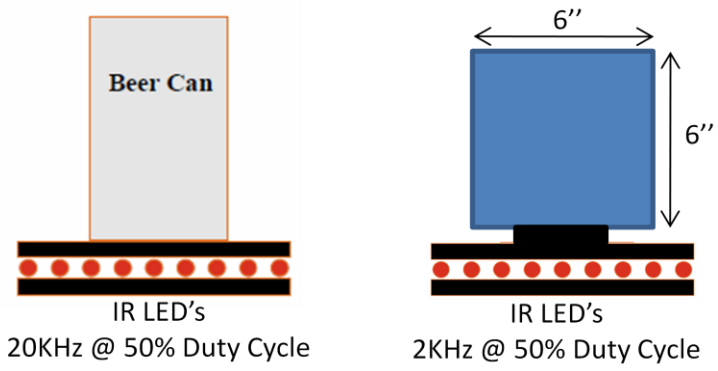

Figure 2: The Targets

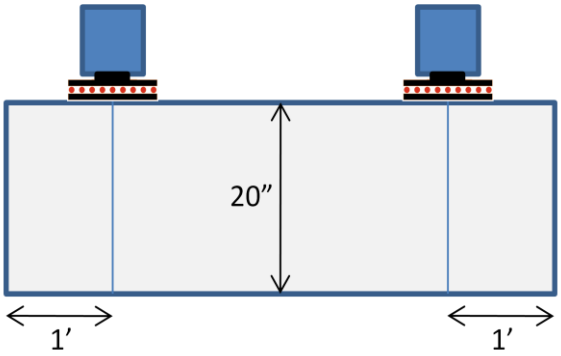

Figure 3: Back Wall View

Background Briefing:

It looks like things have not quite settled down in Tombstone, Arizona at the OK Corral. Wyatt Earp, Doc Holiday, Virgil and Morgan Earp are fighting again with the McLaurys and Clantons, this time about slug rustling!!! Unlike the first time, things are fairer this time around, as each team only has 3 members. Words were said, and feelings were hurt, leading to a slug out in the tradition of the wild old west.

Your goal is to shoot your enemies down like the dogs they are, hopefully before they shoot you down. You might be a fine marksman and use your wit and skill to calming aim and shoot your opponents from a fixed position, making yourself a target. You could be a fast and nibble gunman though, not staying in any one position too long so as to present a more difficult target. Either strategy, or some sort a combination of both, are possible for your defense and offense.

The authorities in Tombstone have set certain restrictions on the shoot out in hope of preventing it from spilling over into the streets of Tombstone. They have also decided that in place of humans, the battle would be with machines. Thus each side has hired a team mechatronics engineers to build an autonomous gunner for them following the Tombstone authorities specifications.

Project Specifications

The robots must be stand alone entities, capable of meeting all specifications while drawing power only from batteries. Your code must be flashed into the HC12 microcontrollers, and for setup purposes, you may be able to communicate to your ‘bot using a standard terminal program. Once any setup/initialization is done, the computer will be disconnected. To make use of this feature you must be prepared to provide the file to be downloaded to the TA’s.

The fighting zone is shown in Figure 1 and consists of two areas of plywood that measure 4’ x 6’ each, with side walls that are constructed from 1” x 4” pine boards, secured firmly to the plywood floor. There is a wall separating the two halves that is also made of 1” x 4” board. The surface of the battle zone is covered with green felt. There is 2” wide black tape as shown in Figure 1 that can be used as a reference for your robot. It is located 2’ from the back wall, and

has 3 tabs on it that identify the center of the field and the placement of the two wall mounted targets.

Each contestant is required to have a "beer can mount" located at a height of 12". At that height your robot must have a platform that will measure approximately 4" x 4" and is unobstructed. A template for this platform will be provided to you for integration into your designs. This mount can be allowed to rotate relative to your robot as you wish. One of your objectives is to shoot the opponents can off its head with either ping pong or with small foam balls (there are a limited number of these available in the lab). A shot will be considered a valid hit if the ball makes contact with any part of the other robot before the ball bounces. A shot that knocks the can off your opponents head will be worth even more.

Droids are placed into the fighting zone, and then have 2 minutes to win the match by accumulating the most points. The match will be run in a double elimination fashion until all droids have faced off against each other and the winners are determined. Your machine is required to occupy a volume not to exceed 12" x 12" in horizontal dimensions and 12" in height when initiated. Your machine must contain the complete supply of balls to be used during the event. At least there are required, but there is no upper limit, except that imposed by the total volume of the machine.

Scoring does not affect grading, but will be used as the basis of a competition between teams. Once your machine has been activated, the operator may not touch it until the entire sequence is complete. During operation, the machine is required to stay within the boundaries of the field. If the machine makes contact with the edge, it is required to back away at least 3" before continuing with any other activities.

A report describing the technical details of the machine will be required. The report should be of sufficient detail that a person skilled at the level of CMPE118 could understand, reproduce and modify the design.

Safety

The machines should be safe to the user, the lab and the spectators. For this project, excessively high velocity ball delivery will be discouraged.

NOTE: Once the field is up in the lab (BE115), the ONLY thing you are allowed to put on it are droids and subsystems being tested. Anything else on top of the field will result in an **IMMEDIATE** one dollar penalty that goes into the Soda/T-shirt kitty. Repeat offenders will have that penalty go up to $5, we are not kidding about this.

Evaluation

Performance testing procedures: All machines will be operated by one of the team members. There will be one round for grading purposes, and one round for entertainment purposes.

Level 1: Grading evaluation. Each machine will be graded based on its performance in the testing before the class competition at the end of the quarter. Each machine will have up to 2 minutes to shoot a droid-like target. Grading is not based on point value, but is simply a measure of successfully shooting three body shots, shooting the can off a robots head or hitting the two targets on the wall.

Level 2: Class Competition. After a few trial runs, each group and machine will be entered into a double-elimination tournament. Each machine will receive points for successful shots delivered within the 2 minutes.

Grading Criteria:

1. Concept (20%) This will be based on the technical merit of the design and coding for the machine. Included in this grade will be evaluation of the appropriateness of the solution, as well as innovative hardware and software and use of physical principles in the solution.

2. Implementation (20%) This will be based on the prototype displayed at the evaluation session. Included in this grade will be evaluation of the physical appearance of the prototype and the quality of construction. We will not presume to judge true aesthetics, but will concentrate on craftsmanship and finished appearance.

3. Report (10%) This will be based on an evaluation of the written report. It will be judged on clarity of explanations, completeness and appropriateness of the documentation.

4. Performance (20%) Based on the results of the performance during the evaluation session.

5. Design Evaluations (30%) Evaluations will be based on the three project milestone reviews.

Project Milestones

First Review: Tuesday, 9-February-2010, Turned in Class. Note that this is done by each person in the class individually.

Generate 5 concepts of how you are going to build a droid that will successfully compete in the tournament. Sketch them all out, and deliver a sketch of your best two concepts to the professor at least 2 hours before class begins, include:

- Sketches
- Details where you have them
- Plan-B in case things don't work out the way you expect

Check-off 1: Thursday, 11-February-2010, Presented to Class using overhead or computer.

Using the five concepts that you created for the first review, now that you are assigned to teams, come up with 5 team concepts for your design, how you are going to accomplish your project goals.

Deliverables are:

- 5 detailed TEAM concepts for solving the project.
- pick 2 concepts and present them

Check-off 2: Tuesday, 16-February-2010, Presented to TAs or Instructor

Deliverables are:

- Time schedules
- Personnel assignments
- System Block Diagram
- Mechanical Design Sketches

Check-off 3: Thursday, 18-February-2010, Presented to TAs or Instructor

Deliverables are:

- State Machine(s)
- Final Mechanical Design (Solidworks/Sketch-up)

Check-off 4: Tuesday, 23-February-2010, Presented to TAs or Instructor

Deliverables are:

- Working sensors (breadboard is ok) and schematics
- Actuators (breadboard is ok) and schematics

Check-off 5: Thursday, 25-March-2010, Presented to TAs or Instructor

Deliverables are:

- Final sensors and final schematics
- Final actuators and final schematics

Check-off 6: Tuesday, 2-March-2010, Presented to TAs or Instructor

Deliverables are:

- Autonomous platform that can move and sense
- Reverse off of a collision sensor
- Keep itself on the field

Check-off 7: Friday, 5-March-2010, Presented to TAs or Instructor

Deliverables are:

- Robot that can autonomously locate tower/targets and score points?

Specifications Check-Off: Wednesday, 10-March-2010, Presented to TAs or Instructor

Deliverables are:

- Robot that meets minimum specifications

Final Presentations: Friday 12-March-2010, Finished, operational machines, fun performance for SOE audience. Public Demo will be held in Engineering Lecture Hall #101, starting at 6:00 PM.

PS: With this many people in the lab, it is going to be very important that you keep the lab clean, and not leave your things out. We will be assigning I/O boards and batteries to each team, and they will

be yours until the project is over. An early trip over the hill to Halted will probably be very useful, and if you are going to order things from McMaster-Carr, All Electronics, Digikey/Jameco, gang your orders together to save on the shipping. We will be bringing down our “box o’ freedom” that has random parts that people have donated over the years, and if you happen to find surplus printers, or other random electronics that people no longer want, feel free to dismantle and put parts in.

PSS: We reserve the right to make minor changes to these specifications, we will give you fair warning and attempt to keep any changes to a minimum and only if absolutely required.