

Goals:

The goal of this project is to provide you with an opportunity to apply your knowledge to solve an open-ended problem. The task is to design and build a machine that can play an interesting game against an opponent machine.

Purpose:

The underlying purpose of this project is to give you some experience in integrating all that you have learned. The avenue through which you will gain this experience is the design and implementation of an autonomous mobile robot that can compete in a game of skill and strategy against a machine constructed by another team from the class.

Your lab kit contains sensors, actuators and power transistors. Although you might be able to construct the electro-mechanical parts of this project using only the parts in your kits, you are not limited to this.

The Game:

The object of the game is to deposit Happy Fun Balls (actually Nerf Ballistic Foam Balls) into goals of varying difficulty and point value to accumulate a higher score than your opponent before 2 minutes, or the supply of foam balls, runs out. Those unfamiliar with Happy Fun Ball should visit YouTube (www.youtube.com/watch?v=fk_ba4Qs-Bs) to learn more.

Specifications

The Field:

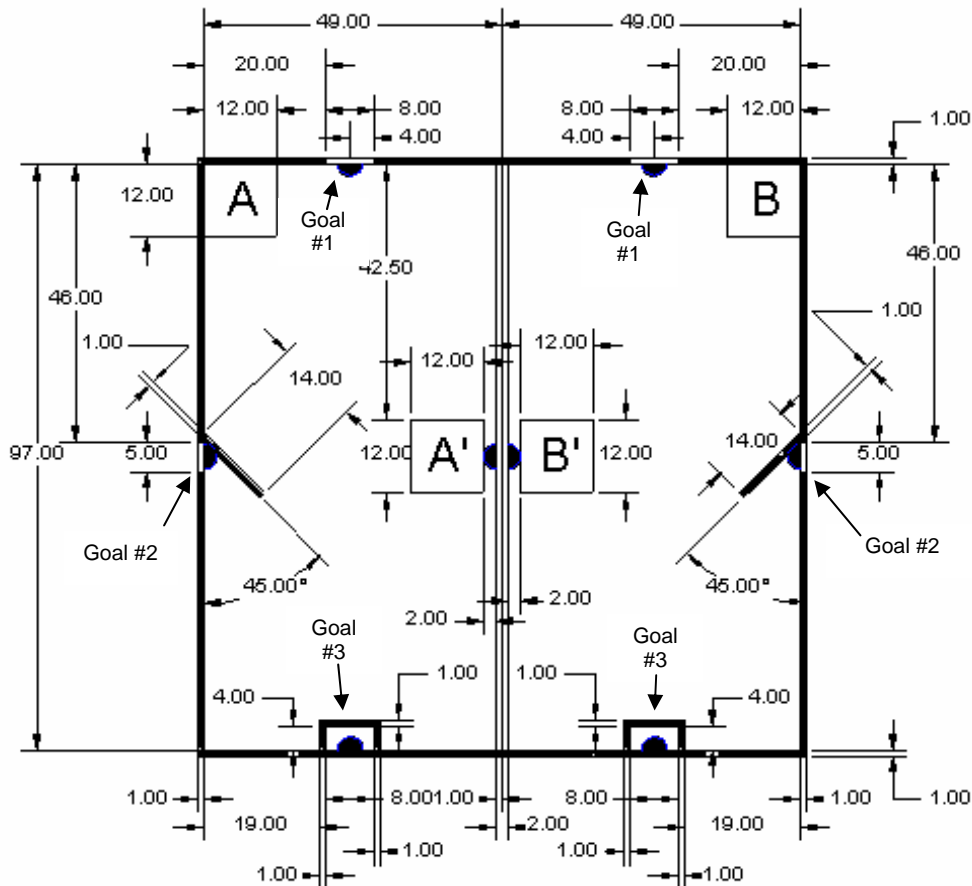


Fig. 1: Top View of Playing Field
(Tape not shown – See Fig. 2)

- The playing field measures 98"x97" (W x L). The field is divided into two equal halves, Side A and Side B, each with 49"x97" (W x L). The legal playing region for each 'bot is one side of the playing field. Both playing regions are bounded on all four sides by a wall that is 3" high.
- At the beginning of each game, 'bots will be placed in a random orientation in the zones labeled A and B in Fig. 1. The assignment of a 'bot's side of the playing field and orientation will be made by a member of the teaching staff.

- In the center of the playing field, each side of the board has a Happy Fun Ball Dispenser. Happy Fun Balls will be dispensed in zones A' and B', and the details are further described below. The Dispenser incorporates an IR beacon to help successfully determine its location. The Dispenser is further described below.
- There are three goals on each side of the playing field. As shown in Fig. 1, Goal #1 is located along the top of the playing field. Goal #2 is located along the side of the playing field, and has a 5.5" tall blind blocking direct shots. Goal #3 is located along the bottom of the playing field, and is an 8"x4" (W x L) long region defined by a 3.5" tall border. Each goal incorporates an IR beacon to facilitate scoring points. The Goals are further described below.

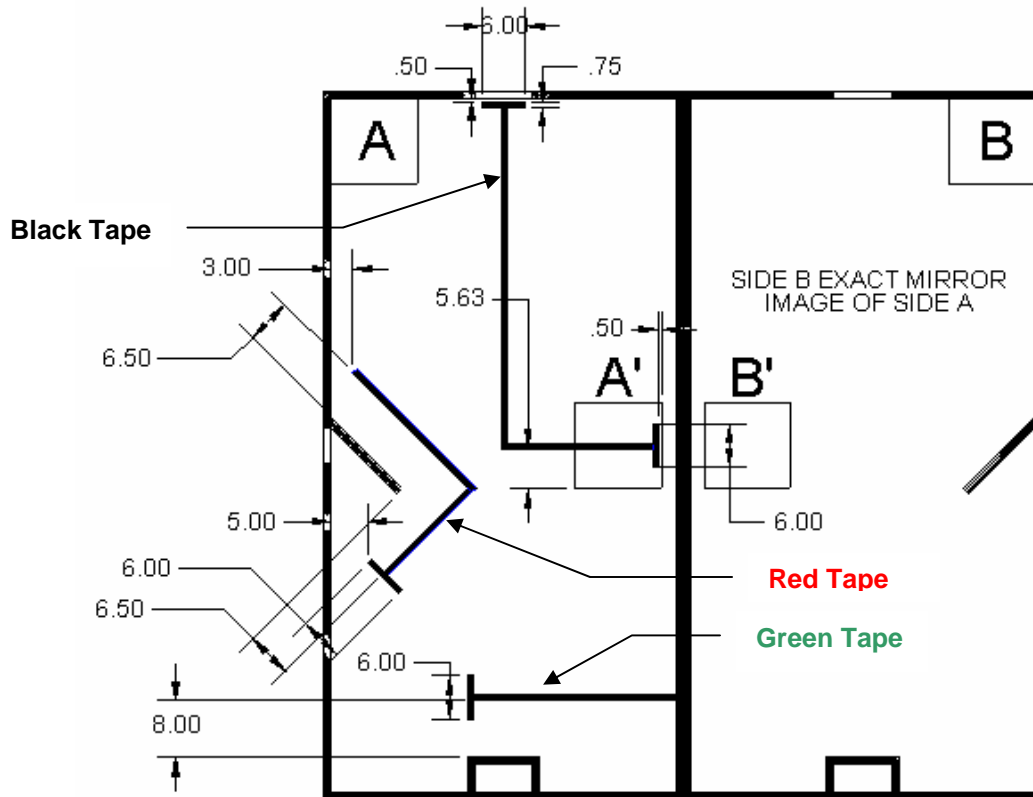


Fig. 2: Top View of Playing Field Tape

- A line of black tape extends between Goal #1 and the Happy Fun Ball Dispenser on each side of the playing field (see Fig. 2).
- A line of red tape extends around the blind surrounding Goal #2 on each side of the playing field (see Fig. 2).
- A line of green tape extends horizontally from the center wall to the region in front of Goal #3 on each side of the playing field (see Fig. 2).
- Tape locations on the playing field are approximately as shown in Fig. 2. Expect variations on the order of $\pm 1''$.

The Happy Fun Ball Dispensers:

- The Happy Fun Ball Dispensers will be situated at the midpoint of the center divider separating Side A and Side B of the playing field. Each side has its own dedicated, independently operating Happy Fun Ball Dispenser.
- An IR beacon, modulating at 1250 Hz with a duty cycle of 50%, will be located at the center of each Happy Fun Ball Dispensers at a height of 10". The emitters for the beacon are LTE5208A IR LEDs.
- 'Bots will request a Happy Fun Ball from a Happy Fun Ball Dispenser by depressing a 2"x2" region located immediately below the IR beacon for a duration of 1 second. This region is sprung in such a way that positive contact is required to depress it, but the force required is minimal.
- Successful requests for a Happy Fun Ball will result in the Ball Dispenser dispensing a ball. Balls are dispensed 6" in front of the beacon, at a height of 14".

- After a Happy Fun Ball is dispensed, a 'bot may immediately request another ball, however after the 5th consecutive ball has been requested and delivered, a pause of 3 seconds will occur between the dispensing of each successive ball.
- A pause of 10 seconds or more between requests for a Happy Fun Ball will reset a Dispenser. The next requests for up to five consecutive balls will be fulfilled immediately, according to the specification above.
- Each Happy Fun Ball Dispenser begins each round with a compliment of 20 Happy Fun Balls.
- Four of the Happy Fun Balls will have a uniform black color – these are Super Happy Fun Balls. These will be randomly mixed with the regular yellow Happy Fun Balls when the Dispensers are loaded, prior to each round.

The Goals:

- Each goal is a different size and shape (see Figure 1). The challenge of successfully placing a Happy Fun Ball in a particular goal corresponds to the point value of that goal.
- Each goal has a beacon directly above it at a height of 10" that emits IR light, modulated at a frequency of 1250 Hz, with a duty cycle unique to each type of goal. The emitters for the beacons are LTE5208A IR LEDs.
- Goal #1 is comprised of an 8" wide gap in the perimeter wall around the playing area, and has goal posts extending vertically to support its beacon. A shot is successful when a ball passes under the beacon between the goalposts. The beacon located above Goal #1 emits at a 30% duty cycle.
- Goal #2 is comprised of a 5" wide gap in the perimeter wall around the playing field, immediately adjacent to a shielding wall that has a height of 5.5". Goal #2 also has goal posts extending vertically that support its beacon. A shot is successful when a ball passes under the beacon between the goalposts. The beacon located above Goal #2 emits at a 70% duty cycle.
- Goal #3 is comprised of a region on the playing field bordered by a wall that is 3.5" tall. The enclosed area measures 8"x4" (WxL). Successful shots come to rest within the confined area. Shots that miss or bounce out are not considered successful. The beacon located above Goal #3 emits at a 90% duty cycle.

The Robots:

- Your robot must be a stand-alone entity, capable of meeting all specifications described in this document. Battery power is required. Your robot must execute from code contained in flash memory on the processor.
- Robots must be autonomous and un-tethered.
- At the beginning of a game, your robot must fit completely within a 12"x12"x11.5" (L x W x H) volume.
- The only parts of a robot that may ever touch the playing field surface are wheels or low-friction, non-marring sliding supports used to balance the robot.
- Each robot will incorporate an easily accessible toggle switch on the top of the robot. The purpose of the switch will be to power down the 'bot in the event of a software or hardware malfunction. This serves as an E-stop.
- Your robot may carry a maximum of 10 Happy Fun Balls at any one point in time.
- The Happy Fun Balls used in the project must remain unaltered by the robots and/or the teams. No marking, scuffing, stabbing, gouging, folding, spindling or mutilating.
- Each robot must be constructed as part of ME218b. It may not be based on a commercial or otherwise pre-existing platform.
- Any exterior corners on the robot must have a radius of at least 1/4".
- You are limited to an expenditure of \$150.00/team for all materials and parts used in the construction of your project. Materials from the lab kit or the Cabinet of Freedom do not count against the limit. All other items count at their fair market value.
- Happy Fun Ball velocity during throwing must be kept low enough to be safe. We reserve the right to disqualify any 'bot for excessive ball velocity.
- The supplied motors must be used to drive anything that transfers force to the ground.

Game Play:

- The game is a head-to-head match up between robots as they attempt to place Happy Fun Balls into one of three goals and obtain the highest score to win.
- The number of points earned for successfully placing a ball into a goal depends on the goal and the color of the ball.
- A yellow ball successfully placed in Goal #1 is worth 2 points.
- A yellow ball successfully placed in Goal #2 is worth 3 points.
- A yellow ball successfully placed in Goal #3 is worth 4 points.
- A black ball successfully placed in Goal #3 is worth 8 points. A black ball placed in any other goal is worth the same number of points as a yellow ball.
- Any ball left on the playing field that is not in a goal at the end of a game is worth -1 point.
- A game will end after 1) two minutes have elapsed, or 2) when either robot's supply of Happy Fun Balls is exhausted (its dispenser is empty and no balls remain on board).
- At the end of two minutes the 'bot must stop all motion.
- In case of a tie at the end of a round, the round will be re-run.

Rules:

- Each robot must start and remain in one piece during the game.
- Your robot may not alter the playing field IN ANY WAY.
- Intentional jamming of your opponent's senses is prohibited.
- Your robot may not mar the walls or floor of the playing area.

Safety:

- The robots should be safe, both to the users and the spectators. The teaching staff is the sole arbiter of safety, and reserves the right to disqualify any robot considered unsafe at any time. This applies during testing and competition. Keep ball velocity low enough that it is not cause for concern.
- Robots must be stable in the presence of a 30 mph wind.
- No part of the machine may become ballistic.
- Happy Fun Ball contains a liquid core, which, if exposed due to rupture, should not be touched, inhaled, or looked at.
- Do *not* taunt Happy Fun Ball.

Check-Points**Design Review:**

During class time on 02/12/08, we will conduct a design review. Each group should prepare a few sheets of paper showing your idea(s) and a preliminary software design. You will pin these up to the walls in Terman 556, and members of the teaching staff and coaches will come around to hear about your ideas and provide feedback and advice.

First Check-Point:

On 02/15/08, you will demonstrate working beacon detection hardware. In addition, you will turn in a set of Protel schematics, textual descriptions and software design documentation that describes the state of the design *at this point in time*. The designs need not be tested at this point. It must be turned in as soft copy. Only one team member needs to submit the required checkpoint materials.

Second Check-Point:

On 02/22/08, you must demonstrate your motorized platform moving under software control.

Project Preview:

At the Project Preview on 02/29/08, each Robot must demonstrate 1) the ability to move and 2) the ability to sense and identify the beacons and 3) sense tape and respond to all sensed inputs and 3) the ability to request a Happy Fun Ball from a Dispenser and 4) the ability to release a Happy Fun Ball. The platform used for the Project Preview must be the platform used in the grading session.

Grading Session:

During the Grading Session on 03/04/08, each Robot will be required to demonstrate the ability to successfully obtain at least one Happy Fun Ball from its Dispenser, and score at least 2 points in any of the goals. This evaluation will take place without an opponent. Evaluation for grading purposes will occur only during these sessions. At the time of the grading session, you must submit a copy of the .S19 file that you run during the grading session to your Reports folder for archiving.

Public Presentation:

Will take place on 03/05/08 starting at 7:00 pm in Annenberg Auditorium.

Report:

Draft due on 03/10/08 at 4:00 pm. Final version with revisions due by 5:00 pm on 03/14/08.

Evaluation**Performance Testing Procedures:**

One or more of the team members will operate the Robots during the performance evaluation. A competition among the class's robots will take place after the performance evaluation.

Performance Evaluation:

Performance evaluation will take place twice during the project duration, at the Project Preview and at the Grading Session. Everyone will participate at this level.

The Competition:

On the night of the public presentations, a tournament will be held. Performance during the tournament has no impact on your grade.

Grading Criteria:

- Concept (15%) 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, software and use of physical principles in the solution.
 - Implementation (15%) 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 quality of construction. We will not presume to judge true aesthetics, but will concentrate on craftsmanship and finished appearance.
 - Preliminary Performance (15%) Based on the results of the performance testing during the Project Preview.
 - Performance (20%) Based on the results of the performance testing during the Grading Session.
 - Report (20%) 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.
 - Report Review (10%) These points will be awarded based on the thoroughness of your review of your partner team's report. Read the explanations, do they make sense? Review the circuits, do they look like they should work?
 - Housekeeping (5%) Based on the timely return of SPDL components, cleanliness of group workstations as well as the overall cleanliness of the lab. No grades will be recorded for teams who have not returned their E128 & C32 boards.
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