ME EN 1010 Competition Spring 2015
BATTLESHIP

Sixty four teams have been assembled in the Pacific Ocean to demonstrate their programming skills and compete for elite status. Each team will control an identical "ping-pong" missile launcher, which must be programmed to hit six randomly located battleships. Teams must first use MATLAB programming to correctly identify the coordinates of the battleships in a provided satellite image and transmit them to the microcontrollers on-board their launchers. Their launchers must be programmed to autonomously aim, shoot, and reload. Points will be awarded for identifying and hitting each battleship, with time acting as a tie-breaker.

Your Arduino program must be able to autonomously:

1. Receive target coordinates from MATLAB running on a laptop computer
2. Compute launch angle and lateral position required to hit battleship coordinates
3. Turn on an IR LED to start the clock while your launcher is in the home position
4. Control the servomotor to achieve desired launch angles
5. Control the DC motor and read the encoder to achieve desired lateral positions
6. Shoot ping pong balls using the solenoid you made in lab
7. Position the launcher underneath the reloader and command the reloader servo to dispense additional ping pong balls
8. Return the launcher to the home position and turn on an IR LED to signal the clock to stop

In addition, you must have MATLAB code on a laptop computer to:

1. Find battleship coordinates given an image file provided to you at the time of the competition
2. Mark and display the centroids of the battleships on the image to verify acquisition of the battleship coordinates
3. Transmit the battleship coordinates to your Arduino Romeo

The Field

The competition field will consist of a target area between two platforms.

The target area will have seven target holes (10 cm in diameter) as shown in Figure 1. The hole locations will be randomly changed each round of the competition. Each team will shoot at six of the seven holes (i.e., those shown as red circles in Figure 1). The seventh hole (shown as a yellow circle) is not a valid target since the reloader limits the launch angle at the right end of the linear stage.

Each platform will have a docking station for a Makeblock launcher and reloader. Each docking station will consist of a (1) Makeblock beam that you will use to position your launcher with respect to the target area, (2) another Makeblock beam that you will use to position your reloader, and (3) a rail system for your Romeo/baseplate to slide on.

The home position will be defined as the left end of your launcher when viewed from behind (the end with your DC motor). An IR detector will be mounted at the home position to detect when you turn your IR LED on.

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Launcher Origin

Image Origin (Row=1, Col=1)

Scale = 1mm/pixel

55 mm

Shoot from left
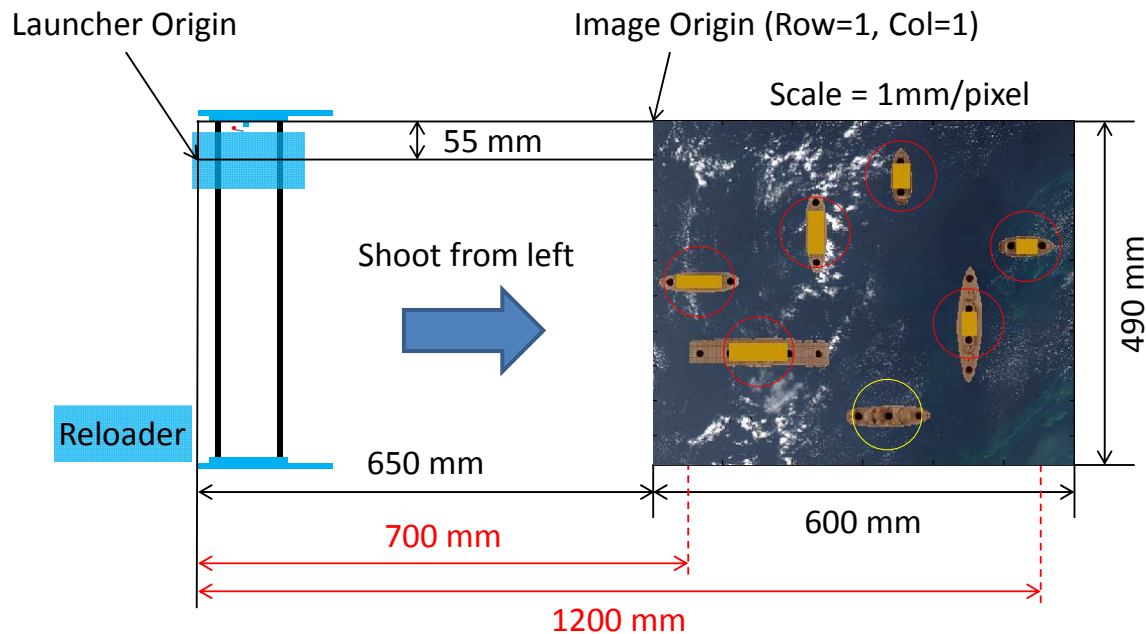
490 mm

Reloader

650 mm

600 mm

700 mm

1200 mm

Figure 1. Satellite image orientation and offsets

The Image

The image provided to you will look similar to the image shown in Figure 1 (without the red and yellow circles). It will have exactly six (no more, no less) rectangles composed of a single color (e.g., all target pixels will have the same R, G and B values). The background may vary, but there will be no other pixels in the image with the target R, G and B values. The dimensions and locations of the rectangles will vary, but the centroid locations will always correspond to the centers of the holes in the target area of the field for the particular round you are competing in. The scale of the image will be 1.0 mm/pixel. The image provided to you will always be oriented such that you are shooting from the **left side** of the image, as shown in Figure 1.

Scoring

Type of Points	No. of Points
Image Processing	1 point each for correctly locating and displaying target centroids on provided image (max possible 6 points)
Shooting Accuracy	3 points each for landing* ping pong ball in each hole (max possible 18 points)

Must be a direct hit such that the ball goes directly in the hole without touching the target plate, or glances off the rim and goes directly into the hole. Cannot bounce off of the target plate into the hole or roll into the hole.

Tiebreaker. In the event of a scoring tie, teams with the same score will be ranked according to time of completion of shooting.

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Timing

A maximum of 120 seconds are allowed for completion of battleship locating and shooting. The shooting clock will start when the launcher turns on its IR LED in the home position, which must be done before moving/shooting, but may be done after receiving the target coordinates from MATLAB. The clock will stop when the launcher returns to the home position and turns on its IR LED again, after which the launcher may not move/shoot again. If your Arduino fails to provide valid start/stop signals, then you will be assigned a time of infinity for tiebreaker ranking.

Rules

1. *Autonomous Operation:* The only method of controlling your launcher is via the Arduino Romeo microcontroller. The only input allowed to the Arduino are the row, column coordinates of the battleship locations, communicated by MATLAB over the serial port prior to the start signal. The launcher **cannot** be touched after the set-up time has expired. The launcher **cannot** be remotely controlled.

2. *Time Limits:* Five minutes are allowed for set up. 120 seconds are allowed for completion of battleship locating and shooting.

3. *Competition Projectiles:* Official projectile ping pong balls will be provided by the instructors the day of the competition and will be the only ones used for the competition.

4. *Launcher Apparatus:* You are only allowed to the use the materials provided you in lab:
   - Makeblock parts including servomotor and DC motor
   - Arduino Romeo (only one can be used) and power supply
   - Your solenoid that you made in lab
   - Limit switches and IR LED/sensors provided in lab

5. *Modifications to Launcher*: Your launcher should be assembled according to the instruction manuals provided in lab. No modifications to the Makeblock launcher are allowed with the following exceptions:
   - You may alter the link lengths on your fourbar mechanism if you feel this is strategically beneficial, but do so at your own risk. The link lengths we have chosen for you should work well. Note that your linkage will have to position the launcher at a proper height with respect to the reloader, which is at a fixed height.
   - You may choose where on the launcher trough to mount your solenoid, and are free to use various attachment methods (e.g., rubber bands, velcro straps, etc.). Again note that any changes you make will need to be compatible with positioning the launcher for reloading.

6. *Reloading:* The trough of your launcher may only contain one ping pong ball at a time. You will start with one ball placed in your trough during setup. Your reloading mechanism, which is capable of holding 5 additional ping pong balls, must be used to reload all additional balls. No additional balls may be added to the reloader.

7. *Restrictions on Arduino Code:* Your Arduino code must compute the launch angles using an equation (lookup tables are not allowed). You may choose to calibrate and use your own empirical equation(s) if you feel it gives you better performance than the physics-based equations. You may use two different solenoid power levels to shoot the balls (e.g,. high power for far targets, low power for near targets) if you feel it gives you a strategic advantage, but no more than two power levels will be allowed. You may also use two different equations or parameter values (e.g., you can use two different values for initial velocity depending on your solenoid power/target distance), but no more than two.

8. *Disqualification:* Any team that violates competition rules will be disqualified.

9. *Logistics:* Due to limited time, each team will only be guaranteed one chance to compete. In the event that some unforeseen circumstance outside the team's control interferes with the performance of their launcher, they may be granted an opportunity to recompete at the discretion of Dr. Mascaro and the Project TA, whose judgments will be final.

10. Questions concerning the project or these rules (e.g., Does our strategy "push" the rules?) should be directed to the Project TA (Andy Pamp) as follows:

    ▪ Confidential questions: Send Andy a message in Canvas

    ▪ Non-confidential questions: Post your question to the Project Discussion in Canvas

    You do not want to spend a lot of time and effort on a strategy that will not be allowed.

11. Any ambiguous situations not covered by these rules will be decided by Dr. Mascaro and the Project TA, whose judgments will be final. The rules may be amended if necessary to preserve the spirit of the contest. Answers to questions posted to the Project Discussion will be considered official rulings. Major amendments to the rules will be posted in the Project Assignment. **It is your team's responsibility to check the Project Discussion and Project Assignment regularly.**

Awards

Prizes (TBD) will be awarded to the top-scoring teams. **Students on the top six teams may elect to skip the Final Exam**, but only if their grades are already above the class average. Do NOT plan to skip the final exam until you hear from Dr. Mascaro that you have met the eligibility criteria. If a student is eligible and elects to skip the final exam, he/she will be assigned an equivalent final exam score equal to their semester average. If a student is eligible to skip the final exam, but chooses to take the final exam anyway in the hopes of raising their grade, their final exam score will only be counted if it raises their semester average.