

You have entered the SAFARI ZONE! Each partnership has been given six Safari balls and two and half minutes to catch up to six PoKéMoN in the Safari Zone. The best PoKéMoN trainer team will be the one who catches the most PoKéMoN in the shortest amount of time. Each lab group will represent one of the following teams: Valor, Instinct, and Mystic. Win glory for your team and immortality for yourself as you CATCH 'EM ALL!!!

Your **Arduino program** must be able to autonomously:

- 1. Receive target coordinates from MATLAB running on a laptop computer
- 2. Turn on an IR LED to start the clock while your launcher is in the home position
- 3. Compute launch angle and lateral position required to hit the target coordinates
- 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 stop the clock

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

- 1. Find target coordinates in an image file provided at the competition
- 2. Mark and display the centroids of the targets on the image to verify acquisition of the coordinates
- 3. Transmit the target 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 linear stage/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.

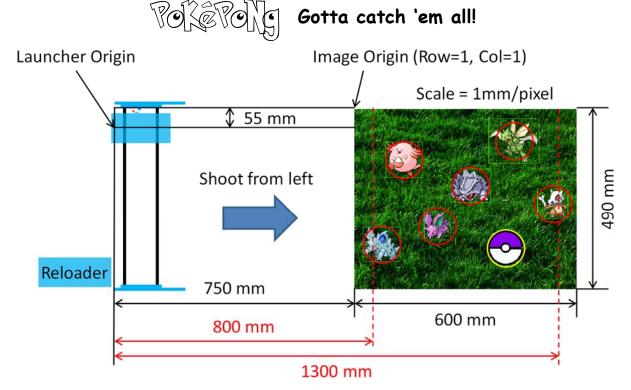


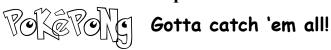
Figure 1. Satellite image orientation and offsets

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) Pokémon surrounded by a rectangle composed of a single color (e.g., all pixels in the enclosing rectangle will have the same R, G and B values). The linewidth of the enclosing rectangle will be one pixel. The background may vary, but there will be no other pixels in the image with the target R, G and B values. The image will also have a Pokéball. The R, G, and B values of the top and bottom halves of the Pokéball will be used to determine the R, G, and B values of the rectangles that enclose the Pokémon (see Demo 5 for more information). The dimensions and locations of the enclosing 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.

Timing

A maximum of 150 seconds are allowed for completion of targeting and shooting. The clock will start when the launcher turns on its IR LED in the home position, which will be done <u>after</u> receiving the target coordinates from MATLAB but <u>before</u> calling the targeting functions (to compute the required launch and servo angles) and starting to move/shoot. 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.



Scoring

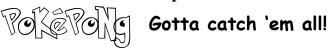
Type of Points	No. of Points
Image Processing	1 point each for correctly locating and displaying target centroids on provided image
	(max possible 6 points)
Shooting	3 points each for landing* ping pong ball in each hole
Accuracy	(max possible 18 points)

^{*}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 targeting (computing the required launch and servo angles) and shooting.

Rules

- 1. Autonomous Operation: The only method of controlling your launcher is via the Arduino Romeo microcontroller. The only inputs allowed to the Arduino are the row, column coordinates of the target 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. 150 seconds are allowed for completion of target locating and shooting.
- 3. *Competition Projectiles:* Official projectile ping pong balls will be provided by the instructor on 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 Cannon Assembly*: Your cannon assembly should be assembled according to the instruction manuals provided in lab. No modifications to the Makeblock cannon assembly are allowed with the following exception:
 - You may alter the link lengths on your fourbar mechanism if you feel this is strategically beneficial, but you are strongly encouraged to discuss your reasoning and choice of link lengths with Dr. Mascaro before making the modification. Note that your linkage will have to position the cannon trough at a proper height with respect to the reloader.



- 6. Modifications to Reloader: Your reloader should be assembled according to the instruction manual provided in lab. The reloader base must straddle the reloader alignment beam on the docking station. The alignment beam restricts side-to-side adjustment of the reloader position, but does allow a range of distances between the front of the reloader and the linear stage positioning beam. No modifications to the Makeblock reloader are allowed with the following exception:
 - You may change the height of the reloader trough by attaching the 1x5 beams in different holes in the C bracket.
- 7. *Reloading:* The trough of your cannon may only contain one ping pong ball at a time. You will start with one ball placed in the cannon trough during setup. Your reloading mechanism, which is capable of holding five additional ping pong balls, must be used to reload all additional balls. No additional balls may be added to the reloader, and the reloader **cannot** be touched after the set-up time has expired.
- 8. 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.
- 9. *Disqualification:* Any team that violates competition rules will be disqualified.
- 10. *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 re-compete at the discretion of Dr. Mascaro, whose judgment will be final.
- 11. Questions concerning the project or these rules (e.g., Does our strategy "push" the rules?) should be directed to Dr. Mascaro as follows:
 - Confidential questions: Send Dr. Mascaro 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.

12. Any ambiguous situations not covered by these rules will be decided by Dr. Mascaro, whose judgment 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.

Reference Gotta catch 'em all!

Awards

Prizes (TBD) will be awarded to the top-scoring teams. Students on the top three 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.