CMSC477: Robotics Perception and Planning
Project 3: Teamwork Makes the Dream Work

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Competition Day: May 17, 2023, 10:30am - 12:30pm, ~~1:30 to 3:30pm~~ (RAL Lab)
There will be a prize for 1st place
Report Due: May 19, 2023
It is not possible to use late days because the final exam time will be used for the competition.
There will be no extension.

Introduction:

In this project, you will compete against another team to collect the most lego bricks autonomously. Each team will use two robots to autonomously pick up, pass, and place LEGO blocks as shown in Figure 1. The arena will contain obstacles at unknown locations. One robot must remain in the left half of the arena and the second must remain in the right half. The object's initial location will be in the right half and the target location will be in the left half for each team. The number of studs on a LEGO equals the number of points it is worth. The team with the most points in 5 minutes wins. An animated description is given below:
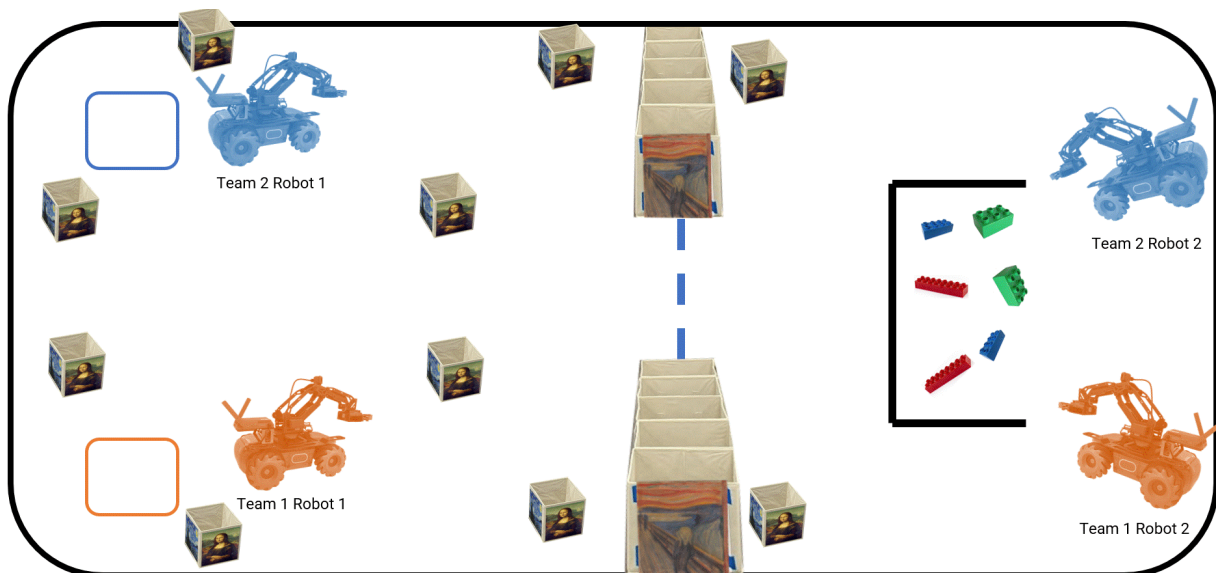

Figure 1: Animation of Project 3 Competition. Robots cannot cross the blue dashed line. Pictures will be mounted on cubes scattered around the arena for -. The number of studs on a LEGO is the number of points it is worth. The team with the most points in 5 minutes wins.

Competition:

1. Two teams will be competing against each other at once.
2. One robot of each team will remain in the right half of the arena. In this half, LEGO blocks will be scattered around.
3. One robot from each team will remain in the left half of the arena. It will take LEGOs from the first robot and place them in it's team's basket.
4. The number of studs on a LEGO is the number of points it is worth.
5. All types of LEGO blocks will be used. They will not be attached to any other LEGOs.
6. The team with the most points at the end of 5 minutes wins!
7. Creative strategies such as taking other teams LEGOs from the final location is allowed.
8. *You may not block the narrow point by the blue line for more than 20 seconds.*

Requirements:

- The robots must be completely autonomous
- The robots must be able to avoid moving obstacles (other teams robots) and maneuver around static obstacles whose positions are not known beforehand.
- Do not use AprilTags for the final demonstration
    - You can use AprilTags before the final demo to help "bootstrap" the system
- The robot's wheels should not cross the blue line separating halves of the arena

Suggestions:

You are free to accomplish this project in the manner of your choosing. However, we make the following suggestions:

- Reuse concepts and code from Projects 1 and 2.
- Make a concrete plan for your final system early in the project, but be quick to revise the plan as the project proceeds. Talk with your TA about your strategies.
- Make a rough schedule for when you expect to achieve certain capabilities and revise it frequently.
- Use communication between the robots to perform tasks in parallel.
- Use visual odometry to and estimate robot pose as taught on Apr 4, 2023 .
- Detect obstacles using YOLO or geometric concepts from visual odometry).
- Do not separate each team member's work with the intention of "integrating" everything at the end. Instead work together on a single unified program and incrementally add features and capabilities.
- Use simulation to speed software development and test corner cases.
- Be creative!

Grading:

- Demonstrate navigation from point A to B an environment with static obstacles at unknown locations using visual odometry: 20 points
- Demonstrate avoidance of dynamic obstacles: 20 points

- Participate in competition: 30 points
- Get at least 5 LEGOs to the goal location in 5 minutes: 10 points
- Report: 20 points
- Bonus: Use a search based planner or other sophisticated method to dynamically determine an optimal policy for maximizing points. 20 points

Submission Guidelines:

Please submit a video and PDF report. The video should show your team's demonstration and any relevant animated visualizations. The report should have the following sections:

- Introduction
- Block Diagram
- Link to and description of demonstration video (Google Drive or YouTube)
- Methodology
- Results
- Conclusion
- Appendix A: Code Listing

Collaboration Policy:

You can discuss the assignment with any number of people. But the report and code you turn in MUST be original to your team. Plagiarism is strictly prohibited. A plagiarism checker will be used to check your submission. Please make sure to cite any references from papers, websites, or any other student's work you might have referred to.

FAQ:

- Do the LEGOs need to be passed without touching the floor?
  - No
- Can we block the narrow point near the blue line?
  - No. You may block the narrow point for no longer than 20 seconds.
- Did the time of the competition change?
  - Yes there was a typo. The day is the same, but the time has changed.
- What color will the basket locations will be?
  - Currently blue and red. Ivan is going to paint them this week (April 5th, 2023)
- What color will the "U" shape around the LEGO's be?
  - We will be using the U shaped structure pictured below

- Can robots reach over the "U" to grab LEGO's?
  - Yes, but you won't be able to reach the ones in the center
- Can we take LEGO's from another teams basket or if they drop them?
  - Yes
- Can we run into the other team's robots?
  - There should be no collisions when you can see the other team's robot.
  - If the crash occurs, the team responsible for the crash will lose 4 points.
- What types of LEGO's will be used?
  - LEGO's will be stacked 2 blocks high in 2x2, 2x4 and 4x4 stud configurations
- What colors will the LEGO's be?
  - Each configuration (2x2, 2x4, 4x4) can be any color
  - Each stack of legos will be a single color
- What will the arena walls be made of?
  - Orange cones about 2-3 feet apart
- What will the stationary obstacles be?
  - Storage cubes with pages from academic papers taped on. Same for walls.