CMSC730 - Fall 2026
University of Maryland

[Robot Competition]

Rapid-Prototype Robot Competition

Abstract

In this Project, you are going to form groups of two and collaboratively design and prototype a working bridge-crossing robot. The robot design is under given constraint and will fulfill given tasks at the competition. Please read this document **THOROUGHLY** before starting on the project.

Team

Unlike the weekly assignment, in this robot design project you will pair up with another classmate and work together on the design. Although, as we have an odd number of students, we will reserve 3 spots for students who would like to work on this individually. The compensation for you working by yourself, is that your grade will have a 1.3X multiplier (caps at full). We have opened a number of groups on ELMS. You can sign up yourself to one of the groups like how we did for the semester-long project.

Design Target

In this competition, we challenge you to design a tether-less robot that is remotely controlled to move on a "bridge" and cross some obstacles (Figure 1). Below is the target design goal of your robot.

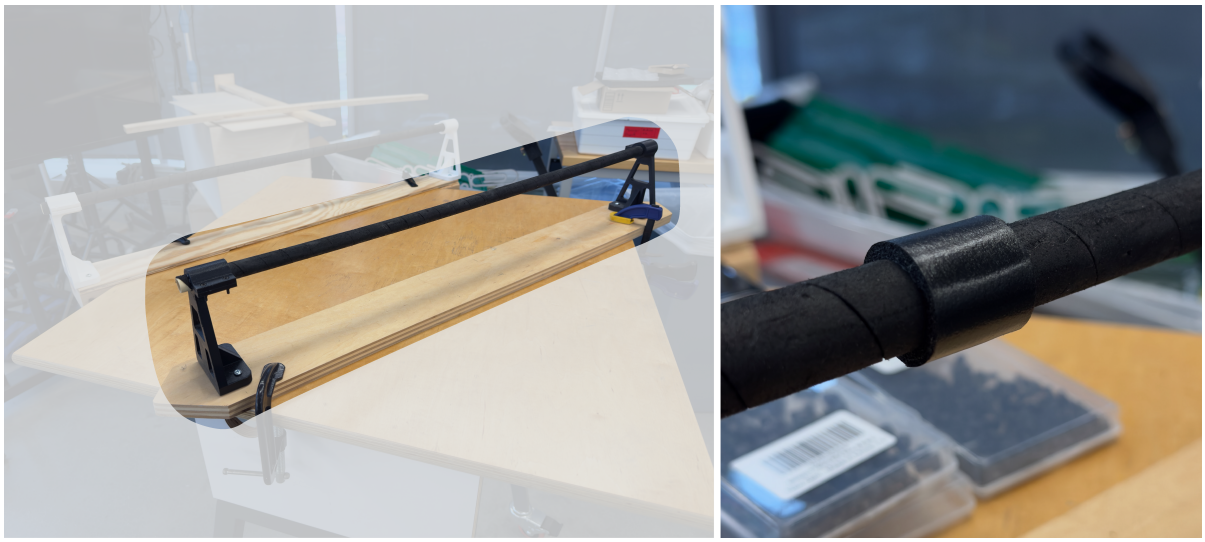

Figure 1: Bridge setup: left is the bridge that your robot will cross, right is the bump obstacle.

1. Your robot will start behind a start line (will be marked with bright marker on the day of competition) on the bridge, go through a bump, cross the finish line (marked on the competition day), and stop. Each group will be given two chance (On the mark of robot start moving). Accomplishing this task partially will be granted partial grade.

2. You will design the robot with the ESP32 microcontroller and **only ONE stepper motor** from your kit. The instructor and TA will pick 2 of the most outstanding mechanism design and award bonus credit (worth 10% of the total points of this project) to the two groups.

3. Your robot will be powered via a battery of your choice. By default we provide two **shared 5V USB power bank**. If you are using the shared power bank, please design your robot so that the power bank can be easily accessed.

4. Your robot has to be controlled remotely. This can be through 1) WIFI network. 2) Bluetooth, 3) IR switch from your kit. If you choose to use WIFI or Bluetooth, you can choose to issue the control from either a laptop, a phone, or a custom controller made with another ESP32 module.

5. You should design your robot with a "body" to affix all the parts. All components including motor, power bank, breakout board, bread board, etc, should be properly installed and constraint mechanically. If any of the components can be directly removed from your robot body by hand without extra strength, tools, or effort will be considered as "not properly installed." All forms of glue and tape are also not allowed.

6. Your robot body should contain at least one part that is made with laser cutter with a justified reason (e.g. laser cut large-area flat piece with 2D features is more efficient than other processes; or you want a see through window to monitor internal part and acrylic is hard to 3D print but easy to laser cut)

Logistics

To accommodate this competition and your robot development, Sandbox is generously offering a spot for you to test your prototypes along the way. We will use the same setup to hold the competition. Please make sure all the items at the "development center" won't leave sandbox. The setup includes:

1. The "bridge" your robot will be crossing.

2. 2 of USB power banks for sharing and their charger.

3. M3 and M4 hardware set. (We only have limited number of that that should sufficiently supply all your designs, do not take extra hardware with you).

Please charge the power bank before you leave.

Please respect Sandbox rules and the resource they provide for us.

Hints

- Robot Design Degree of Freedom. Since you are only allowed 1 motor, so that is going to be the only source of kinematic energy. Feel free to come up with any kinematic chain to fulfill the task, but this can also be as simple as one rotational wheel.

- Center of Gravity. During the testing you might find your robot not willing to stay on the bridge because it is "top-heavy." You should try to put as much weight below the bridge and balanced left-to-right, front-to-back to make stable traveling happen.

- You can create mounting hole patterns in arrays to test for the best mounting location between parts in order to adjust and fine tune the balance of your robot on the bridge.

- Consider how to install and uninstall your robot to the bridge. This can be done with either quick release mechanisms, or design to hang the robot on the bridge directly.

- Certain parts that are large in area and only have 2D features (anything that can be created with one extrusion operation in Fusion 360) are good candidate for laser cutting, as it takes much less time to iterate using laser.
- Certain reversible latching/affixing structure will be needed to accommodate fast install/uninstall process of the shared power bank. Remember once the power bank is installed it should also be well constraint.
- Useful libraries to start exploring with: WiFi.h, BLEDevice.h, BluetoothSerial.h.

Delivery

There are two deliverable items other than the competition. The deliverable files will be 50% of the total grade for this project, and the competition will be used to grade the rest 50%.

Items to submit on Elms:

- Upload your control code.
- Your Fusion file(s) for your robot assembly. This will be a ".f3d" file or ".f3z" file following the same naming convention as above (except for the different file extension name). Please try to upload your file to a new repository to make sure your models will load correctly. The file should contain all the 3D models you make and the motor model. Bread board and the power bank is not required to be presented in this file.
- Please also include a video of your robot in its complete stage moving on the bridge, tetherless, and remotely controlled. You can include the unlisted video link in your submission comment.

*Please zip all files into a ".zip" file and name it in the following format: "group_GROUPNUMBER.zip". The file should be uploaded to ELMS under "robot competition".

Competition day: The competition will be held in Sandbox, please arrive on time. Groups will take turns to run their robots on the bridge setup, we will record the entire competition for archival reason, in case we need to reference it for grading. As only one group will be running their robot at a time, the group after them should start installing the power bank. Before you setup your robot on the bridge, the TA will conduct "tech check" and grade on the mechanical design. We will time your runs with a stop watch for two laps, and take the faster one on record. After your run, please sign your name (at least one out of the two group members) on the lap time record.

Due Date

Th Apr 16th, 3:30 PM EST

Last Modified Date: Mar 7th, 2026