



WPI

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RBE 1001: Introduction to Robotics C-Term 2019-20 Final Project: Overview

1 Overview

The goal of this project is for you to demonstrate that you can apply the technical skills and design techniques that you have developed in class over the course of the term. To do that, you will design, build, and demonstrate a (semi-)autonomous system that can complete a challenge, specifically a robot that can deliver 'pizzas' to various floors of the 'dorms' on the competition field. Some of the system operation will depend on sensor-based autonomy, and the rest will rely on tele-operation by your team. While the original competition was conceived as a head-to-head, coalition-based event, your system will be evaluated primarily on its own through a series of design reviews, demonstrations, and a final report. There will also be a competition at the very end of the term.

Detailed rules for the challenge are provided to you in a separate document. While these rules allow for a diverse range of strategies to accumulate points, this project is intended to allow you to demonstrate what you have learned in the course. Therefore, the score for your team's performance is only partially based on the performance in the challenge, and the grade points awarded for various subtasks differ from the points awarded in the competition rules.

Your completed design must be sufficiently ambitious to demonstrate understanding of the core mechanical, electrical, and programming fundamentals of this course. Important topics include drivetrain analysis, power transmission, sensor integration, and programming for autonomous control.

2 Game objectives and arena

The arena is set up in the Robotics Lab and is a large, table top field with several structures on it. The red and blue, multi-level structures represent dorms where you need to deliver pizzas: small, wooden squares about 6" on a side. Your robot can obtain pizzas either by picking them up off the ground or by being "handed" one through the pizza slot on the side of the arena. Your robot should then proceed to a dorm and deliver the pizza. The more pizzas you deliver, the more points.

There are other ways to score points, including navigating to particular areas in autonomous mode and moving the green structure to one side of the arena. You can also score points by lifting your robot off the ground using one of the beams near the center of the arena. A complete list of rules will be posted – we're putting the finishing touches on some updates – but this overview should help you identify the *functionality* of your BaseBot.

For part of the demonstration/competition, your robot will act autonomously, with no intervention from your team. Navigation aids have been placed on the field to help your robot move around the arena during autonomous mode. These aids include tape to mark paths and boundaries and colored objects that can be detected with a camera (we'll do a lab with the vision sensor later). You have

a number of sensors in your Lab Kit that can be used to detect the robot's surroundings. For the remainder, your robot will be controlled using remote control.

3 Design reviews

Your design will be evaluated at four different design reviews in the term. The first, the Preliminary Design Review (PDR), is intended to evaluate how well you have understood the project requirements, and the fundamentals of your design. The second, the Intermediate Design Review (IDR), takes a closer look at the realized mechanical design and evaluates your plan for autonomous function. The third, the Comprehensive Design Review (CDR), gives your team the opportunity to demonstrate how your system achieves the subtasks within the competition without any other teams on the field. The final opportunity to earn grade points for your system is at the Optional Extended Demonstration (OED), where the competition rules are strictly enforced. The OED gives your team the opportunity to demonstrate any subtasks that were not functional at the CDR and it's a lot of fun.

Your system design will be documented in a project report; guidelines are described in a separate document. While your report will present technical details, it will also include descriptions of your design processes, including test results, justifications for design decisions, and so forth. Intermediate deliverables are geared towards supplying the information that will be contained in the report. With careful planning, you will only need to make small additions to your report after the CDR (a summary of the performance). Note that design changes are encouraged after each design review; these steps are intended to give you multiple, early opportunities for feedback on your design and strategy.

3.1 PDR

The first formal design review will take place early in the term. It will be a summation of your preliminary design work, including descriptions of your objectives and understanding of the requirements, system functionality, and the results of your ideation activities. You will also be expected to lay out your future plans for completing your robot. Your team will present your preliminary design to a panel of instructors and peers. Criteria will be presented in the formal Assignment on canvas.

3.2 IDR

The second design review will occur a couple of weeks before the end of the term. Your team will demonstrate the mechanical integration of your system and plans for continued development, most notably your strategies for autonomous operation. You will be expected to show test results and other objective rationales for your design decisions. Your team will present your design to a panel of instructors and peers. Criteria will be presented in the formal Assignment on canvas.

3.3 CDR

The Comprehensive Design Review is your team's best opportunity to demonstrate the capabilities of your system. The CDR will take place during the final lab session. Your team will be assigned

a specific window of time to present your system and demonstrate it to the Instructors/TAs. Your team will present your system to a panel of instructors. Criteria will be presented in the formal Assignment on canvas.

3.4 OED

Your team will have a limited opportunity to demonstrate additional system capabilities on the evening of the final lab. Teams will be scheduled to compete in four matches with assigned collaborators and opponents. Your team will be responsible for getting an instructor's attention to recognize the additional capabilities. The evaluation criteria in the OED will be essentially the same as in the CDR.

4 Report

Guidelines for the final report are provided elsewhere.