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

Last modification: February 21, 2020

The Final Report is an opportunity for your team to demonstrate that you built the best robot you reasonably could for the task at hand. To do that, you will need to demonstrate you identified the core functionality of the robot, considered a wide set of options for each of those functions, and performed the necessary analyses and experiments to decide among those options. Finally, you'll show that you combined all your concepts into a well-functioning system.

The report is also a chance for you to work on technical writing and to demonstrate the technical skills that we have covered in this course.

Structure

Organize your report as described below. The main body of the report should describe findings, rationales, etc., but leave the detailed analysis to the appendices. Some of the material already exists from previous assignments, but be sure to look at the comments from those before you incorporate it herein. Just to be clear: your final report is not just a compilation of previous work – it incorporates previous work, but also builds on it.

When describing your decisions, avoid writing a "diary" of what you did: "first we tried this, but it didn't work, so we tried that, but then we realized that we needed more duct tape..." Clearly, adjustment is part of design, but focus on the alternatives and discuss why one is better than the other: "We investigated how rubber bands on the intake mechanism affects performance. As shown in Figure X, adding two rubber bands to the roller mechanism greatly improved the ability to intake pizzas."

Be sure to include the following sections:

Title page. Attach a title page with your names and an attestation, signed by all, of the division of labor on the project as a whole. Deviations from equal effort will affect individual grades. A sample cover page is provided.

You do not need a Table of Contents or List of Figures (traditionally included in RBE 1001 reports, but you have enough to do already).

Introduction and overview. Give a brief (two sentences or so) overview of the project – we know what you're doing, but frame it in your own words. Give a descriptive overview of your final system, concentrating on the main functionality and components (drive train, lifting mechanism, pizza manipulator, control algorithms). You don't need all the details here, just something to provide context for the rest of the report. For example, describe the high-level hardware you used to lift the pizzas, but save any CAD drawings and descriptions of performance for later. A clear figure or image of your BaseBot is essential.

Solutions and justifications. For each of the core functions,

- Describe the functionality and related challenges and constraints. E.g., "The dorms are X inches tall, and our lifting device had to be able to reach the top floor."
- Describe briefly some of the ideas that were considered. Don't describe "throw away" solutions (e.g., "Building a quadrotor from scratch...").
- Describe the activities you used to decide among competing ideas. Keep in mind that some decisions are easy and don't need much justification – others require a deeper consideration of constraints and trade-offs. Describe any analysis and experiments you performed to help decide among competing solutions.[1] Your decisions should reflect back on the constraints (e.g., "Using method X for navigation was shown to be more reliable than method Y, and reliability is very important."). Some of your justifications may sound obvious, but it's easy enough to state them – be complete!
- Describe analysis and experiments you performed to implement a specific solution (but put detailed calculations and experimental results in an appendix).
- Describe the final implementation, including a figure with your BaseBot (picture or drawing – no need to use CAD, but if you have a CAD model, include it) and important implementation details. Another student in the class should be able to pick up your report and understand your how your robot works.

System integration. Describe the complete system and the overall integration. Describe the overall strategy of your system as it performs its mission. For example, you might walk through the steps that the robot does during autonomous delivery or describe what happens when you're pushing Gompei. Include results of system testing:

- Recap the testing from the IDR. You don't need to go into the same detail that you did for the IDR assignment, but summarize the test results. You may cite your IDR results; "As shown in the experiments we did for the IDR, our robot is able to reliably traverse the speed bump in under 5 seconds.
- *You are expected to present new test results as well*. The purpose of the IDR was to get you experience with integrated testing – here is your chance to demonstrate that you can apply those skills to your project. For example, your IDR testing focused on functionality, but you'll likely want to do significant testing of autonomous capabilities. Present a summary in your report and attach graphs, figures, or data in the appendix. These tests should focus on proof-of-performance.

Performance. Describe how your BaseBot performed during the trial(s). It should be detailed enough that someone could assess a grade for performance from your report. Describe how well it met your expectations and how other solutions or improvements could potentially improve performance, where needed.

Appendices. Detailed calculations, experimental results, and code snippets should go in appendices. Power or torque calculations; state machines all go here. There will be a separate place to submit code, so don't attach any here.

Code. Code will be submitted elsewhere. Your code should be well-documented Most notably, you should have a comment describing each function at the start of the function.

[1] With the time constraints of the class, it is understood that you may not have had as much time to explore alternative solutions as we would like. Don't make stuff up just to please your instructor. When it comes to grading, the focus will be on your decision making, so even if you didn't explore many alternatives with prototypes, still give a rationale for your choices!

Formatting and particulars

Every report should be in .pdf format, double-spaced with 12 point font and adequate margins. It should be submitted electronically via Canvas. We expect the main body of the report to be 8-12 pages long. All figures/drawings must be clearly labeled, have a caption and a figure number.

Lack of proofreading (and spell-checking) can turn an otherwise excellent report into a mediocre one. Clarity in writing and in presenting figures and diagrams is of utmost importance. If you include images of whiteboard calculations, the letter/numeral size must be approximately equal to 12 pt font and they must be **very clear**. Be sure to include all significant calculations with appropriate units. Sketches (if they are readable!), photos, or screenshots are very useful. Be sure to include a sketch or photo of your final configuration. In most cases a figure and its caption should be self-explanatory, independent of the text. If it is not, the caption should state where the reader should refer to in the text for further explanation.

Report Evaluation Criteria

Your report will be graded on both content (80%) and presentation (20%), which includes mundane, but important, tasks like formatting and style, clarity, and organization. For content, the main focus should be on the integrated system and its performance. Don't short-change the functional descriptions, but if you did well on the previous assignments, you're mostly just organizing and clarifying; if you needed more work on those assignments, you will need to show improvement.

Though the bulk of the weight is on content, don't let poor style get in the way of good content.