MAE/CpE 412 Mobile Robotics
Fall 2024 Final Project

Word Writing Challenge

Request for Proposal

Issued: Oct. 22, 2024
Individual Pre-Proposal Due: Oct. 31, 2024
Full Team Proposal Due: Nov. 19, 2024

Introduction
This is a formal request for students to propose the technical and management plans for your final project. This Request for Proposal (RFP) document explains the project objectives and requirements, the proposal format, and the final report format. Each student is first required to submit a pre-proposal independently. Several project teams will then be assigned by the instructor, each with 5-6 students. A full proposal with a comprehensive plan and preliminary results is requested from each team. The final deliverables of the project will include robot demonstrations, short team presentations, and a project final report.

Mission Objectives
The overall mission objective is to allow a mobile robot to autonomously write English words on the floor. The word writing activity can be supported with robot dead-reckoning or through recognition of features in its surrounding environment using Lidar or camera sensors.

The developed algorithms will be first demonstrated in a computer simulation and later on a SMART robot. In each trial, each team will be provided with a 3-6 letter word. The robot would then be required to use driving to display this word (any font type is allowed).

A robot simulation software package based on Cameron Salzberger's iRobot Create MATLAB simulator is available on eCampus. Only the measurement data with noises (instead of the Truth data) are allowed to be used in your code. Also, try not to use the localization solution provided by the simulator because these will not be available on the actual SMART robot. One SMART robot will later be provided to each team (after a few training sessions).

The first competition trial will be performed offline. The day before the actual competition day, each team will be uploading to a Google drive a pre-recorded video of the SMART robot driving a word in an environment chosen by the team. For this run, the word is "ROBOT". A team will score 10 points for successfully completing this task.

The in-person competition will include two trials with a word provided right before each trial. After the robot displayed a word, visitors and other students not on the same team will be asked to guess the word. If more than 50% of the guesses are correct, the run would be declared as successful. A team will score 10 points for successfully completing each trial.

The combined score of the three trials (one pre-recorded and two in-person) will be the final score for each team. The winning team(s) will be the one(s) with the highest combined score. If there is a tie, the team with the highest guess rates will be the winner.

For all the demonstrations, the robots need to be fully autonomous, without the need for human's help other than starting the program. Each trial will have a 5-minute time limit. If a robot is shown signs of not being productive (e.g., frozen or performing random or repetitive motion for an extended period), it will be asked to be turned off and removed from the competition field.

The main educational objective of this project is to apply knowledge you learned during and outside of the Mobile Robotics class into solving a practical robotics problem. Furthermore, you will practice how to write technical documents and how to work effectively in a team environment.

Technical Challenges (Gu's take)

There are several technical challenges for this final project:

1. Perception – e.g., wheel-inertial odometry, feature-based localization in the environment.
2. Handling uncertainty – modeling and propagating uncertainties over time.
3. Robot control, decision making – path planning and controlling the robot to follow the desired trajectory, deciding on the proper actions.
4. Software systems integration and testing – getting subsystems working together in a seamless and reliable fashion (*note*: this part typically takes the longest time).

Individual Pre-Proposal Requirement

The pre-proposal should include one cover page and no more than three single-spaced pages of technical discussions in font size 12. The following components are required for the pre-proposal:

1. Cover page (1 page)
2. Technical discussion (no more than 3 pages, single spaced, font 12)
    a. Introduction and objective
    b. A literature review of relevant papers/articles (review and summarize at least 10 articles in a coherent section)
    c. Proposed technical approach (with plans on how to address each of the four technical challenges listed above)
    d. Preliminary findings through simulation studies (report tests performed, results, insights, challenges, and potential solutions)
    e. Related experience of the proposer
3. References (as needed, no page limit)

Please use the IEEE format for the "Reference" section. The IEEE format can be found here: http://www.ieee.org/publications_standards/publications/authors/author_templates.html

Full Team Proposal Requirement

Teams will be assigned by the instructor. One full proposal will be submitted by each team. The following components are required for the proposal:

1. Cover page (1 page)
2. Executive summary (1 page)
4. Table of content (1 page)

5. Project description (no more than 6 pages, single spaced, font 12)
    a. Introduction and objective
    b. Literature review (review at least 10 related papers)
    c. Proposed technical approach
    d. Preliminary results (simulation, physical experiments, lessons learned)
    e. System integration and testing plan
    f. Project schedule (includes tasks, milestones, and internal deadlines)
    g. Potential risks and risk management plan
    h. Team qualification
    i. Project management and individual responsibility
6. References (as needed)

Approval

Each proposal will be reviewed and graded by the instructor. A proposal with grade equal to or above 60% will be approved. A proposal with grade below 60% will be rejected and a revised proposal will be requested.

Final Project Report Requirement

The final project report can be modified from the team proposal. Within this document you should address issues in the proposal, add updates, demonstration results, and a workload distribution table (*i.e.*, peer review). The following components are required for the final report:

1. Cover page (1 page)
2. Project summary (1 page)
3. Table of contents (1 page)
4. Project description (no more than 8 pages, single spaced, font 12)
    a. Introduction and objective
    b. Literature review
    c. Technical approach
    d. Demonstrations
    e. Project management
    f. Conclusion
5. References (as needed)
6. Appendix (as needed)

In the "Demonstrations" section, provide a description of the demonstration results (with data and figures) and issues encountered. In the "Project Management" section, include a *workload distribution table* that summarizes the contribution of each team member (in percentage) for each of the main tasks (e.g., document writing, perception, path planning, robot control, software integration, testing and debugging, and project management). In the "Conclusion" section, discuss what you have learned through this project and what could be done differently if you were starting over again. In the "Appendix" section, attach the source code.

Final Project Score

The final project will contribute to 20% of your final grade of the class. This means a total of 20 points with the following distribution:

- Pre-proposal: 4 points

- Full proposal: 4 points
- Successful demonstration: 3 points
- Competition result: 2 points for the No. 1 team and 1 point for the No. 2 team
- Team presentation: 2 points
- Final report: 2 points
- Individual contributions to the team (peer-review): 3 points

Important Dates

Oct 31, 2023 – Pre-Proposal Due
Nov 19, 2023 – Full Proposal Due
Dec 09-13, 2023 – Project Demonstration and Team Presentation
Dec 16, 2023 – Project Report Due

Useful Resources

- Robotics, Vision and Control: Fundamental Algorithms in MATLAB
  http://link.springer.com/content/pdf/10.1007%2F978-3-642-20144-8.pdf
- MATLAB Robotics Toolbox
  http://petercorke.com/Robotics_Toolbox.html
- Search Google Scholar (https://scholar.google.com/) for related papers.