Project Information for Autonomous Space Robotics (ROB-GY 7863, CSCI-GA 3033 7863), Fall 2025

1 Overview

- Project 1 is to design a physics-based simulator for a space mission.
- Project 2 is to design an autonomy solution (can be control, perception, planning, or learning) for that mission.
- Both projects will be graded on three deliverables: (i) proposal, (ii) 5 minute presentation to the class with 2 minute Q&A and (iii) 2 page IEEE formatted report.
- Goal of project is to dive into an application and technical topic from the class that students wanted to explore more, and then test your ability to learn, develop, and communicate. You are encouraged to ultimately export a video of your mission working and include it as part of your portfolio. Groups of 1-3 are allowed.

2 Deadlines

- Project 1 Proposal is due on September 29th 2025, submitted on Brightspace
- Project 1 Report is due on October 13th 2025, submitted on Brightspace
- Project 1 Presentation will take place in class on **Tuesday** October 14th (Note that Fall Break is on our usual time on **Monday**, October 13th)
- Project 2 deadlines are TBD.

3 Project 1 Proposal Details

- Submit a mission or operation concept to Brightspace. In a few sentences, explain the motivation of the mission, the expected contribution for simulation, and the expected numerical experiment.
- The proposal must include a primary reference that you will be using for the dynamics.
- The proposal must include the names of your group members.
- The proposal topic must be space or aerospace related (planes, rockets, spacecraft, rovers, robots on moon, etc).
- Grading: based on completion.

4 Project 1 Report Details

- Must use Double column IEEE file template on Brightspace. Submit a compiled pdf. Should be copy-pastable into overleaf. Must include the following sections:
  - Discuss motivation of mission: science, economic, technology demonstration, etc. **Why should we care about this mission?**
  - Discuss related work: **what has been done already in this area?**
  - Discuss technical approach: **What are you proposing and how is different from related work?**
  - Discuss results: **What is your experiment test? What were the results? How does this validate your simulation?**
- Two pages, not including references.
- Minimum 3 figures.
- The focus of Project 1 is the simulation, so the method section must include some specific innovation on the dynamical modeling, and the experiment section must provide some thought out experiment that validates the specific innovation.
- Grading:
  - 50% technical correctness
  - 40% clarity of writing
  - 10% proposal
- See report template document on Brightspace.

5 Project 1 Presentation Details

- Present same information as in report.
- Suggested number of slides: 4-5
- 5 minute presentation plus 2 minutes Q&A.
- Grading:
  - 50% Coverage: did you discuss motivation, related work, technical approach, and results?
  - 20% Aesthetic: do your slides look nice?
  - 20% Communication: do you communicate clearly? will your peers understand what you are doing?
  - 10% Timing: do you finish on time? Additional penalties: 10 points off per minute over presentation (Q&A will not be penalized).

6 Project 2

- TBD.

7 General Advice

- Choose a mission with some existing background literature. Good sources are textbooks, journals: Journal of Guidance, Navigation, and Control, Acta Astronautica, etc. or conferences: International Astronautics Conference, etc.
- Although you will be judged on technical correctness in governing equations and control strategy, you will not be judged on feasibility if you have well-stated assumptions. For example, if you want to do this mission, you can assume there exists an ion beam with arbitrary of arbitrary power/strength.
- Choose, install, and test your physics-based simulator early. **Rika has specifically set office hours to help with this.** We recommend Mujoco, Basilisk, or manual implementations. For Operating Systems, we have tested Mac and Linux systems, but not Windows.
- For presentations, tell a simple story with figures and equations, do not put too many words on a single slide.
- If you do not know which project to do, an easy option is a formation flying controller, and find an application you think is interesting. You can also come to us to brainstorm.
- A basic test of simulation fidelity is conservation of energy: does the total energy of the system stay the same over time?
- Related work tips:
  - search for a review paper of your topic
  - reputable sources is very important: reputable sources include: top journals/conference venues, federal space agencies like NASA, JPL, ESA, JAXA, ISRO, etc. and top university labs.