CMSC 311
Robotic Agents
Fall 2019
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Lab 4
23 October 2019
Due Wednesday, 6 November, by 4:20pm

Agreement
This laboratory assignment will be completed in small teams of two or three in cooperation with at least one other team. **Each team member must follow the robotics team member guidelines** developed by the students in this class, included in the next section. Instructor will reduce the grade of the team member who fails to follow the team guidelines generated in our robotics group.

By working on and completing this laboratory assignment you agree to use the hardware given to you in a responsible manner. Each team is responsible for the safety and security of their assigned drone while it is in their possession. Team members are expected to repair the drone with the assistance of the instructor in case of an accident. Malicious unsafe operation of the drone by any team member will result in the inability of that team member to work with the drones provided by the instructor.

**You must check out and check back in the drone every time you take it outside of Doane.** To do so, one team member must fill out the sheet located on the door of the cabinet with the drones indicating the drone number and its status (checked in or checked out).

Lab Team Work Guidelines

1. **Play to your strengths:** each team member is assigned specific task(s) that tailor to their strength.

2. **Try every task:** despite possibly concentrating on a particular task more heavily, each team member will also participate in some degree in every aspect of the lab completion tasks, including robot design, robotic software development, testing, and demonstrations.

3. **Communicate any concerns:** each team member will continuously communicate with other team members, especially when any concerning issues arise.

4. **Don’t abandon your team members:** under no circumstances a team member is to stop completing their assigned tasks and attending team work meetings.

5. **Prioritize time and set boundaries:** team members are to discuss the feasibility of the project at the beginning and fill out the “Timeline” section of the report document before beginning the lab work.

6. **Plan the robotic design and team work:** team members should discuss and agree on the robotic design and its task and also how the work for the lab is to be completed/distributed in the team.
7. **Teams on GitHub**: teams are to use GitHub to commit their work regularly and to submit their completed code and the report. All team members can contribute to their lab team repository as necessary.

**Drone Safety**

Drones can be dangerous and cause injury! Additionally, Bebop drones are notoriously hard to catch. You must obey the following safety rules:

- No flying inside the buildings unless it is in the Wise Center.
- No flying over or near anyone.
- Must fly in the flying zone (Wise Center’s blue courts or public property outside).
- Use hull protection for Bebop 1 or 3D print propeller guards for Bebop 2 (the 3D printing files are provided in the lab repository).
- Use safety glasses (available in ALIC) if you are operating in the close proximity of the flying drone, especially if flying it without hull or propeller protection.
- If you are not wearing glasses, do NOT put your eyes near the propellers.
- If you decide to test your drone outside, make sure to do so outside of campus, remember flying drones on Allegheny campus is not allowed! Also, be sure to obey the FAA flying restrictions.
- Do NOT connect to drone’s wifi of another team – this is dangerous.

**Objectives**

To continue exploring the robotic platform, Parrot BEBOP, and the [pyparrot](#) Python Interface for Parrot drones. To learn how to use [opencv](#) and [pyparrot](#) interface to perform a multi-drone cooperation. To implement a multi-robot task completion using at least two autonomous aerial vehicles for an application of your choice that stems from biological inspiration. To reflect on the ethical considerations of the developed strategy.

**Reading Assignment**

To further explore [pyparrot](#) interface please read the [pyparrot documentation](#). To learn about [openCV](#) please consult [OpenCV documentation](#).

**Configuring Git and GitHub**

To access the template directory for the laboratory assignment, you should go into the #labs channel in our Slack team and find the announcement that provides a link for it. The team leader (one per cooperating teams) should accept the laboratory assignment first, create a team and set up the GitHub repository for the team to access the assignment’s starting materials and to store the completed version of your assignment. Once the team has been created, the other members of the team and the members of the cooperating team can click on the given GitHub Classroom
link and join the team. Every team member can clone the team’s lab04 repository, and use regular Git commands, such as `git commit`, `git push` and `git pull`. Please ensure your team practices standard GitHub practices to avoid merge conflicts.

**Cooperation Task**

In this lab you are invited to design a cooperative multi-drone system that accomplishes a specific task of your choosing. Using the `pyparrot` and `opencv` tools and techniques and your experience during the previous lab and class exercises, you are to develop program(s) in Python that allows a single drone to cooperate with at least one other drone to complete some task.

Since this lab is very open ended, to ensure fairness in the amount of work you dedicate to this lab, your selected application (what your robot will do) and your chosen cooperative design has to be approved by me. In general, your proposed implementation for this lab must satisfy the following requirements:

- Your problem must involve getting the robots to continuously move and to complete at least one simple cooperative task for a duration of at least one minute.
- You must cooperate with at least one other team to select problem/solution and work together to test your robots. The drones do not need to communicate to complete a cooperative task.
- Your implementation must collect some numerical data and produce at least one graph with the data over time. Choose data that is beneficial for your application. The data can include your drone’s sensor data, its flying time, time it takes it to complete a task, etc.
- Your drone should take at least five photos during its operation and record the video of its operation in its entirety.

Feel free to use any online resources and online programs as a starting point. Just make sure to cite the resources you have used outside of `pyparrot` in your report.

**Planning**

The first step should be to identify a simple application that would involve at least two drones. Then, identify the tasks to be completed for this lab with your team members and your partnering team. By the end of the day on October 30th, you must add a description (at least 3 sentences) of your chosen multi-drone system application and you must complete the planning portion in your report that includes the tasks your team has to complete and a timetable for their completion.

**Required Deliverables**

This assignment invites you to submit the following deliverables through your team repository.

1. Description of the selected application, the other team you are cooperating with, and the planning timetable portion of the report due on October 30th by 11:59 pm. The rest of the requirements are due at 4:20 pm on November 6th.

2. A properly completed and commented source program(s). Additionally, your program(s) must conform to Google style standards. Please make sure your source code is inside “src/lab04” directory in your lab04 repository. Each team’s code should be clearly labeled with ‘author’ tags inside the program(s).
3. The report, stored in `/writing/report.md` and written in Markdown, that contains the application description and the planning schedule as described above, three paragraphs, with each paragraph containing at least 150 words, and answers to a five question survey. In the first paragraph you should describe the details of your chosen task, the cooperative nature of it, and its implementation. Also, comment on the observations from the data you have collected and include your data graph. The second paragraph you should describe any challenges and learning experiences you have encountered during this lab. In the third paragraph, discuss any implications of your drone implementation with respect to drone ethics concentrating on its positive design; for example what makes it ethical, how does it benefit the society, etc. Then, answer the five questions provided in the survey inside the `report.md` file. Finally, in the last section, describe your team working strategy and identify which tasks and coding functionality which team member was responsible for. Here, also discuss how your team cooperated with another team.

4. Lab session on October 30th will be used for lab work and include reserve flight testing period in the Wise Center. Additionally, extra flight times have been booked in the Wise Center (will be posted in the Slack workspace). Lab session on November 6th will be used to finalize the lab and to give demonstrations. Videos of successful demonstrations are also accepted at this time instead of the actual demonstrations.