Preliminary Briefing, Week 3

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Background

This final year project (FYP) will build on the outcomes of a research project that I conducted in the summer of 2018. The goal of the earlier project was to devise a decentralized control algorithm for autonomous cooperative transportation of a payload (CPT) by two unmanned aerial vehicles (UAVs). The proposed algorithm relied on one UAV as a 'leader' agent and the second UAV as a 'follower' agent. Over the course of the placement I formulated a mathematical model of a simplified CPT system (constrained to motion in two dimensions) and simulated its operation using MATLAB and ROS/Gazebo. Due to limitations with time and computer hardware, it was not possible to explore the full capabilities of the proposed system – only a proof of concept that the system could be simulated. Work remains to be done in executing more complicated maneuvers, managing more than one follower and incorporating greater robustness to the environment.

Objectives

For the FYP I wish to build on my previous by developing a more complex CPT system. The title of the project will be 'A Decentralized Multi-Agent Scheme for Cooperative Payload Transportation'.

Possible extensions that I could pursue include:

1. **Executing motion control in three dimensions**
2. **Including more followers to reduce loading per agent**
3. Transportation of payloads with complex features (asymmetry, fragility, non-rigidity, non-homogeneous composition)
4. **Safely managing hardware failures**
5. Obstacle avoidance, or tracking
6. Integration of humans as ad-hoc leader agents
7. Increasing the robustness of the system to environmental conditions
8. Finding a less-computationally intensive means of navigation and localization than motion capture feedback

I have decided to pursue ROS/Gazebo simulation testing only, due to time and budgetary constraints. Tasks 5, 7 and 8 are dependent on specific components of the hardware implementation, therefore they are outside the scope of this FYP. Tasks 3 and 6 are deeper explorations of the CPT system's capabilities, so they should follow the development of the core system. Given the limited time, it would be appropriate to limit the scope of the project to achieving tasks 1, 2 and 4 as core objectives for the improved CPT system.

During the first week of the literature review, I will re-read a list of materials that I prepared for the earlier project concerning CPT schemes. In the subsequent two weeks I will search for more recently published research on CPT schemes and swarm hardware failure management, and summarize my findings as part of the Inception Report (due 5 November).

Technical Contacts

My local supervisor at KAUST was Professor Jeff Shamma (Jeff.Shamma@kaust.edu.sa), Director of RISC Lab, KAUST. I have also consulted Dr Petar Kormushev (P.Kormushev@imperial.ac.uk), who has agreed for me to use the computers at Imperial's Robot Intelligence Laboratory from mid-November onwards.

Equipment

For simulations I will need access to a PC with the following:

- CPU must be at least 2.50 GHz, with at least 32 GB of RAM
- GPU must have superior performance than the AMD Radeon R4 series
- Must have Ubuntu Linux, ROS Kinetic Kame, Gazebo and PX4 installed (freeware), MATLAB 2018 (Imperial College has an academic licence)

Project Roadmap

Stage	Task	Deadline
Preliminary Scoping	~~Meet with academic supervisor to settle research topic~~	~~Week 1, Autumn~~
	~~Allocated project supervisors~~	~~Week 2, Autumn~~
	~~Review summer progress~~	~~Week 3, Autumn~~
	~~Create detailed project roadmap~~	~~Week 3, Autumn~~
Reflection	*Inception report*	*Week 6, Autumn (5 November)*
Literature Review	Review literature on CPT schemes using UAVs	Week 6, Autumn
	Summarize findings of literature survey	Week 8, Autumn
System Design	Review and update system design (including sensor type, sensor placement, cooperation scheme)	Week 9, Autumn
	Update mathematical model of system proposal	Week 10, Autumn
Simulation	Create a visual simulation of the updated system proposal using ROS/Gazebo	Week 1, Spring
Reflection	*Interim report*	*Week 4, Spring*
Simulation	Troubleshoot and refine simulation	Week 6, Spring
Reflection	*First draft of final report*	*Final week, Spring*
	Final report	*Penultimate week, Summer*
	Presentation of results	*Penultimate week, Summer*