CP33 –
Scope and Requirements Document

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Below is the scope document for the project involving Object Detection for Simulated Drones tasks using the Gazebo Simulator. Contained in this document is the client expectations for the semester.

[Initial Project Outline]

Contents

Scope & Requirements

This project is broken into two challenge and problem components that are closely related.

Challenge & Problem 1: Simulator Tasks.

Challenge & Problem 2: Sign & Object Detection using Computer Vision / TensorFlow.

The goal of this project is for students to leave with an excellent understanding on simulation in the drone community and detection technologies such as OpenCV and TensorFlow. Students will also gain valuable project management, industry and professional experience.

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High-Level Scope Summary

This project assumes we are flying drones at low altitude at approximately 3 metres off the ground and still able to read traffic signs and directions. The idea being that the technology developed for the drone could then be deployed to another type of vehicle that is required to follow road rules autonomously.

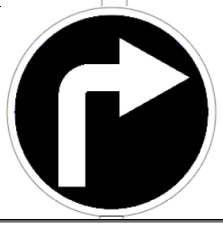
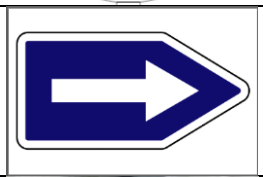
All objects and worlds should use a 1:1 scale to the real world where possible. E.G if a stop sign is 500mm x 500mm in the real world, the simulator should represent it accurately.

- **Milestone 1 – Simulator Tools & Components (Week 3)**
    1. Install and Configure Gazebo Simulator Tools with ArduPilot
    2. Show how to control the drone using code/scripts (backend)
    3. Show how to create worlds and drop assets
- **Milestone 2 – Simulator Improvements & Further Work (Week 6)**
    1. Model trees and plants in the simulator
    2. Create assets of all the signs and objects into the simulator
    3. Build a simulated city / CBD environment in the simulator (open to suggestions)
    4. Build a simulated residential environment in the simulator (open to suggestions)
    5. Install and Configure Gazebo Simulator Tools with PX4
    6. Documentation for placing objects (signs, traffic lights, objects)
    7. Object placement can be customised by user in all worlds
    8. Random placement of objects (trees, signposts)
    9. Autonomous drone flight possible and demonstrated.
    10. Multiple drones in the simulator at the same time.
- **Milestone 3 – Sign & Object minor sign detection (Week 5)**
    1. Show primitive detection / model working on initially provided 4 signs (stop, turning, parking, traffic lights).
    2. Autonomous flight with detection active.
    3. Demo in simulator (different environments / worlds)
- **Milestone 4 – Sign & Object major detection (Week 9)**
    1. All outlined signs and objects (total 12 unique objects in table) detected and corresponding action response from the drone.
    2. Demo in the simulator (different environments)
    3. Show working for both PX4 and ArduPilot environments
    4. Simulator improvements completed and demo / video showing process to import new objects and create worlds.
- **Milestone 5 – Completed Solution with Demo and Documentation (Week 12)**
    1. Usage documentation (as per each Milestone)
    2. Demo of working solution in simulator
    3. Deliverables as per ‘Hand-over deliverables’ section
- **Extended**:
    1. Students welcome to create extra worlds for the purposes of testing in the Gazebo simulator.
    2. Students welcome to model extra objects in the simulator.

Signs & Objects

Some of the signs in this table will need high-resolution copies made for modelling in simulators. All objects below are expected to be modelled in the simulator.

For the purposes of consistency, the dimensions of all the signs are locked to 500 mm by 500 mm areas (measured to the edge of the frame for round signs, and on the height axis for non-square ones). All signs are mounted on black poles.

Description	Image (Sample)	Actions
Stop		Stop the drone at the white line (if present) for 3 seconds
Traffic Lights (Red, Amber, Green) Lights should be able to automatically change colour at set intervals in the simulator		**Red**: Stop the drone in front of the trafic lights and wait for green light **Green**: Go or continue **Amber**: Open interpretation. Either choose continue or stop
Turn Blue round Left & Right		**Turn** the drone in the direction of the sign immediately
Turn Black round		**Turn** the drone in the direction of the sign immediately
Turn Blue Arrow Left & Right		**Turn** the drone in the direction of the sign immediately
Turn white on black Left & Right		**Turn** the drone in the direction of the sign immediately

Park Green		**Park Routine**: Stop the drone and land (subject to change later)
Park White		**Park Routine**: Stop the drone and land (subject to change later)
Park Yellow		**Park Routine**: Stop the drone and land (subject to change later)
Buildings	(various)	**Collision Avoidance**: Avoid the building. Do not colid
Speed Sign (Advanced) (read out / report speed as integer) 5 10 25 40 50		**No Action**: Report the detected speed in the console (print)
Other vehicles in the simulator Cars, Other Drones	(various)	**Collision Avoidance**: Avoid the vechile if heading for collision. Do not colid

* Advanced are for when students have completed and demonstrated all other signs in the simulator and real-world environment. Students are still requested to model the speed signs as part of the simulator improvement, even if they don't detect them.

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Client Expectations

General

This project is broken into two major components each with two milestones. This scope document will outline the expected delivery of each milestone as per the *High-Level Scope Summary* list found below. Students are also expected to do lots of research to ensure the best solutions are found, with research recorded in the appropriate repository and format. Documentation must be included with all work completed in a format that is legible and understandable.

The client reserves the right to amend the scope of the project throughout the semester based on team progress and unforeseen challenges that may arise. The client reserves the right to communicate problems with tutors to be raised with the course coordinator to take academic action if deemed essential for lack of progress or not meeting expectations.

Contribution

The client (Robotics Masters) expects that students meet and exceed the scope and requirements outlined in this document to achieve the best grade in the course. Each individual student in the team are expected to contribute to the project. Contribution and time expected per a week on this project is approximately 15+ hours per week for each student, excluding meetings. That is a total contribution of 60 to 90+ hours per week for each team.

Contribution to the project will be tracked through Bitbucket (there should be constant daily commits being made by all team members), communication (activity on Discord Server) and through all updates provided to the client. This information will be used at the end of the semester when it comes to evaluating everyone's contribution and final grade for the capstone unit.

Meetings

Each team is expected to attend two Zoom meetings per week. The times have now been sent to everyone.

Each team member is expected to submit and present a 1-minute summary of their contribution for each week on Monday/Tuesday meetings. These videos should be uploaded to YouTube as an unlisted video, presented during each Monday/Tuesday meeting and shared to the client after the meeting. Feedback will be given after each individual video during the meeting.

Any technical questions that arise should be asked during these meetings.

Each team is to present and submit the plan for next 'sprint' period at the end of each meeting. This should contain a list of tasks that each team member is working on for the next time period and outline what is expected to be delivered at the next meeting.

Communication

Email – the client prefers email communication for official documents, scope questions and communicating with tutors. The client will also respond to technical and scope questions via email, however, would prefer that the Discord Server (Sydney 2020) is used.

Discord – the client has selected Discord and email as the preferred tool to use throughout the semester for questions and notices. Teams will also be collaborating/discussing/sharing ideas with other teams run by Ben Sand (another client). There is a total of 15 capstone teams taking part in this initiative. This kind of collaboration has been done before and it has been very positive for

students and opens several different opportunities, such as meeting tech influencers, established developers and other technology specialists.

Events

Students are expected to participate in the following activities throughout the semester as part of the core component of this project and to ensure understanding of the project

Venture Café - Students will be required to participate and present at two Venture Café sessions throughout the semester. It is an online meeting community where different creators, start-up owners meet and discuss what they are doing with their own projects. It works like a 'drop-in session' where people may only join for a short amount of time or could stay for longer. Teams will be sharing your progress and discoveries through this platform. Teams are welcome to attend Venture Cafe on any Thursday to get a feel for the platform and chat with other technology people.

Hand-over Deliverables

Documentation – All documentation is to be created and written in Markdown, then build with Readthedocs for portability and usability.

Maintainability – The client would like the code developed to be able to be integrated into the PX4 and ArduPilot repositories cleanly on completion. Students are expected to document the changes and improvements and leave the code in a way that it can be merged by pull request to the corresponding repository.

Test Code – Where students have developed code for testing detection, this is to be uploaded onto Bitbucket and provided to the client at the end of the unit. It is preferable that students include intrinsic documentation within each file explaining its purpose.

Reference Material

All reference materials will be provided by the client to teams via Discord or email.

End of Document