Individual Lab Report 11

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Team A / The Avengers

Teammates: Tushar Agrawal & Pratik Chatrat

ILR11

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1. Individual Progress

Our project is nearly complete. Team A has demonstrated a complete package delivery without obstacle avoidance. Over the past two weeks, my main task has been to (a) coordinate with CMU's legal services over use of the stadium for flight. Additionally, I've been assisting Tushar on two topics involving simulation: (b) modifying the code to stabilize the z-axis position, and (c) rotational velocities in Gazebo.

a. Coordinate Permission to Fly over Stadium

Since last PR, Team A has been talking to various members of Carnegie Mellon's legal services to gain permission to fly over the stadium. As of now, the team cannot legally fly over university property. We were offered assistance to submit for a Section 333 Waiver with the FAA issuing a joint "blanket" Certificate of Waiver of Authorization (COA) for operating under 400 feet.

However, the expected turn-around time is 120 days normally, but that has been lengthened due to excessive applications caused by the FAA's new rulings. With less than 20 days till SVE, It is unlikely that we will receive authorization. Rather than waste resources, Team A has made alternate arrangements and will be documenting the appropriate process for next year's class. The notes below come directly from Daniel Munsh:

As of April 2016, there are four general government requirements for non-recreational (called "civil") outdoor drone operation:

1. The aircraft must be registered with the FAA;

2. The aircraft must have a Section 333 Exemption from the FAA (this exempts the drone from the FAA regulations for traditional aircraft that would otherwise apply);

3. The aircraft must have a COA from the FAA (this authorizes the specific parameters for flight operations). Section 333 Exemptions automatically come with a "blanket" COA for operations under 400 feet.

4. Comply with any state or local laws regulating drones. For example, the City of Pittsburgh prohibits drone operations in public parks. So even if you have all the proceeding items from the FAA, you still can't operate in city parks in Pittsburgh.

Important points of contact for next year's class include Daniel J. Munsch, AVP and Assistant General Counsel (dmunsch@andrew.cmu.edu) and Diane Patterson, Senior Risk Management and Insurance Specialist (dianep@andrew.cmu.edu).

The current legal landscape is expected to change sometime in calendar year 2016. Future classes should reference CMU's Office of the General Counsel's Page on Drones. Separately, the Senate is considering a proposed law, the Higher Education UAS Modernization Act, that would create a separate regulatory structure for drone operations related to research at institutions of higher education.

b. Control Simulation and Testing

Additionally, I focused on producing two modifications to the code. Both were delayed due to complications which I'll detail in the Challenges section below.

The first modification centers on stabilizing the Z-axis during flight. Currently, the z-axis isn't controlled in-flight. This leads to a slow decay during flight. This isn't an issue at altitude. However, with the changes to obstacles and the new altitude we'll be using during scanning, this change is noticeable.

For these reasons, we've attempted to implement a PID controller. Tushar was able to implement a basic version of position control, which we still have room for refinement by calibrating the gain variables on the actual drone.

Additionally, development has been slowed by the need for the second modification -- rotational velocities aren't recognized by the simulator. If we could fix this issue, then we could test more effectively on the simulator. I've been researching why these commands, which work on the actual drone, aren't represented in simulation (and what we can do about it). Research is ongoing.

II. Challenges

This sprint was loaded with obstacles. Demands in other priorities diminished the effort I could commit to the MRSD Project. The first obstacle was the changes in government regulations, which started after our academic year, which outlawed drone flights without a lengthy authorization process. However, this bureaucratic difficulty was expected once we reached out to the Athletic Department for permission to fly.

The real challenge, for me, this sprint revolved around getting Gazebo to simulate drone flights properly. Originally, conflicting documentation delayed my efforts to simulate our project. Additionally, I had allocated too little RAM and CPU cores dedicated to my Ubuntu VM. This caused the drone to crash -- rather spectacularly -- when I launched ROS or made any other change to the computer. Navigating this oversight (lack of hardware resources), in addition to other setup difficulties caused a delay this sprint. These delays have been remedied and I'm able to focus on research and experimentation within the ROS/Gazebo ecosystem.

The final challenge revolved around locating a suitable replacement for the Hokuyo Lidar. Our version is only rated for indoor use. As we've been experiencing, outdoor use causes 'ghosts' to appear due to IR interference. The sensor is seeing objects which do not exist. To fix this issue, we're looking for a Hokuyo Lidar rated for outdoor use. The team reached out to a dozen labs within the CMU community and are waiting on word back.

III. Teamwork

Team A has recovered on the revised schedule that we committed to at the beginning of the semester. This sprint, each team member took on different components of the task. This allowed the team to build their individual skillsets while expediting the work.

Tushar Agrawal

Tushar is the back bone of this team. This PR, he assisted me with the setup of my Gazebo environment. Additionally, Tushar tested the code on the live drone leading to a successful demonstration of obstacle-less drone delivery.

Pratik Chatrat

Pratik continues integrating the navigation stack with Tushar's code. Additionally, he assisted in testing the drone. He and Tushar spent over a dozen hours out in the cold testing the drone.

IV. Plans

Before the next PR, the team has 3 main goals:

1. *Complete PID of z-axis and research rotational velocities (Sean)*
2. *Complete Integration of the Navigation Stack (Tushar/Pratik)*
3. *Complete a Full Dress Rehearsal with Obstacles (All hands on deck)*