CS 395T: Robot Learning (Fall 2017) - Final Project Proposal

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1 Objective

We are interested in investigating a reinforcement learning, data-based approach to drone flight and obstacle navigation. Historically, work has been done on using deep reinforcement learning to create drone control policies that take in raw inputs (such as an RGB image or sensor data). However, extending these to real-world flight tasks has proven challenging due to trial-and-error methods being unsafe and impractical with drones. A recent method, CAD2RL [1], attempts to solve this by training "drones" on hallways generated in simulation, using RGB image data. Another effort [2] takes a similar approach, but instead uses simulated depth-based data to pilot a surface level robot.

We would like to build off of the two approaches mentioned above by using simulation to train a drone policy based off of depth data. We would then like to experiment with various reinforcement learning algorithms (for example, guided policy search), and eventually transfer our trained policy to a drone (either inferring depth data from an RGB camera or using a stereo sensor). Given the scope of this problem, we may not be able to transfer our obstacle avoidance policy onto a physical drone before the semester is over, but that may be a stretch goal if transfer is tractable. We plan to devote roughly half of our time to creating a reasonable simulation + RL system, and the other half towards experimentation between policies and transfer to a drone.

We will be doing most development in simulation. We plan to procedurally generate geometric scenes (for example, hallways) with start and goal points, and evaluate the drone's ability to successfully reach its target. We will be using a reward function based on whether the drone crashed as well as distance from walls. The metrics we care about are:

- Did our drone successfully reach the target without collision?
- How quickly did our drone reach the goal? Qualitatively, was its trajectory smooth, or jittery and unpredictable?
- How well did the simulation results transfer over when run on a real drone?

We will be developing our system in ROS and most likely use Gazebo for simulation and Tensorflow for implementation. We will also be using a Parrot AR Drone 2.0.

It is important to disclose that this project overlaps slightly with an electrical engineering senior capstone research project with Dr Nuria Gonzalez-Prelcic. The topic of the capstone project is "Navigation for Unmanned Aerial Vehicles". However, our project focuses on data-based reinforcement learning, while the capstone project is mostly focused on geometry-based navigation methods (e.g. SLAM).

References

[1] Fereshteh Sadeghi and Sergey Levine. CAD2RL: Real single-image flight without a single real image. 2017.

[2] Linhai Xie, Sen Wang, Andrew Markham, and Niki Trigoni. Towards monocular vision based obstacle avoidance through deep reinforcement learning. *CoRR*, abs/1706.09829, 2017.