mavsim + holodeck

Final Project Description

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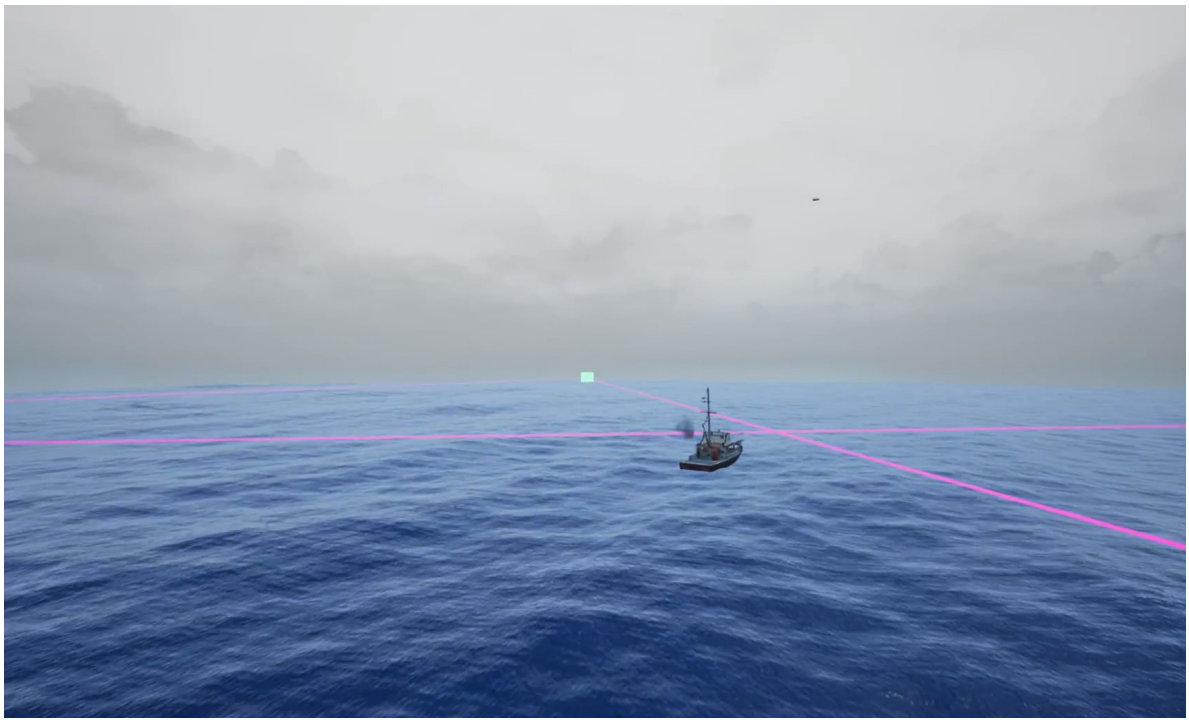
The design project for this class involves building a flight simulator from the ground up. In doing so, intelligent software was developed for an unmanned aerial vehicle which includes path planning around obstacles, state estimation using an extended Kalman filter, path following, and the multi-loop controls needed to do so. While the software may be a thorough solution for autonomous navigation of the aircraft, the simulator is a visually lacking and very simple in this regard; thus limiting the scope for extending the simulator to vision-based navigation. It was decided that a solution with greater visual fidelity would be a useful and interesting extension of the simulator.

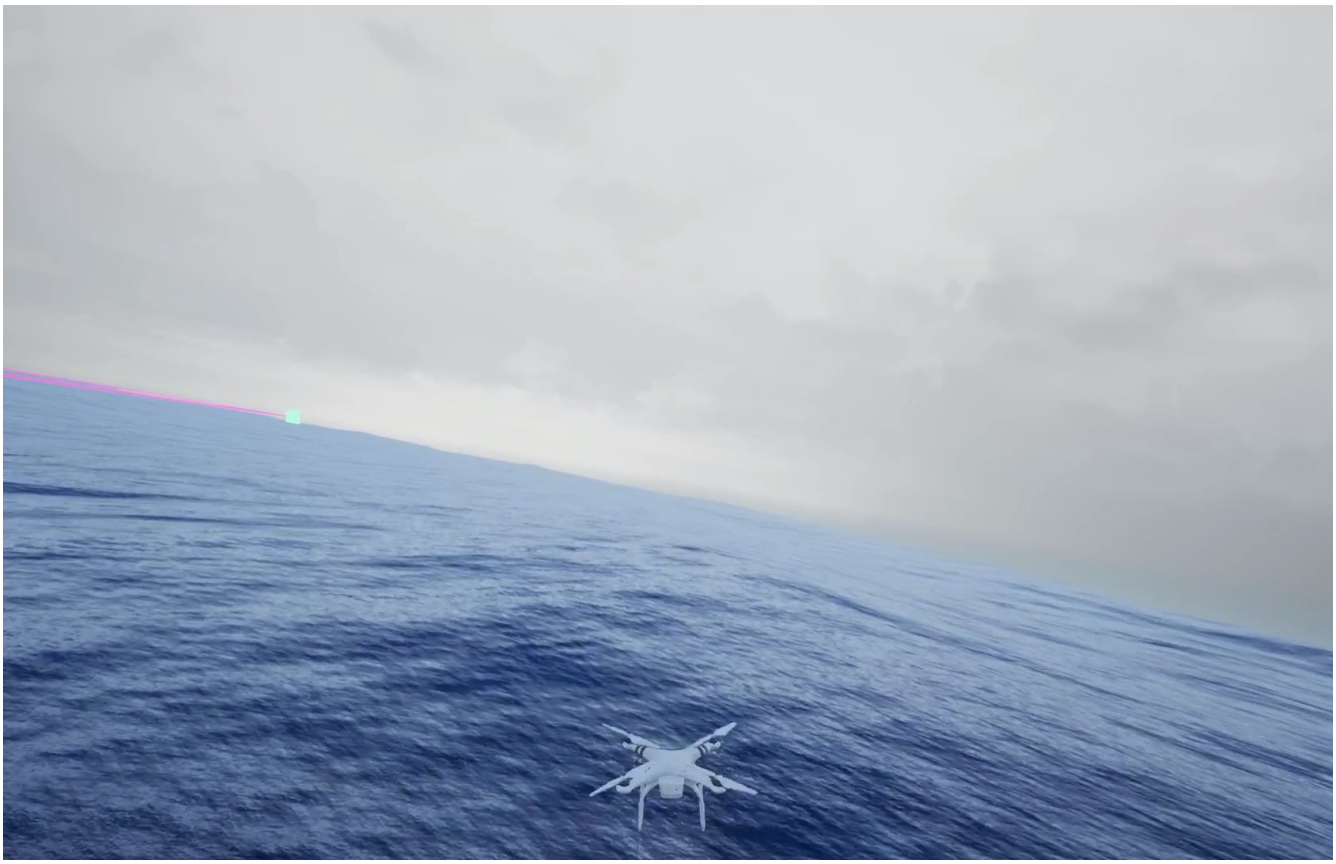
Holodeck is a high-fidelity simulator built on top of Unreal Engine 4, and it is the ideal tool for the job. The simulator was created by BYU's Perception, Control, Cognition Lab (PCCL) and is in active development. Several highly photo-realistic worlds are available in which a controllable agent, such as a UAV, can explore. The UAV agent has several simulated sensors, with the simulated camera being the most important in this use case. Holodeck uses a simple Python 3 interface to control the agent and to read the sensor data, allowing integration with the mavsim_python simulator developed for this class.



mavsim running in the Holodeck environment

A recent feature added to Holodeck is the ability to overwrite the state as computed by Unreal's physics engine. This is a massive advantage in that the dynamics model, the low and high level control schemes, and the simulated sensor models can all be customized to the project's needs. In the case of the design project for this class, the entire software architecture can remain as-is with the extra benefit of a photo-realistic video feed from Holodeck's simulated camera.

A few drawbacks with the setup were found, mostly due to Holodeck's active development. The ideal Holodeck world of an urban city with building laid out in blocks did not have the ability to overwrite the vehicle's state at the time of this project's completion. Thus, the only world available was an ocean world with no other obstacles other than a single boat. Also, there is currently no fixed-wing agent available for Holodeck, meaning that a quadcopter agent was the only option for a flyable agent. This resulted in a quadcopter flying with the dynamics of a fixed-wing aircraft. Fortunately, this was only a visual drawback as it did not affect the actual functionality of the simulation, given that the state was being completely overwritten by mavsim.



The quadcopter agent was flown as the fixed-wing aircraft in mavsim

All in all, the project was a success. The path planned by the path planner was able to be plotted, the quadcopter agent flew and used its estimated state in mavsim to follow the path, and all of this was able to be visualized in Holodeck. The results of this project show that there is great future potential for implementing more advanced vision-based navigation for this class and for other purposes.