This study discusses the modeling and simulations carried out to design and tune a control system for autonomous microquadrotor vehicles (MQVs) and the construction and implementation of a testbed for flight testing of the control system. Unmanned Aerial Vehicles (UAVs) will be implemented in MQV systems, requiring agents to achieve stable autonomous, point-to-point navigation and trajectory tracking. Modeling methodology is presented along with the selected controller design. Various maneuvers are investigated to assess the ability of the UAV under control. These maneuvers include hover, constant-speed translation, and constant-yaw-rate maneuvers. Additionally, navigation performance is assessed using a profile representative of those expected during swarm operations. The control algorithm uses feedback data from different components of the testbed. The testbed is comprised of an Optitrack Flex 13 motion capture system, Crazyflie 2.0 mini-quadrotors, and a user-friendly Ground Station. Each of these components is interfaced through our communication system. The testbed is functional and single quadrotor flight testing has begun.

The Quadrotor Swarm Arena (QuaSAr) test bed was specifically developed with the intention of conducting research in control theory via the flight of quadrotors. Quadrotors are excellent candidates for control theory research because of their inherent instability. These simulations showed that the selected cascaded PID controller was adequate for stabilizing quadrotor agents.

### Simulation & Results

Simulations were conducted using MATLAB and Simulink to predict system performance and test-bed requirements. The full, nonlinear quadrotor dynamics were modeled and tested using a simple combination of cascaded PID controllers. Simulations were used for two primary items:

- Select/test quadrotor control law
- Determine test-bed performance requirements

These simulations showed that the selected cascaded PID controller was adequate for stabilizing quadrotor agents.

Additionally, the results show that a refresh rate of 10 Hz (left) is necessary for reasonable agent performance. This realization confirms that the developed system will meet the needs; the measured refresh rate is approximately 30 Hz (right).

### Conclusions

The developed system meets all the initial objectives.

Flight testing of quadrotor agents is currently under development.

### Future Work

The next step for QuaSAr is to improve the quality and reliability of all the communication paths. This work includes the reduction of external source dependencies and the refinement of current ground station methodology. In addition, the actual

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