Modern Helicopter Flight Control
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Design

Results

Summary

The purpose of this project was an academic exercise in flight control system design. The goal was to create a new assisted flight mode, called ACVH (Attitude Command Velocity Hold), for the PX4 Autopilot. This flight mode, which maintains the aircraft’s velocity and stability, will help reduce pilot workload. Design was done through Matlab/Simulink, implementation in PX4, and testing software-in-the-loop (SITL) in jMAVSim and Simulink. The system is broken up into three parts. First is Input Signal Management (ISM), which sends accurate data to the controller by reading sensor data and doing rate/range checks, voting, and sensor fusion. Rate checks ignore redundant sensor values that change too frequently. Range checks ignore redundant sensor values that are outside a certain range. Voters then decide the proper output given the remaining redundant sensor values after the rate/range checks. Together these provide highly reliable and accurate sensor data and also reconfigure sensor network systems if a sensor was to fail. Sensor fusion is the next step in the ISM, where sanitized values from different types of sensors are put into an Extended Kalman Filter (EKF). An EKF is a class of algorithms that take sensor values and output reliable values of desired states that may not be measurable directly from sensors, such as velocity. They also eliminate sensor biasing. For example, the AHRS filter takes in the IMU sensors and a magnetometer to give the controller accurate orientation of the drone. The controller uses feedback control via Proportional-Integral-Derivative controllers (PIDs) to obtain the desired velocity by making attitude commands. Lastly, the OSM uses a mixer (matrix multiplier) to convert calculated Yaw, Pitch, Roll and Thrust torques to PWM output for each DC motor driving the rotors of the drone. This is specific to a particular kind of drone.

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