Abstract

This thesis presents the end-to-end design, modeling, and control of an electric hybrid-wing UAV, formed by integrating a quadrotor VTOL module onto a fixed-wing Aerosonde airframe. Beginning with structural and propulsion sizing using FlyEval, we selected an X-configuration quadrotor optimized for thrust, endurance, and minimal aerodynamic interference. A 6-DoF model was then assembled by merging the dynamics of the quadrotor and fixed-wing subsystems. The dynamics of the quadrotor and fixed-wing subsystems were then combined to create a six-DOF Simulink model. We developed, implemented, and compared four transition-control strategies in simulation, ranging from dual-controller attitude sharing with thrust augmentation to basic PID blending with a fixed incidence angle. We designed and tuned cascaded PID for hover, transition, and cruise regimes, then validated performance over a waypoint-driven mission profile. Key results include a 20 % reduction in altitude error during forward transition, stable cruise establishment within 13 s, and controlled backward transition within under 1.6 m error in altitude. Our findings open the door for feasible electric hybrid-wing UAV operations by showing that a decoupled, gain-scheduled PID architecture can accomplish smooth VTOL-to-cruise transitions with low complexity and high reliability.