**Attitude and Position Control of Flapping-Wing Micro Aerial Vehicles**

Compared with the fixed-wing and rotor aircraft, the flapping-wing micro aerial vehicle is of great interest to many communities because of its high efficiency and flexible maneuverability. However, issues such as the small size of the vehicles, complex dynamics and complicated systems due to uncertainty, nonlinearity, and multi-coupled parameters cause several significant challenges in construction and control. In this thesis, based on Euler angle and unit quaternion representations, the backstepping technique is used to design attitude stabilization controllers and position tracking controllers for a good control performance of a flapping-wing micro aerial vehicle. The attitude control of a flapping-wing micro aerial vehicle is achieved by controlling the aerodynamic forces and torques, which are highly nonlinear and time-varying. To control such a complex system, a dynamic model is derived by using the Newton-Euler method. Based on the mathematical model, the backstepping technique is applied with the Lyapunov stability theory for the controller design. Moreover, because a flapping-wing micro aerial vehicle has very flexible wings and oscillatory flight characteristics, the adaptive fuzzy control law as well as control strategy is also used to estimate the unknown parameters and attenuate the impact of external disturbances. What is more, due to the problem of the gimbal lock of Euler angles, the unit quaternion representation is used afterwards. As for position control, the forward movement is controlled by the thrust and lift force generated by the wings of flapping-wing micro aerial vehicles. To make the actual position and velocity follow the desired trajectory and velocity, the backstepping scheme is used based on a unit quaternion representation. In order to reduce the complexity of differentiation of the virtual control in the design process, a dynamic surface control method is then used by the idea of a low-pass filter. Matlab simulation results prove the mathematical feasibility and also illustrate that all the proposed controllers have a stable control performance.