Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

CHEN MA

BSc (Hangzhou University, 1995)

“Application of LQR and H2-optimal Control for a Quadrotor System”

Department of Mechanical Engineering

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Remote Defence

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Abstract

A quadrotor is a type of small unmanned aerial vehicle (UAV) with four rotors. Various control techniques have been successfully applied to the quadrotor. In this thesis, two control methods, including linear quadratic regulator (LQR) and H2-optimal control, are applied to the autonomous navigation and control of a quadrotor named QBall-X4 that is developed by Quanser.

The continuous-time dynamic model is established using the Euler-Lagrange approach. Due to the high nonlinearities in the quadrotor dynamics, we propose a simplified linear model, which is further used for the controller design in this thesis. According to the simplified quadrotor dynamics, we design an LQR controller to regulate the quadrotor system from its initial position to the desired position. The effectiveness of the controller is verified by simulation studies. However, the LQR control system is operated in the nominal model, and it can not present guaranteed performance when system uncertainties exist.

The main emphasis is placed on designing an H2-optimal controller that minimizes the H2-norm of the transfer function. The solution is obtained by using the state-space approach and linear matrix inequality (LMI) method, respectively. In contrast to LQR control method, which is normally applied to a system with no disturbance, the H2-optimal controller takes the form of an observer together with a state feedback control gain to deal with the system uncertainties and disturbances. The simulation results and experimental study verify that the proposed H2-optimal controller is an effective option for the quadrotor with the attendance of uncertainties and disturbances.