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

of

KUNWU ZHANG

BEng (Hubei University of Science and Technology, 2013)

"Flight Control of a Quadrotor: Theory and Experiments"

Department of Mechanical Engineering

Tuesday, July 19, 2016
2:30 P.M.
Engineering Office Wing
Room 430

Supervisory Committee:
Dr. Yang Shi, Department of Mechanical Engineering, University of Victoria (Supervisor)
Dr. Nikolai Dechev, Department of Mechanical Engineering, UVic (Member)

External Examiner:
Dr. Kui Wu, Department of Computer Science, UVic

Chair of Oral Examination:
Dr. Juergen Ehlting, Department of Biology, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

In the last decade, the quadrotor has been adopted in many application areas. Deigning an effective flight control algorithm for the quadrotor has attracted great interests in both control and robotics communities. This thesis focuses on the flight control of the quadrotor by using two different methods: The extend Kalman filter (EKF)-based linear quadratic regulator (LQR) method and the learning-based model predictive control (LBMPC) method.

This thesis investigates the flight control of a quadrotor subject to model uncertainties and external disturbances. An LQR-based tracking algorithm is proposed. The designed LQR controller is hard to be implemented because of the existing noises in the measured states. A modified EKF is then designed for the online estimation of the position, velocity and motor dynamics by using the measured outputs. The simulation and experiment results are provided to evaluate the proposed algorithm.

The tracking control problem of the quadrotor subject to external disturbances and physical constraints is also studied. A model predictive control (MPC)-based tracking control algorithm is adopted. To reduce the computational load, a modified prior barrier interior-point method is adopted to solve the quadratic programming (QP) problem. Nevertheless, the achievable flight performance by using the standard MPC algorithm is affected by external disturbances. An LBMPC algorithm is introduced for the disturbance rejection. The simulation results obtained from the LBMPC algorithm are also provided.