主 論 文 の 要 約

論文題目　Investigation of Multicopter Flight Dynamics and Integration of Autonomous Flight and Millimeter Wave Power Transmission
(マルチコプターの飛行力学ならびに自動飛行とミリ波パワー伝送の統合に関する研究)

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論 文 内 容 の 要 約

Multirotor helicopters (MRHs) offer excellent tool to support variety of missions from educational purposes to industrial applications. With the development of micro-electro-mechanical system (MEMS) technology, a multirotor helicopter embedded intelligent flight controller onboard can be utilized to perform various tasks such as cargo transportation, observation, photography, power line inspection, and swarm formation flight. The widely use of MRHs demands great concern the matter of safety. The MRHs are inherently unstable. The mathematical model should be derived before control design takes place, therefore the comprehensive understanding of aerodynamic aspect would benefit the control system design process. This research addresses three primary areas of interest.

The first, investigating the aerodynamic characteristics of a small MRH in uniform flow. This research topic deals with the issue of development the analytical equations of thrust and drag coefficients and formulation the interference effect between rotors in a tandem configuration on the basis of the Biot-Savart law. The theoretical predictions of the thrust coefficient and drag coefficient are validated with

the wind tunnel experimental results.

The second research topic contributes to clarifying an aerodynamic aspect that enables the prediction of MRHs behavior in maneuverable flight. Since the conventional theories such as momentum theory or blade element theory are insufficient to model the aerodynamic parameters under unsteady conditions. A new model to predict aerodynamic parameters under unsteady flight is proposed and validated on the basis of the flight data.

Towards application for wireless powered drone aircraft, the third research topic devotes to the development of autonomous flight controller for millimeter wave power harvesting. The challenges regarding the problem is narrow beam microwave requires drone UAVs must be controlled precisely inside the beam of energy. For achieving the goal, the flight controller is designed with optimal controller gains obtained by applying Iterative Feedback Tuning (IFT) method for cascade position and velocity controllers. As a result, the autonomous flight experiment for energy harvesting is demonstrated and the overall efficiency of the millimeter wave power transmission (MPT) system are estimated and validated.