University of Victoria | Graduate Studies

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

of

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BEng (Royal Military College of Canada, 2013)

“Magnetic Signature Characterization of a Fixed-Wing Vertical Take-off and Landing (VTOL) Unmanned Aircraft Vehicle (UAV)”

Department of Mechanical Engineering

Monday, October 22, 2018
10:00 A.M.
Engineering Office Wing
Room 430

Supervisory Committee:
Dr. Afzal Suleman, Department of Mechanical Engineering, University of Victoria (Supervisor)
Dr. Andrew Rowe, Department of Mechanical Engineering, UVic (Member)

External Examiner:
Dr. Pan Agathoklis, Department of Electrical and Computer Engineering, UVic

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Dr. Daniel German, Department of Computer Science, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

The use of magnetometers combined with unmanned aerial vehicles (UAVs) is an emerging market for commercial and military applications. This study presents the methodology used to magnetically characterize a novel fixed-wing vertical take-off and landing (VTOL) UAV. The most challenging aspect of integrating magnetometers on manned or unmanned aircraft is minimizing the amount of magnetic noise generated by the aircraft's onboard components. As magnetometer technology has improved in recent years magnetometer payloads have decreased in size. As a result, there has been an increase in opportunities to employ small to medium UAV with magnetometer applications. However, in comparison to manned aviation, small UAVs have smaller distance scales between sources of interference and sensors. Therefore, more robust magnetic characterization techniques are required specifically for UAVs. This characterization determined the most suitable position for the magnetometer payload by evaluating the aircraft's static-field magnetic signature. For each aircraft component, the permanent and induced magnetic dipole moment characteristics were determined experimentally. These dipole characteristics were used to build three dimensional magnetic models of the aircraft. By assembling the dipoles in 3D space, analytical and numerical static-field solutions were obtained using MATLAB computational and COMSOL finite element analysis frameworks. Finally, Tolles and Lawson aeromagnetic compensation coefficients were computed and compared to evaluate the maneuver noise for various payload locations. The magnetic models were used to study the sensitivity of the aircraft configuration and to simultaneously predict the effects at potential sensor locations. The study concluded by predicting that a wingtip location was the area of lowest magnetic interference.