Design and Implementation of Rate Table Framework for Autopilot Testing

By

Mohannad Ahmed Mohamed Draz

A Thesis Submitted to the

Faculty of Engineering at Cairo University

in Partial Fulfillment of the

Requirements of the Degree of

DOCTOR OF PHILOSOPHY

in

Aerospace Engineering

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Title of the Thesis:
Design and Implementation of Rate Table Framework for Autopilot Testing
Key Words:
Rate Table, Design, Implementation, Autopilot, Aircraft, FPGA, Stepper Motor
Summary:
The rate gyro is an essential sensor for aircraft autopilot systems, as it is used to measure the angles rate of aircraft attitudes and feed them back to the autopilot algorithm. The accuracy and testing of such sensors is a must in order to guarantee the operation of the autopilot. Therefore a three degree of freedom rate table has been designed and manufactured to perform the testing of rate gyro sensors. The rate table is controlled using three stepper motors with high precision stepper driver supported with an FPGA controller to guarantee highly accurate and precise rate motion.
The aircraft under test is the Mantis mini UAV which is designed and manufactured in the Aerospace department in 2008. In order to design the autopilot for such UAV, the aerodynamic derivatives are needed to be measured. A wind tunnel testing and measurements for a quarter scale model for the Mantis has been done to measure the aerodynamic derivatives using a six degree of freedom force/torque sensor as well as manual tilting table to perform different angles of attack and angles of the side slip to the model. The results from the testing have been validated with a numerical results using ANSYS software.
Then, the aerodynamic derivatives will be used in the aircraft nonlinear simulation program which demonstrates the aircraft motion and also testing the autopilot and guidance algorithms on the aircraft. This simulation program is integrated with both the 3 DOF rate table as a simulator for the aircraft attitudes, and with the rate gyro sensor as a feedback signal to the autopilot algorithm. Thus, hardware in the loop platform was suitable for testing the components of the autopilot system; such as the sensor of rate gyro and the implemented algorithm of the designed autopilot.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the reference section.

Name: Mohannad Ahmed Mohamed Draz Date: May 2019

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