



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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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

Signature:

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Table of Contents

Disclaimer	i
Acknowledgments.....	iii
Table of Contents	v
List of Figures	vii
List of Tables	xi
List of Symbols and Abbreviations.....	xiii
Abstract	xv
Chapter One “Introduction”	1
1.1 Introduction	1
1.2 Literature Review	2
Chapter Two “Aircraft Aerodynamic Derivatives Wind-Tunnel Measurements”	8
2.1 Chapter summary.....	9
2.2 Wind-Tunnel Measurements	9
2.2.1 Static aerodynamic derivatives measurement	9
2.2.2 Titling table	9
2.2.3 Force/Torque Sensor	11
2.2.4 Aircraft scaled model	12
2.2.5 Wind tunnel	15
2.2.6 Wind-tunnel airflow control.....	16
2.2.7 Data Acquisition System (DAQ)	17
2.3 Results and Verification	19
2.3.1 Longitudinal coefficients	19
2.3.2 Lateral coefficients.....	24
2.3.3 Aerodynamic derivatives summary.....	26
Chapter Three “Autopilot Design and Guidance Law”	29
3.1 Chapter summary.....	29
3.2 Aircraft Simulation Software.....	29
3.2.1 Aircraft Equation of Motions	29
Building and Testing the Aircraft Model	33

Jet-Engine Model	33
3.2.2 Aircraft Simulation Software	36
3.3 Autopilots and Guidance Functions	40
3.3.1 Guidance.....	40
3.3.2 Autopilot.....	43
3.3.3 Autopilot and guidance Implementation	46
3.4 Results	48
Chapter Four “IMU Hard-Ware-in-the-Loop Using Three Degree of freedom Rate Table”	59
4.1 Introduction	59
4.2 Stepper Motors FPGA Control	59
4.3 Three Degree of Freedom Rate Table Design and Manufacturing	68
4.4 Aircraft Hardware in the Loop platform	77
4.5 Summary.....	89
Chapter Five “Conclusion and Future Work”	91
5.1 Conclusion	91
5.2 Future Work.....	91
References	93
Appendices.....	95
Appendix A “CAD Drawing”	95
Tilting Table	95
Aircraft Model.....	98
Wind Tunnel.....	101
Rate Table	104
Appendix B “Software Codes”	105
Aircraft Simulation (LabVIEW)	105
Rate Table Testing (LabVIEW)	116
Appendix C “NT-33 Aircraft Data”	119
Appendix D “Mini-40 Calibration Certificate and Accuracy Report”	123

List of Figures

Chapter one

Fig. 1- 1: Murali <i>et al.</i> 2016 block diagram setup	2
Fig. 1- 2: Gans <i>et al.</i> 2009 block diagram.....	3
Fig. 1- 3: Wataru <i>et al.</i> 2016 calibration system.....	3
Fig. 1- 4: Jywe <i>et al.</i> 2007 calibration technique schematic.....	4
Fig. 1- 5: Saulnier <i>et al.</i> 2014 testbed	4
Fig. 1- 6: Muhsin <i>et al.</i> 2018 test platform	5
Fig. 1- 7: Jingxuan et al. 2018 HIL simulation system.....	6
Fig. 1- 8: Dehghani <i>et al.</i> 2017 HIL Structure	6
Fig. 1- 9: Kamali <i>et al.</i> 2016 HIL System Architecture	7
Fig. 1- 10: Jindeog <i>et al.</i> 2003 wind tunnel test setup	8
Fig. 1- 11: Deluca <i>et al.</i> 2004 flexible and rigid body MAVs.....	8

Chapter two

Fig. 2- 1: Two Degree of freedom titling table	10
Fig. 2- 2: Mini 40 force/torque sensor	11
Fig. 2- 3: Mantis UAV CAD drawing	13
Fig. 2- 4: Fuselage, wing, vertical tail, and horizontal tail	14
Fig. 2- 5: Assembled scaled model	15
Fig. 2- 6: Aerodynamic Lab., Cairo University wind tunnel	16
Fig. 2- 7: ABB Motor driver	16
Fig. 2- 8: PXI system	17
Fig. 2- 9: LabVIEW software for wind tunnel control	18
Fig. 2- 10: block diagram for wind tunnel control.....	18
Fig. 2- 11: Lift coefficient for different angle of attacks at $\delta e = 0$	20
Fig. 2- 12: Drag coefficient for different angle of attacks at $\delta e = 0$	20
Fig. 2- 13: Moment coefficient w.r.t c.g. for different angle of attacks at $\delta e = 0$	21
Fig. 2- 14: Drag polar curve at $\delta e = 0$	21
Fig. 2- 15: Lift coefficient for different elevator deflections at $\alpha = 0$	22
Fig. 2- 16: Drag coefficient for different elevator deflections at $\alpha = 0$	23
Fig. 2- 17: Moment coefficient w.r.t c.g. for different elevator deflections at $\alpha = 0$	23
Fig. 2- 18: Side force coefficient for different side slip angles at $\alpha = 0$	25
Fig. 2- 19: Rolling moment coefficient for different side slip angles at $\alpha = 0$	25
Fig. 2- 20: Yawing moment coefficient for different side slip angles at $\alpha = 0$	26