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FACULTY OF ENGINEERING

ELECTRICAL POWER AND MACHINE DEPARTMENT

Power Balance and Control of (UAV)

By

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Statement

This dissertation is submitted to Ain Shams University for the Degree of M.Sc. in Electrical Power Engineering .

The author has carried out the work included in this thesis at the Department of Electrical Power Engineering, Faculty of Engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or a qualification at any other University or institute.

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Dedication

To my father, my mother and my wife.

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Abstract

Unmanned aerial vehicles suffer from inherent instabilities in the pitch axis due to their small size and the lack of pilot feedback. Therefore, a flight control system is needed whose primary function is the artificial stabilization of the aircraft. This system is known as the pitch axis stability augmentation system.

Control augmentation system is a common part of modern airplane control. It is best characterized as a form of tracking control. In this thesis we enhanced the performance of PID controller when applied to the problem of position control. The investigation is based on a permanent magnet DC motor (PMDC) servo system.

Furthermore, the whole power system for the UAV has been designed in such that it would function autonomously. This means that the entire UAV design is autonomous.

This thesis is devoted to the design of an adequate automatic flight control system to stabilize the attitudes and natural modes of a flying fixed wing (Aerosonde) UAV under exogenous disturbances. Towards that objective, a nonlinear mathematical model for the underlying aircraft is developed and linearized yielding a state-space model. Consequently, this linearized model is decoupled into two smaller models associated to the longitudinal and lateral motions of the aircraft. The flight control system is designed to augment both stability and control for an unmanned aerial vehicle called Aerosonde. This control system is designed using Linear Quadratic Gaussian technique. The performance of the control system is compared with the performance of a classical PID controller in terms of input tracking and disturbance rejection properties.

Finally, the design has been experimentally verified using an interface card to control the angle of servo motor. The results of experimental verification of the control system show that LQG technique results in better transient performance than the classical one.

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LIST OF ABBREVIATIONS

UAV	Unmanned Air Vehicle
PID	Proportional, Integral and Derivative
LQR	Linear Quadratic Regulator Unmmand Air vehicle
LQG	Linear Quadratic Gaussian
Z-N	Ziegler and Nichol
SAS	Stability augmentation system
CAS	Control augmentation system
SCAS	Stability and control augmentation system
OP-AMP	Operational amplifier
MIMO	Multiple-Input And Multiple-Output
AUVSI	Association Unmanned Vehicle System International
c.g	center of gravity
6DOF	Six Degree of Freedom
PMDC	Permanent Magnet Direct Current

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