الآية

بسم الله الرحمن الرحيم

قال تعالى:

﴿ أَلَمْ يَرَوْا إِلَى الطَّيْرِ مُسَخَّرَاتٍ فِي جَوِّ السَّمَاءِ مَا يُمْسِكُهُنَّ إِلَّا اللَّهُ إِنَّ فِي ذَلِكَ لَآيَاتٍ لِقَوْمٍ يُؤْمِنُونَ ﴾

صدق الله العظيم

(سورة النحل {79})

DEDICATION

This Thesis is dedicated to my parents, Aaisha Yousif Dafallah and Elsiddig Ahmed Ali, for their unconditional love and prayers. May Allah SWT accept their worship and good deeds. May Allah SWT give them the best of health. This work is also dedicated to my wife and children for encouragement and constant support. May Allah bless them all with the best of health and joy.

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ABSTRACT

The development of performance longitudinal autopilot is very important to maintain aircraft in the longitudinal stability mode during flight operation. The longitudinal control consists of four control loops which pitch angle attitude, altitude, vertical speed and forward speed. This research exhibits comparative assessment based on the time response specification between using fuzzy logic control and conventional Proportional-Integral-Derivative (PID) controller for pitch angle attitude control using MATLAB/SIMULINK toolbox. The performances of pitch angle control systems are investigated and analyzed based on common criteria of step response in order to identify which control strategy delivers better performance with respect to the desired pitch angle. The simulations results demonstrate that the using fuzzy logic control give better performance than conventional PID controller to achieve the design requirements.

المستخلص

تطوير الطيار الألى الطولى فى غاية الأهمية لحفظ الطائرة في وضــع الاستقرار الطولي أثناء الطيران. التحكم الطولى يتكون من أربعة حلقات تحكم وهي سلوك زاوية الانحدار، الارتفاع، السرعة الرأســـية، والسرعة الأمامية. يسلك هذا البحث تقيم مقارنة تستند على أساس خصـــــــائص الاستجابة الزمنية بين استخدام منطق التحكم الغامض والمتحكم النسبى التكاملى التفاضلى التقليدي للتحكم في ســـــلوك زاوية الانحدار باستخدام مختبر الرياضيات/ وأدوات المحاكاة. أداء نظم التــحكم فى زاوية الإنحدار تم التحقيق فيـها وتحليلها اســـــتناداً إلى معايير مشتركة لاستجابة الخطوة بغية تحديد استراتيجية التحكم التي تحقق أفضل أداء فيمـــا يتعلـق بزاوية الانحدار المطلـوبة. نتائج المحاكاة بينت أن اســـــتخدام منطق التحكم الغامض يعطى أفضل أداء مقـارنة بالمتحكم النسبى التكاملى التفاضلى للتحقيق متطلبات التصميم.

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LIST OF SYMBOLS

θ	Pitch angle, rad
$\emptyset$	Roll angle, rad
ψ	Yaw angle, rad
q	Pitch rate, rad/s
p	Roll rate, rad/s
r	Yaw rate, rad/s
α	Angle of attack, rad
w	Angular frequency, rad/s
δ_e	Elevator control deflection, rad
δ_r	Rudder control deflection, radians
δ_a	Aileron control deflection, radians
I_x	Moment of inertia about x* axis, kgm^2
I_y	Moment of inertia about y* axis ,kgm^2
I_{xz}	Moment of inertia about x*z* plane, kgm^2
X, Y and Z	Stability axes
m	Aircraft mass, W/g
W	Weight, lb
Q	Dynamic pressure, $0.5pV^2$, lb/sq ft
S	Wing area, sq ft
s	Laplace transform variable
t	time, second
V	True airspeed, ft/sec
g	Acceleration due to gravity, ms^{-2}
M	Pitching moment, kgm^2s^{-2}
L_A	Rolling moment, ft-lb
N_A	Yawing moment, ft-lb
X_{vx}	Derivative of X with respect to v_x
X_{α}	Derivative of X with respect to α
X_q	Derivative of X with respect to q
X_{θ}	Derivative of X with respect to θ
μ	Membership functions
u	Control signal
e	Error
Δe	Change - of - error
U_0	Resultant aircraft velocity, ms^{-1}
v	Incremental component of velocity on y axis, ft/sec
V_x	Velocity of aircraft in x* direction, ms^{-1}
V_y	Velocity of aircraft in y* direction, ms^{-1}
V_z	Velocity of aircraft in z* direction, ms^{-1}
Z	Aircraft Lift force (force in z* direction), N
Z_{vx}	Derivative of Z with respect to v_x
Z_{α}	Derivative of Z with respect to α
Z_q	Derivative of Z with respect to q
Z_{θ}	Derivative of Z with respect to θ

$C_{x\alpha}$	Angle of attack derivative of drag coefficient
$C_{x\delta e}$	Elevator angle derivative of drag coefficient
$C_{z\alpha}$	Angle of attack derivative of lift coefficient
$C_{z\delta e}$	Elevator angle derivative of lift coefficient
$C_{m\alpha}$	Angle of attack derivative of pitching moment coefficient
$Cm\delta_e$	Elevator angle derivative of pitching moment coefficient
C_{mq}	Pitch rate derivative of pitching moment coefficient
X_b, Y_b and Z_b	Aerodynamics force components
K_P, K_i, and K_d	PID controller gains
$\theta^{\cdot}, \emptyset^{\cdot}, and\ \psi^{\cdot}$	Incremental angular velocity for (pitch , roll and yaw)

LIST OF ABBREVIATIONS

Abbreviation	Describe
AFCS	Automatic Flight Control System
CWS	Control Wheel Steering
FBW	Fly- By- Wire
COG	Center Of Gravity
PID	Proportional Integral Derivative
PD	Proportional-Derivative
PI	Proportional-Integral
P	Proportional
MISO	Multi Input Single Output
T-S	Takagi-Sugeno
Z-N	Zegler Nichole
MFs	Membership Functions
GUI	Graphical User Interface
FIS	Fuzzy Inference System
FLC	Fuzzy Logic Control