FUZZY-LOGIC BASED GRIPPER DESIGN AND ANALYSIS FOR OBJECTS GRASPING

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DEDICATION

This thesis is dedicated to my family especially my lovely father and mother who have always supported me. I love both of you so much.

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LIST OF SYMBOLS

G	Gain
$G_c(s)$	Controller
$G_p(s)$	Plant
$\theta_i(s)$	Desired angle
$\theta_o(s)$	Simulated output
a_i	Length of common normal
d_i	Distance between previous x-axis and current x-axis
α_i	Desired input around common normal between earlier z-axis and current z-axis
θ_i	Desired input around z-axis between earlier x-axis and current x-axis
l	Length of link
s	Sin
c	Cos
σ	Membership function’s width

LIST OF ABBREVIATIONS

3D	Three Dimensional
ANN	Artificial Neural Networks
CS	Coordinate system
D.O.F	Degree of freedom
D-H	Denavit-Hartenberg
Eq.	Equation
et al.	and others
FL	Fuzzy Logic
NFL	Non Fuzzy Logic
FLwFB	Fuzzy Logic with Feedback Controller
FLw/oFB	Fuzzy Logic Without Feedback Controller
FB	Feedback Controller
Kd	Derivative gain
Ki	Integral gain
Kp	Proportional gain
MF	Membership Functions
P	Prismatic
PID	Proportional integral derivatives
R	Revolute
S	Spherical
SCARA	Selective Compliance Assembly Robot Arm/ Articulated
SMA	Shape Memory Alloys
W	Weld

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ABSTRAK

Tiga jari penggenggam adalah salah satu contoh untuk effector akhir dalam teknologi robotik yang digerakkan oleh pengawal dan penggerak bersama. Penggenggam telah digunakan secara meluas dalam industri untuk memilih dan menempatkan, pemasangan produk, lukisan, dan tugas-tugas lain. Dalam kajian ini, salah satu kaedah dalam Kepintaran Buatan dikenali sebagai Fuzzy Logik (FL) digunakan untuk mengawal pergerakan penggenggam untuk objek menggenggam. Pertama, penggenggam direka dengan menggunakan SimMechanics dalam Matlab Simulink untuk mendapatkan output tork yang lebih baik dan sudut simulasi dalam teknik menggenggam. Menggenggam saiz yang berbeza objek juga dikaji dan kemudian dibandingkan di antara dua teknik; FL dan berkadar-Integral-derivatif (PID) dianjurkan untuk menilai prestasi mereka. Kaedah FL dengan pengawal maklum balas (FLwFB) dicadangkan dalam kajian ini untuk membandingkan prestasi kepada FL tanpa maklum balas (FLw/oFB) dalam sistem. Analisis simulasi untuk perbandingan ini juga dibentangkan. Penggenggam memegang objek sebetulnya dengan pengawal suap balik untuk melaraskan nilai dalam sistem. Sistem ini mempunyai dua input; sudut yang dikehendaki dan saiz objek juga dua output; sudut daripada simulasi dan tork. Nilai sudut yang dikehendaki dibandingkan dengan sudut simulasi sebagai rujukan untuk tujuan analisis. Ukuran ini menunjukkan keadaan penggenggam selepas Berjaya menggenggam objek. Hasil kajian telah menunjukkan bahawa output untuk fungsi trapezoid di FL mempunyai prestasi yang lebih baik daripada fungsi keahlian lain terutama apabila tindak balas masa yang di ambil kira. Semasa kajian diambil, terdapat dua jenis peraturan fuzzy diambil dalam analisis yang merupakan peraturan nombor 3 dan peraturan nombor 5. Keputusan simulasi menunjukkan bahawa peraturan nombor 3 lebih baik untuk sistem yang dicadangkan ini. Keputusan perbandingan antara FL dan bukan FL juga dianalisis dalam penyelidikan dan hasil digambarkan bahawa FLwFB adalah lebih baik daripada yang lain; ralat antara sudut yang diingini dan simulasi adalah kecil apabila penggenggam menggenggam objek. Untuk menilai prestasi teknik yang dicadangkan, FL dan PID dipertimbangkan. Hasilnya menunjukkan bahawa FL melepasi prestasi PID dari segi masa. Hasil daripada kerja penyelidikan ini, sumbangan baru untuk FL pada reka bentuk penggenggam telah dicapai untuk pelbagai jenis objek dengan sistem pengawal suap balik yang mudah.

ABSTRACT

Three fingered gripper is one of the examples for end effector in robotic technologies that are actuated by the controller and joint actuator. Gripper has been used widely in industrial applications such as to pick and place, product assembly, paintings, and other tasks. In this research, one of the methods in Artificial Intelligence known as Fuzzy Logic (FL) is applied to control the gripper movement for object grasping. Firstly, the gripper is designed by using SimMechanics in Matlab Simulink to get the better outputs torque and simulated angle in grasping technique. The grasping of different sizes of objects are also examined and then the comparison between two controllers; FL and Proportional-Integral-Derivative (PID) were organized to assess their performance. The methods of FL with feedback controller (FLwFB) is proposed in this research to compare its performance to the FL without feedback (FLw/oFB) in the system. Simulation analysis for this comparison is also presented. The gripper grasps the objects properly with the feedback to adjust the value in the system. The system has two inputs; desired angles and sizes of objects and two outputs; simulated angles and torques. The value of desired angles are compared with the simulated angles as a reference for the analysis purposes. This measurement demonstrates the gripper condition after grasping an object. Findings have shown that the outputs for trapezoidal function in FL has better performance than the other membership functions especially when the time response is concerned. During the investigation, there are two types fuzzy rules are taken in the analysis which is 3 number of rules and 5 number of rules. Simulation results suggested that 3 number of rules demonstrated a better solutions for this proposed system. The comparison results between FL and non-FL are also analyzed in the research and outcomes illustrated that FLwFB is better than others; the error between desired and simulated angle is small when the gripper grasping an object. To evaluate the performance of the proposed technique, FL and PID controllers performance in gripper are also considered. The result indicates that FL surpassed the PID performance when time response is considered. As a result of above research works, a new contribution for FL based gripper design has been achieved for different kind of object with a simple feedback system.

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