Faculty of Engineering

Robust Position Control of Hydraulic System Subjected to Different Load Patterns

A thesis submitted in partial fulfillment of the requirements for the degree of

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In
MECHANICAL ENGINEERING
By

Shady Ahmed Maged Ahmed Mohamed Osman

B.Sc. Mechanical Engineering
Ain Shams University, 2010

Supervisors:

Prof. Dr. Magdy M. Abdelhameed

Dr. Mohamed Abd-Elaziz

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Statement

This thesis is submitted in the partial fulfillment of master degree in Mechanical Engineering to Ain-Shams University.

The author carried out the work included in this thesis, and no part of this thesis has been submitted for a degree or qualification at any other university.

Signature

Shady Ahmed Maged Ahmed Mohamed Osman

Examiners Committee

The undersigned certify that they have read and recommend to the Faculty of Engineering – Ain Shams University for acceptance a thesis entitled "Robust Position Control of Hydraulic System Subjected to Different Load Patterns" submitted by Shady Ahmed Maged Ahmed Mohamed Osman, in partial fulfillment of requirement for the degree of Master in Science in Mechatronics Engineering.

Signature

Prof. Dr. Farid Abd El Aziz Tolbah
Professor of Automatic Control
Design and Production Engineering Dept.
Faculty of Engineering – Ain Shams University

Prof. Dr. Fahmy Metwally Ahmed Bendary
Professor of Automatic Control
Electrical Power Dept.
Faculty of Engineering in Shoubra – Benha University

Prof. Dr. Magdy Mohamed Abdelhameed
Professor of Automatic Control and Mechatronics
Design and Production Engineering Dept.
Faculty of Engineering – Ain Shams University (Supervisor)

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Abstract

The continuous motion of hydraulic implement in industrial applications is important parameters which affects productivity of mould casting machine. A lab setup is designed to evaluate a position control technique of a hydraulic cylinder at different load patterns. The lab setup consists of two loops, the first loop represents the controlled cylinder and the second loop represents the control of the loading cylinder. A controller is developed to reduce the synchronization errors in cylinders positions to acceptable values. The second loop is controlled so that to simulate variable loads with different patterns. A model representing the lab setup is developed and the system response is verified using experimental results. In this thesis, the background information of hydraulic systems was reviewed. A Simulink model of a typical commercial electro-hydraulic proportional system was constructed and verified on an experimental system. The uncertainty in the model is different load pattern. The theories of robust control and classical control were reviewed. A μ-synthesis control algorithm was developed for position tracking of such hydraulic system. The performance of the controlled system relies on the accuracy of the system model. To compensate for parameter uncertainties in the model, a parameter adaptation based on μ-synthesis was developed. The adaptation scheme was coupled with the control law and applied to an experimental system. The experimental results show very good tracking for position at different load patterns. The hybrid fuzzy robust control was developed on simulation and test rig using Matlab/Simulink. The main aim from this thesis is to develop a Hybrid Fuzzy Robust Control in order to eliminate the different pattern of load non linearity effect and enhance the performance of the system according to simulation and experimental results.

Keywords:
Load cylinder, Hybrid Fuzzy Robust Control, Robust μ-synthesis controller, PID, Pattern of load.

Summary

The objective of this work is to design and implement a robust controller and hybrid control algorithm based on an artificial intelligent to reduce the errors in cylinder positions at mould casting to acceptable values and enhance the performance of position control in the hydraulic cylinder at different patterns of load. The thesis consists of six chapters and the summary of each chapter is as the following. Chapter one consists of introduction on the thesis with a survey of the published papers in the field of control the position of a hydraulic system and ended this chapter with the problem statement. Chapter two contains the theoretical study in electro-hydraulic control system by building mathematical modeling and simulation using computer. Chapter three gives a proposal for two different control techniques one of them is robust controller (μ-synthesis) and the other fuzzy logic control with μ-synthesis to reduce the position error of hydraulic cylinder at different pattern of load. Chapter four exposed to design an experimental test rig that simulate the real system and its major components are main cylinder, load cylinder that make a different pattern of load on the main cylinder, proportional valves, hydraulic control valves, hydraulic power unit, all necessary electrical component and electronic interfaces for operating and testing. Chapter five provides laboratory experiments that show its result advantages of using fuzzy robust controller in improving the position control of hydraulic cylinder at different patterns of load and finally chapter six contains conclusions and future works.

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