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Control of Hardware Implementation of Hydraulic Servo Application Based on Adaptive Neuro Fuzzy Inference System

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***Abstract*— This paper introduces the applying of Adaptive Neuro Fuzzy Inference System (ANFIS) to position and force control of Electro Hydraulic Servo Mechanism (EHSM). It also presents a linear identified Autoregressive Exogenous (ARX) model. In order to verify the ability of the proposed ANFIS controller applied to the EHSM, an experimental setup of a test hydraulic servo system is also given and setup to be used in this paper. Therefore, the research has been implemented based on an identified model then checked the behavior via the experimental test rig. Actual EHSM experiments are investigated to evaluate the suggested control strategy in a large system parameters perturbation of working environments. Considerable enhancement in the performance produced by the proposed ANFIS controller is compared with the conventional and fractional order controllers. Moreover, the results depict that the performance criteria in terms of settling, rise times, system overshoots, system parameters perturbation and applying different test signals are distinct values in case of applying the robust ANFIS controller over using traditional and fractional order controllers in this study. As a general conclusion, one can conclude that the ANFIS controller have the priority of applying it in the field of the industrial EHSM. Furthermore, the obtained results are promising in the field of mechatronic.**

Keywords— Hydraulic Servo System, Fractional Controller, ANFIS, ARX.

I. INTRODUCTION

The hydraulic system has a wide range of machinery applications such as hydraulic press machines and material test machines. It can supply with a high torque and high force with small components for the mentioned industrial application. The control of hydraulic systems could be divided into position, velocity and force control. As a result of classification, the position and force control of EHSM has been discussed in this research. The hydraulic servo system has been modeled based on system identification and Matlab/ Simulink model in [1]. The force control of experimental setup for electro hydraulic servo system based on model predictive control is discussed in [2]. While, the design of backstepping controller for tracking problem of electro-hydraulic system is implemented in [3]. In addition, the Gravitational Search Algorithm (GSA) and Particle Swarm Optimization (PSO) techniques are used to optimize the parameters of the desired controller in order to achieve the required system performance. In [3], the performance is chosen to be the error between the reference input and the output for the system. The problem of two tank system that resembles the operation of many chemical processes is given in [4]. In addition, the research in [4] presents the design of a non-linear model predictive controller for a simulation and experimental couple tank system based on a neural network model. The hybrid of fuzzy and fuzzy self-tuning PID controller for electro- hydraulic servo system is depicted in [5]. In [5], the simulation and experimental results present that the hybrid of fuzzy and fuzzy self-tuning PID controller give a better performance as compared to a hybrid of fuzzy and PID controller. The position control of hydraulic servo system using PID controller based on PSO, Adaptive Weighted PSO and Genetic Algorithm (GA) is discussed in [6]. The simulation results in [6] show that the tuning of PID parameters using PSO demonstrates good results. However, this research lacks to investigate an experimental hardware implementation to verify the simulation results. While the strategy of model predictive control based on back propagation neural network for the die forging hydraulic press machine is given in [7]. Whilst, the force control of an electro-hydraulic servo press system is given in [8]. In addition, the used control strategy in [8] is the fuzzy logic controller to achieve the required precise control of the system. In [9] the fractional order position controller based on GA has been applied to a simulation model of hydraulic servo system and experimental hardware system. The model predictive control has been used to control the position of the simulation model and hardware implementation of the hydraulic system as presented in [10]. The contribution of this research can be summarized as follows: (a). Build an identified model for the studied problem. (b). Investigate an experimental test rig for the EHSS. (c). Design a classical and fractional controllers that tuned by genetic algorithm. (d) Enhancement the controllers and generate a new strategy based on ANFIS training. The rest of this research is prepared as follows.