Neural Network Based Control Of Hydraulic System

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Abstract: In a heavy equipment hydraulic support system, the oil pressure must be a constant value. The hydraulic support system would not be stable due to disruption from the external environment and the running process; hence, we present a closed loop feedback system with an artificial neural network control system to stabilize the oil pressure by controlling the hydraulic pump motor's rotational speed. The response and stability in this hydraulic system are key factors in determining whether the control method is successful or not .It demonstrate in our simulation that this artificial neural network system can meet the requirements of design. It has good properties of responseandstability.As the neural network mimics the functionality of the brain and can deal with the complexity a nd non-linearity of the system when properly trained. It should be remembered that the hydraulic control system is not appropriate for high speed cycling.ANN time series is chosen as a suitable tool to provide future driving condition based on past driving conditions and is used for dynamic programming to optimize energy management for a series of hydraulic hybrid vehicle.

Keywords: Hydraulics control system, Artificial Neural network (ANN), Proportional Integral derivate.

1-Introduction:

Hydraulic control system requires any technology that uses fluid action instead of electronics power or pneumatic power when control units are moved within this system, the internal fluid moves or flow throughout the internal operation of the machine .The hydraulic control system can affect the operation of a machine in a number of ways .hydraulic have easy energy storage that can be used to modulate high speed or shutdown. since then, numerous paper dedicated controller parameter based on various forms of presumed controlled processes .It is estimated that more than 95 percent of controller used in industry are PID controller ,and most of them are PI controller[1].The research carried out in connection with the efficiency of control contour in industrial production has shown that PI controller are used to a large extent ,but are usually tuned in a bad way[1].According to [2] ,about 20 percent of controller in the industry work well.althought 30 percent of the controllers have poor performance due to improperly tuned controller[1]. Lin-ke,Ynke ,Y.Jian-ming,Z, Fuzzy PID control for the direct electro-hydraulic position servo system[2].provide a guide to improve the control effect of the proportional electro hydraulic system[2].The analyzes carried out in connection with the efficiency of control contours industrial production have shown that PI controllers are used to a large extent, but are usually tuned in a bad way[1].In order to improve the response speed of the hydraulic tensioning device and to address the drawback of non linear and large delays in the hydraulic system, the dynamic characteristics of the hydraulic system under PID control were studied using the pressure curve simulated using MATLAB[3]. Self Tuning FUZZY PID controller is designed to enhance electro hydraulic actuator efficiency .the controller is designed based on the system's mathematical model, which is calculated using the method of system identification [4].the controller model consists of a PID controller in a feedback loop and a feed forward neural controller for suspension travel to increase the comfort and performance of the vehicle riding[5].For hydraulic system, an optimal non-linear PID controller design strategy is proposed[6]An ideal PID controller is designed to meet the desire output time-domain requirement[6].Hydraulic run over a large range of speeds and pressures. PID controller is well known to have low control quality for an integration process and a long time delay system. The goal of this study is to improve the hydraulic control system in Artificial Neural Networks. it should be noted that the hydraulic control system is not ideal for high speed cycling .ANN time series is chosen as a suitable method to provide potential driving condition based on the past driving condition and is then used for dynamic programming to optimize energy management for a hydraulic hybrid vehicle series.

The goal of this study is to improve the hydraulic control system in Artificial Neural Neural Networks. It should be noted that the hydraulic control system is not ideal for high speed cycling.ANN time series is chosen as a suitable method to provide potential driving condition based on past driving conditions and is used for dynamic programming to optimize energy management for a hydraulic hybrid vehicle series.

2-Introduction to Artificial Neural Network: Artificial Neural Network (ANN) is a dynamic and self-adaptive computing tool to control a system's complex and non-linear properties. Neural Network is neuron based and it is estimated that the human brain comprises about 150 billion neuron interconnected to create the network which make makes it complex and organized .ANN is inspired by the human brain's biological neural network and imitates the role that it performs. In ANN, one neuron is bound to the other with various weights and information that is than transmitted during preparation of reading.

ANN is commonly used in control application involving processes such as elimination of non-linearity, optimization and classification in complicated operation with different parameters, Arificial Neural Network has the ability to learn from the experience and to make decisions when faced with a similar environment .The Artificial Neural Network is multitasking and can perform more than one function over the same period of time.

This paper suggests regulators of artificial neural networks.

3-Simulation Model.

The simulation model used in this paper is based on literature showing that block diagram of a hydraulic control system.Liu,G.P, & Dailey's. thoroughly analyzed and studied the model [6].In MATLAB SIMULINK ,Liu ,G.P, & Daley used three standard PID controller to control speed [6].but those controller are linear controller ,so we substitute those controller with controller based on Artificial Neural Network,The prototype can be seen in Figure-1. Which is a system block diagram of hydraulic control system..A feed forward Neural Network is modify with proportional integrated derivated.we modify the PID controller with adjustable gain calculating by ANN. Due to non linear nature of Artificial Neural Network, better performance is expected .Neural feed forward network are trained through the supervised learning strategy.

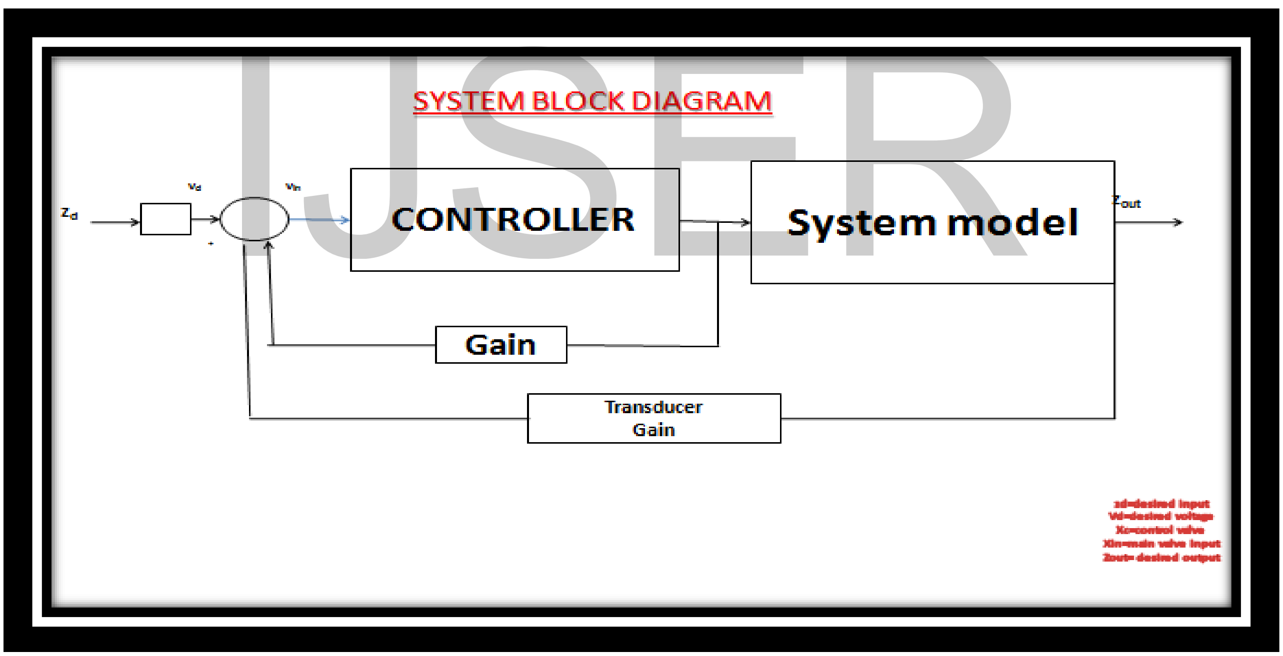

Fig.1 System block diagram.

4-Result and discussions.

The first step toward designing a neuro controller is to produce training data. We generated data for this purpose, usi ng the reference PI controller[11].The neural network toolbox was used for network testing.Figure5.below shows th e active NN speed controller model training and its contrast with the original speed controller where dotted blue line s are the original controller response and solid red lines are trained NN speed controller response.Different response s from the original and trained NN model show that neural network technique for this particular application .

We take transfer function and put different values of Kp,Ki and Kd,

$$G(s) = \frac{213041}{s(s+653)}$$

Controller PID

KP=0.0041 (PROPORTIONAL)

KI=3.12 (INTEGRATED)

KD= 15.5 (DERIVATIVE)

We take transfer function and putting different values of PID.

In fig-2 we take three values of proportional , integrated and derivate the value of derivative is 0.0041, value of proportional is 3.12 and value of integral is 15.5 we combine all these values with the transfer function then we see the result with the scope the result will be shown in the fig -3.

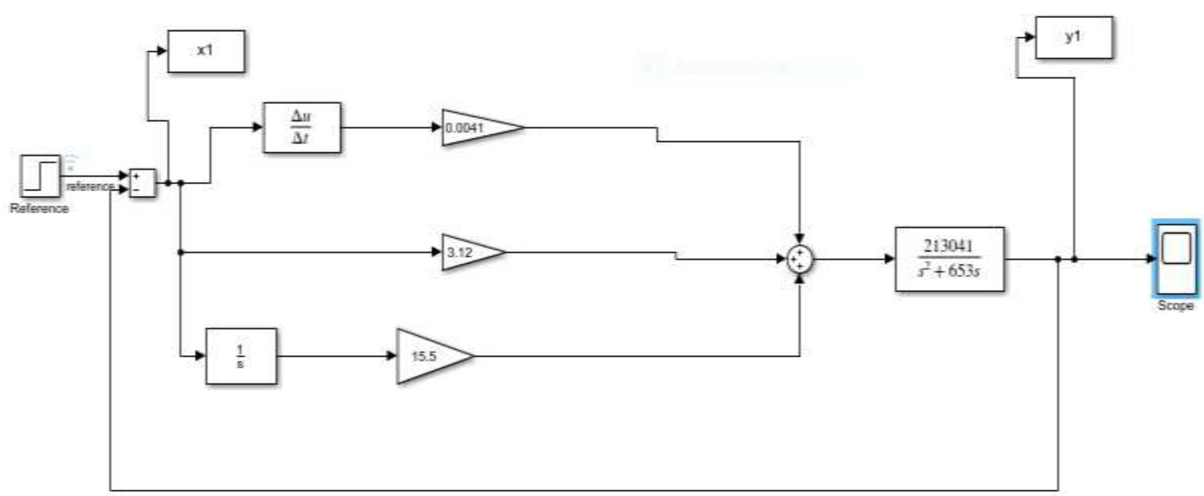

Fig-2 With Proportional Integrated Derative

In this fig -3 The time shows the pressure applied to the fluid and the Amplitude shows the flow of liquid .when the pressure of fluid is approximately 0.8 the Amplitude is unit response.the input shows the time and the output shows the Amplitute we see the response is step.

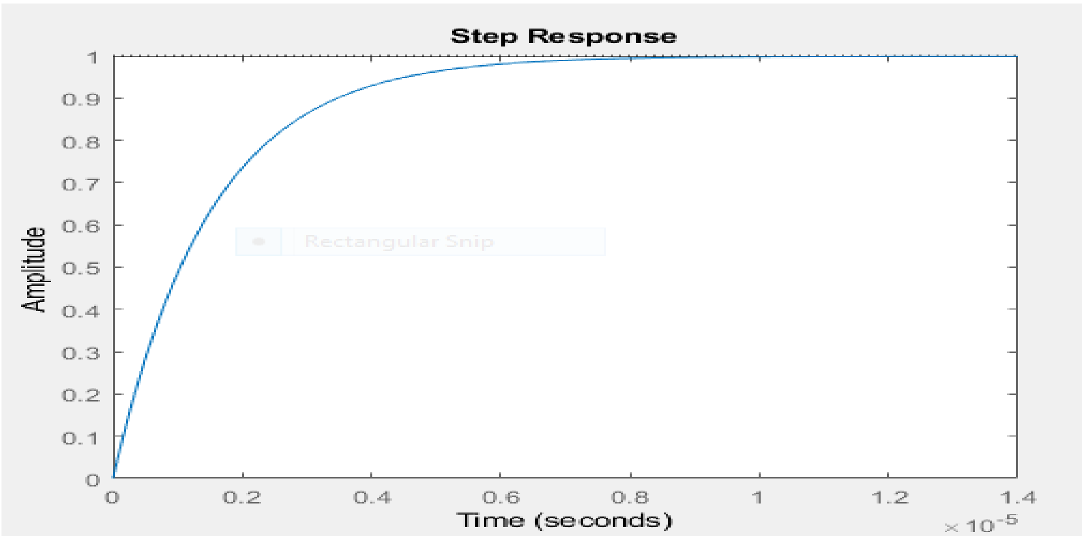

Fig-3 .Step response of PID controller

In this fig -3 The time shows the pressure applied to the fluid and the Amplitude shows the flow of liquid .

Neural Network training tool is shown in figure 5 which shows details and performance specifications about the trained NN speed controller, taken from MATALB. In training process of NN model, 50 iterations were done for successful results of NN speed controller as shown below.

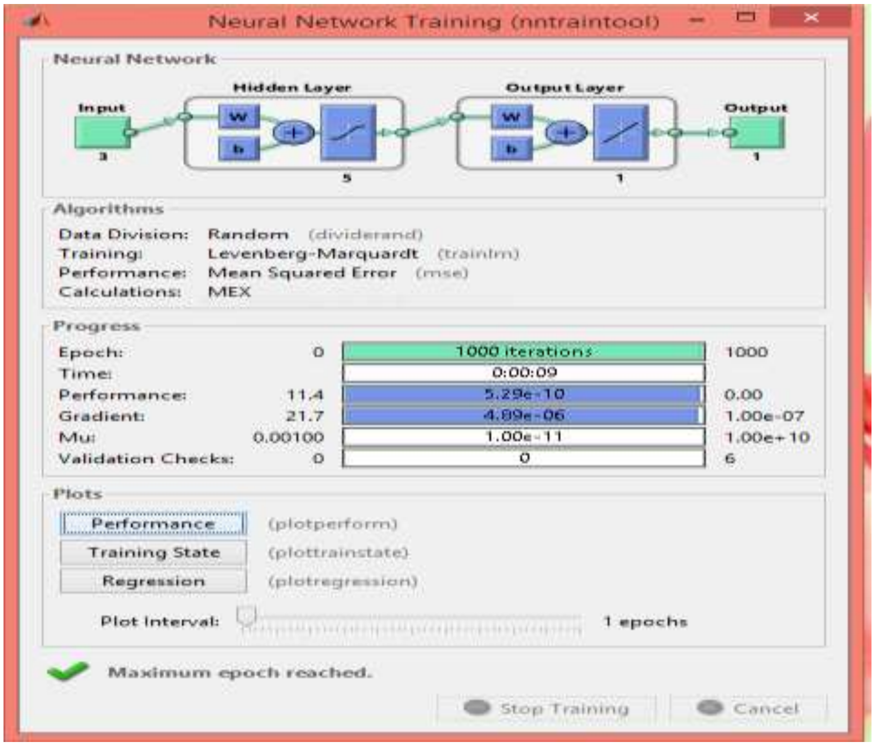

Figure.4. Training Tool for NN Speed Controller

Figure 5 .Displays the total output of the system when the neural network fluid controller is proposed. Neural network fluid controller derive response is better and more efficient than traditional fluid controller, which has no over shooting of the transient response and a stable steady response ,as shown in figure below, result obtained by the neural network fluid controller compared to the conventional PID controller. Solid blue lines in this figure represents the response of the conventional PID fluid controller and dotted lines shows the response of the neural network fluid controller . It can be seen that the proposed neural network controller response does not have any overshoot, however PID controller has overshoot. The proposed controller and PID controller both have same response but the neural network Fluid controller's transient response is better and more efficient than traditional PID fluid controller.

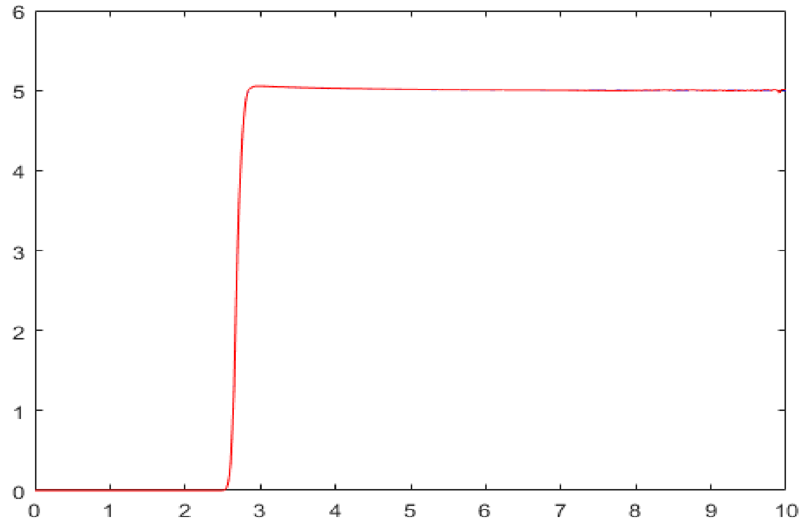

Figure.5. System Response of Neural Network fluid Controller

In fig 6 first we trained derivate controller then, we trained proportional controller and integral control controller with neural training box and we add these entire controller with transfer function we see result on the scope which will be shown on fig figure 6.

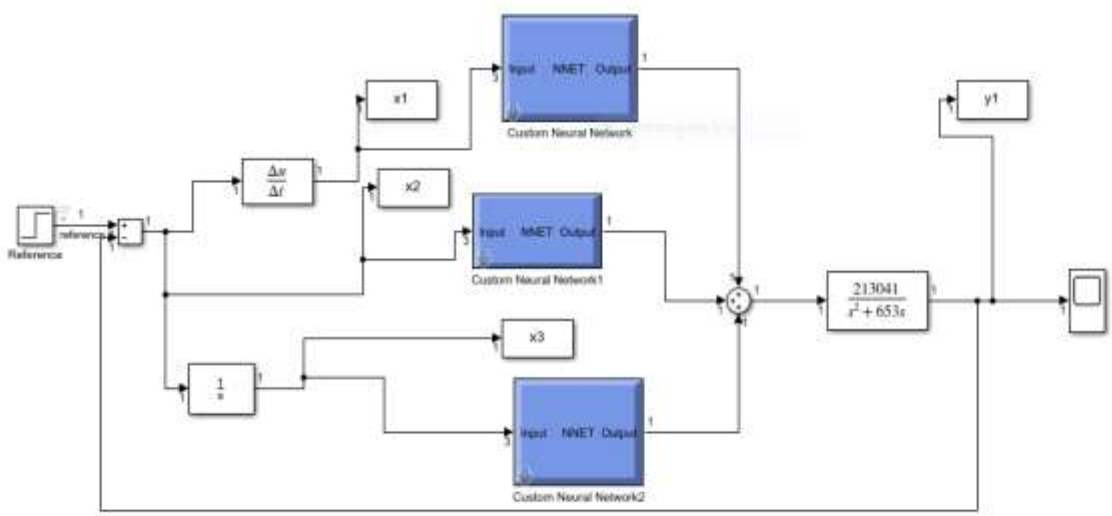

Fig.6 All neural network with PID.

In fig 7 shows the scope result of neural network based Proportional integrated derivate .in this fig we develop the neural network based controller for the application, steady state and the transient analysis of the system

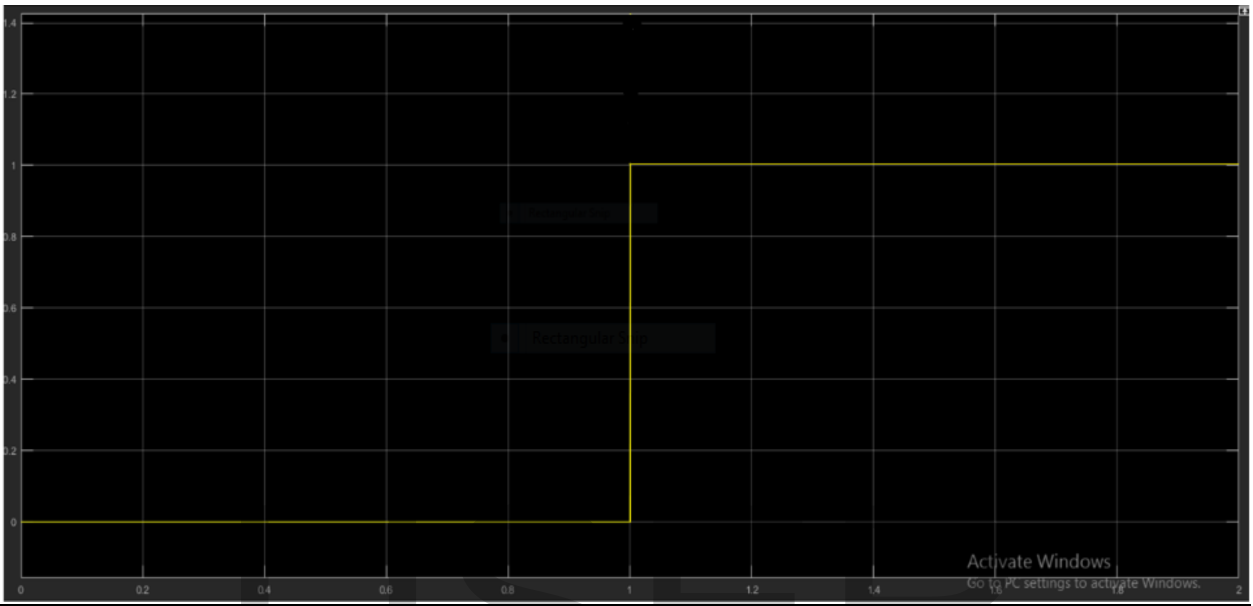

Fig-7 .SCOPE RESULT OF NEURAL NETWORK BASED PID.

CONCLUSION

This paper, proposes a neural network has been developed to compute three gains of an ANN. The controller is used to behave as an ideal hydraulic_switch, the results shows that Artificial Neural Network has been successful to behave like a switch and A comparison with PID shows that ANN is much better than PID. Neural network as a fluid controller for a hydraulic control system .The literature took a mathematical model, and a traditional PID controller was used to produce training data. Result of the simulation shows that the proposed fluid controller based on a neural network displays stronger transients behavior in terms of overshooting. Therefore, since its response is better than the PID controller, it gives optimal and efficient control of fluids. This is additionally preliminary work.

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