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Modeling of Micro-Hydro Power Plant and Its Control Based On Neural Network

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Abstract - ***Micro hydro power plants are hydro plants with small capacity. In the present scenario, the main problem is that, the voltage generated and its frequency is not stable when there is a change in load demand. Hence, we propose to build a closed loop system with change in output frequency as the control variable which can be fed into the PID controller and necessary actions can be taken so as to maintain constant parameters. The control circuit will employ a neural network based PID control which can effectively control the governor which regulates the amount volume of water running into turbine. The neural network block is constructed using Brandt-Lin Algorithm, which enables the controller to adapt changes of plant efficiently. In this paper, it was observed that the most accurate and precise result was given by neural network based controller in minimum stipulated time which effectively improved the plant performance.***

Key Words: *Micro hydro, PID controller, Neural Network*

1. INTRODUCTION

Engineering is concerned with understanding and harnessing the forces of nature for the benefit of mankind while maintaining an ecological balance and a safe planet on which we live. Control engineering deals with understanding the plant under operation and obtaining a desired output response in presence of system constraints. Due to the ample use of Proportional Integral Derivative (PID) controllers in process industry, there always has been a significant endeavor to obtain effective PID controller design methods, which will meet certain design criteria and provide system robustness.

Micro hydro is a type of hydroelectric power that typically produces up to 100 kW of electricity using the natural flow of water. These installations can provide power to an isolated home, small community, small industry or sometimes connected to electric power networks. But in Micro hydro plant, the main problem is maintenance of frequency at 50 Hz. Lie Jasa et al [1] describes the neural network based on PID control in Micro hydro power plants. By adjusting the volume of water from the spill away through the governor, the turbine rotation can be maintained automatically. With the stability of turbine rotation, the generator will generate a voltage and frequency was stabilized. M Hanmandlu et al [2] describes that the maintenance of desired power generation and frequency of micro hydro power plants using flow control as the main theme. Himani Goyal et al [3] proposed a flow control based model for the automatic control of micro hydro power plants. In the proposed model, a servomotor is used to control the flow of water by controlling the rotational motion of the spear valve.

Issam Salhi et al [4] realized real-time implementation of the MHPP model where good correlations have been achieved between the real-time MHPP model and the experimental data. Both simulation and practical results show the inability of a simple linear PI-type controller with fixed parameters to regulate and to keep the frequency of MHPP around its nominal value for all load variations. Hence this paper overcomes the problem by proposing to build a closed loop system from the change in output frequency by constructing neural network based PID control for controlling the governor. The simulation results show the feasibility of the proposed controller.

2. MODELING OF THE MHP SYSTEM WITH PID CONTROLLER

The main purpose of this paper is to build a PID controller based on neural network that can be used to control micro-hydro power plant. This control is set to be able to control the turbine rotation to become stable at a certain round when the load changes. The system is a closed loop control using feedback from the output of the generator. By adjusting the volume of water from the spill-way through the governor, the turbine rotation can be maintained automatically at the set points. With the

stability of turbine rotation, the generator will generate a voltage at frequency of 50 Hz. Plant model for study of MHP was done using servomotor as governor. It consists of 5 blocks: - PID controller, Governor, Servomotor, Turbine, Generator as given in Fig. 1 at the bottom of this page

3. PID CONTROLLER WITH NEURAL NETWORK

The Brandt-Lin algorithm which is originated from gradient descent considers a complex system consisting of sub-systems called nodes which interact through connection weights.

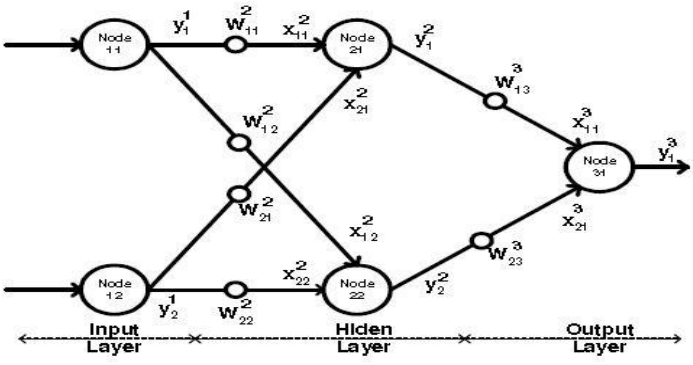

Fig -2: Brandt – Lin Algorithm

The design goal is to optimize the parameters of PID controller in a MHP to make the steady state error zero by applying neural network. Because of its non-linear property and input-output mapping, the controller based on neural network has the ability the make the system stable. In addition, the training procedure enables the controller to adapt changes of plant.

The inputs are created by proportion, integration and derivation of error between reference input and output.

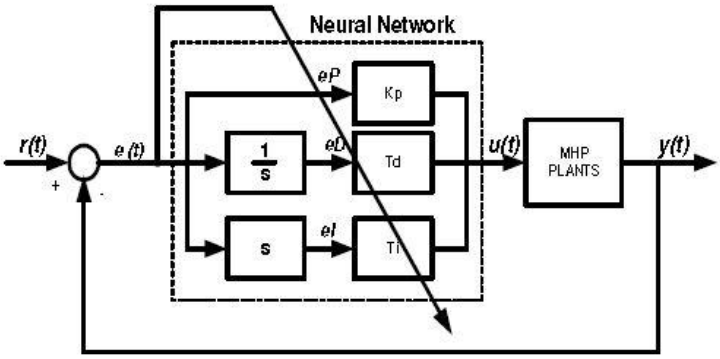

Fig -3: Training blocks- PID Neural Network

4. SIMULATION RESULTS

Firstly, the value of Kp, Ki and Kd is calculated using trial and error method. Secondly, training process is applied offline employing Brandt-Lin algorithm, in order to calculate weight of each neuron. The above two system are modeled in Simulink which is shown in Fig. 4 and Fig.5.

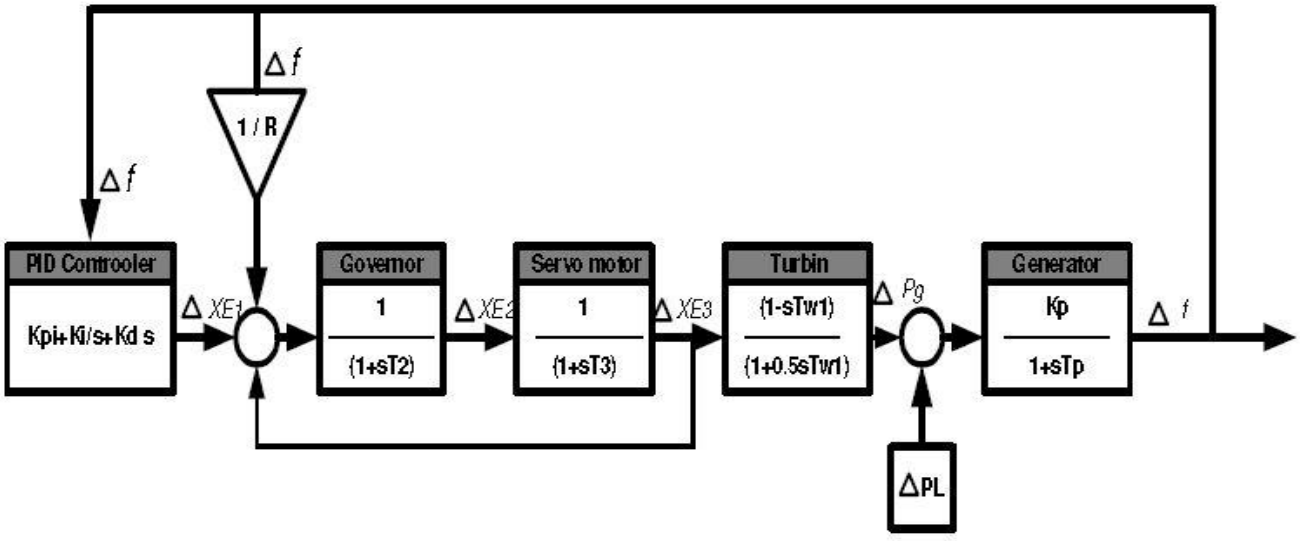

Fig -1: Model of MHP Plant using servomotor as governor with PID controller

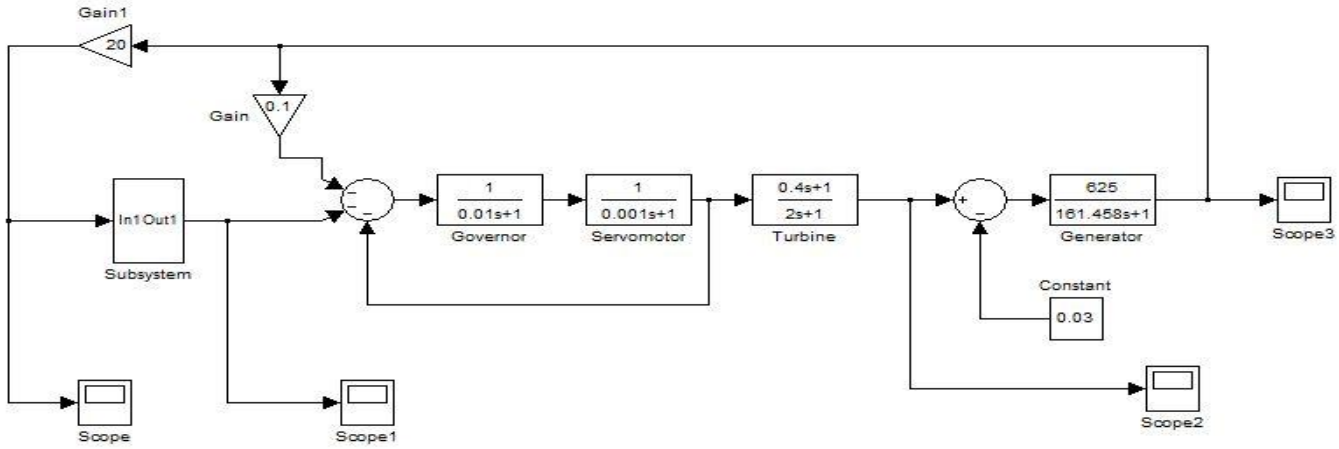

Fig -4: Simulink model of the Hydro power plant

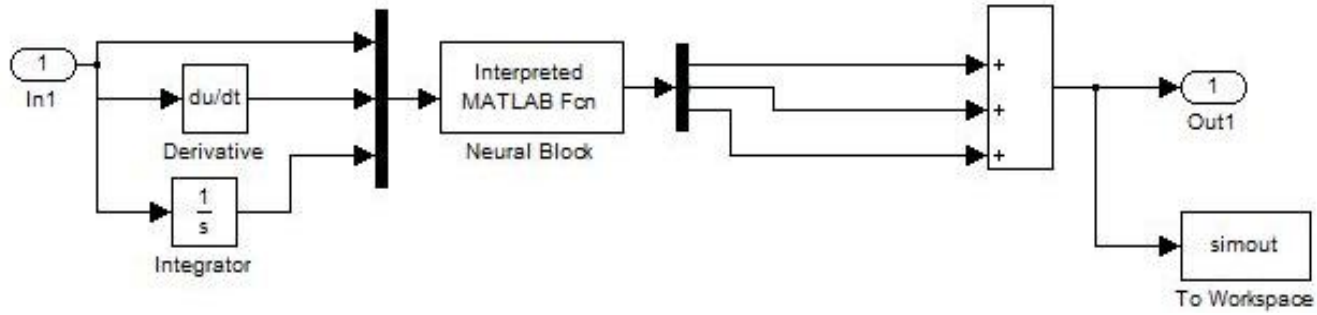

Fig -5: Simulink model of the Subsystem

Table -1: Comparision for various Kp, Ki and Kd values

ΔPl	0.03	0.05	0.08	0.5	0.8	1
Kp	0.9553	0.9721	0.9937	1.2680	1.5585	1.7105
Ki	1.2077	1.2244	1.2459	1.5175	1.8031	1.9523
Kd	0.9808	0.9967	1.0163	1.2588	1.5343	1.6816

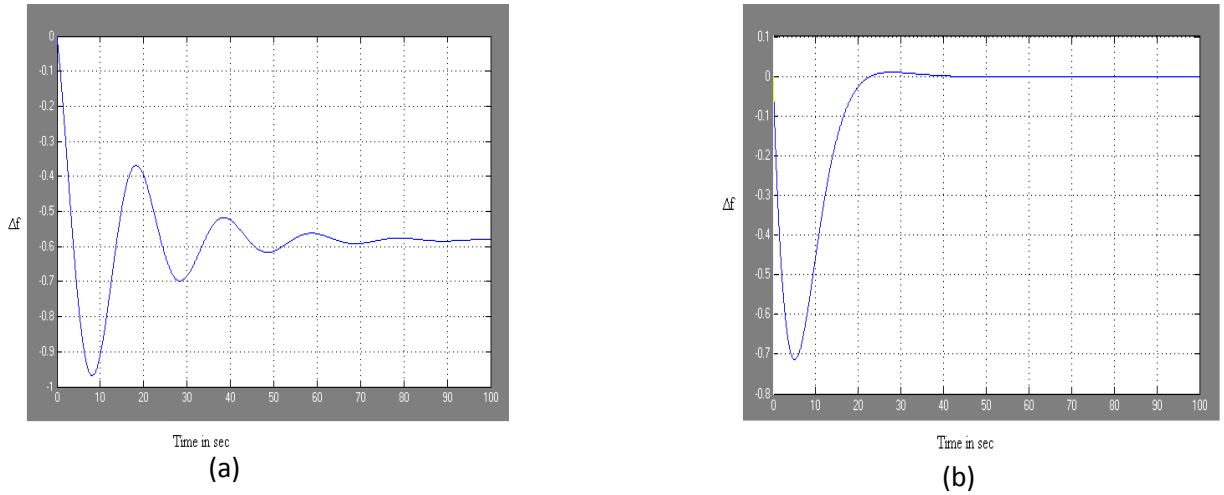

Fig -6: Change in Frequency (a) Without Controller (b) With controller.

From figure Fig.6 (a) and (b) it is evident that the proposed controller was able to maintain constant frequency without deviation when the disturbance is applied unlike the system without controller where there exists a permanent difference in the frequency.

5. CONCLUSION

The demonstrated success of neural network applications in optimizing parameters of PID controller and the increasing interest of researchers and electric power companies indicate the strength and applicability of the ANN technology. With regards to simulation, the results were satisfactory as the neural network based PID-controller was able to stabilize the system by bringing the value of steady-state error to zero in case of change in load demand. To obtain more practical performance results to further improve on the design, scheme can be developed to model more realistic load variations. Also, the proposed project can be implemented by using other algorithms for design of neural network.

REFERENCES

[1] Lie Jasa et al, "PID Control for micro-hydro power plants based on neural network", *Proceedings of the IASTED Conference* April 2 - 4, 2012 Phuket, Thailand, Modeling, Identification, and Control (AsiaMIC 2012)

[2] M.Hanmandlu, Himani Goyal,"Proposing a new advanced control technique for micro hydro power plants', *Journal Electrical Power and Energy System, 30(2008*), pages 272-282.

[3] H Goyal, TS Bhatti and DP Kothari,"A novel technique proposed for automatic control of small hydro power plants", International Journal of Global Energy Issues, 24 (1/2), 2005, pp. 29-46.

[4] Salhi, I., Chennani, M., Doubabi, S., & Ezziani, N. (2008, June). Modeling and regulation of a micro hydroelectric power plant. In *Industrial Electronics, 2008. ISIE 2008. IEEE International Symposium on* (pp. 1639-1644). IEEE.

[5] Salhi, I., Doubabi, S., Essounbouli, N., & Hamzaoui, A. (2014). Frequency regulation for large load variations on micro-hydro power plants with real-time implementation. *International Journal of Electrical Power & Energy Systems*, *60*, 6-13.

BIOGRAPHIES

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