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Modeling of Micro-Hydro Power Plant and Its direct Based On Neural system

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Abstract - *Micro hydro power plants are hydro plants with small capacity. In the here circumstances, the main problem is that, the voltage generated and its frequency is not stable when there is a change in load command. 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 needed 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.

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.

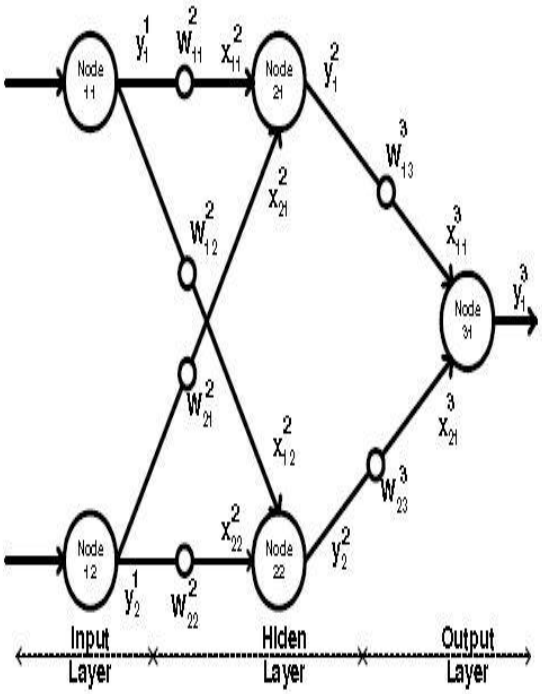

Fig -1: Brandt – Lin Algorithm

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.

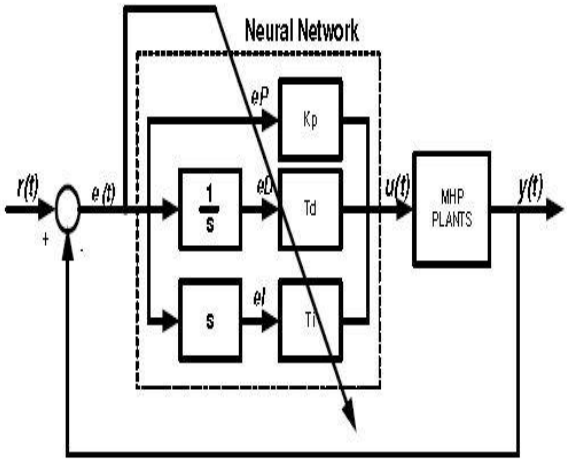

Fig- 2:Neural Network

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.

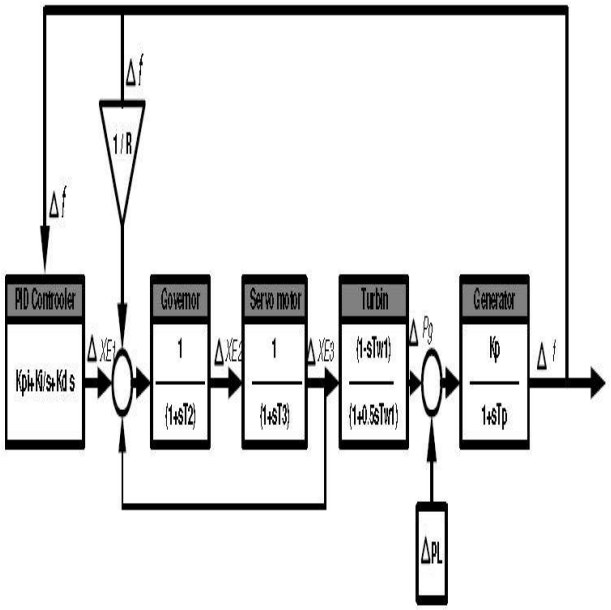

Fig- *3*: Model of MHP Plant using servomotor as governor with PID controller

Generator is used to transform energy mechanic into electric energy. By rotating magnetic field on the rotor, it will cause the magnetic field in the stator. The magnetic field that occurs at the stator with certain patterns will produce electric. The larger the generator is used, the greater the electrical energy generated.

Spill away is used to channel water from top to bottom and direct the water flow onto the turbine. The length of pipe diameter will affect the volume of water that runs. The larger the volume of water passes the bigger water impetus to the turbine. The spill awayallows placing micro-hydro in the secure area from flooding during the wet season.

Automatic control system of micro-hydro is built ina closed loop. First some water are flow in the value, it continue to the spill way and rotate the turbine. The generator will produces electricity in the nextstep and output it will through on the sensorfrequency.

The frequency measurement will be compared with the reference frequency. Difference frequency (Δf) will be entered into the control integrator. It will used to set and behind the valve.

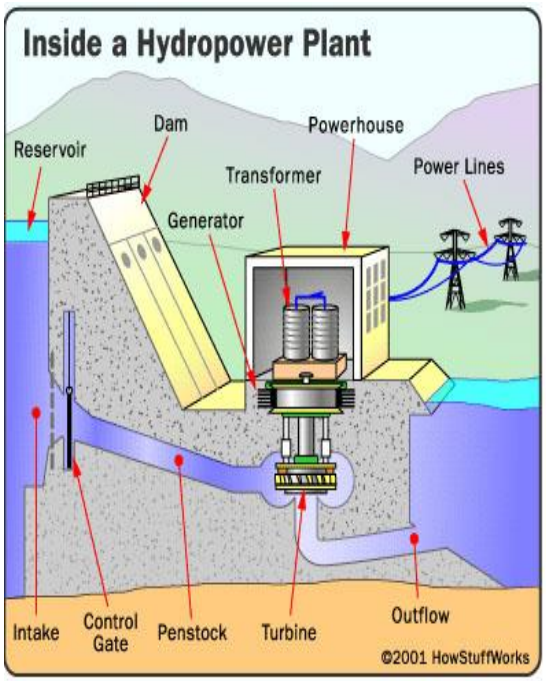

Fig -3: Hydropower Plant

A neural network usually involves a large number of processors operating in parallel and arranged in tiers. The first tier receives the raw input information -- analogous to optic nerves in human visual processing. Each successive tier receives the output from the tier preceding it, rather than from the raw input -- in the same way neurons further from the optic nerve receive signals from those closer to it. The last tier produces the output of the system.

Each processing node has its own small sphere of knowledge, including what it has seen and any rules it was originally programmed with or developed for itself. The tiers are highly interconnected, which means each node in tier *n* will be connected to many nodes in tier *n-1* -- its inputs -- and in tier *n+1,* which provides input for those nodes. There may be one or multiple nodes in the output layer, from which the answer it produces can be read.

Neural networks are notable for being adaptive, which means they modify themselves as they learn from initial training and subsequent runs provide more information about the world. The most basic learning model is centered on weighting the input streams, which is how each node weights the importance of input from each of its predecessors. Inputs that contribute to getting right answers are weighted higher.

It's a technique for building a computer program that learns from data. It is based very loosely on how we think the human brain works. First, a collection of software "neurons" are created and connected together, allowing them to send messages to each other. Next, the network is asked to solve a problem, which it attempts to do over and over, each time strengthening the connections that lead to success and diminishing those that lead to failure.

For a more detailed introduction to neural networks, Michael Nielsen's Neural Networks and Deep Learning is a good place to start. For a more technical overview, try Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.

Plant model for study of MHP was done using servomotor as governor. It consists of 5 blocks: - PID controller, Governor, Servomotor,

In defining the rules and making determinations -- that is, each node decides what to send on to the next tier based on its own inputs from the previous tier -- neural networks use several principles. These include gradient-based training, fuzzy logic, genetic algorithms and Bayesian methods. They may be given some basic rules about object relationships in the space being modeled. For example, a facial recognition system might be instructed, "Eyebrows are found above eyes," or "moustaches are below a nose.

Moustaches are above and/or beside a mouth." Preloading rules can make training faster and make the model more powerful sooner. But it also builds in assumptions about the nature of the problem space, which may prove to be either irrelevant and unhelpful or incorrect and counterproductive, making the decision about what, if any, rules to build in very important.

Neural networks are sometimes described in terms of their depth, including how many layers they have between input and output, or the model's so-called hidden layers. They can also be described by the number of hidden nodes the model has or in terms of how many inputs and outputs each node has. Variations on the classic neural-network design allow various forms of forward and backward propagation of information among tiers.

Artificial neural networks were first created as part of the broader research effort around artificial intelligence, and they continue to be important in that space, as well as in research around human cognition and consciousness.

Training consists of providing input and telling the network what the output should be. For example, to build a network to identify the faces of actors, initial training might be a series of pictures of actors, non-actors, masks, statuary, animal faces and so on. Each input is accompanied by the matching identification, such as actors' names, "not actor" or "not human" information. Providing the answers allows the model to adjust its internal weightings to learn how to do its job better.

For example, if nodes David, Dianne and Dakota tell node Ernie the current input image is a picture of Brad Pitt, but node Durango says it is Betty White, and the training program confirms it is Pitt, Ernie will decrease the weight it assigns to Durango's input and increase the weight it gives to that of David, Dianne and Dakota.

Hydro power continued to play a major role in the expansion of electrical service around the world. Hydro electric power plants generate from few kW to thousands of MW and are much more reliable and efficient as a renewable and clean energy source than fossil fuel power plants. This resulted in upgrading of small to medium sized hydro electric generating stations wherever there was an adequate supply of moving water and a need for electricity.

As electricity demand was increasing Mega projects of Hydro power plants were developed. The majority of these power plants involved large dams which flooded big areas of land to provide water storage and therefore a constant supply of electricity. In recent years, the environmental impacts of such large hydro projects are being identified as a cause for concern.

It is becoming increasingly difficult for developers to build new dams because of opposition from environmentalists and people living on the land to be flooded. Therefore the need has arisen to evaluate smaller scale hydroelectric power plants.

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.

Most hydroelectric power comes from the potential energy of dammed water driving a water turbine and generator. In this case the energy extracted from the water depends on the volume and on the difference in height between the source and the water's outflow.

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