Performance of Single Area Power System with PI And ANN Controller

Sandeep Kumar¹, Dhananjay Prasad², Silky Jindal³, Krishan Kumar Gola⁴

Abstract—This paper investigates the load frequency control problem with and without ANN controller. Primary load frequency control has static and dynamic features. One of the basic objectives of the loop is to maintain constant frequency in spite of changing loads. The static response of the load frequency control yield important information about frequency accuracy. The dynamic response of the loop will inform about tracking ability and stability of the loop. The PI controller is very simple for implementation and gives better dynamic response, but their performance deteriorates due to disturbances. To overcome this problem Artificial Neural Network (ANN) is used. Frequency response of single area power system with and without ANN compared. Thus, simulation result shows that ANN give better frequency response and minimizes the frequency deviation.

Index Terms—Load frequency Control (LFC), PI-controller, ANN Controller.

I. INTRODUCTION

A well designed power system is composed of several control areas that are connected with each other through tie lines. For satisfactory operation of a power system, the frequency should remain nearly constant i.e. frequency deviation should be zero. Relatively close control of frequency ensures constant of speed of induction and synchronous motors. The frequency of a power system is dependent on active power balance. [1,5].

In electric power generation, system disturbances caused by load fluctuations results in changes to the desired frequency value. Load Frequency Control (LFC) is a very important issue in power system operation and control for supplying sufficient and both good quality and reliable power. The basic aim of load frequency control is to maintain desired megawatt output of a generator unit [2,6].

Generally, the load–frequency control is accomplished by two different control actions in interconnected power systems:

(a) The primary speed control
(b) Supplementary or secondary speed control actions.

We consider the case of a single generator supplying power to a single service area, and consider two types of turbine used in generation.

Since for the load-frequency control problem the power system under consideration is expressed only to relatively small changes in load, it can be adequately represented by the linear model shown in Fig.1. The droop characteristic is a feedback gain to improve the damping properties of the power system, and it is generally set to 1/R before load frequency control design.

Fig.1 Single-area power system.

Single area power system is controlled by PI controller and ANN controller. This paper investigates which controller is better on the basics of their simulation results.

II. MODELING OF LOAD FREQUENCY CONTROL

Load frequency control analysis consists of several elements such as governor, turbine power system [3,4,8].

A. Governor

Governors are the units that are used in power systems to sense the frequency bias caused by the load change and cancel it by varying the inputs of the turbines. Representation of governing system is shown in figure. 2

Fig.2 Representation of Governing system
A. **Turbine**

A turbine unit in power systems is used to transform the natural energy, such as the energy obtained from steam or water, into mechanical power that is supplied to the generator. Generally, Steam and hydraulic turbines are used in power systems for analysis of load frequency control (LFC). These turbines are modeled by transfer functions. Steam turbine is two types that is reheat and non-reheat steam turbine.

Transfer function of non-reheat is written as

\[ G_t(s) = \frac{1}{1 + sT_T} \]

B. **Machine**

The equation of motion or swing equation in power system stability analysis is rotational inertia equations describing the effect of unbalance between the electromagnetic torque and mechanical torque of the individuals.

C. **Load**

The load on the power system consists of a variety of electrical drives. The equipments used for lighting purposes are basically resistive in nature and the rotating devices are basically a composite of the resistive and inductive components.

\[ \Delta P_e = \Delta P_L + D\Delta f \]

Where, \( \Delta P_L \) is the non-frequency-sensitive load change.

\( D \Delta f \) is the frequency sensitive load change.

\( D \) is expressed as percent change in load by percent change in frequency. Typical values of \( D \) are 1 to 2 percent.

\[ u(t) = K\left( e(t) + \frac{1}{T_i} \int_0^t e(t) dt + T_d \frac{de(t)}{dt} \right) \]

(30)

Where, \( u = \) control signal

\( e = y_r - y = \) control error

\( y = \) measured process variable

\( r = \) reference variable, the reference variable is often called the set point

\( K = \) proportional gain

\( T_i = \) integral time

\( T_d = \) derivative time
B. NARMA-L2 Control

The neuro controller is referred to by two different names: feedback linearization control and NARMA-L2 control. It is referred to as feedback linearization when the plant model has a particular form. It is referred to as NARMA-L2 control when the plant model can be approximated by the same form.

The idea of this type of control is to transform nonlinear system dynamics into linear dynamics by cancelling the nonlinearities.

IV. SIMULATION RESULTS

Secondary load frequency control strategy is needed that not only maintains constancy of frequency and desired tie-power flow but also achieves zero steady state error and inadvertent interchange.

Fig. 5 Response of power system with non-reheat turbine (with PID controller)

The PI controller is very simple for implementation and gives better dynamic response, but their performance deteriorates due to disturbances. To overcome this problem Artificial Neural Network (ANN) is used. Frequency response of single area power system with and without ANN compared. Thus, simulation result shows that ANN give better frequency response and minimizes the frequency deviation.
A dynamic frequency response controller. Simulation results show ANN provides suitable power system controls with PID controller and ANN. A single area frequency model is examined using linear load frequency model. The frequency response for steam and hydraulic turbine characteristics is determined by simulation analysis. Simulation results show ANN provides suitable dynamic frequency response.

V. CONCLUSION

Turbine characteristics examined using linear load frequency model. The frequency response for steam and hydraulic turbine is determined by simulation analysis. A single area power system controls with PID controller and ANN controller. Simulation results show ANN provides suitable dynamic frequency response.

APPENDIX

Table 1 Parameters of single area power system

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Tp</td>
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<tr>
<td>Tg</td>
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<tr>
<td>Tm</td>
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<tr>
<td>R</td>
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<tr>
<td>KP</td>
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</tbody>
</table>

Fig. 4 Single area response with and without ANN

REFERENCES


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