Chapter 22

Load Frequency Control in Power System via Improving PID Controller Based on Particle Swarm Optimization and ANFIS Techniques

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ABSTRACT

The main objective of Load Frequency Control (LFC) is to regulate the power output of the electric generator within an area in response to changes in system frequency and tie-line loading. Thus the LFC helps in maintaining the scheduled system frequency and tie-line power interchange with the other areas within the prescribed limits. Most LFCs are primarily composed of an integral controller. The integrator gain is set to a level that compromises between fast transient recovery and low overshoot in the dynamic response of the overall system. This type of controller is slow and does not allow the controller designer to take into account possible changes in operating conditions and non-linearities in the generator unit. Moreover, it lacks robustness. This paper studies LFC in two areas power system using PID controller. In this paper, PID parameters are tuned using different tuning techniques. The overshoots and settling times with the proposed controllers are better than the outputs of the conventional PID controllers. This paper uses MATLAB/SIMULINK software. Simulations are done by using the same PID parameters for the two different areas because it gives a better performance for the system frequency response than the case of using two different sets of PID parameters for the two areas. The used methods in this paper are: a) Particle Swarm Optimization, b) Adaptive Weight Particle Swarm Optimization, c) Adaptive Acceleration Coefficients based PSO (AACPSO) and d) Adaptive Neuro Fuzzy Inference System (ANFIS). The comparison has been carried out for these different controllers for two areas power system. Therefore, the article presents advanced techniques for Load Frequency Control. These proposed techniques are based on Artificial Intelligence. It gives promising results.

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1. INTRODUCTION

Frequency is an explanation of stability criterion in power systems (Ismail & Hassan, 2012; Salami et al., 2006; Wang, et al., 1993). To provide the stability, active power balance and steady frequency are required. Frequency depends on active power balance. If any change occurs in active power demand/generation in power systems, frequency cannot be hold in its rated value. So oscillations increase in both power and frequency. Thus, system subjects to a serious instability problem. In electric power generation, system disturbances caused by load fluctuations result in changes to the desired frequency value. Automatic Generation Control (AGC) or Load Frequency Control (LFC) is an important issue in power system operation and control for supplying stable and reliable electric power with good quality (Skogestad, 2003; Tammam, 2011). The principle aspect of Automatic Load Frequency Control is to maintain the generator power output and frequency within the prescribed limits.

In order to keep the power system in normal operating state, a number of controllers are used in practice. The PID controller will be used for the stabilization of the frequency in the load frequency control problems (Ismail & Hassan, 2012; Salami et al., 2006; Skogestad, 2003; Wang, et al., 1993). Each control area is responsible for individual load changes and scheduled interchanges with neighboring areas (Tammam, et al., 2012a). Area load changes and abnormal conditions leads to mismatches in frequency and tie line power interchanges which are to be maintained in the permissible limits, for the robust operation of the power system. For simplicity, the effects of governor dead band are neglected in the Load Frequency Control studies. To study the realistic analysis of the system performance, the governor dead band effect is to be incorporated. To improve the stability of the power networks, it is necessary to design LFC system that controls the power generation and active power at tie lines.

Many studies have been carried out in the past on this important issue in power systems, which is the load frequency control. As stated in some literature (RamaSudha, et al., 2010; Bevrani, 2009; Ismail, 2006), its objective is to minimize the transient deviations in these variables (area frequency and tie-line power interchange) and to ensure their steady state errors to be zeros. In this paper, different intelligent techniques such that Particle Swarm Optimization (PSO), Adaptive Weighted Particle Swarm Optimization techniques (AWPSO), Adaptive Acceleration Coefficients based PSO (AACPSO) and Adaptive Neuro Fuzzy Inference System (ANFIS) will be used to determine the parameters of a PID controller according to the system dynamics. Using the same parameters of PID controller for the two different areas because it gives a better performance for the system frequency response than in case of using two different PID parameters for each different area (Panigrahi, et al., 2008). In the integral controller, if the integral gain is very high, undesirable and unacceptable large overshoots will be occurred. However, adjusting the maximum and minimum values of proportional (Kp), integral (Ki) and integral (Kd) gains respectively, the outputs of the system (voltage, frequency) could be improved. The main objectives of LFC, is to regulate the power output of the electric generator within a prescribed area in response to changes in system frequency, tie line loading so as to maintain the scheduled system frequency and interchange with the other areas within the prescribed limits.

In this simulation study, two area power systems parameters are chosen and load frequency control of this system is made based on PID controller by using Particle Swarm Optimization and Adaptive Weight Particle Swarm Optimization Techniques (PSO) and (AWPSO) to choose best parameters of PID Controller (Rania, 2012; Naik, et al., 2005; Gaing, 2004) and Also using Adaptive Neuro Fuzzy Inference System (ANFIS) to control LFC in power system (Azar, 2012; Azar, 2010a, b; Panigrahi, et al., 2008). This paper is organized