Chapter 16

BFO Optimized Automatic Load Frequency Control of a Multi-Area Power System

Pravat Kumar Ray
National Institute of Technology Rourkela, India

Sushmita Ekka
National Institute of Technology Rourkela, India

ABSTRACT

This chapter presents an analysis on operation of Automatic Load Frequency Control (ALFC) by developing models in SIMULINK which helps us to understand the principle behind ALFC including the challenges. The three area system is being taken into account considering several important parameters of ALFC like integral controller gains (KIi), governor speed regulation parameters (Ri), and frequency bias parameters (Bi), which are being optimized by using Bacteria Foraging Optimization Algorithm (BFOA). Simultaneous optimization of certain parameters like KIi, Ri and Bi has been done which provides not only the best dynamic response for the system but also allows us to use much higher values of Ri than used in practice. This will help the power industries for easier and cheaper realization of the governor. The performance of BFOA is also investigated through the convergence characteristics which reveal that that the Bacteria Foraging Algorithm is quite faster in optimization such that there is reduction in the computational burden and also minimal use of computer resource utilization.

INTRODUCTION

Power systems are very large and complex electrical networks consisting of generation networks, transmission networks and distribution networks along with loads which are being distributed throughout the network over a large geographical area as per Yao (2007). In the power system, the system load keeps changing from time to time according to the needs of the consumers. So properly designed controllers are required for the regulation of the variations in the system so as to maintain the stability of the power system and ensure its reliable operation.

DOI: 10.4018/978-1-5225-0427-6.ch016

The rapid growth of the industries has further lead to the increased complexity of the power system. Frequency greatly depends on active power and the voltage greatly depends on the reactive power. So the control difficulty in the power system can be divided into two parts. One is related to the control of the active power and the frequency whereas the other is related to the reactive power and the control of voltage. The active power control and the frequency control is generally known as the Automatic Load Frequency Control (ALFC).

Basically the Automatic Load Frequency Control (ALFC) deals with the regulation of the real power output of the generator and its frequency (speed). The primary loop is relatively fast where changes occur in one to several seconds. The primary control loop responds to frequency changes through the speed governor and the steam (or hydro) flow is managed accordingly to counterpart the real power generation to relatively fast load variations. Thus maintain a megawatt balance and this primary loop performs a course speed or frequency control.

The secondary loop is slower compared to the primary loop. The secondary loop maintains the excellent regulation of the frequency, furthermore maintains appropriate real power exchange among the rest of the pool members. This loop being insensitive to quick changes in load as well as frequency, it focuses on swift changes which occur over periods of minutes.

Load disturbance due to the occurrence of continuous and frequent variation of loads having smaller values always creates problem for ALFC. Due to the change in the active power demand/load in an area, tie-line power flows from the interconnected areas and the frequency of the system changes and thus the system becomes unstable. So we need Automatic Load Frequency Control to maintain the stability during the load variations. This is done by minimizing transient deviations of frequency as well as tie-line power exchange and also making the steady state error to zero [3,4]. Inequality involving generation with demand causes frequency deviations. If the frequency is not maintained within the scheduled values then it may lead on the way to tripping of the lines, system collapse as well as blackouts.

BACKGROUND

Literature Review

A lot of work has been done related to automatic load frequency control in power systems. Load variations give rise to drifts in frequency along with voltage consequential in reduction of generation because of line tripping as well as blackouts. These variations are reduced by AGC that constitutes of two sections namely LFC and AVR. Adil et. al. (2012) discussed simulation analysis is dispensed to comprehend operation of LFC by rising models in SIMULINK that helps to know the principles and various challenges relating to LFC.

The PI controller parameters derived from conventional or trial-and-error methods can't have sensible dynamical act for a large variety of operating circumstances and changes in load in multi-area power system. To solve this difficulty, decentralized LFC combination is developed as an H-∞ control problem and furthermore solved by means of iterative linear matrix inequalities algorithmic rule to style sturdy PI controllers in multi-area power systems as discussed by Bevrani et. al. (2004).

Rout et. al. (2013) discussed, a unified PID tuning technique dependent on two-degree-of-freedom for LFC of power system. Also time domain act and robustness of consequential PID controller is associated to two regulation parameters and its robustness is discussed. Simulation results shows improvement in