Electrical Power and Energy Systems 33 (2011) 633–638

Contents lists available at ScienceDirect

Electrical Power and Energy Systems

journal homepage: www.elsevier.com/locate/ijepes

Bacteria foraging optimization algorithm based load frequency controller for interconnected power system

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ARTICLE INFO

Article history:
Received 2 January 2010
Received in revised form 21 August 2010
Accepted 1 December 2010
Available online 31 January 2011

Keywords:
LFC
PI
Power system control
Genetic algorithm
Bacteria foraging

ABSTRACT

Social foraging behavior of *Escherichia coli* bacteria has recently been explored to develop a novel algorithm for distributed optimization and control. The Bacterial Foraging Optimization Algorithm (BFOA), as it is called now, is currently gaining popularity in the community of researchers, for its effectiveness in solving certain difficult real world optimization problems. This paper proposes BFOA based Load Frequency Control (LFC) for the suppression of oscillations in power system. A two area non-reheat thermal system is considered to be equipped with proportional plus integral (PI) controllers. BFOA is employed to search for optimal controller parameters by minimizing the time domain objective function. The performance of the proposed controller has been evaluated with the performance of the conventional PI controller and PI controller tuned by genetic algorithm (GA) in order to demonstrate the superior efficiency of the proposed BFOA in tuning PI controller. Simulation results emphasis on the better performance of the optimized PI controller based on BFOA in compare to optimized PI controller based on GA and conventional one over wide range of operating conditions, and system parameters variations.

1. Introduction

For large-scale power systems, which normally consist of interconnected control area, Load Frequency Control (LFC) is important to keep the system frequency and the inter-area tie power as close as possible the scheduled values. The mechanical input power to the generators is used to control the frequency of output electrical power and to maintain the power exchange between the areas as scheduled. In a deregulated power system, each control area contains different kinds of uncertainties and various disturbances due to increased complexity, system modeling errors, and changing power system structure. A well designed and operated power system should cope with changes in the load and with system disturbances, and it should provide acceptable high level of power quality while maintaining both voltage and frequency within tolerable limits [1].

Several strategies for LFC of power systems have been proposed by researchers over the past decades. A robust decentralized power system LFC controller design approach has been designed in [2] using structure singular value. Two robust decentralized LFC controllers are introduced in [3]. The first one is based on H_∞ theory, and results in a high order controller. The second controller is a PI controller tuned by Genetic Algorithm (GA) to achieve the same robust performance as the first one. A decentralized adaptive control scheme for LFC of multi area power systems to deal with variations of system parameters is introduced in [4]. An application of a fuzzy gain scheduled proportional and integral (FGPI) controller for LFC of a two area electrical interconnected power system is introduced in [5]. An approach based on the Tabu Search (TS) algorithm for optimal design of a Fuzzy Logic based Proportional Integral (FLPI) LFC in a two area interconnected power system is presented in [6]. The PI and I control parameters are tuned based on Hybrid Particle Swarm Optimization (HPSO) algorithm method for LFC control in a two area power system in [7]. PSO based multi stage fuzzy controller is proposed for solution of LFC problem in power system in [8]. Designing of PID controller for LFC in interconnected power system using PSO has been discussed in [9]. Hybrid Neuro Fuzzy (HNF) approach is employed in [10] for an Automatic Generation Control (AGC) of interconnected power system with and without generation rate constraint (GRC). Application of real coded GA for optimizing the gains of a PI controller for two area thermal reheat power system has been discussed in [11]. Fuzzy Logic Controller is designed for automatic LFC of two area interconnected power system in [12]. A new adaptive load shedding scheme that provides emergency protection against excess frequency decline, whilst minimizing the risk of line overloading is presented in [13]. Various novel heuristic stochastic search techniques have been introduced in [14] for optimization of PID gains used in Sugeno fuzzy logic based AGC of multi-area thermal generating plants. A new robust PID controller for AGC of hydro turbine power systems is presented in [15]. The method is mainly

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doi:10.1016/j.ijepes.2010.12.022