Chapter 3

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ABSTRACT
This chapter presents four effective evolutionary methods, namely grey wolf optimization (GWO), symbiotic organism search (SOS), JAYA, and teaching-learning-based optimization (TLBO), for solving automatic generation control (AGC) problem in power system. To show the effectiveness, two widely used interconnected power plants are examined. To extract maximum possible generation, distinct PID-controllers are designed employing ITAE-based fitness function. Further, to enhance the dynamic stability of concerned power systems, 2DOF-PID controllers are proposed in LFC area and optimally designed using aforesaid algorithms. To demonstrate the supremacy, obtained results are compared with some existing control algorithms. Moreover, robustness of the designed controller is believed under the action of random load perturbation (RLP). Finally, sensitivity analysis is carried out to show the stability of the designed system under loading and parametric disturbance conditions.

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1. INTRODUCTION

Balance between total power generation and load consumption is always an intricate task particularly at peak load. Hence this is assigned as serious issue to ensure stable and reliable operation of power system at dynamic period. Since the term frequency is directly correlated with system loading, thus any abrupt change in loading cause serious deviation of system frequency from its tolerance value. Owing to load variations, the oscillation in frequency and interchange tie-line power persist for long time. Primary controller served by speed governor would be unable to nullify these fluctuations after load perturbation. An ample variation of frequency may severely affects the equilibrium states of the system and causes high flow of magnetizing current in transformers, induction motors etc (Arya, 2017). Hence, continuous monitoring of power generation and loading demand is needed. This is accomplished by automatic generation controller (AGC). AGC continuously monitor the generator output to meet load demand so as to regulate the frequency error down to zero value. The AGC scheme is not only maintaining the frequency level, it offers steady flow of power through tie-line between the nearby control areas.

Sudden load fluctuation due to variation of load is the key source of disturbance in power system. In this connection, AGC play a significant role to ensure system stability under the action of load perturbation (Naidu et al., 2017). In the literature an extensive works have been undertaken for continuous improvement of AGC performance. The implementation and impact of AGC in power system has been documented by Chon (Chon, 1956). However, the success of optimal control theory in LFC has been shown by Elgerd and Fosha (Fosha & Elgerd, 1970). An extensive review of literature of LFC for conventional and deregulated power systems has been available in (Kumar and Kothari, 2005). Gradual expansion in dimension, change in structure and increasing load demand in power system necessitated establishment of new control strategies. The traditional control strategies may be inept to takeover such abrupt changes in AGC. Some of the recently addressed control strategies in the literature are dual mode linguistic hedge fuzzy logic (Ansari & Velusami, 2010), dual mode fuzzy logic (Kumar et al., 2015), feedback controller (Ahmadi & Aldeen, 2017), fractional order fuzzy proportional-integral-derivative (PID) controller (Arya, 2017), 3 degree-of-freedom integral-derivative (3DOF-ID) controller (Rahman et al., 2015). Load frequency control in deregulated environment via active disturbance rejection scheme is illustrated in (Tan et al., 2015). The infliction of PID controller or its variants in AGC analysis has been appeared in the literature because of its numerous practical amenities (Padhan et al., 2014, Shankar & Mukherjee, 2016, Dhillon et al., 2016, Guha et al., 2016a). Recently in (Guha et al., 2017) an optimized PID-controller is designed to resolve the load frequency control (LFC) issue of an interconnected power system.

The type and design of controller is an important aspect that influences the behavior and stability of system significantly. Classical methods such as Zeigler-Nichols (ZN), trial and error, steepest decent etc. used for design of controller shows sluggish responses and laborious. To revoke this issue, researchers are trying to implement different optimization techniques that amalgamate knowledge, advance theories from different sources to take care AGC problem efficiently (Arya, 2017). Some of the recently applied optimization techniques in AGC are backtracking search algorithm (BSA) (Guha et al., 2016b), ant-lion optimization (ALO) (Raju et al., 2016), quasi-oppositional harmony search algorithm (QOHSA) (Shiva and Mukherjee, 2015), cuckoo search algorithm (CSA) (Abdelaziz & Ali, 2015), improved particle swarm optimization (IPSO) (Zare et al., 2015), bat algorithm (Abd-Elazim & Ali, 2016) etc. The aforesaid optimization techniques show better results leaving behind few shortcomings. In the line of ‘no-free-lunch (NFL)’ theory, no optimization technique is well suited for all optimization problems.