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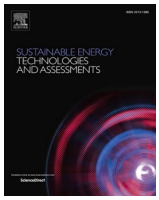

Original article

Simultaneous controllers for stabilizing the frequency changes in deregulated power system using moth flame optimization

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ABSTRACT

This paper introduces a stochastic idea for two-area automatic generation control (AGC) of the restructured system for enhancing the system dynamic performance. In this work, a new 2-degree of freedom of proportional-integral derivative-fractional order proportional derivative with filter (2DOF PID-FOPDN) approach is proposed for the AGC two area system. To ensure realization of optimal gains of the controller, a novel nature-inspired moth-flame optimization (MFO) is suggested using integral of time multiplied absolute error (ITAE) model. The performance of MFO-based 2DOF PID-FOPDN is evaluated against Cuckoo search (CS), Bat algorithm (BA), and Teaching learning-based optimization (TLBO) approaches in different contract scenarios of deregulated system. Further work to reduce the changes in tie-line has been applied through different FACTS controllers, such as Distributed power flow controller (DPFC), Thyristor-controlled series capacitor (TCSC), Unified power flow controller (UPFC), and Static synchronous series compensator (SSSC); integrated into the AGC system with the co-ordination of Ultra-capacitor (UC). The results indicate that the MFO-based 2DOF PID-FOPDN shows superior performance with DPFC-UC over other approaches in all contract scenarios of liberalized system. A sensitivity analysis is examined to recognize the robustness of the suggested approach under ± 25% deviation in loading and system parameters.

Introduction

Nowadays, the electrical power system is striving with several difficulties due to integrating the wide range of renewable sources, high capacity of power production units, abrupt changes in load demand, and more utilization of power electronic technology. Since the interconnection system has been connected with various control areas, a small load disturbance (SLD) may occur in any area, which may alter the system specifications namely, frequency, current, and voltage, then the entire system would be unproductive. Different types of control techniques have been presented in the interconnected power system to equate the power generation and the required amount of load without changing the system parameters. Among these control approaches, automatic generation control (AGC) is a reliable method to mitigate the variations in frequency at different operating conditions [1,2].

Recently, more countries are proclaiming the distinct type of lucrative policies for reshaping their electric system. The objectives of the restructured power system are to ensure cost-effective and reliable power for utilizers at favourable prices. Furthermore, the deregulated power system involves different companies, such as generation companies (GENCOs) for power generation, transmission companies (TRANSCOs) for transmitting the power, distribution companies (DISCOs) for distribution, and independent contract administrator (ICA). All power agreements between the companies are supervised by the ICA from the government sector. Diverse types of power agreements are endured in a liberalized environment such as pool-co based scenario, bilateral based, and contract violation type [3]. The AGC control mechanism performs an effective role in the restructured system with unequal sources for retaining the tie-line power and frequency within scheduled values.

Several researchers have investigated the effect of AGC with different control strategies in the restructured system described briefly. Previous examinations have mainly focused on the conventional techniques like integral double derivative (IDD), proportional-integral (PI), and proportional integral derivative (PID) for alleviating the variations in frequency and tie-line power [4,5]. As the traditional approaches are

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