Automatic Generation Control of Interconnected Power System using Cuckoo Optimization Algorithm

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ABSTRACT

Automatic generation control (AGC) is added in power system to ensure constancy in frequency and tie-line power of an interconnected multi-area power system. In this article, proportional integral (PI) controlled based AGC of two-area hydrothermal system is solved by cuckoo optimization algorithm (COA). It is one of the most powerful stochastic real parameter optimization in current use. The design objective is to improve the dynamic performance of the interconnected system following a disturbance. System performance is examined considering 1% step load perturbation in thermal area with generation rate constraints. The results are compared with BBO, GA and DE to show the effectiveness of the proposed method. Computed results shows that the proposed method effectively improve the performance of the objective function with corresponding minimization of the overshoot, undershoot and settling time to reach steady state.

Keywords: *Automatic Generation Control (AGC), Cuckoo Optimization Algorithm (COA), Load-Frequency Controller, Multi-Area System, Proportional Controller*

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1. INTRODUCTION

An interconnected power system is made up of several areas. Electric power systems are continuously growing in size and complexity with increasing interconnections. In day to day life the load consumptions are varying abruptly. As such a wide fluctuation in load occurs which causes variation in the frequency and voltage of the system in the power plants, which in turn may hamper the regulation, power balance and stability of the system. The gap between demand and supply is increasing day by day and often it is not possible to meet the demand of big consumers. The three main sources of electric power generation are thermal, hydro and nuclear power. First of all, the fuel used in nuclear power is expensive and is difficult to recover. Gas power plant, ideal for meeting the varying load demand, has no participation of automatic generation control (AGC). So, thermal and hydro power plants are the natural choice for AGC. Hydro turbine differs from thermal turbine in many respects. Greater time-lag in response of the change in prime mover torque to a change in gate position has been observed in hydro-turbine power plant. AGC maintain the system frequency and tie line flow at their scheduled value during normal operation and also during small perturbations.

Over the years AGC has been extensively used to regulate the above mismatch and achieve a highly regulated power generations by controlling the steam power flow through the turbine. It is basically a centralized operation that operates in real time and in closed loop with strong interface to other functions oriented towards the economy and security of power system. A robust controller (Azzam, 1999), (Azzam, Yehia & Mohamad, 2002) used to achieve both robust stability and good dynamic performance against the variation of system parameters. The literature survey shows that most of the earlier works are done in the area of AGC pertain to interconnected thermal systems and relatively lesser attention has been devoted to the AGC of interconnected hydro-thermal system.

The researchers in the world over trying to employ several strategies for AGC of power systems to maintain the system frequency and tie line flow at their scheduled values during normal operation and also during disturbance conditions. A critical literature review on the AGC of power systems was presented in (Saikia, Nanda & Mishra 2011) where different control techniques pertaining to AGC problem were discussed. In (Chandrakala. Balagurugan & Sankaranarayan, 2013), Chandrakala *et al.* proposed fuzzy gain scheduling for solving the load frequency control problem of multi-source multi-area hydro-thermal power system. Ghoshal *et al.* (Bhatt, Roy & Ghosal, 2011) used the dynamic power flow control of static synchronous series compensator (SSSC) in coordination with superconducting magnetic energy storage to stabilize the area frequency oscillation of two area hydro-hydro system. From the last ten years interest has focused on optimization techniques to find optimal values for the tuning parameters. In (Panda, Mohanty & Hota, 2013), Panda *et al.* proposed hybrid bacteria foraging optimization (HBFO) algorithm for solving AGC problem of an interconnected power system and its performance were compared with particle swarm optimization (PSO), genetic algorithm (GA) and BFO to show the robustness of the proposed algorithm. In (Roy, Bhatt & Ghosal, 2011), various novel heuristic stochastic search techniques were proposed for optimization of proportional-integral-derivative gains used in sugeno fuzzy logic based AGC. Saikia *et al.* (Saikia, Mishra, Sinha & Nanda, 2011) proposed reinforced learning neural network controller to simultaneously optimize the integral gains and speed regulator parameter keeping frequency bias fixed at frequency response characteristics. Various modified version of GA and PSO for optimizing the PID controllers is available in the literature (Ghosal & Goswami, 2003), (Bhatt, Roy & Ghosal, 2010), (Bhatt, Roy & Ghosal, 2010). Recent research has identified some deficiencies in GA performance (Abido, 2002). Reinforcement learning algorithms, called Q-learning, was used by Ahamed *et al.*

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