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Performance comparison of several classical controllers in AGC for multi-area interconnected thermal system

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ABSTRACT

This paper presents automatic generation control (AGC) of interconnected two equal area, three and five unequal-areas thermal systems provided with single reheat turbine and generation rate constraints of 3% per minute in each area. A maiden attempt is made to apply integral plus double derivative (IDD) controller in AGC. Controller gains in the two-area system are optimized using classical approach whereas in the three and five area systems controller gains and governor speed regulation parameters (R_i) are simultaneously optimized by using a more recent and powerful evolutionary computational technique called bacterial foraging (BF) technique. Investigations reveal on comparison that Integral (I), Proportional–Integral (PI), Integral–Derivative (ID), or Proportional–Integral–Derivative (PID) controllers all provide more or less same response where as Integral–Double Derivative (IDD) controller provides much better response. Sensitivity analysis reveals the robustness of the optimized IDD controller gains and R_i of the five area system to wide changes in inertia constant (H), reheat time constant (T_r), reheat coefficient (K_r), system loading condition and size and position of step-load perturbation.

1. Introduction

In order to achieve the interconnected operation of a power system, an electric energy system must be maintained at a desired operating level characterized by nominal frequency, voltage profile and load flow configuration. This is achieved by close control of real and reactive powers generated through the controllable sources of the system. Automatic generation control (AGC) plays an important role in the power system by maintaining scheduled tie power and scheduled system frequency in normal operation and during small perturbation. Most research in the area of AGC [1–8] pertains to interconnected two equal area thermal systems and not much attention has been paid to AGC of unequal multi-area systems. Almost all past works have been centered on the design of governor secondary controllers, and design of governor primary control loop (i.e. selection of suitable governor droop or speed regulation parameter 'R') has somehow not been given enough attention. It is known that without the secondary control, smaller the value of governor speed regulation parameter, smaller is the steady state error in frequency. In the presence of supplementary control, there is nothing to be sacrosanct to use a small governor droops (of the order of 4% used in practice) as any large but credible value of R can also guarantee zero steady state error in frequency. Few works [5,6] have been reported in the past for selection of speed regulation parameters. However, a more elaborate and comprehensive approach for finding optimum value of R for a multi-area system using bacterial foraging (BF) technique has been proposed by Nanda et al. [9].

Several classical controllers such as Integral (I), Proportional–Integral (PI), Integral–Derivative (ID), and Proportional–Integral–Derivative (PID) have been used in AGC as secondary controllers, but surprisingly there is hardly any literature that compares performances of these controllers on some AGC model to establish the best of this lot.

The main purpose of this paper is to have a comprehensive comparison of the above said classical controllers and to explore whether some other new classical controller can well compete and even provide better performance than these controllers. Further, the new classical controller parameters must be duly subjected to sensitivity analysis to establish its robustness to wide changes in system loading and parameters.

Several approaches such as classical, optimal, GA, Fuzzy Logic, Particle Swarm optimization (PSO), artificial neural network (ANN), and BF techniques have been reported in the literature

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