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Performance Verification of PID Controller in an Interconnected Power System Using Particle Swarm Optimization

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Abstract

There are many methods available for Load frequency control in an interconnected power system. This paper deals with tuning of PID controller for Load frequency control. A two area thermal power system is considered for study. Both the areas are equipped with PID controller. Parameters of these PID controllers are obtained using Particle Swarm Optimization. A comparative study on tuned values has been presented to verify effectiveness. Ziegler-Nichols method is used for tuning of parameters for comparative study. The simulation results demonstrate the effectiveness of the designed system in terms of reduced settling time and oscillations. MATLAB/SIMULINK was used as simulation tool.

Keywords:Load Frequency Control(LFC);Automatic Generation Control(AGC);Particle Swarm Optimization(PSO);PID controller.

1. Introduction

In case of interconnected power system, it is practically impossible to run all the generators at the synchronous speed all times. Therefore, for satisfactory operation of power system, the frequency should remain nearly constant. Relatively close control of frequency ensures constancy of speed of generators. In an interconnected power system with two or more independently controlled areas, in addition to control of frequency, the generation within each area has to be controlled so as to maintain the scheduled power interchange. The controller should maintain [1]

1. Frequency at scheduled value
2. Net interchange power with neighboring areas at the scheduled values.

There are many methods available for Load frequency control in an interconnected power system. The simplest one is use of integral control action to minimize the area control error [1].

With advancement in control technology several other methods have been proposed to provide better LFC. These methods are based on modern control theory [2], Neural network [7], Fuzzy system theory [8]

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and Genetic Algorithm [5]. The rest of the paper is organized as follows: Section 2 deals with problem formulation which includes system representation and formation of objective function. In Section 3 parameters of PID controller were tuned using conventional as well as PSO based algorithm, performance analysis is made in section 4 and finally conclusion is discussed in section 5.

Nomenclature

Δf = Frequency deviation.

i = Subscript referring to area (i=1, 2...)

$\Delta P_{tie\,(i,\,j)}$ = Change in tie line power.

ΔP_{Li} = Load change of i^{th} area.

R_i = Governor Speed regulation parameter for i^{th} area.

T_{gi} = Speed governor time constant for i^{th} area.

$T_{t\,i}$ = Speed turbine time constant for i^{th} area.

T_{pi} = Power system time constant for i^{th} area.

$K_{p\,i}$ = Power system gain for i^{th} area.

ACE_i = Area Control Error of i^{th} area.

u_i = Control input to i^{th} area.

B_i = Frequency bias for i^{th} area.

2. Problem Formulation

2.1 System Representation

The control system that is used in this paper is composed of a two area interconnected power system. At the simulation, it is assume that there is a load demanding in area-1.The linearized model of the controlled system is depicted in Fig.1, and system parameters are given in Appendix A.

In the model, u_1 and u_2 are the control inputs from the controllers.ΔP_{L1} is step load changes of %1 of the nominal loading in area-1.Δf_1 and Δf_2 are frequency deviations of the control areas and ΔP_{tie} is the changing of the tie-line power. In two area system considered for study, the PID controller with following structure is used.

$$G_c(s) = K_p + \frac{K_i}{s} + K_d\, s \tag{1}$$

where K_p is proportional gain, K_i is integral gain and K_d is derivative gain respectively. The PID controllers in both the areas were considered to be identical.