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A Comparison of Several Approaches to Load Frequency Control of Multi Area Hydro-Thermal System

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ABSTRACT

The main contribution of Load Frequency Control (LFC) is preserving frequency constant against the varying active power loads. System has several generating units in which the notion of fault/load tolerance has to be enhanced. For this purpose tie-lines are made between these interconnected units. In this paper, a fuzzy controller has been suggested for LFC of multi unequal area hydro-thermal interconnected power system. Simulation has been performed on a test system with four areas. First and second areas have thermal reheat power plant and third and fourth areas consists of hydro power plant with electric governor. Simulation has been carried out by Matlab / Simulink software and capability of the proposed technique confirmed by comparing its results with related values of PI and PID controllers.

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Load frequency control, Fuzzy controller, Controller design, Area hydro-thermal, Tie-line.

Introduction

Load Frequency Control (LFC) is of importance in electrical power system design and operation. The objective of the LFC, in an interconnected power system, is to maintain the frequency of each area and to keep tie-line power flows within some pre-specified tolerances by adjusting the MW outputs of the LFC generators so as to accommodate the fluctuating load demands [1].

Ref.[2] presents a new population based parameter free optimization algorithm as Teaching Learning Based Optimization (TLBO) and its application to automatic LFC (ALFC) of multi-source power system having thermal, hydro and gas power plants. In [3], a new method is presented to solve the load-frequency control of non-linear power systems. In the proposed methodology, a two-area interconnected hydrothermal power system is considered to optimal adjustment parameters of Proportional-Integral-Derivative (PID) controller. The proposed intelligent strategy in [4] is based on a combination of a novel heuristic algorithm named Self-Adaptive Modified Bat Algorithm (SAMBA) and the Fuzzy Logic (FL) which is used to optimally tune parameters of Proportional–Integral (PI) controllers which are the most popular methods in this context.

Ref.[5] presents an optimal method to tune the PID controller for a hydraulic turbine coupled with the corresponding Transient Droop Compensator (TDC). Fractional-order proportional-integral-derivative (FOPID) controllers have been designed in [6] for LFC of two interconnected power systems. In [7], a hybrid gravitational search algorithm (GSA) and pattern search (PS) technique is proposed for LFC of multi-area power system. In [8], a novel hybrid Differential Evolution (DE) and Pattern Search (PS) optimized fuzzy PI/PID controller is proposed for LFC of multi-area power system. In [9], a Fractional Order PID (FOPID) is designed for single area LFC for all three types of turbines i.e., non-reheated, reheated and hydro turbines.

Ref.[10] presents an application of the novel artificial intelligent search technique to find the parameters optimization of nonlinear LFC considering PID controller for a power system. In [11], design and performance analysis of DE algorithm based parallel 2-Degree Freedom of PID (2-DOF PID) controller for LFC of interconnected power system is presented. Ref.[12] presents controller parameters tuning of DE algorithm and its application to LFC of a multi-source power system having different sources of power generation like thermal, hydro and gas power plants.

In this paper, a fuzzy controller has been suggested to control LFC in multi unequal area hydro-thermal interconnected power system. This context is consists of five sections. Concept of multi area power system has been introduced in Section 2. The proposed fuzzy controller has been designed in third sections. Simulation results are visible in Section 4. This work is concluded in 5th section.

2. Multi area power system

2.1 Modeling of the Tie-Line

Power transferred from area 1 to 2 through tie line. Then power transfer equation through tie-line is given by

$$P_{12} = \frac{V_1 . V_2}{X_{12}} \sin(\delta_1 - \delta_2) \tag{1}$$

Where, δ_1 and δ_2 are power angles of end voltages $V1$ and V_2 of equivalent machine of the two areas respectively. X_{12} is reactance of tie line.