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Load frequency control in two area power systems using fuzzy logic controller

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Abstract

This paper presents a fuzzy application to the area of load-frequency control (LFC) using fuzzy gain scheduling of PI controllers. The study has been designed for a two area interconnected power system. Using variable values for the proportional and integral gains in the controller unit, the dynamic performance of the system is improved. A comparison among a conventional PI controller, some other fuzzy gain scheduling controllers and the proposed fuzzy gain scheduling of PI (FGPI) controller is presented and it has been shown that the proposed FGPI controller can generate the best dynamic response following a step load change.

Keywords: Two area power system; Load-Frequency control; Fuzzy logic controller

1. Introduction

The dynamic behaviour of many industrial plants is heavily influenced by disturbances and, in particular, by changes in the operating point. This is typically the case for power systems [1]. Load-frequency control (LFC) in power systems is very important in order to supply reliable electric power with good quality. The goal of LFC is to maintain zero steady state errors in a multi-area interconnected power system [2]. In addition, the power system should fulfill the requested dispatch conditions.

A lot of studies have been made in the past about load-frequency control in interconnected power systems. In the literature, some control strategies have been suggested based on

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Nomenclature

K_i	integral gain constant
K_p	proportional gain constant
R_i	regulation constant
T_g	speed governor time constant
T_t	turbine time constant
T_p	power system time constant
A	system matrix
B	input matrix
L	disturbance matrix
$x(t)$	state vector
$u(t)$	control vector
$d(t)$	disturbance vector
Δf_i	frequency deviation from nominal value in Area i
ΔP_{12}	change in tie line power between two Areas
$\Delta P_{d,i} = \Delta P_{L,i}$	load demand increment in Area i
b_i	frequency bias factor in area i
T_a	settling time of proposed controller
T_b	settling time of Akalın's controller
T_c	settling time of conventional controller
T_d	settling time of Chang's controller
a_{12}	synchronizing power coefficient

conventional linear control theory. To some authors, a variable structure system control [3,4] maintains stability of the system frequency. However, this method needs some information for the system states, which are very difficult to know completely. According to Ref. [5], conventional PID control schemes will not reach high performance. Since the dynamics of a power system, even for a reduced mathematical model, is usually nonlinear, time-invariant and governed by strong cross-couplings of the input variables, the controllers have to be designed with special care. Therefore, a gain scheduling controller can be used [2]. Gain scheduling is a controller design technique used for non-linear systems. In this method, the control parameters can be changed very quickly, since parameters estimation is not required. It is easier to realize than automatic tuning or adaptation of the controller parameters. However, the transient response can be unstable because of abruptness in the system parameters. Besides, it is impossible to obtain accurate linear time invariant models at variable operating points [2]. Some fuzzy gain scheduling of PI controllers have been proposed to solve these problems. Chang and Fu [2] and Akalın and coworkers [6] used such methods for load-frequency control in power systems. Both of them developed some fuzzy rules for the proportional and integral gains separately. In this paper, the rules for the gains are chosen identical. Therefore, the system performance is improved. The comparison among the proposed controller, a conventional PI controller and some other FGPI controllers shows that the