ISSN 2601-6303 (Print)
ISSN 2601-6311 (Online)
European Journal of Engineering and Formal Sciences
January-April 2020
Volume 4, Issue 1

Design and Application of Optimally-Tuned Variable Parameters PID Controller for Nonlinear Engineering Systems

Magdy A. S. Aboelela
Faculty of Engineering, Cairo University, Electrical Power Dept., Giza 12613, Egypt

Abstract

The goal of this article is to investigate the implementation of the Cuckoo Search Algorithm (CSA) as an optimization technique to determine the parameters of variable parameters PID (VP-PID) controller. The VP-PID has three parameters that have to be optimally evaluated. A case of three physical imbedded nonlinearities in a single area electric power system has been selected to test the suitability of the proposed technique. The integral-square error (ISE) criterion has been considered as a part of the objective function together with the percentage overshoot and settling time. Matlab/Simulink software has been used in the simulation process. The simulation results show that the proposed VP-PID controller furnishes a better performance than the conventional PID controller.

Keywords: Proportional-Integral-Derivative controllers (PID); Variable Parameters PID controller (VP-PID); Cuckoo Search Algorithm; Nonlinear physical Systems; Matlab/Simulink

Introduction

In recent years, the problem of maintaining the power and frequency of a power system free from oscillations has become rapidly crucial need because of irregular load variations and imbedded system nonlinearities [1]. The unexpected load variations result in many undesired behaviours such as the mismatch of generated power and load demand for consumption. This can be achieved by the load frequency control (LFC) methods. Nowadays, plenty research work is going on to make the systems intelligent so the systems can successfully serve the benefits of all customers [2].

Several optimization approaches have been recorded in literature that can be applied to tune the conventional PID controller. This includes but not limited to:

Particle Swarm Optimization (PSO),

Genetic Algorithm (GA),

Bacterial Foraging Optimization (BFO) [2].

Furthermore, the LFC and AGC of a single area power system been investigated by a variety of techniques such as gravitational search algorithm [3], the modified particle swarm optimization [4], the artificial neural network [5], optimal control design [6], fuzzy controllers [23], proportional-integral-observer techniques [7], as well as LQR and Legendre wavelet function [8]. Also, the AGC control of single area power system with distributed generation has been investigated in [9]. All these researches deal only with no nonlinearities in the control loops.

On the other hand, the application of VP-PID controller has been studied in different fields by many research workers. The contribution of the variable parameters class of controllers is the cope the desired characteristic of dynamic systems. Based on the desired behavior of the system output, we can assume variable parameter controller. In general, most of the systems will start their response with peak overshoot and sustained oscillations. This can be reduced by implementing a conventional PID controller [10]. The tuned parameters of this class of controllers may be reduced after sometime when the response tends to have steady state. This is the philosophy behind the use of VP-PID controller [11-12].