Chapter 13
Oppositional Differential Search Algorithm for the Optimal Tuning of Both Single Input and Dual Input Power System Stabilizer

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ABSTRACT

Low frequency oscillation has been a major threat in large interconnected power system. These low frequency oscillations curtain the power transfer capability of the line. Power system stabilizer (PSS) helps in diminishing these low frequency oscillations by providing auxiliary control signal to the generator excitation input, thereby restoring stability of the system. In this chapter, the authors have incorporated the concept of oppositional based learning (OBL) along with differential search algorithm (DSA) to solve PSS problem. The proposed technique has been implemented on both single input and dual input PSS, and comparative study has been done to show the supremacy of the proposed techniques. The convergence characteristics as well authenticate the sovereignty of the considered algorithms.

INTRODUCTION

Power system stability is authentic as the adeptness of the system to endure in a state of equilibrium under normal operating condition and to achieve an adequate accomplishment to calm afterwards getting subjected to disturbance. Over the accomplished few years, the major concern for many power system

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researchers is the damping of squat frequency vibrations in the ambit of 0.2-0.3 Hz. Most important types of oscillations observed so far are local-modes, occurring between one machine to the rest of the systems. Apart from these, another type includes inter-area oscillations, occurring between interconnected machines. The effects of fast acting, high gain (to improve transient stability) automatic voltage regulator (AVRs) and the burden of heavy transmission line over weak tie-line are the supreme grounds for small signal disturbances that are realized on the power. The introduction of high gain voltage regulator introduces negative damping in the system. A solution to improve damping is to introduce a stabilizing signal into the excitation system (Abido et.al., 2002). Power system stabilizer (PSS) is acclimated to boost the system stability by providing auxiliary damping. Power system stabilizer (PSS), as emerged as a facile and economical approach in reducing low frequency oscillation in accession to providing of affixed stabilize indicator to the excitation system (Ugalde-Loo et al., 2010, Arrifano et al., 2007). In order to produce extra damping to the excitation control loop of the generating unit, PSS engender an additional stabilizing signal. The frequently used PSS identified as conventional PSS (CPSS), (Talaq, 2012) consists of the lead-lag type factors along with high gain stage and washout block. Frequently used conventional techniques such as root locus and phase compensation are used to refrain the factors of the lead-lag block at a definite operating condition recompense for the system's phase lag. In addition to these, the practical power system of concern is awful non-linear in nature in which the machine parameters changes continuously with elapsed time span and implementation of load. The dynamic response also varies at different points. PSS does not provide adequate damping in the vicinity of changing operating conditions. To tune the factors of PSS, several techniques have been implemented from time to time to reach optimal set of parameters.

Many approaches based on modern control theory have been applied to design different PSS structures such as adaptive controller (Wu & Malik, 2006), Fuzzy logic controller (Hossenizadeh & Kalam, 1999) and extended integral controller (Hoensu & Hyun, 2002). In (Ellithy et al., 2014) proposed the design of the PSSs based on μ-controller to enhance power systems stability and improve power transfer capability using lead-lag PSS structure. Damping torque technique is applied to tune the PSS parameters and the results have been verified by eigen value analysis and time-domain simulations. In (Farahain et al., 2015) online trained fuzzy neural network controller (OTFNNC) derived by the Lyapunov stability has been employed to improve the stability in a power system. The overall dynamic performance of the power system by using a comprehensive analysis of the effects of the different CPSS has been presented in (Kundur, Klein, Rogers & Zywno, 1989). In the past few years, Artificial Neural Network (ANN) techniques have been used for designing PSS (Zhang, Chen, Malik & Hope, 1993; Mahabuba & Khan, 2009). The ANN approach has its own merits and demerits. Even though the performance of the system is improved by the ANN based controller, yet, it suffers from long training time, the selecting number of layers and the number of neurons in each layers. Another techniques like pole shifting is illustrated in (Kothari, Bhattacharya & Nanda, 2002; Vasant, Marmolejo & Litvinchev, 2019; Vasant, Zelinka, Weber & Wilhelm, 2019; El-Sherbiny, Hasan, El-Saady & Yousef, 2003; Ganesan, Vasant & Elamvazuthi, 2016, Vasant, Kose & Watada, 2017,) to design PSS. However the above stated demerits has been overcome by optimization methods(Izquierdo et al., 2017; Kaliannan et al., 2017; Vasant, Zelinka & Weber, 2018). Here, the tuning process is converted to a constrained optimization problem which is solved by using an optimization algorithm.

Recently various evolutionary techniques are explicitly used in various fields of engineering and technology (Marmolejo et al., 2017). These evolutionary techniques are found to be advantageous in solving various complex problems. Due to fast computing ability, these techniques have found its ap-

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