

Smart Innovation, Systems and Technologies 301

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A QSSA Optimized Fractional-Order Controller for Improving Transient Response in AC Autonomous Microgrid VSC System



Manoja Kumar Behera, Lalit Chandra Saikia, Satish Kumar Ramoji, Biswanath Dekaraja, Arindita Saha, Sanjeev Kumar Bhagat, and Naladi Ram Babu

Abstract As part of the primary control of the autonomous microgrid (MG) voltage source converter (VSC) system, the inner loop voltage and current controller help to provide a fast transient response for frequency and voltage restoration. This paper proposed a fractional-order proportional plus integral (FOPI) controller for effective voltage and frequency management in autonomous MG VSC systems. Because of their fractional features, FO controllers make the VSC system more resilient than traditional PI controllers. Along with the conventional PI controller K_p and K_i gains, the FOPI controller has an extra edge of flexibility “ λ ”. The FO controllers parameters are tuned using the quasi-oppositional salp swarm algorithm (QSSA), a novel metaheuristic process. A droop controller that utilizes the dynamic change in the droop coefficients is also used to condense power transient and enhance the systems dynamic response while operating in the islanded mode. Furthermore, simulating the MG system in MATLAB Simulink, the dynamic performance of the proposed controllers is validated for the various abrupt change in system condition such as different initial load switching conditions for unequal ratings of distributed generation inverter and the effect of momentary fault (i.e., double line to ground fault). This paper compares the performance of conventional droop with PI controllers in inner voltage and current controllers and the suggested QSSA optimized FOPI controller with modified droop controller for autonomous MG systems. The simulation findings showed that the MG performance has improved using the proposed controller.

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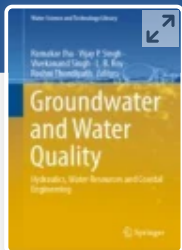
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ANN Modeling of Groundwater Development for Irrigation

[Pritam Malakar](#) & [Susmita Ghosh](#) 

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Abstract

The groundwater level is required to keep within the permissible limit for sustainable groundwater development in any area. In the present study, an Artificial Neural Network (ANN) model has been developed for groundwater development with respect to state variables of a groundwater system, i.e., a maximum depth to water table for agricultural purposes. The zonal cropping areas are considered as inputs to the ANN model. The methodology has been illustrated in the Yamuna-Hindon Inter basin,

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LFC of Thermal System with Combination of Renewable Energy Source and Ultra-Capacitor



Arindita Saha, Lalit Chandra Saikia, and Naladi Ram Babu

Abstract An effort is made to explore load frequency control (LFC) of uneven three-area multiple source schemes including thermal, solar thermal power plant (STPP) in addition ultra-capacitor (UC) considering generating rate constraint. An amalgamation of whole number order proportional+integral+derivative (PID) using filter (PIDN) with fractional-order integrator (FOI) controller (PIDN-FOI) is projected as second controller for the scheme. Whale Optimization Algorithm (WOA) finds its usage for concurrent optimization of controller gains along with parameters. The execution of PIDN-FOI is found enhanced compared to other typical controllers regarding less settling time, peak deviation and reduced oscillations. The analysis says that with the integration of STPP in all areas and UC in area-1 the scheme provides enhanced responses. Sensitivity analysis concludes that WOA optimized PIDN-FOI gains/other parameters at basic circumstances are robust to any alterations in scheme condition or factors and further reset is not required.

Keywords Generating rate constraint · PIDN-FOI controller · Solar thermal power plant · Ultra-capacitor · Whale optimization algorithm

1 Introduction

The intention of load frequency control (LFC) is to manage frequency and tie-line power flow during usual and minor disorders. Elgerd et al. [1] were the first to give the awareness of demonstrating a multiple area system for AGC [2, 3]. Most of

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Maiden Application of Hybrid Crow-Search Algorithm with Particle Swarm Optimization in LFC Studies



Naladi Ram Babu, Lalit Chandra Saikia, Sanjeev Kumar Bhagat,
and Arindita Saha

Abstract This article presents the hybridization of crow-search algorithm with particle swarm optimization (hCA-PSO) in load frequency control (LFC) studies. A new ancillary controller entitled as tilt-integral-derivative with filter (TIDN) is proposed and its dynamic performance is found to be better over PID, PIDN. The proposed hCA-PSO technique is used to optimize the parameters of controller and is found to be better over CA and PSO algorithms in terms of setting time. It is also observed that the responses with AC-HVDC tie-line are found to be better over AC tie-line. Moreover, sensitivity analysis reveals that TIDN controller parameters optimized by hCA-PSO are found to be robust at system varied conditions like loading and inertia conditions. Furthermore, the superiority of hCA-PSO is analyzed with system comprising TIDN and thermal-HVDC in terms of dynamic performance and convergence over CA and PSO.

Keywords LFC · AC-HVDC tie-line · hCA-PSO · Sensitivity analysis and TIDN controller

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Stability Analysis Of A Grid Connected Microgrid Under Numerous Fault Conditions Based On Centralized Digital-Controlled HESS

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Abstract—This work is presenting the dynamic stability analysis of a Grid connected Microgrid with controlled Hybrid Energy Storage System (HESS) with a digitally operated centralized P-Q and V-f control mechanism to maintain system stability in terms of Voltage, Frequency and Power at the common coupling lump. Both Internal and External fault conditions have been considered at base loading condition of the microgrid. A worst fault (L-L-G) has been considered with the common L-G fault both in the main grid and load side and the role of HESS in holding the system stability has been studied. A difference between the behaviors of HESS has been studied by considering the Base Load condition. The simulation of the system with various conditions is analyzed and presented for the proposed operating philosophy and the role of Hybrid Energy Storage System (ESS) in maintaining the steadiness is also verified.

Keywords—Stability Analysis; Grid Connected Microgrid; Digital-Controlled Hybrid Energy Storage System; PQ-Vf Control

I. INTRODUCTION

Microgrids are the moderate level local grids with a highly spread DG units and renewable energy technologies. Energy storage system (ESS) plays the dynamic role in a microgrid (MG) to overcome possible power inconsistency and scheduling the imbalances between the demand side and the supply side logically either in the form of homogeneous or hybrid. The ESSs, participate in smoothing the voltage and frequency disturbances of the microgrid for both small and durable applications. Energy storage equipments can either be dispersed or centralized in a microgrid.

In order to provide uninterrupted supply to the load under grid connected and islanded conditions without affecting the stability of the microgrid, cohesive management inkling has been reported [1]. Where in [2], a grid connected Fuel cell - PV hybrid power engendering system has been reported. In [3], the basic concepts, control structures, modeling of various equipments, and Energy Storage Technologies used in Microgrids have been well clarified. In [4], a review on various control methods for refining the stability, quality and sharing in microgrid had been discussed. The above mentioned literature is covering AC-DC grid control, modeling, and basic concepts of Microgrid, like control architecture, hierarchy, etc., and interfacing the inverter into the microgrid. However, Grid connected Microgrid behavior is not analyzed under different load changes and faults on Microgrid and Main grid.

A coordinated Vf- PQ control of PV with MPPT and battery has been reported in [5], where in [6], a control tactic has been proposed to study the Fault ride through capability by using an inductor in the grid side both in balanced and unbalanced grid voltage sags. In [7], a seamless switching between the PQ and Vf control modes using an Electro Magnetic relay is well explained. In [8], PQ-Vf control modes along with droop control [9] have been discussed considering the Islanded PV based microgrid condition. In [10], in order to maintain Voltage and Frequency Stable, a control method for ESSs based MG that combines classical Vf droop control and PQ droop control has been proposed. Most of the works reported in literature have based on droop control of inverters, which involves a set of functions to be adjusted. Still, the conventional P-Q and V-f controls with smooth digitally controlled switching without any set of functions to be adjusted, are not being reported.

The Energy storage technologies have been discussed for High power applications in [11], where in [12] advanced trends in energy storage technologies, benefits of ESSs, ways of integration of ESS into MG have been discussed. In [13], the importance of Lead Acid Batteries has been addressed. The inference from the above papers is that the combination of Battery and Supercapacitor is best adoptable due to the increased chances of power density and energy density, withstand capacity in case of contingencies.

In [14], Stabilization of PV based microgrid using SMES-Battery ESS under different fault conditions has been discussed. Also, SMES and Battery capabilities in reaching the stability have been discussed. In [15], overall optimal control designs for PV/Double Fed Induction Generation/Diesel Synchronous generator DGs enduring grid integration or islanded mode are addressed. In the above works, the controls of the inverters of the Microgrid and the ESS have done separately. In [16], Battery ESS models were presented that replaced the switches with ac voltage sources in [17], it is initially discussed about the technologies of Fuel Cells, where in [18], two numbers of coordinated control strategies (CCS) are proposed in order to manage the power of FC based microgrid. In [19] various materials and operating principles of various Supercapacitors have been proposed. The performance of a hybrid power system comprised of PEMFC and SC have been briefly discussed in [20]. In [21], a novel control strategy of an adaptive fractional fuzzy sliding mode control (AFFSMC) has been proposed