Hindawi
International Transactions on Electrical Energy Systems
Volume 2023, Article ID 6812351, 20 pages
https://doi.org/10.1155/2023/6812351

Research Article

Consensus-Based Intelligent Distributed Secondary Control for Multiagent Islanded Microgrid

Ali M. Jasim,[1,2] Basil H. Jasim,[1] Flah Aymen ,[3] Hossam Kotb ,[4] and Ahmed Althobaiti[5]

[1]*Electrical Engineering Department, University of Basrah, Basrah, Iraq*
[2]*Department of Communications Engineering, Iraq University College, Basrah, Iraq*
[3]*National Engineering School of Gabès, Processes, Energy, Environment and Electrical Systems, University of Gabès, LR18ES34, Gabès 6072, Tunisia*
[4]*Department of Electrical Power and Machines, Faculty of Engineering, Alexandria University, Alexandria, Egypt*
[5]*Department of Electrical Engineering, Taif University, P.O. Box 11099, Taif 21944, Saudi Arabia*

Correspondence should be addressed to Flah Aymen; flahaymening@yahoo.fr

Received 20 December 2022; Revised 26 January 2023; Accepted 30 January 2023; Published 15 February 2023

Academic Editor: Michele De Santis

Isolated microgrids (MGs) face challenges in performance stability and active/reactive power sharing as a result of frequency/voltage deviations and mismatched line impedance issues. In this paper, a consensus-based multiagent system (MAS) is proposed as a solution to restore voltage/frequency deviations and enable true power sharing. The invention of an Intelligent Distributed Secondary Control Scheme (IDSCS) can efficiently achieve hoped-for outcomes. The proposed IDSCS features estimation and compensation sublayers. For the estimation sublayer, discrete dynamic consensus algorithm-based state estimators are presented to collect average information of frequency, voltage, and reactive power. Each DG is viewed as an agent sharing information with its immediate neighbors through a sparse cyber communication network. In the compensation sublayer, online tuned proportional integral (PI) controllers using artificial neural networks (ANNs) are proposed as an intelligent voltage and frequency compensators. This combination uses the simplicity of the PI controller mathematical formula and ANN's ability to deal with parameter variations and nonlinearity. Due to the global nature of the frequency parameter, the active power-sharing compensator is unnecessary. For compensating reactive power deviations, ANNs-based reactive power controllers are proposed. Furthermore, at the primary control level, the proposed strategy employs discrete-time proportional resonant (PR) controllers in a stationary reference frame, eliminating the need for any $\alpha\beta/dq$ or $dq/\alpha\beta$ transformations. Distributed implementation of the proposed method guarantees system scalability without MG topology or demand pattern expertise. The control scheme was validated using hypothetical MAS in MATLAB Simulink platform. The simulation findings indicate the proposed MG system can effectively distribute power among the DGs while maintaining voltage and frequency stable.

1. Introduction

MGs can be operated on a grid-connected or islanded basis. Islanding capability enhances MG reliability in terms of supplying load demands during utility outages. In islanded operation, MG control is more difficult, and efficient voltage and frequency control strategies are essential for achieving stable operation. Consequently, the system's frequency and voltage are always controlled by DGs. Conventional active power-frequency (P-f) and reactive power-voltage (Q-V) droop methods have seen extensive use for controlling frequency/active power and voltage/reactive power, respectively. Since the frequency is a global system quantity, P-f droop allows for real power to be shared among DGs based on their individual power ratings. Reactive power sharing is disrupted by the Q-V method because: (1) voltage parameter is local, unlike frequency [1]; (2) the network's reactive power requirement depends on loads, network configuration, and transmission line parameters [1]; and (3) the resistive nature of the transmission lines in the network makes the active power and reactive power mutually dependent [2]. Improper sharing of the reactive power among