Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 115 (2017) 151–158

Procedia Computer Science

www.elsevier.com/locate/procedia

7th International Conference on Advances in Computing & Communications, ICACC-2017, 22-24 August 2017, Cochin, India

Implementation of Fuzzy Based Frequency Stabilization Control Strategy in Raspberry Pi for a Wind Powered Microgrid

Jayapriya M.*, Shashank Yadav[a], Ram Aravind R., Sathvik S., Lekshmi R. R. and Selva Kumar S.

Department of Electrical and Electronics Engineering, Amrita School of Engineering, Coimbatore, Amrita Vishwa Vidyapeetham, Amrita University, India

Abstract

The microgrid has become an integral technology in the power systems, which eventually provide an option to integrate renewable technologies. The intermittent characteristics of these renewable energy based units are effectively utilized with the help of battery units. This paper deals with the development and implementation of a fuzzy logic based control strategy that manages the charging and discharging of battery units depending on the generation-demand mismatch and battery status in a wind powered microgrid to stabilize the frequency fluctuation. The proposed strategy is developed using Python 2.7 language and implemented in Raspberry Pi 3 development board.

Peer-review under responsibility of the scientific committee of the 7th International Conference on Advances in Computing & Communications.

Keywords: Battery storage units; distributed generation; fuzzy logic; microgrid; restructured power system.

1. Introduction

Electric power system has been under recent trend of reformation from vertical structure to horizontal. The new structure aims at improving social welfare, providing customers with choices in sources of power [1]. Deregulation

* Corresponding author. Tel.: +91 8883583310;
E-mail address: jayapriya054@gmail.com

1877-0509
Peer-review under responsibility of the scientific committee of the 7th International Conference on Advances in Computing & Communications
10.1016/j.procs.2017.09.120

has created an increased interest in Distributed Generation (DG), which is expected to play an essential role in operation and planning of electric power systems. Integration of DG with power system offers several benefits. [2] has modelled and quantifies the economic benefits brought by DG technologies. Switching from nuclear energy and conventional fossil fuel to environmental friendly and sustainable renewable sources successfully addresses issues like growing demand and environment problems, especially global warming. [4] has addressed the merits and drawbacks of renewable energy sources. Clusters of loads and DGs that operate as single controllable system make up a micro grid [3]. The reason for incorporating microgrid into existing grid and the recent developments in modelling and control methods of microgrid has been presented in [11]. The microgrid can operate both in islanded and grid connected mode. These two modes of microgrid operation have been clearly explained in [11]. Frequency regulation in electricity networks is inevitable so as to maintain supply quality and security. The upward or downward frequency drift in a power system indicates the momentary disparity between real power generation and demand. If, at any instant, power demand exceeds generation, then the system frequency drops. Conversely, if power supply overreaches demand, frequency rises. However, the real power demand in power system keeps varying and it is practically impossible to instantaneously control the generation to track all changes in demand. This results in continuous system frequency fluctuations. Energy storage system (ESS) provides an effective option for smoothing the renewable power generation and enhancing the stability of isolated power systems. The battery energy storage system (BESS) is the most efficient technology deployed so far, because of its quick and reliable response [6]. Literatures [5-8] have proposed different control strategies to effectively manage power from wind sources. However, some of the storage technologies are still in infancy stage of development because of use of low energy density storage devices, while, some adopts older technology controllers. These technologies lack in implementing the hardware of the proposed system. This paper proposes the development and implementation of a Fuzzy based control strategy that aims at stabilizing the system frequency. The strategy through the fuzzy environment, manages the charging and discharging of BESS depending on the generation and demand mismatch. The proposed strategy thus assures to maintain the supply quality and security. The control strategy is implemented in Raspberry Pi 3 development board using python 2.7. The developed control strategy proves for its effective performance for all system conditions.

Section 2 gives the overview of the microgrid architecture. Section 3 explains in details about the proposed fuzzy based control strategy. The Fuzzy model for the proposed system is presented in section 4. The fuzzy rules are also developed and elucidated in detail. Section 5 presents the simulation of the proposed strategy in MATLAB and the related results. Hardware implementation of fuzzy based control strategy is shown in section 6, followed by conclusion.

2. Microgrid architecture

A microgrid is a network of generating units with storage systems and loads capable of supplying a local area with electric power and heat. Microgrid can operate in stand-by or when integrated to the utility/main grid. One of the essential requirements in microgrid management is to balance the supply and demand of power. To meet the balance in grid integrated mode, the power of microgrid is exchanged to the interconnected grid. In islanded mode of operation, the balance between demand and supply is achieved by load shedding or by decreasing the generation [9]. This concept serves as a new paradigm to define the operation of DG [3]. Introduction of DG units reduces the stress on the central power grid and hence it enhances the system security. DG can be non-renewable (e.g., diesel, fuel cell, gas engine, natural gas, thermal, nuclear, etc.) or renewable (e.g., solar, wind, biomass gasification, hydro, etc.). With the concerns over economic and environmental issues, and with the significant advancement in control technologies and power electronics, renewable sources of energy become a vital alternative for the non-renewable fossil fuel system. Particularly, Wind energy is predominantly used because of the reduced harmonics in power than any other renewable sources of power. However, in standalone wind system, the main challenge is the susceptibility and weakness of wind system to the sudden change because of its low inertia [10]. So, the system is prone to frequency fluctuations. This paper deals with framing the control strategy for stabilizing the frequency in a wind powered microgrid with the help of BESS. The paper assumes a wind powered micro grid operated in islanded mode as shown in Fig. 1.