Chapter 20
An On-Line PSO-Based Fuzzy Logic Tuning Approach:
Microgrid Frequency Control Case Study

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ABSTRACT

Modern power systems require increased intelligence and flexibility in control and optimization. This issue is becoming more significant today due to the increasing size, changing structure, emerging renewable energy sources and Microgrids, environmental constraints, and the complexity of power systems. The control units and their associated tuning methods for modern power systems surely must be intelligent (based in flexible intelligent algorithms). This chapter addresses a new intelligent approach using a combination of fuzzy logic and Particle Swarm Optimization (PSO) techniques for optimal tuning of the existing most popular Proportional-Integral (PI) or Proportional-Integral-Derivative (PID) controllers in the power electric industry. In the proposed control strategy, the PI (PID) parameters are automatically tuned using fuzzy rules, according to the on-line measurements. In order to obtain an optimal performance, the PSO technique is used to determine the membership functions' parameters. The proposed optimal tuning scheme offers many benefits for a new power system with numerous distributed generators and Renewable Energy Sources (RESs).In the developed tuning algorithm, the physical and engineering aspects have been fully considered. To demonstrate the effectiveness of the proposed control scheme, secondary frequency control problem in an islanded Microgrid (MG) system is considered a case study. The main source of power for a Microgrid is small generating units of tens of kW that are placed at the customer site. Simulation studies are performed to illustrate the capability of the proposed intelligent/optimal control approach.

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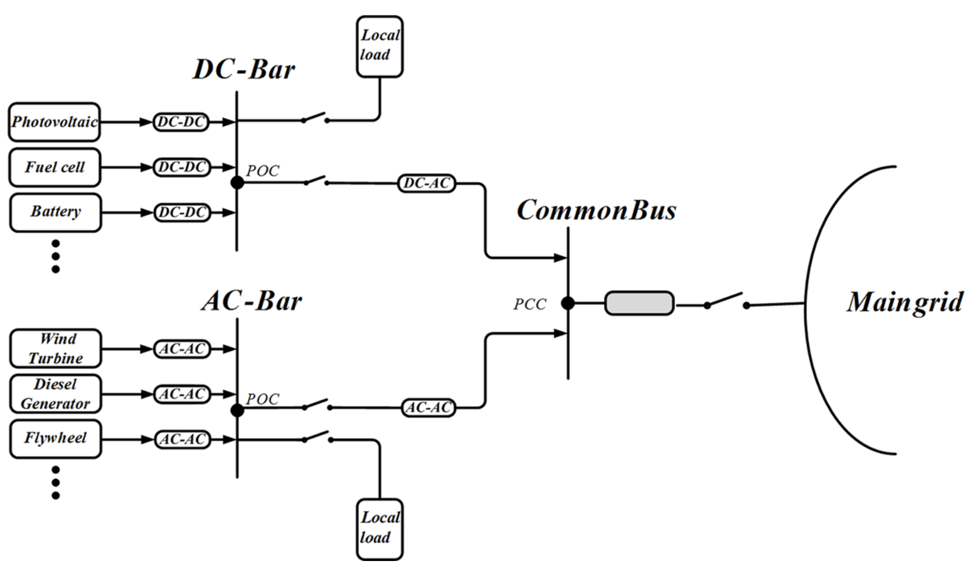
INTRODUCTION

In recent years, with significant growth in electrical energy consumption, conventional generating units in power systems are faced into a variety of problems, such as global warming, energy crisis, deficiency of fossil fuels and high cost of building new power plants and so on. Hence, environmental concerns, reducing dependency on fossil fuels, improvements of new energy technologies and also enhancing the reliability of power systems, are the factors that have been affected on the entrance of Distributed Generation Resources (DGRs) such as wind turbines, solar panels, fuel cells and micro turbines to the conventional power systems in the past two decades.

The DGs are electrical power sources which are connected to the low voltage side of a bulk grid (Ackermann, Andersson, & Soder, 2001). These units generate electrical power less than ten megawatts. Although these resources have solved many problems, but increasing the numbers of them made the power systems being more complicated. Therefore, some instructions have been developed by different institutions on how to connect these resources to the power system, like the standard IEEE Std 1547-2003 as a standard for connecting the distributed generations to the power system (IEEE, 2003). But in recent years, in order to increase the reliability of provided energy needed by consumers, there is a theory about the operation of the resources that are connected to the power grid, which is called Microgrid (Lasseter, 2002; Lasseter & Paigi, 2004). Microgrids are consisting of several distributed generations, local loads and controllers that are connected in medium/low voltage to the main grid and supplying their local loads. Junction of a Microgrid with the main grid is called Point of Common Coupling (PCC). Mostly, recourses are not connected directly to the Microgrid and this work is done via the power electronic interfaces. The microsources and storage devices use power electronic circuits to connect to the MG. Usually, these interfaces depending to the type of unit are ac/ac, dc/ac, and ac/dc/ac power electronic converters/inverters. A typical Microgrid is shown in Figure 1.

New strategies will be opened by increasing number of MGs for finding a more control hierarchy/intelligence and decentralized methods

Figure 1. A typical Microgrid



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