Real-time Distributed Economic Dispatch for Distributed Generation Based on Multi-Agent System

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Abstract

In recent years, in order to make full use of renewable energy and other distributed energy resources (DERs), distributed generation operation optimization and coordination control has become a hot topic. Distributed generation economic dispatch is an important element of the operation optimization which aims at allocating the power generation to meet the power demand in an economic way. Distributed generation economic dispatch must be completed in a comparatively short time due to the frequent changes of generation and load operating conditions, therefore, fast and reliable economic dispatch algorithm is particularly important.

Currently, there are many optimization methods for the distributed generation economic dispatch, and centralized control schemes are used to solve problems in most methods, therefore a lot of data are needed to be transported to the central control center, which makes it difficult for real-time control.

As DERs are distributed in the distribution systems, the distributed control architecture is preferred to solve the optimization problem. A well-designed distributed control strategy can efficiently solve the economic dispatch problem. In addition, distributed control solutions are more flexible and robust compared to centralized solutions, and faster due to parallel computation. Thus distributed control is a good option for solving real-time economic dispatch problems.

Multi-Agent System (MAS) originates from distributed artificial intelligence. It can not only be an artificial intelligence algorithm to solve optimization problems, but also provide a distributed framework for the distributed algorithm to integrate. This paper presents a MAS based real-time distributed economic dispatch method, and a selection mechanism based deterministic and nonlinear evolutionary game algorithm - replicator dynamics algorithm is employed in the framework of a distributed MAS, which decomposes a global optimization problem into multiple coordination optimization problems among agents. Each distributed generation is controlled by an intelligence agent, and agents can interact with each other to maximize their own benefits. When all the benefits reach a steady state, optimal solution of the system can be obtained. With a quick converge speed, the replicator dynamics algorithm is suitable for real-time optimization, and can provide performances comparable to that of the centralized algorithm.

Real-time simulation studies were conducted to demonstrate the effectiveness of the proposed solution, and reliability, speed and good performance of the solution are analyzed. With a good interaction strategy among agents, operation optimization problems can be solved in distributed way, thus it provides a valuable reference for the further study on operation optimization of large-scale distributed generation integration.