Tashkent island microgrids

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The methods proposed for the adaptive PI-controller are generally limited to linear processes. In other words, a controller with a linear model operates in a linear range, but due to the capabilities of ANN in solving problems with high mathematical complexity and the high power of these networks in estimating functions, designers are encouraged to use these networks in the design of self-tuning controllers to control nonlinear processes23. In24,25,26,27, a PI-controller with a hybrid ANN form is used as a direct adaptive controller to control the microgrid frequency, in which PSO and fuzzy algorithms are used to optimize ANN coefficients and their rapid training.

The following is the sections of the article. In "General microgrid structure and conventional control strategy" section, the microgrid structure with the conventional PI-controller is presented. "A proposed control strategy based on ANN-GA" section announces the proposed control strategy based on the combination of ANN and GA algorithms. In "Simulation results" section, the simulation results of the proposed method are exposed and discussed and finally, a conclusion will be presented in "Conclusions" section.

The basis of stability in the microgrid was based on controllable resources. In these sources, the more accurate, robust, and practical the control process used, the more it improves the stability of the microgrid. For this purpose, different control levels are used sequentially in a microgrid. Each of these control levels is responsible for part of the microgrid stability tasks. In a microgrid, these levels are divided into three parts:

Primary control level: In this control, the initial stability of frequency/frequency angle is considered. This type of control is responsible for preventing voltage/frequency collapse. One of the most common methods for this purpose is frequency drop control.

Microgrid secondary control level: In this frequency/voltage drop control, the goal is stability. In the sense that events such as islanding or load change and even the occurrence of an error can cause a steady-state error in the underlying microgrid variables. This type of control is used for this purpose.

Primary and secondary control in the microgrid.

If there is a disturbance in the power system and it disturbs the balance between generation and consumption, the frequency will fluctuate. For example, if the load increases suddenly, the frequency will drop from the nominal value, which if not controlled and limited, will see frequency instability. Here, the primary control loop is the first control loop to limit the frequency drop after disturbance. Based on the frequency-active power characteristic of a generator, this control loop operates according to Eq. (1) and this loop is installed on the generator itself.

where f0 and P0 are the rated frequency and power of the network, respectively. The status of the frequency change in the presence and absence of the primary controller is shown in Fig. 2.

System frequency, (a) without a primary controller, (b) with a primary controller.

The primary control loop limits the dropped frequency but is unable to return the frequency to the nominal value hence the secondary control loop is used. In this control loop, conventional PI-controllers are often used to return the frequency to the initial value. Adjusting these controllers will be more based on classic methods and trial and error. The problems of these methods were mentioned in the introduction, and based on these reasons, in this article, while using these controllers, we have tried to solve their problems by using an intelligent method based on ANN.

PID controller structure.