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| **Title:** | Genetic Algorithm-Optimized Adaptive Network Fuzzy Inference System-Based VSG Controller for Sustainable Operation of Distribution System |
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**Abstract:**

To achieve a more sustainable supply of electricity and reduce dependency on fuels, the application of renewable energy sources-based distribution systems (DS) is stimulating. However, the intermittent nature of renewable sources reduces the overall inertia of the power system, which in turn seriously affects the frequency stability of the power system. A virtual synchronous generator can provide inertial response support to a DS. However, existing active power controllers of VSG are not optimized to react to the variation of frequency changes in the power system. Hence this paper introduces a new controller by incorporating GA-ANFIS in the active power controller to improve the performance of the VSG. The advantage of the proposed ANFIS-based controller is its ability to optimize the membership function in order to provide a better range and accuracy for the VSG responses. Rate of change of frequency (ROCOF) and change in frequency are used as the inputs of the proposed controller to control the values of two swing equation parameters, inertia constant (J) and damping constant (D). Two objective functions are used to optimize the membership function in the ANFIS. Transient simulation is carried out in PSCAD/EMTDC to validate the performance of the controller. For all the scenarios, VSG with GA-ANFIS (VOFIS) managed to maintain the DS frequency within the safe operating limit. A comparison between three other controllers proved that the proposed VSG controller is better than the other controller, with a transient response of 22% faster compared to the other controllers.