

ABSTRACT

A dynamic frequency regulation control system and method for a distributed photovoltaic edge intelligent controller, the system comprises a distributed photovoltaic unit, an edge intelligent controller cluster, a communication network, an energy storage execution module, and a monitoring center, a "leader-follower" distributed consensus architecture is constructed, each edge intelligent controller makes independent decisions and exchanges information in real time through a low-latency communication network, eliminating the need for a central control node, this not only avoids the single point of failure risk inherent in a centralized architecture but also addresses the lack of coordination in decentralized architectures, thereby enhancing system scalability and fault tolerance; to tackle the issue of weak adaptive capability of the controller, this solution integrates fuzzy logic and a recurrent neural network to design a self-adaptive tuning fractional-order PID controller, control parameters are precisely initialized via a fuzzy rule base and optimized in real time to adapt to photovoltaic output fluctuations and complex disturbances; simultaneously, frequency regulation is coordinated with the energy storage execution module, further improving frequency stability.