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1. A dynamic frequency regulation control system and method for a distributed photovoltaic edge intelligent controller, characterized by comprising: a distributed photovoltaic unit, an edge intelligent controller cluster, a communication network, an energy storage execution module, and a monitoring center; the distributed photovoltaic unit being configured to convert solar energy into electrical energy and output the electrical energy to a power grid; each distributed photovoltaic unit in the edge intelligent controller cluster being correspondingly configured with an edge intelligent controller, each edge intelligent controller integrating an FRNN-FOPID control module, a local data acquisition module, and a communication module; the communication network being configured for information interaction among the edge intelligent controllers, supporting a distributed consensus collaborative mechanism; the energy storage execution module being connected in parallel with the distributed photovoltaic unit and configured to receive instructions from the edge intelligent controller and execute charging or discharging actions; and the monitoring center being configured to monitor system operating status and store data, without participating in real-time control.

2. The dynamic frequency regulation control system and method for a distributed photovoltaic edge intelligent controller according to claim 1, wherein: the FRNN-FOPID control module comprises a fuzzy logic initialization unit, an RNN dynamic optimization unit, and an FOPID execution unit; the fuzzy logic initialization unit has a built-in set of 25 fuzzy control rules, with input variables being power grid frequency deviation and deviation change rate, both being divided into five fuzzy subsets of "negative medium (NM)", "negative low (NL)", "zero (ZE)", "positive large (PL)", and "positive medium (PM)", and configured to generate initial proportional gain, integral gain, derivative gain, and fractional-order parameters for the FOPID controller by mapping using trapezoidal membership functions.

3. The dynamic frequency regulation control system and method for a distributed photovoltaic edge intelligent controller according to claim 2, wherein: the RNN dynamic optimization unit is configured to construct an optimization model based on a Lyapunov energy function, aiming to minimize frequency regulation error, and configured to update FOPID control parameters in real time using a stochastic gradient descent algorithm, with a learning rate set between 0.01 and 0.05, completing one parameter optimization every 10

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milliseconds.

4. The dynamic frequency regulation control system and method for a distributed photovoltaic edge intelligent controller according to claim 1, wherein: the communication network employs industrial ethernet or a wireless local area network (WLAN), with a transmission delay of ≤ 50 milliseconds, implements control instruction calibration based on a "leader-follower" consensus collaborative mechanism, and supports a "plug-and-play" function allowing newly added photovoltaic units to automatically join the control cluster.

5. The dynamic frequency regulation control system and method for a distributed photovoltaic edge intelligent controller according to claim 1, wherein: the local data acquisition module comprises a data acquisition unit and a data preprocessing unit; the data acquisition unit is configured to acquire output data of the distributed photovoltaic unit, power grid frequency deviation, and deviation change rate at a sampling frequency of 100 Hz; and the data preprocessing unit is configured to reduce noise and eliminate outliers using a mean filtering algorithm, performing data processing at a frequency of once every 10 milliseconds.

6. The dynamic frequency regulation control system and method for a distributed photovoltaic edge intelligent controller according to claim 1, wherein: the energy storage execution module comprises a battery energy storage system and a bidirectional converter; the battery energy storage system has a rated power between 20% and 30% of the rated power of a corresponding distributed photovoltaic unit; and the bidirectional converter has a charging and discharging response time of ≤ 10 milliseconds, and is configured to perform bidirectional conversion between direct current and alternating current.

7. The dynamic frequency regulation control system and method for a distributed photovoltaic edge intelligent controller according to claim 1, wherein: the edge intelligent controller employs an ARM Cortex-A9 processor, with an operating frequency of ≥ 1 GHz, supporting hardware floating-point operations, ensuring the real-time performance of the FRNN-FOPID algorithm.

8. A dynamic frequency regulation control method based on the system according to any one of claims 1 to 7, characterized by comprising the following steps:

(1) a local data acquisition module acquiring and preprocessing power grid frequency deviation, deviation change rate, and photovoltaic output data;

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(2) a fuzzy logic initialization unit generating initial parameters for an FOPID controller based on the preprocessed data;

(3) an RNN dynamic optimization unit optimizing FOPID control parameters in real time;

(4) edge intelligent controllers performing consensus coordination through a communication network to calibrate control instructions;

(5) an FOPID execution unit outputting instructions to adjust active power of a distributed photovoltaic unit and a charging or discharging state of an energy storage execution module;

(6) a monitoring center monitoring and storing system operating data in real time until the power grid frequency returns to a rated value.