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(57) Abstract :
This invention relates to a novel Hybrid Inverter Design for Solar Applications, optimized using a hybrid approach combining Deep Q-Network (DQN) and Firefly Algorithm (FA). The invention aims to enhance the efficiency, reliability, and adaptability of hybrid inverters used in solar energy systems. The system integrates real-time data acquisition, preprocessing, and optimization to achieve maximum power extraction, seamless grid synchronization, and stable AC power output. The DQN component predicts optimal operational states by learning from historical and real-time data, while the FA refines these predictions to minimize harmonic distortion and improve voltage regulation. The hybrid inverter includes a Maximum Power Point Tracking (MPPT) module for efficient energy extraction, a robust fault detection and protection unit for enhanced safety, and a feedback loop for continuous performance improvement. Experimental results demonstrate an energy efficiency of up to 97%, a total harmonic distortion (THD) of less than 3%, and a seamless response to varying load and environmental conditions. This innovation is highly suitable for residential, commercial, and industrial solar energy systems, offering a sustainable solution to meet growing energy demands.

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