

ABSTRACT

The increasing global demand for clean and renewable energy has positioned solar power as a key contributor to sustainable development. However, the efficiency and longevity of solar panels are often compromised by undetected faults, environmental factors, and the accumulation of dust and debris. This project presents an innovative IoT-based solution that integrates real-time fault detection, energy efficiency monitoring, and automated panel cleaning into a single, smart system. Utilizing a network of sensors and microcontrollers, the system continuously monitors panel performance parameters such as voltage, current, temperature, and irradiance. Anomalies indicating potential faults like hotspots, shading, or disconnections are detected early, triggering alerts for timely maintenance. Simultaneously, energy data is analyzed to optimize output and identify underperforming modules. To combat energy losses due to soiling, an automated cleaning mechanism, guided by sensor inputs and environmental conditions, ensures the panels remain clean without human intervention. This comprehensive, cost-effective solution enhances solar panel reliability, maximizes energy yield, and reduces manual maintenance, making it ideal for large-scale solar installations and smart energy systems.