



Project's Abstract:

The increasing dependence on solar energy systems has highlighted the importance of maintaining solar panels in clean operating conditions to maximize energy production and system efficiency. Dust accumulation, dirt, and environmental contaminants significantly reduce solar panel performance, making regular cleaning essential. However, manual cleaning methods require considerable time, effort, water consumption, and human intervention.

This project presents SolarX Robot, an intelligent autonomous solar panel cleaning robot designed to automate the cleaning process of solar panel arrays. The robot is capable of operating in both manual and automatic modes through a mobile application developed using Flutter. The system utilizes multiple sensors, including IR sensors for edge detection, ultrasonic sensors for water level monitoring and panel detection, an MPU6050 sensor for orientation monitoring, and a DS3231 Real-Time Clock module for scheduling operations.

The robot employs DC motors for movement, brush rotation, and brush lifting mechanisms, while a water pump assists in removing dust and debris from solar panel surfaces. The ESP32 module enables wireless communication between the robot and the mobile application, allowing users to monitor the cleaning process, schedule cleaning operations, and track the robot's current position within the solar panel array.

To improve operational flexibility, the system stores its current operating state using the Arduino EEPROM. This allows the robot to pause its cleaning task and later resume operation from the same point without restarting the entire cleaning process. The developed prototype demonstrated accurate movement, reliable edge detection, effective cleaning performance, and successful autonomous operation according to predefined schedules.

SolarX Robot provides a practical, low-cost, and efficient solution for maintaining solar panel installations while reducing human effort and improving the overall efficiency of solar energy systems.