PROJECT ABSTRACT

Solar Panel Cleaning Robot using Brushes

Arduino-driven dry-brush robot that sweeps tilted solar panels on a schedule, with IR edge safety, battery management and a coverage dashboard — built-to-order with report, PPT and viva kit.

01. Title

Solar Panel Cleaning Robot using Brushes

02. Introduction / Background

Dust is a quiet tax on solar power: in arid regions soiling visibly cuts rooftop-array output, and manual cleaning is labor nobody schedules. Water-based cleaning wastes water; a dry-brush robot that sweeps on a schedule is the low-maintenance answer — and a multidisciplinary student build. This robot is a four-wheeled chassis for standard ~1x2 m panels with two counter-rotating brush rollers, Arduino-controlled lawnmower sweep patterns, IR edge sensors that stop it at panel edges, and a 12 V 18650 pack for about two hours of cleaning per charge. A dashboard shows status, battery, coverage grid, schedule and event log.

03. Problem Statement

Soiled panels underperform and cleaning is irregular, yet no affordable automated option exists for small rooftop arrays. The project addresses this with a schedule-driven brush robot: autonomous sweeps, edge safety, battery management and a dashboard — with effectiveness verified by the buyer's own before/after measurement procedure rather than a pre-claimed gain figure.

04. Objectives

- Build a 4-wheel chassis with dual counter-rotating brush rollers (~180 RPM) sized for standard ~1x2 m panels at 10–30° tilt.
- Implement Arduino sweep firmware: lawnmower passes, turn-at-edge logic, brush control and dock return.
- Provide IR edge-sensor safety (stop-and-reverse at edges/gaps) and 18650 battery monitoring with low-battery dock return.
- Deliver a weekly scheduler with rain-skip, a coverage dashboard, the before/after measurement guide, report, PPT and viva Q&A.

05. Proposed Methodology

On schedule the robot undocks and drives onto the first row at ~0.4 m/min with brushes spinning. The Arduino executes lawnmower passes; four downward IR sensors watch for panel edges and gaps, triggering stop-and-reverse maneuvers. Battery voltage is monitored continuously and the robot returns to the dock at the low threshold. Every pass and event is timestamp-logged to the dashboard's coverage grid and event log. The buyer verifies cleaning effectiveness by logging panel output at solar noon before and after a clean, per the measurement guide.

06. System Architecture / Working

The system has four blocks. (1) Mechanics: chassis, brush rollers on DC gear motors, suspension-set brush pressure. (2) Control: Arduino with motor drivers running sweep patterns, edge logic and scheduling. (3) Safety + power: 4x IR edge sensors, 12 V 18650 pack with BMS and voltage monitoring. (4) Presentation: web dashboard with live status, battery gauge, cleaned area/panel count, 40-panel coverage grid, schedule editor and event log.

07. Hardware / Software Requirements

- 4-wheel robot chassis with dual brush-roller head (DC gear motors)
- Arduino Uno/Nano; L298N/TB6612 motor drivers
- 4x IR edge sensors; 12 V 18650 battery pack with BMS
- Dock/charging station at array edge
- Arduino IDE firmware; single-file HTML/CSS/JS dashboard

08. Expected Outcomes

The student receives a working robot that undocks on schedule, sweeps panel rows with the brush head, reverses at edges, and returns to dock on low battery — with the dashboard showing coverage and logs. Cleaning gain is whatever the buyer's before/after measurement shows for their dust and climate; no percentage is pre-claimed, and dry brushing's limits (caked soiling needs manual attention) are documented.

09. Applications

- Rooftop solar array maintenance (10–30° tilt, framed panels)
- Teaching platform for mobile robots, IR sensing and battery management
- PV soiling studies with measured before/after data
- Base build for water-assisted or larger-array variants

10. Future Scope

- Dust-density sensing to trigger cleans on demand instead of schedule
- Water-mist assist for caked soiling (with waterproofing redesign)

- Multi-robot coordination for large arrays
- Panel-output feedback loop closing the cleaning-effectiveness loop