IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 9, April 2025
Impact Factor: 7.67

Design and Parametric Optimization of a Solar Panel Cleaning Robot Using Simulink and Regression Techniques

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Abstract: *The performance degradation of solar panels due to dust accumulation necessitates frequent maintenance to ensure optimal energy output. This research presents the design and parametric optimization of a solar panel cleaning robot using experimental data modelled through Simulink and multiple linear regression techniques. Experimental variables such as brush speed, cleaning velocity, and cleaning time were studied for their impact on dust removal efficiency and battery usage. Regression models were developed to predict battery consumption and cleaning efficiency based on these input parameters. Simulink simulations were used to visualize system dynamics and validate the regression outputs. The regression model for battery usage revealed a positive correlation with cleaning velocity and time, while efficiency was inversely related to all three parameters. Simulink block models confirmed the accuracy of these relationships, enabling precise tuning of cleaning operations. Results demonstrated that moderate brush speeds and optimized cleaning velocities yield high efficiency while minimizing energy consumption, thereby ensuring sustainable operation. This dual approach offers a scalable and cost-effective method for improving the functionality and energy performance of solar panel cleaning systems.*

Keywords: Solar Panel Cleaning Robot, Parametric Optimization, Simulink, Regression Techniques, Dust Accumulation, Cleaning Efficiency, Battery Usage, Cleaning Velocity

DOI: 10.48175/IJARSCT-25715