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A Framework for the Design of Robotic Photovoltaic Cleaning Systems

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Abstract

Given the prominent role of solar energy among the other clean energy sources, the increase of photovoltaic (PV) systems efficiency becomes crucial. A problem that was recognized to degrade the performance of photovoltaic panels is related to the accumulation of dust (soiling) on their surface. In general, the common practice of manual cleaning of PV systems is not efficient. For this reason, it has emerged the need for automatic cleaning procedures. Automated solutions include integrated cleaning systems and robotized solutions.

From a robot design perspective there exist a plethora of issues to be considered, including its energy autonomy but also the employment of appropriate path planning and control methodologies. The available cleaning methods have to be assessed in regard to their suitability for a robotized solution and the corresponding operation parameters have to be optimized.

A monitoring system can assist in targeted cleaning beyond the scheduled routine cleaning operations. Towards that direction a suitable concept may integrate intelligent monitoring of a solar photovoltaic power plant using autonomous drones. An effective robotic cleaning solution can be further enhanced using other modern technologies including advanced image processing, artificial intelligence (AI), machine learning and internet of things (IoT).

The objective of this work is to provide a general perspective of the problem. The motivation for the development of robotized PV cleaning solutions is justified and the application requirements are identified. A general framework for the design of PV cleaning robots is established. Relevant works are reviewed, already proposed systems are categorized and research challenges are identified.