Internship Opportunity: Building an automated software system to identify and address soiling issues in solar farms

TEAM DETAILS

Shoubhik De (PMRF Ph. D. scholar), Prof. Narendra Shiradkar, Prof. Anil Kottatharayil, all from the Department of Electrical Engineering, and an intern Engineering student with experience in Python and C++ coding.

INTRODUCTION

Solar Photovoltaics (PV) is poised to become the dominant energy source by 2060 with a total installation close to 70 TW from the current figure of 1.5 TW [1]. Soiling on the surface of PV panels blocks the sunlight from entering into the cells, thereby reduces their power production. This has already become a major issue in large-scale PV power plants, resulting in severe financial losses. Ilse et al. [2] highlighted global PV power revenue losses of USD 3.2 – 5.4 billion per annum in 2018 (total installation of 0.5 TW). India currently has a cumulative PV installed capacity of 74.3 GW, poised to increase to 280 GW by 2030. The recently announced PM-Surya Ghar: Muft Bijli Yojana aims to install 30 GW of rooftop solar systems in the country. Soiling rates in India, are found to be very high and therefore would hamper the economic growth of PV [2, 3].

The primary objective of this proposal is to harness the skills and knowledge of interns to enhance the efficiency of our PV soiling analysis workflow. Currently, analysing this data using Python software is time-consuming. By integrating interns into our team, we aim to expedite the data analysis process, identify insights more rapidly, and contribute to the optimization of PV plant performance.

PROCEDURE

Soiling in PV power plants can be measured using dedicated sensors [4]. It can also be determined using the power generation time series normalized to expected power generation to derive a metric called performance ratio (PR), and this is preferred due to the challenges in maintaining sensors in the field (soiling sensors need daily cleaning). Soiling is expected to result in a linear drop of the PR. The noise in power generation data, and shadows produced on PV panels by objects flying by, including birds and clouds, pose significant challenges to this method. We have developed robust shadow and noise filtering algorithms, and change point detection methods [5, 6]. These were applied to the SCADA data from a 50 MW power plant of a leading energy sector PSU. We have determined non uniform soiling rates in the power-plant purely from SCADA data. The same methodology was also applied to rooftop solar installations in Mumbai, and Kolkata, and high soiling rates were detected. The methodology can clearly identify cleaning events, providing supervisory information to the power-plant managers.

However, the power plant data is manually fetched, and the data is analysed using Python codes running on local machines. This was useful for rapid prototyping but would soon become a bottleneck in scaling this up to large numbers of PV systems.

PROJECT DESCRIPTION

Develop and implement efficient methods to analyse large volumes of PV SCADA data for soiling analysis.

Project Activities

- Assist in reviewing and understanding existing Python code for PV soiling analysis
- Develop and implement algorithms to optimize data processing and analysis
- Develop a software that
    - Can automatically fetch power generation time series data from SCADA systems, or inverter data stored in the cloud.
    - Can do Dynamic Cleaning Schedule Optimisation by integrating weather forecasts to soiling detection to generate real-time cleaning schedules, optimising resource allocation for rooftop and ground-mounted PV systems.
    - Can produce Comprehensive Health Reports and Dashboards summarising soiling losses, performance metrics, and cleaning history.

INTERN QUALIFICATIONS

- Strong programming skills (in Python, C++), with experience in data analysis
- Understanding of data structure and algorithms
- Familiarity with solar PV systems and SCADA will be an advantage

BENFIT FOR INTERNS

- Gain valuable experience in real-world data analysis for the solar energy industry
- Work on a project with tangible outcomes that can improve efficiency
- Opportunity to contribute to the advancement of solar energy technology

INTERNSHIP DURATION

6 months, extendable to one year.

REFERENCES

[1] Haegel et al., “Photovoltaics at multi-terawatt scale: Waiting is not an option, Science, 2023, DOI:10.1126/science.adf6957

[2] K. Ilse et al., "Techno-Economic Assessment of Soiling Losses and Mitigation Strategies for Solar Power Generation," Joule, 2019, DOI:10.1016/j.joule.2019.08.019

[3] Warade et al., Analysis of Soiling Losses for Different Cleaning Cycles, 7th World Conference on Photovoltaic Energy Conversion, 2018, DOI:10.1109/PVSC.2018.8547867

[4] Photovoltaic System Performance—Part 1: Monitoring, IEC Standard 61724-1:2017, International Electrotechnical Commission, 2017

[5] S. De et al., Improved Shadow Filtering and Change-Point Detection Methods to Extract Soiling Loss from PV-Scada Data”, 8th World Conference on Photovoltaic Energy Conversion, 2022, DOI:10.4229/WCPEC-82022-3BV.3.57

[6] S. De et al., "Improved Cleaning Event Detection Methodology Including Partial Cleaning by Wind Applied to Different PV-SCADA Datasets for Soiling Loss Estimation," IEEE J. Photovolt., 2024, DOI:10.1109/JPHOTOV.2024.3359412