AI-based Solar Energy Framework: explainable AI for solar energy generation and GNN for optimal location identification in Bangladesh

Theme : Related to Environmental Science/Engineering

Abstract

The growing global concern about climate change, as well as the need for sustainable energy sources, has fueled the expansion of solar energy generation. In this context, Bangladesh, a country highly vulnerable to the effects of climate change, has recognized the importance of solar energy as a key component of its renewable energy strategy. However, efficient solar energy utilization in Bangladesh necessitates accurate forecasting of solar energy generation and optimal identification of solar panel locations. In this research, we address these issues by proposing a comprehensive framework for forecasting solar energy generation with explainable AI and identifying optimal solar panel locations using a graph neural network (GNN) in Bangladesh.

Objective

i) To emphasize the importance of explainability in AI systems for solar energy generation,
ii) To explore the application of Graph Neural Networks (GNN) for optimal location identification in Bangladesh,
iii) To analyze the potential impact of the AI-based Solar Energy Framework in Bangladesh.

Goal

Proposing a comprehensive framework for forecasting solar energy generation with explainable AI and identifying optimal solar panel locations using a graph neural network (GNN) in Bangladesh.

Background Study

Solar radiation is affected by some important factors like weather classification and performance evaluation metrics. Prior to model training, filter methods were used and benefited from low computational costs. It is anticipated that by including explainability, the ML models will be more reliable and widespread, enabling future advancements in the regularization of these models.

Methodology

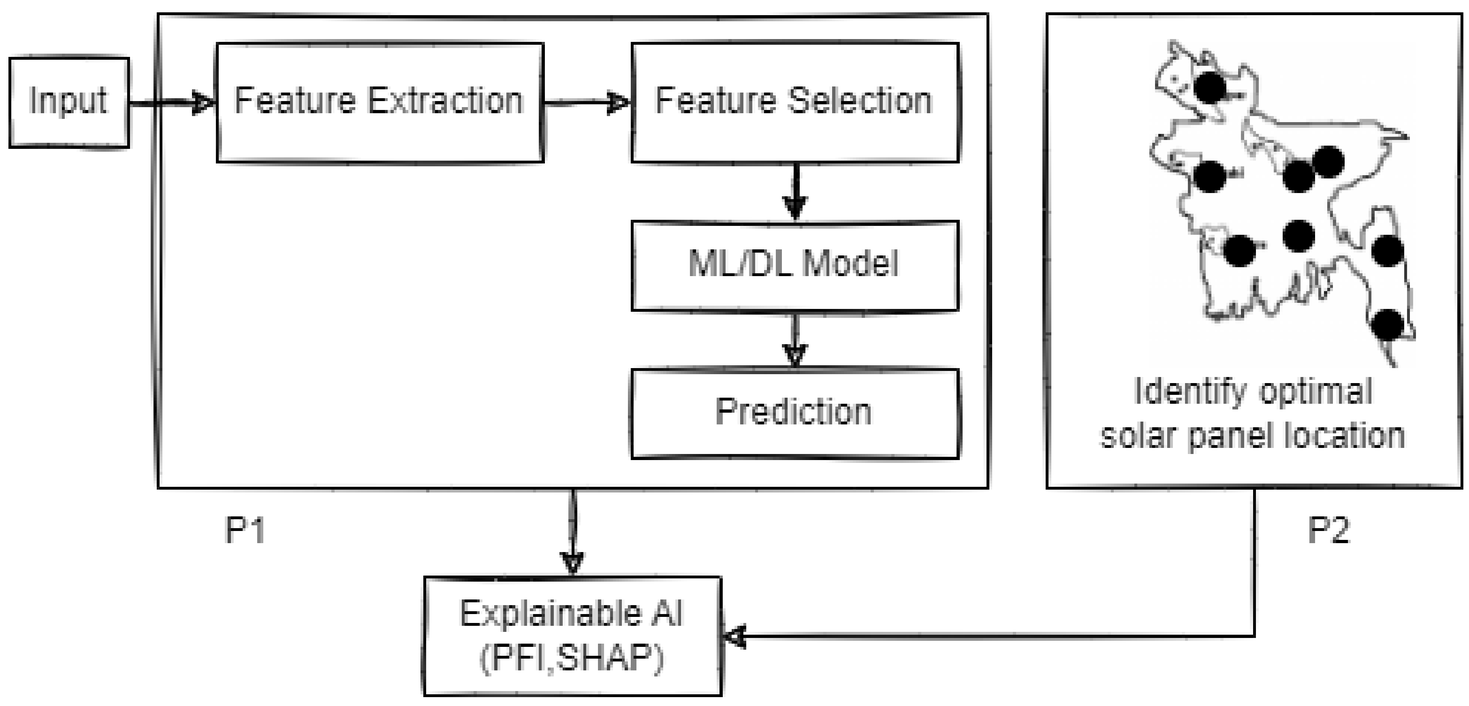
The main methodology is divided into two phases:
i) XaI-based Solar Energy Generation Forecasting, and
ii) GNN-based Optimal Solar Panel Location Identification

i) XaI-based Solar Energy Generation Forecasting
This phase has two main parts:
i) solar radiation prediction and
ii) solar energy generation forecasting.
First, we propose solar radiation prediction using fusion data using weather data, geographical data, and satellite image data. Second, we forecast solar energy generation using the predicted solar radiation with an integrated explainable ai part.

ii) GNN-based Optimal Solar Panel Location Identification
We propose to implement an interactive tool to determine the best location for solar panel installation based on variables like solar radiation, temperature, wind speed, and topography. With the traditional optimization algorithm, here we proposed to use a graph-based deep neural network, to determine the best location for solar panels. We use explainable AI to make our analysis understandable to non-technical personnel.

Our methodology, in general, combines solar energy generation forecasting and optimal solar panel location identification into a single framework. We use a fusion dataset to improve the accuracy of our predictions and an interactive tool to quickly identify the best location for solar panel installation. We also employ AI-based techniques to improve the accuracy of our analyses, as well as explainable AI to make our findings understandable to non-technical personnel.

Proposed Method Overview



References

Ü. Ağbulut, A. E. Gürel, and Y. Biçen, "Prediction of daily global solar radiation using different machine learning algorithms: Evaluation and comparison," Renewable Sustainable Energy Reviews, vol. 135, p. 110114, Jan. 2021, doi: 10.1016/j.rser.2020.110114.

Zhou, Y., Liu, Y., Wang, D., Liu, X., Wang, Y. (2021). A review on global solar radiation prediction with machine learning models in a comprehensive perspective. Energy Conversion and Management, 235, 113960. https://doi.org/10.1016/j.enconman.2021.113960

Sarp, S., Knzlu, M., Cali, U., Elma, O., Guler, O. (2021). An Interpretable Solar Photovoltaic Power Generation Forecasting Approach Using An Explainable Artificial Intelligence Tool. https://doi.org/10.1109/isgt49243.2021.9372263

Alam MS, Al-Ismail FS, Hossain MS, Rahman SM. Ensemble Machine-Learning Models for Accurate Prediction of Solar Irradiation in Bangladesh. Processes. 2023; 11(3):908. https://doi.org/10.3390/pr11030908