EMS Annual Meeting Abstracts
Vol. 19, EMS2022-505, 2022
https://doi.org/10.5194/ems2022-505
EMS Annual Meeting 2022

End to End Global Horizontal Irradiance Estimation Through Pre-trained Deep Learning Models Using All-Sky-Images

Samer Chaaraoui[1], Sebastian Houben[2], and Stefanie Meilinger[1]
[1]International Centre for Sustainable Development (IZNE), University of Applied Sciences Bonn-Rhein-Sieg, 53757 Sankt Augustin, Germany (samer.chaaraoui@h-brs.de, stefanie.meilinger@h-brs.de)
[2]Department of Computer Science, University of Applied Sciences Bonn-Rhein-Sieg, 53757 Sankt Augustin, Germany (sebastian.houben@h-brs.de)

The accurate forecasting of solar radiation plays an important role for predictive control applications for energy systems with a high share of photovoltaic (PV) energy. Especially off-grid microgrid applications using predictive control applications can benefit from forecasts with a high temporal resolution to address sudden fluctuations of PV-power. However, cloud formation processes and movements are subject to ongoing research. For now-casting applications, all-sky-imagers (ASI) are used to offer an appropriate forecasting for aforementioned application. Recent research aims to achieve these forecasts via deep learning approaches, either as an image segmentation task to generate a DNI forecast through a cloud vectoring approach to translate the DNI to a GHI with ground-based measurement (Fabel et al., 2022; Nouri et al., 2021), or as an end-to-end regression task to generate a GHI forecast directly from the images (Paletta et al., 2021; Yang et al., 2021). While end-to-end regression might be the more attractive approach for off-grid scenarios, literature reports increased performance compared to smart-persistence but do not show satisfactory forecasting patterns (Paletta et al., 2021). This work takes a step back and investigates the possibility to translate ASI-images to current GHI to deploy the neural network as a feature extractor. An ImageNet pre-trained deep learning model is used to achieve such translation on an openly available dataset by the University of California San Diego (Pedro et al., 2019). The images and measurements were collected in Folsom, California. Results show that the neural network can successfully translate ASI-images to GHI for a variety of cloud situations without the need of any external variables. Extending the neural network to a forecasting task also shows promising forecasting patterns, which shows that the neural network extracts both temporal and momentarily features within the images to generate GHI forecasts.

References

Fabel, Y., Nouri, B., Wilbert, S., Blum, N., Triebel, R., Hasenbalg, M., Kuhn, P., Zarzalejo, L. F., and Pitz-Paal, R.: Applying self-supervised learning for semantic cloud segmentation of all-sky images, Atmospheric Measurement Techniques, 15, 797–809, https://doi.org/10.5194/amt-2021-1, 2022.

Nouri, B., Blum, N., Wilbert, S., and Zarzalejo, L. F.: A Hybrid Solar Irradiance Nowcasting Approach: Combining All Sky Imager Systems and Persistence Irradiance Models for Increased Accuracy, Solar RRL, 2100442, https://doi.org/10.1002/solr.202100442, 2021.

Paletta, Q., Arbod, G., and Lasenby, J.: Benchmarking of deep learning irradiance forecasting models from sky images – An in-depth analysis, Solar Energy, 224, 855–867, https://doi.org/10.1016/j.solener.2021.05.056, 2021.

Pedro, H. T. C., Larson, D. P., and Coimbra, C. F. M.: A comprehensive dataset for the accelerated development and benchmarking of solar forecasting methods, Journal of Renewable and Sustainable Energy, 11, 36102, https://doi.org/10.1063/1.5094494, 2019.

Yang, H., Wang, L., Huang, C., and Luo, X.: 3D-CNN-Based Sky Image Feature Extraction for Short-Term Global Horizontal Irradiance Forecasting, Water, 13, 1773, https://doi.org/10.3390/w13131773, 2021.