One-Hour Prediction of the Global Solar Irradiance from All-Sky Images using Artificial Neural

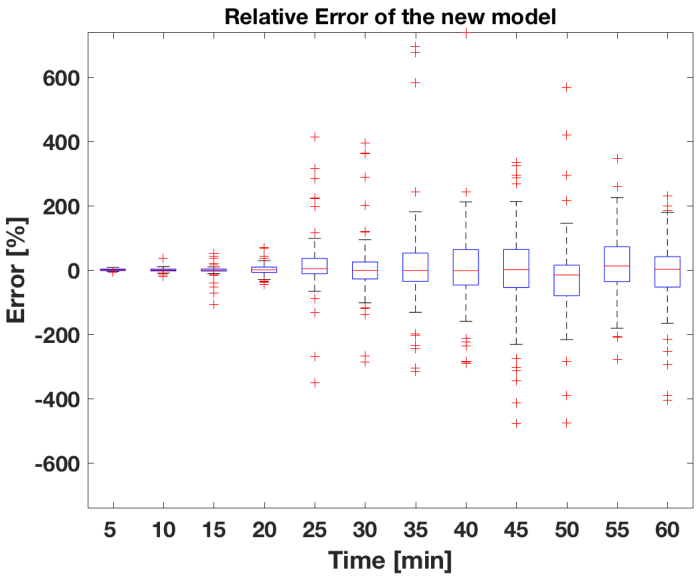
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Abstract

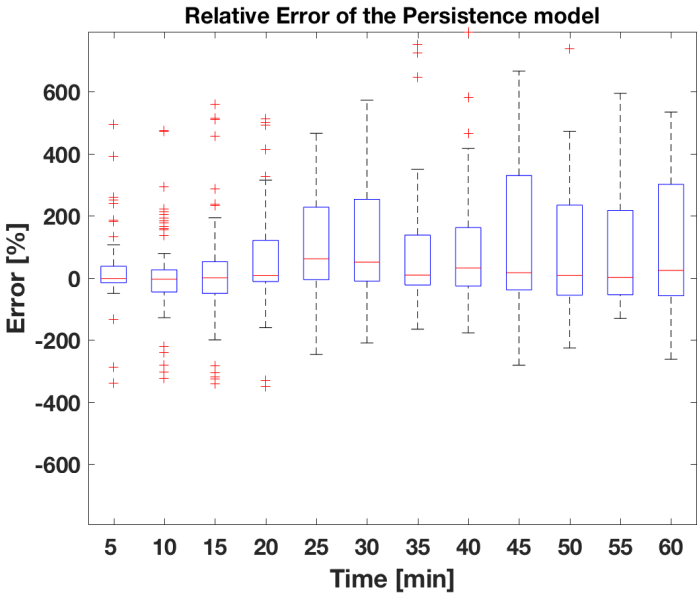
Worldwide, the installed PV power increases by a double-digit percentage per year. This trend makes photovoltaics an even more important alternative for global power supply. The production of solar energy is subject to strong spatial and temporal fluctuations due to the dependence on meteorological boundary conditions. This leads to uncertainties in the planning of energy supplies and, thus, to economic inefficiencies.

Here, will be presented a method to predict the global horizontal irradiance (GHI) one hour ahead in one-minute resolution using Artificial Neural Networks (ANNs). A feed-forward neural network with Levenberg–Marquardt Backpropagation (LM BP) was used and was trained with four years of data from all-sky images and measured global irradiance as input. The pictures were recorded by a hemispheric sky imager at the Institute of Meteorology and Climatology (IMuK) of the Leibniz Universität Hannover, Hannover, Germany (52.23 N, 09.42 E, and 50 m above sea level). The time series of the global horizontal irradiance was measured using a thermopile pyranometer at the same site. The new method was validated with a test dataset from the same source. The irradiance is predicted for the first 10–30 min very well; after this time, the length of which is dependent on the weather conditions, the agreement between predicted and observed irradiance is reasonable. Considering the limited range that the camera and the ANN can "see", this is not surprising. When comparing the results to the persistence model, we observed that the forecast accuracy of the new model reduced both the Root Mean Square Error (RMSE) and the Mean Absolute Error (MAE) of the one-hour prediction by approximately 40% compared to the reference persistence model under various weather conditions, which demonstrates the high capability of the algorithm, especially within the first minutes.

Figure 1



(a)



(b)

Figure 1: *The relative deviation boxplot of the simulation derived for different time's horizon. The symmetry in the 50% of the data decreases as soon as the program receives information from the last picture and increases when the program doesn't receive information from the last picture. Figure 6 (a) corresponds to the new ANN. Here there are narrower interquartile ranges for higher sample sizes but the numbers of outliers are higher than the Figure 6 (b). Figure 6 (b) corresponds to the persistence model. 50% of the data is not exactly located in the middle and the 25% and 75% of the data deviation is higher than in Figure 6 (a).*

Recent Publications

1. **Crisosto, C.**; Hofmann, M.; Mubarak, R.; Seckmeyer, G. *One-Hour Prediction of the Global Solar Irradiance from All-Sky Images Using Artificial Neural Networks*. *Energies 2018*, 11, 2906.
2. **Crisosto, C.**; Luiz, W, E.; Seckmeyer, G. *Cloud Concentration Forecast from All-Sky Images using Artificial Neural Networks*
3. Hofmann, M., Riechelmann, S., **Crisosto, C.**, Mubarak, R., & Seckmeyer, G. (2014). *Improved synthesis of global irradiance with one-minute resolution for PV system simulations.* International Journal of Photoenergy, 2014.



Biography

Cristian Crisosto has his expertise in evaluation and passion to solve problems applying artificial neural networks. His forecast model based on artificial neural network creates new pathways for improving solar irradiance forecasting. He has built this model after years of experience research in mathematics, computer science and in artificial intelligence. This kind of software could be applied in both in business and scientific institutions. The focus further researches is based on the extension of this methodology, which will provide a utilization of that elsewhere.

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