USING ARTIFICIAL NETWORKS FOR PREDICTION OF RENEWABLE ENERGY RESOURCES IN MARINE ENVIRONMENT

Sorin Ciortan, Gheorghe Stăvărache, Rusu Eugen,
Department of Mechanical Engineering, "Dunarea de Jos" University of Galati, 111 Domneasca St., 80008 Galati, Romania, e-mail: sorin.ciortan@ugal.ro

In the marine environment several renewable energy sources can be found as wind, waves, tide, thermal and osmotic. Taking into account that the oceans' estimated energy resource is around 83340TWh/year, representing up to 400% of world electricity demand, it is obvious that its exploitation might represent an important issue in the actual frame of looking for sustainable, green energy. Among the mentioned resources the most targeted are wind, waves and tidal. In order to obtain the most efficient energy conversion two criteria must be followed: the appropriate pairing of converting device type and placement location and an analysis of the specific energy resource evolution in time. If the first criterion is linked mostly by the technological evolution, which is day-by-day more rapid, the second one is linked to the climate changes, requiring forecasting procedures in order to optimize the energy extraction. Usually, these predictions relay on numerical methods, using meteorological parameters linkages and correlation coefficients as inputs. But, during climate changes also the weights of these parameters into the linkage are changing. So, in order to obtain efficient forecast two possibilities occur: the continuously updating of correlation coefficients used or, using a different approach, which can offer prediction and optimization without mathematical formulas - Artificial Neural Networks (ANN). The present work highlights the possibility and the opportunity of using ANN for the analysis, forecasting and optimization of the renewable energy sources evolution in marine environment.

ANNs are parallel calculus systems working in a different way comparing to the systems based on von Neumann machine, i.e. trivial computers. As a consequence, several benefits can be obtained: there is no need for a mathematical algorithm, they can process directly experimental acquired values, less sensitivity to errors and missing data etc. ANNs are working in two stages: first, the network is trained with known input-output pairs of data, second the network can provide predicted outputs for input data which have no known output pairs. ANN based models are similar to biological brains, composed by several so called "artificial neurons", distributed in layers and interconnected through links. These links are modified during the training stage, defining this way the correspondence between input and output data. In the second stage, the ANN model can be used for prediction, optimization or importance analysis.

In the case of the waves, with a power potential roughly estimated at around 1 TW, ANN based models, trained with month, day and hour and wind speed as inputs and wave height as output, offers the benefit to predict waves' height starting from future date, the establishing the most influencing input or finding an optimal date when the waves' height is extreme (minimum or maximum). The training data are obtained from historical records, available in international databases.

Other important renewable energy resource is the wind, the oldest one used by humanity. Today, almost 600 GW of power are obtained all over the world from the wind farms. Lately, due to advances in wind turbine technologies the amount of off-shore wind energy conversion is continuously increasing. As consequence, the evolution analysis and forecasting of the available wind power is a top subject for researchers. The ANN based modelling, using as inputs the wind turbine height, the water surface roughness and the wind speed can provide as output the wind power density and, at consequence, the available power provided. The inputs data are provided by existing international data bases. The model can be used for prediction, importance analysis or optimization of the wind farms placement.

Keywords: marine renewable energy, neural networks, forecasting, optimization

Acknowledgment: This work was carried out in the framework of the research project DREAM (Dynamics of the REsources and technological Advance in harvesting Marine renewable energy), supported by the Romanian Executive Agency for Higher Education, Research, Development and Innovation Funding – UEFISCDI, grant number PN-III-P4-ID-PCE-2020-0008.

References

Onea, F., Ciortan, S., Rusu, E., 2017, Assessment of the potential for developing combined wind-wave projects in the European nearshore, SAGE Journals, *Energy & Environment*, 2017, 010.

Ciortan S., E., Rusu, E., 2018, Prediction of the wave power in the Black Sea based on wind speed using artificial neural networks, International Conference on Advances on Clean Energy Research (ICACER 2018*)*

Rusu, E., A 30-year projection of the future wind energy resources in the coastal environment of the Black Sea, *Renewable Energy*, Volume 139, August 2019, Pages 228-234.

Ciortan S., E., Rusu, E., 2018, Prediction of the wave power in the Black Sea based on wind speed using artificial neural networks, International Conference on Advances on Clean Energy Research (ICACER 2018*)*

Ciortan S., E., Rusu, E., 2019, Analysis of wave energy conversion with dynamic systems theory, International Conference on Advances on Clean Energy Research (ICACER 2019*)*

Stăvărache Gh., Novac V., Ciortan S., E., Rusu, E., 2020, Long term prediction of wind speed with artificial neural networs, XXth International Multidisciplinary Scientific GeoConference Surveying, Geology and Mining, Ecology and Management (SGEM 2020*)*

Ciortan S., Stăvărache Gh., E., Rusu, E., 2020, Optimization of artificial neural networks based models for wave height prediction, International Conference on Advances on Clean Energy Research (ICACER 2020*)*

Stăvărache Gh., Ciortan S., E., Rusu, E., 2021, A long-term evaluation of wind energy resources in Republic of Moldova, International Conference on Advances on Clean Energy Research (ICACER 2021*)*