PhD Open Days

Renewable Energy Forecast using Soft Computing Techniques for Predictive Control

MIT Portugal – Sustainable Energy Systems

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Abstract

Negative impacts of fossil fuels → Renewable energy investment → High variability and unpredictability → Need to optimize → Operate at the highest efficiency point

Ocean waves → Clean, abundant and powerful → Forecasting models can be valuable → Optimal control of Wave Energy Converter → Increase overall efficiency

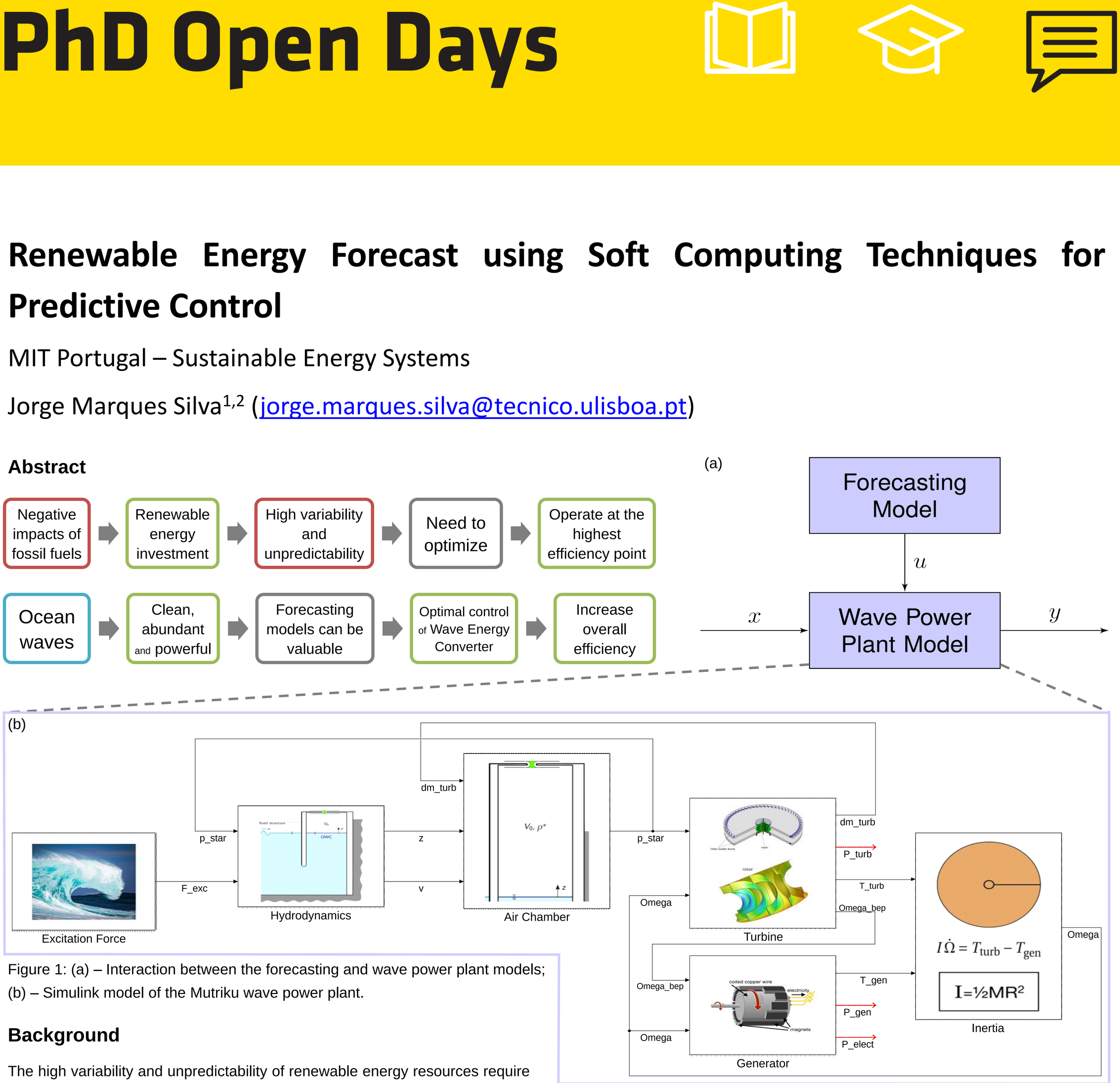

Figure 1: (a) – Interaction between the forecasting and wave power plant models; (b) – Simulink model of the Mutriku wave power plant.

Background

The high variability and unpredictability of renewable energy resources require optimization of the energy extraction, by operating at the best efficiency point, which can be achieved through optimal control strategies. In particular, short-term wave forecasting models can be valuable for control strategies in wave energy converter devices, as illustrated in Figure 1a: by means of a control action *u*, the input *x* can now originate an optimized output *y*.

Methodology

A computational model based on the Mutriku wave power plant (in the Basque Country, Spain) was developed in Simulink (Matlab) (Figure 1b). As for the forecasting model, A Least Squares Support Vector Machine (LS-SVM) algorithm was developed to predict the air chamber pressure and compare it to the real signal. Regressive linear algorithms were executed for reference. The experimental data was obtained at the Mutriku wave power plant in the Basque Country, Spain.

Results

LS-SVM prediction errors varied from 9% to 25%, for horizons ranging from 1 to 3 seconds in the future. There is no need for extensive training data sets for which computational effort is higher. However, best results were obtained for models with a relatively small number of LS-SVM features.

Regressive models have shown slightly better performance (8% to 22%) at a significantly lower computational cost. Ultimately, these research findings may play an essential role in model predictive control strategies for the wave power plant.

Future Work

A robust strategy for this WEC control system is the main forthcoming objective. As the controller will be implemented in the generator in order to adjust the turbine rotational speed to its optimal, there is a need to evaluate the generator efficiency as well. This is a necessary step to quantify the real prediction potential of the OWC predictive controller, in terms of the prediction error, forecasting horizon and computational effort.

References

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