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Load-measurement method for floating offshore wind turbines based on a long short-term memory (LSTM) neural network

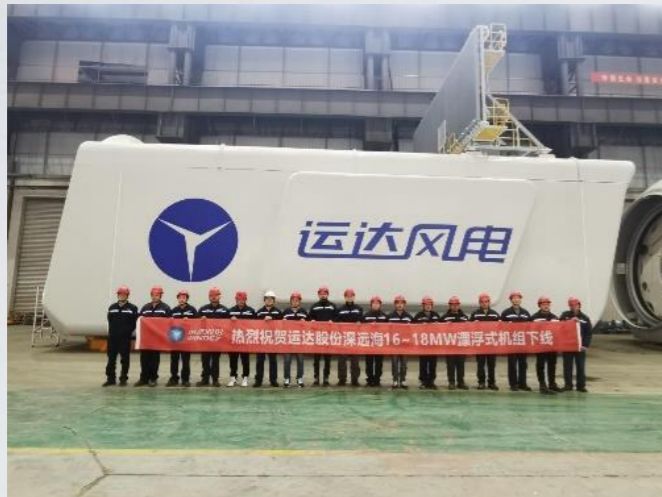
Key words:

Floating offshore wind turbine (FOWT); Long short-term memory (LSTM) neural network; Machine learning technique; Load measurement; Hybrid-scale model test



Motivation

Large scale



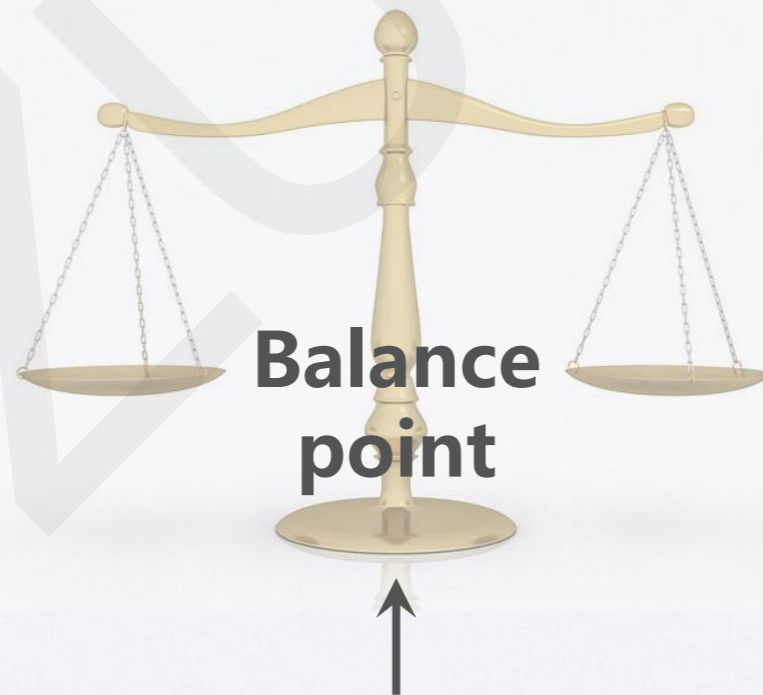
16 MW wind turbine

Commercialization



Hywind Tampen

Safety



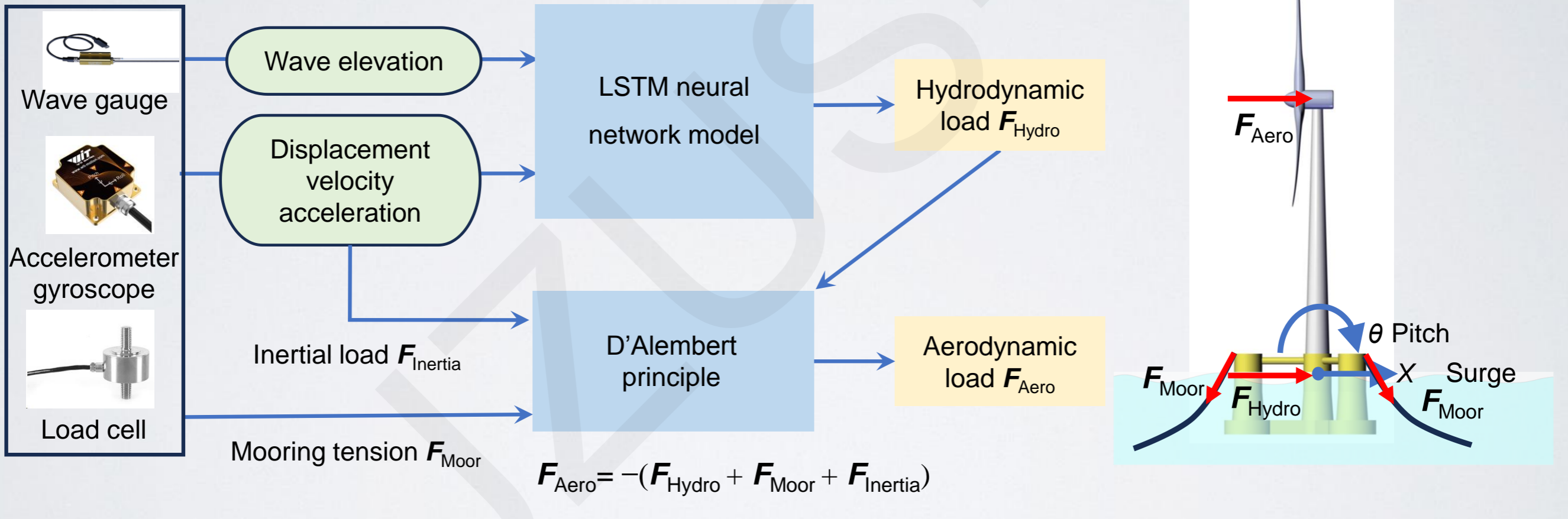
Cost

Load data of the turbine in real sea states

Method

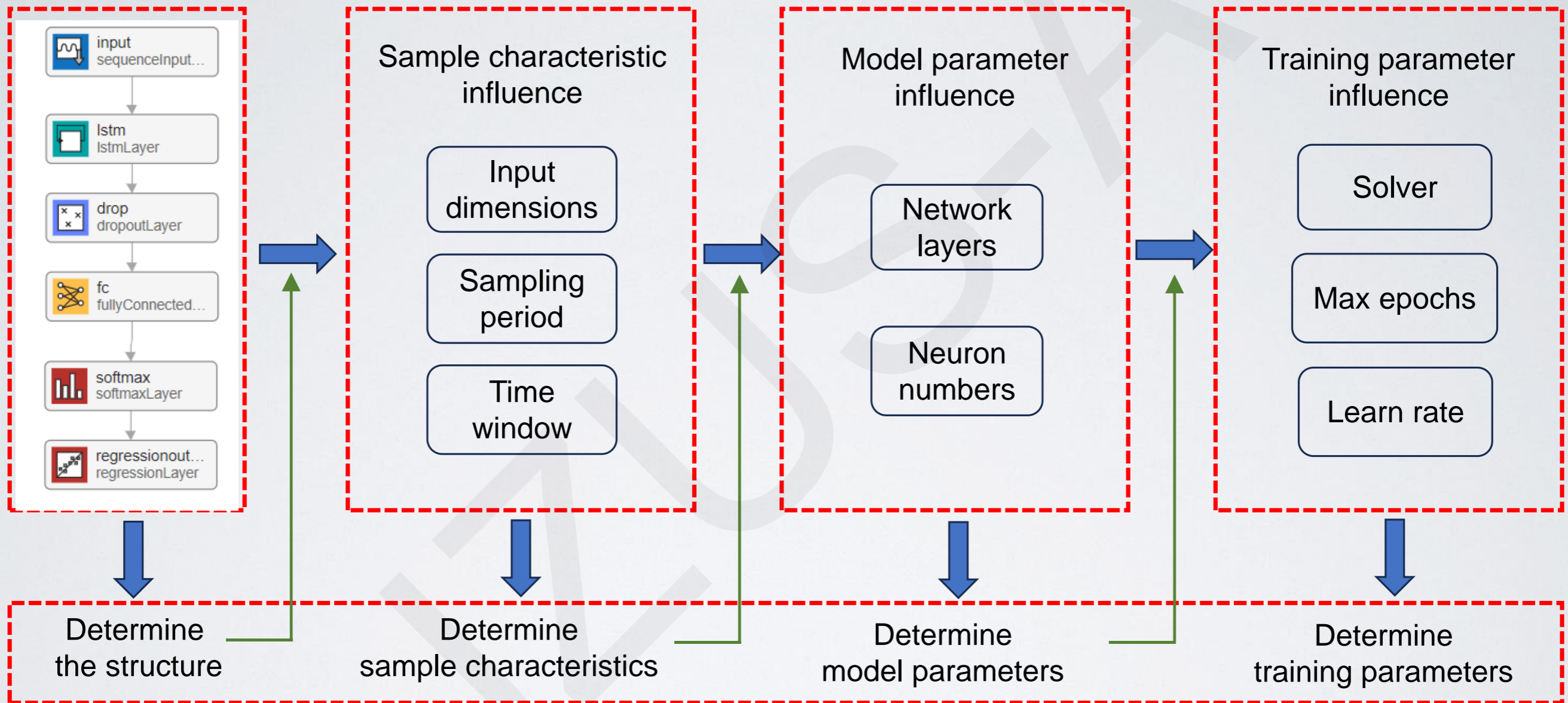
Load measurement method for FOWT

Sensor system



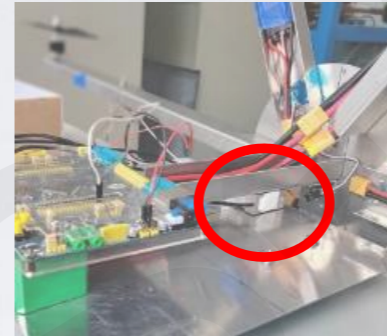
Aerodynamic Load was calculated indirectly by mature sensors

Model training



Optimal LSTM model was determined step by step

Experimental setup



Thrust



Wave elevation



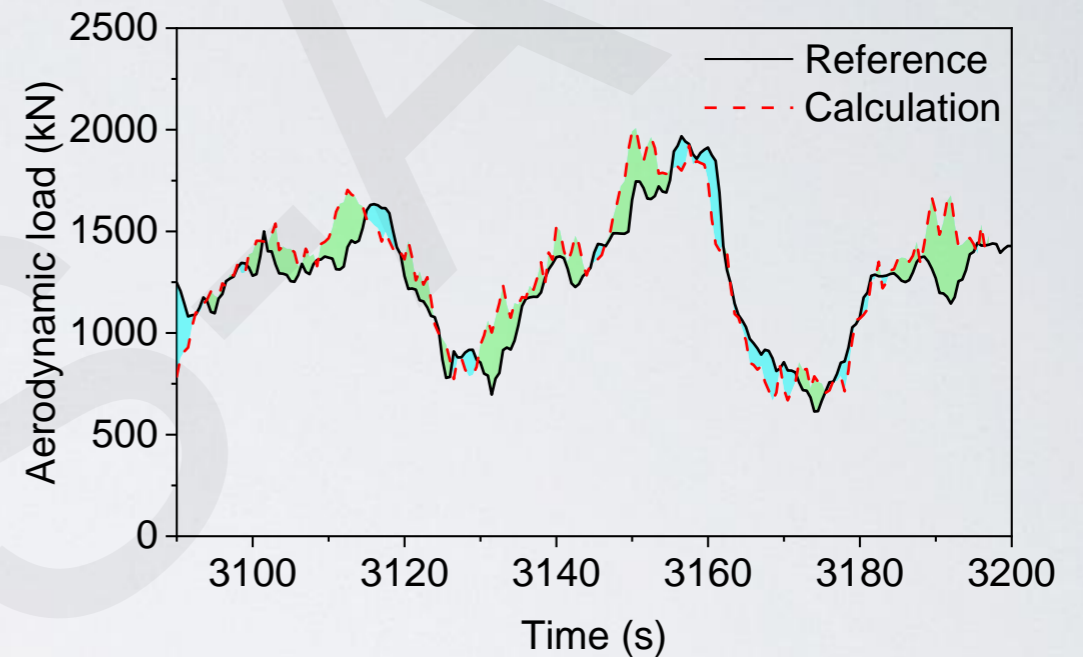
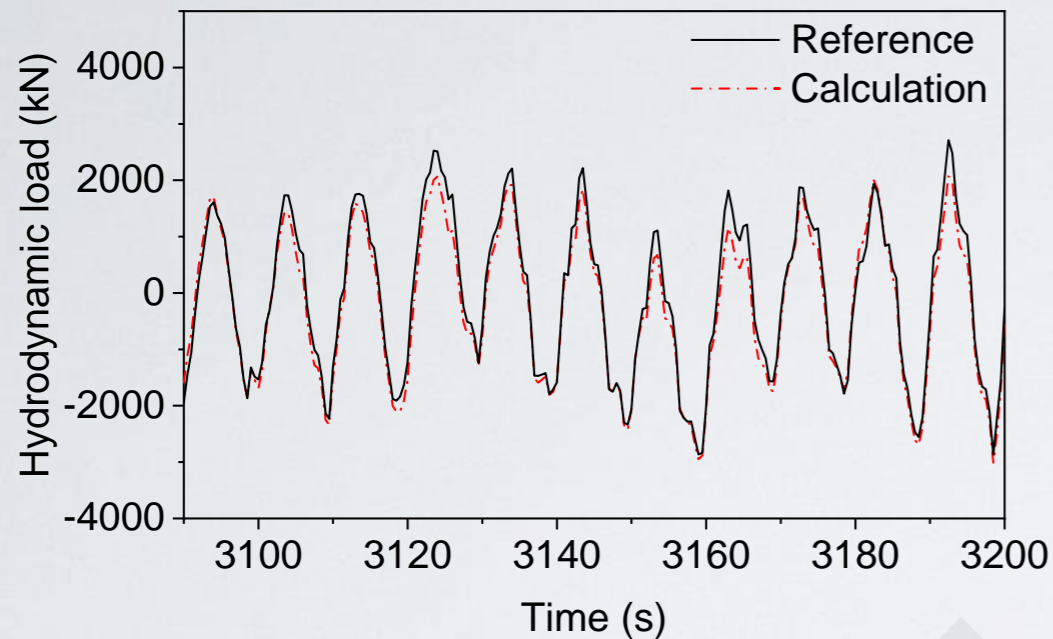
Mooring tension
Mooring angle



Platform motion

Scaled model tests were carried out to collect sample data

Results and Conclusions



For the hydrodynamic load measurement, the curve-fitting degree is 92.44% and the root mean square error is 4.20%.

For the aerodynamic load measurement, the curve-fitting degree is 79.83% and the root mean square error is 10.68%.

In the future, we envision this method being applied to actual full-scale FOWTs in real sea states. This would involve using more measurement equipment with high accuracy and high sampling frequency.