Bayesian identification for nonlinear floating systems

Master thesis proposal at the Marine Offshore Renewable Energy Lab, Politecnico di Torino

Recommended profile:
Mathematical Engineering, Mechatronic Engineering, Mechanical Engineering

Topics involved:
Grey box identification, System identification, Surrogate modells, Data-driven and data based system modelling, Uncertainties, Offshore renewables, Offshore floating structures, Hydrodynamics, Free decay tests

Contact references:
MOREnergy Lab Supervisor - Bruno Paduano (bruno.paduano@polito.it)
MOREnergy Lab Co-Supervisor - Oronzo dell'Edera (oronzo.delledera@polito.it)
MOREnergy Lab Co-Supervisor - Filippo Giorcelli (filippo.giorcelli@polito.it)

A curricular internship can also be associated with the thesis.

Proposal description

Background and Motivation

Accurate yet efficient dynamic models of a floating system are essential for simulation, design, and control tasks. For a Floating Offshore Wind Turbine (FOWT), the coupled dynamics driven by waves and mediated by hydrodynamics and mooring can exhibit strong nonlinearities. These nonlinearities arise from effects such as viscous contributions not captured by potential flow formulations, amplitude dependent damping, nonlinear restoring from moorings, and state dependent excitation. In addition, identification data (numerical or experimental) often include imperfections such as outliers, time varying noise levels, unmodeled disturbances, and mild mismatch between the assumed model structure and the true physics. Standard identification approaches frequently deliver point estimates of parameters and rely on Gaussian error assumptions. This can produce parameter sets that fit one dataset but generalize poorly, and it does not provide a rigorous way to quantify how uncertain the inferred hydrodynamic and mooring parameters are. Bayesian nonlinear system identification addresses this limitation, enabling uncertainty propagation to predicted motions and loads.

Research Aim

The aim of this research is to develop and validate a Bayesian nonlinear system identification framework for a floating system representative of a FOWT dynamics, to infer posterior uncertainty on model parameters and to provide an objective, data driven assessment of the performance of different candidate model structures used within the Bayesian approach.

Expected Contributions

The thesis is expected to deliver a complete method, and an evaluation protocol, to quantify uncertainty in the parameters used to describe the floating system and to compare alternative modeling choices. Concretely, the contributions are:

- Bayesian identification model for floating dynamics.
- Posterior uncertainty quantification for hydrodynamic and mooring parameters.
- Model performance assessment across competing Bayesian model structures
- Benchmarking and demonstration on representative datasets