Real-Time Hybrid Model Testing of Floating Wind Turbines
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Numerical Setup
- Software: SIMA (by MARINTEK)
- Hydrodynamics, kinetics and mooring dynamics modeling
- Actuators (Motor+spring+wheel+wire) modelled by a winch + winch controller + elastic cable.
- Wind turbine aerodynamics modeling for verification of the numerical model
- Real-time communication with the ReaTHM testing controller

The ReaTHM controller can communicate with either the physical or the numerical setup, at its option. Most of its features are compatible with both setups with only minor changes in the code. The numerical setup provides the flexibility necessary to develop a complex ReaTHM testing project. It is also a simulation tool able to reproduce the environment of the ocean wave basin at no cost.

Real-time hybrid model (ReaTHM) testing in NOWITECH model tests
- CSC braceless semi-submersible, scale 1/30, in MARINTEK’s ocean wave basin
- NREL 5MW turbine, physical tower with correct mass properties.
- Actuated wind forces. No physical wind, no rotor, but a set of 6 actuators applying in real-time the thrust force, generator torque and pitch and yaw moments calculated by NREL’s AeroDyn from a turbulent wind field and online measured motions.
- No Froude-Reynolds scaling conflict, controlled wind field and aerodynamic loads, flexible inclusion of the rotor and the generator torque/blade pitch controllers

Software
- Motion observer loop
  - Delay compensation
  - Velocity observer
  - Filter
  - Position
  - Acceleration
  - Rate

Verifications
- Verification of kinematic modeling
- Verification of emergency stop procedures
- Study of the effect of time delays

Numerical model loop
- Structure kinematics
- Rotor dynamics
- Time
- Wind Field
- Blade kinematics
- Wind turbine controller
- Force commands
- Force allocation
- Force integration
- Force observer loop
  - Motor commands
  - Feedforward controller
  - Feedback controller
  - Predicted position
  - Commanded force
  - Filtered force

Controller loop
- Communication loop
- Filtered force
- Force
- Observer
- Motor
- Wind Field
- AeroDyn

Hardware
- ReaTHM testing controller
- Optical measurement system
- Accelerometers, Gyrometers
- Router/logger
- Amplifier
- Wheel Spring Servomotor
- Thin wire
- Disturbances