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TWIND Summer School

Floating offshore wind turbine control strategies for vibration reduction

7th July 2021

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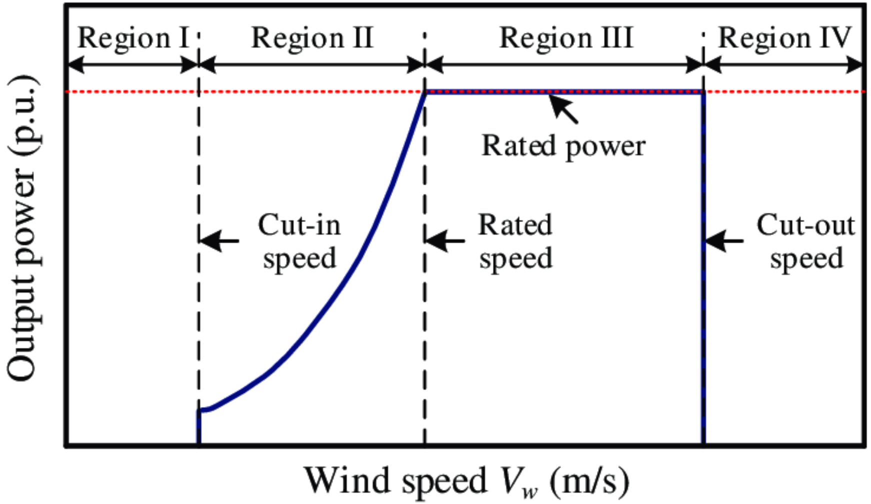
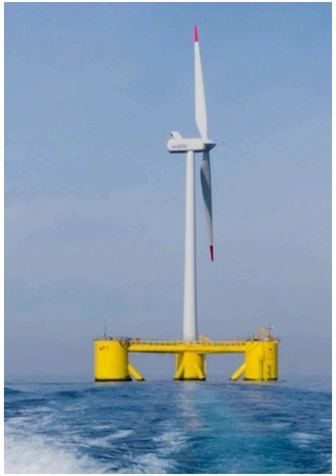
Introduction

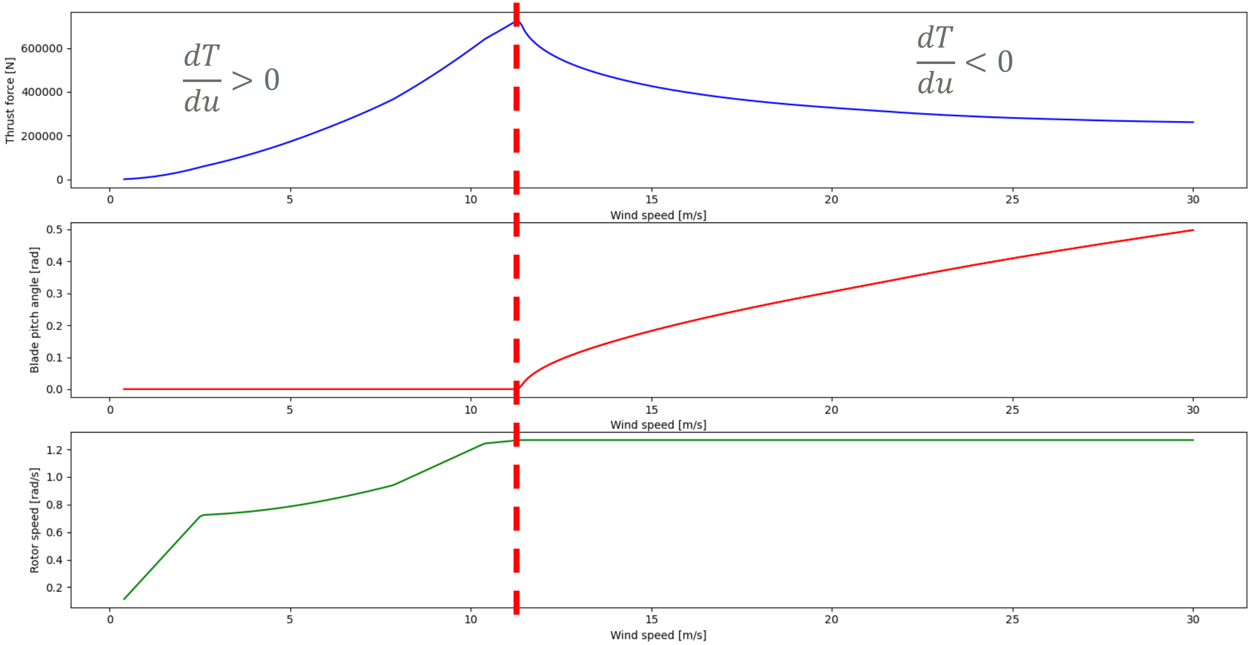
The overall objective of TWIND is to create a network of excellence that will dynamize a pool of specialized research professionals and trainers in the domain of offshore wind energy to support an emerging industry in Portugal in a field with a very strong anticipated growth and no dedicated existing training curriculum

Onshore control strategies and their influence in floating platforms dynamics I

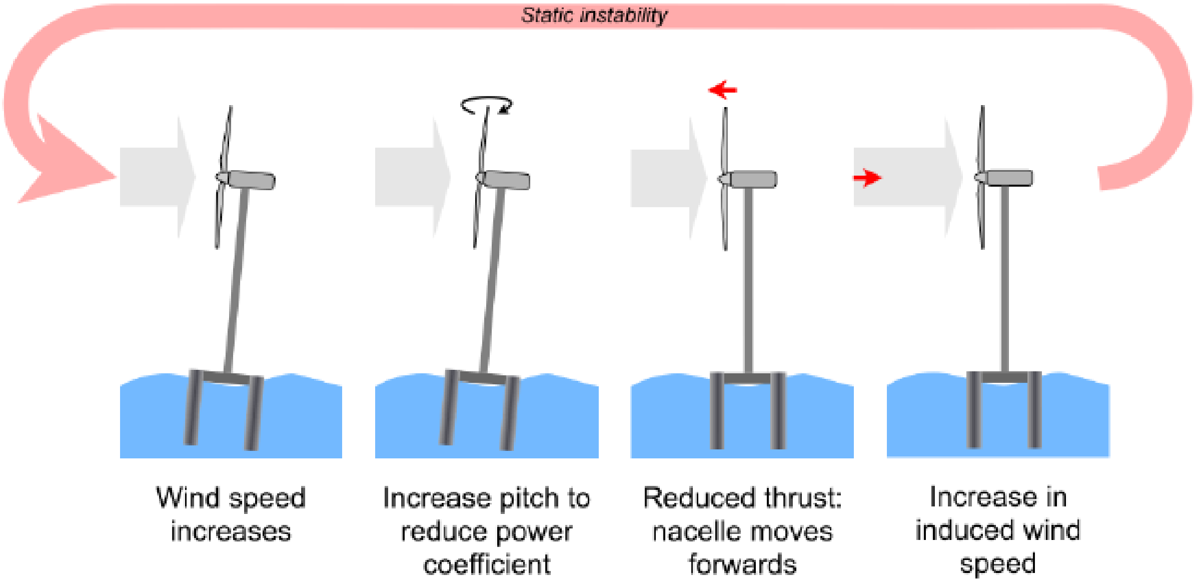




Onshore control strategies and their influence in floating platforms dynamics II



Onshore control strategies and their influence in floating platforms dynamics III



[13]

FOWT control strategies I

Different control strategies are being studied by research community during last years.

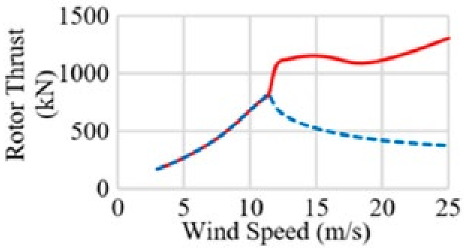
Control methods addressing the **negative damping problem** can be summarized into the following categories [1]:

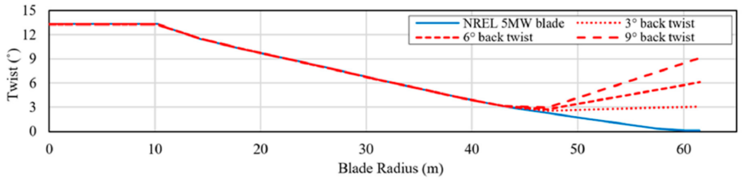
Control strategies	
SISO control	Detuning of the controller gains [2, 3]
MISO control	Tower top acceleration loop [3, 4, 5, 6, 7]
MIMO control	Decouple of the generator speed control [8]
Advanced methods	LQR, H-infinite, MPC [9, 10]

FOWT control strategies II

Other interesting control approaches:

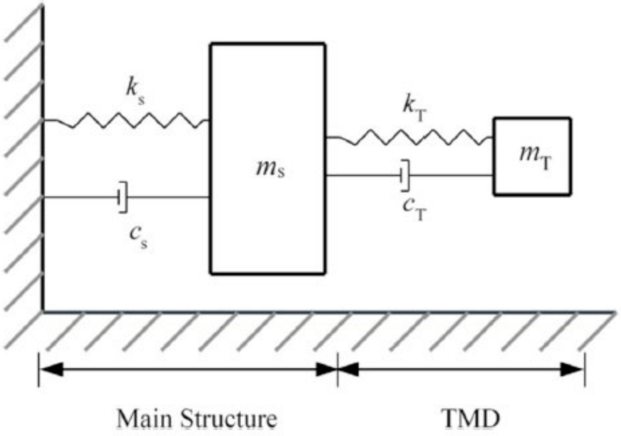
Control strategy	
IPC	Independently control each blade pitch angle [11, 12]
Pitch to stall	Thrust force increases for each wind speed [3, 13]
AI methods	Control parameter tuning [14]





[13]

Passive, active, hybrid and semi-active control



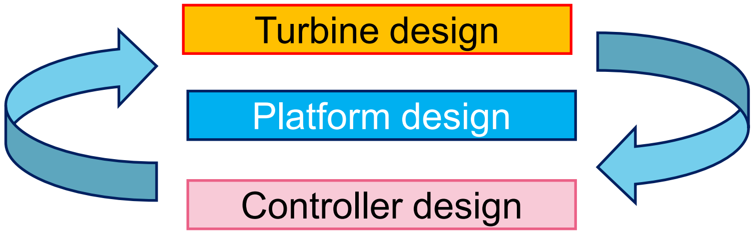
[15]

Control strategies	
Passive devices	These devices do not require external energy [15, 16]
Active devices	They require external energy [17]
Hybrid devices	This kind of device requires less energy than an active one [18]
Semiactive devices	Similar to passive devices [19]

Controller design and control codesign

Current control design methodology: Sequential

Control codesign methodology [20]: ARPA-E agency → ATLANTIS Program



Conclusions

- Many different wind turbine control strategies are promising for floating offshore wind turbines being of interest those based on models.
- Considering new sensors allow a better performance of traditional wind turbine controls. New sensors should be investigated.
- 2 different approaches for vibration control: wind turbine control or structural devices.
- Vibration control devices allows a high reduction of vibrations at cost of increasing system complexity and a higher cost of the FOWT system is expected.
- Control codesign methodology would reduce the high LCOE by reducing costs in terms of desired subsystem (platform, turbine, tower, moorings…).
- Adding the vibration control device to the control codesign methodology would achieve higher costs reductions.

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Thank you for your attention

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