PhD Proposal 2017

School: Ecole Centrale de Nantes	
Laboratory: IRCCyN	**Web site: www.irccyn.ec-nantes.fr**
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Collaboration with other partner during this PhD: **In France:**	**In China:**

Title: Robust nonlinear control of floating wind turbines
Scientific field (*): Automation and Robotics
Key words: robust control, optimization,

(*) *: Chemical engineering, Computer Science, Image and data processing, applied mathematics, Electrical engineering, Automation and Robotics, System Engineering, Industrial Engineering, Fluid Mechanics, Aerodynamics, Acoustics, Combustion, Material Science, Optics, Electronics, Nano technology, Micro-system, Bioscience, Solid mechanics, Surface Science, Civil engineering.*

Details for the subject:

Since many years, the world power production coming from wind turbines [Ramesh_13] is strongly increasing. Among the used systems, one can cite off-shore solutions, which are fixed on the ground and are now efficient by an industrial point-of-view. However, these systems are not usable in case of high depth. In that case, floating systems (spar buoys, tension leg platforms, barges) are used but are in a "hostile" environment due to the combination of wind and waves. These latters engender significant structural vibrations, loads in the blades and support structure, which induces maintenance, failures, …

Then, it is necessary to work on an adequate control of the floating wind turbines by combining two objectives which could be antagonist: provide an optimal power production, and limit the structure fatigues. A solution consists in acting on the pitch angles of the wind turbine, and on the load of the generator.

Many works have been made since several years to propose control solutions, mainly based on linear control (thanks to a linearization of the nonlinear model describing the dynamics of the whole structure): one can cite gain scheduled PI [Namik_11], H_∞-control [Lackner_11], LQR-control [Namik_10, Christian_11], LPV-control [Bagher_13, Bagher_14], MPC (model predictive control), optimal control [Linde_09]… It yields that the proposed controllers are efficient on a reduced operating domain; furthermore, in many case, it is necessary to develop several controllers, tuned for a range of conditions, in order to fulfill the objectives over the whole operating domain.

The objective of the thesis is to evaluate the use of nonlinear robust control solutions in the context of floating wind turbines. Only very few works have been already proposed (input-output linearization and sliding mode control [Bagher_14], nonlinear MPC [Schlipf_14]), but in a limited range of operating conditions or under some quite limited conditions (simplified model). The works of "Control" group of IRCCyN during this last decade, on the development of robust control strategies [Plestan_10, Shtessel_12, Bartolini_13, Taleb_15, Taleb_16, Yan_16, Yan_16a] will be useful. The idea here is to use these robust controllers (some of them have adaptive gain, which simplifies the tuning task) in a scheme with a prediction step in order to evaluate the waves and their effects on the structure, and a trajectory generation step in order to optimize the power production whereas the structure fatigue will be reduced. Furthermore, "Control" group has experience on control of wind turbine [Guenoune_15,Guenoune_16]

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