DC Number	DC 4
Title of the PhD Project	Smart adaptive control scheme for a multi-sources energy system
Keywords	Nonlinear control, adaptive robust control, artificial intelligence
Recruitment organisation	Ecole Centrale de Nantes, France
Supervisors names and contacts	F. Plestan franck.plestan@ec-nantes.fr, M.A. Hamida mohamed.hamida@ec-nantes.fr ,
Scientific context and objectives	Key-points for the large development of nonlinear robust controllers on industrial applications are not only their performances (in terms of robustness, stability, accuracy, …) but also the simplicity of their applications. During the last decades, these features have been demonstrated by adaptive sliding mode approaches (see methodology and applications the survey [1]): less and less tuning effort, low modelling effort, low calculation time adapted to real-time systems, … This type of approach has been enhanced by the use of artificial intelligence tools (basic neural networks), which allow to improve performance even further. These neural networks were used to evaluate the uncertain/unknown parts of the system and were applied, coupled with supertwisting type control, to the control of a floating wind turbine [2]. **The first challenge** of the thesis is to extend these preliminary results to more general AI tools (in particular the use of data, which is of interest in systems such as wind turbines). In this case, the development of control methodologies, the establishment of the stability property of this type of control, and the application to a system that the laboratory knows well (floating wind turbine [3] for which numerous data (winds, waves, forces on the anchoring lines, etc.)) will be the main challenge. The attention will be also focused on control of such systems over Regions 2 (MPPT) and 3 (rated power). Experimental tests in oceanic tank could be made in order to evaluate the performances by a more real point of view. **The second challenge** of the thesis will be to apply this type of control methodology (especially by using datas) to multi-energy systems. A first point will concern the definition, and then the modelling of the under-interest systems (for example, heating systems could be considered based on passivity concept []). Depending on the kind os systems, two kinds of control will have to be defined: the local one (the control of the wind turbine for example, as detailed in the first challenge) and the global one (supervision of the network that can be a wind farm). The problem is not only matching production to the demand, but also to optimize the production quality.
Required skills	• Master degree in control theory with some experience in electrical or mechanical systems. Experience with wind turbines/openFast tool would be desirable • Ability to work scientifically, independence, flexibility, teamwork and communication skills • Ability to work to deadlines and deliver high quality results on time. • Very good knowledge of English
References	[1] Y. Shtessel, F. Plestan, C. Edwards, A. Levant, “Adaptive sliding mode and higher order sliding mode control techniques with applications: a survey”, in *Sliding Mode Cont. & Variable Structure Syst.,* Studies in Syst., Decision, Cont., vol. 490, Springer, pp.267-305, Eds. T.R. Roux de Oliveira, L. Fridman, L. Hsu, 2023 [2] M.J. Mirzaei, M. Hamida, F. Plestan, “Neural network-based supertwisting control for floating wind turbine in region III”, *IFAC World Congress*, Yokohama, Japan, 2023. [3] https://lheea.ec-nantes.fr/lheea/news-and-events/a-look-back-on-the-softwind-project?l=1 [4] – J.J. Machado, M. Cucuzella, J.M.A. Scherpen, “Modeling and passivity properties of multi-producer distric heating systems”, *Automatica*, vol.142, 2022.

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