1 General Informations

Laboratory	FEMTO-ST
University	University of Technology of Belfort-Montbéliard (UTBM),
Supervisors	Salah LAGHROUCHE, associate professor

2 Thesis title and keywords

Barrier function-based adaptive higher order sliding control : application to embedded and stationary microgrids

Keywords: Adaptive sliding modes, embedded and stationary microgrids, adaptive management - data-driven control -source health.

3 Project position wit

Micro-grids are considered as uncertain and complex systems. Indeed, the complexity results from the non-linear relationship between the system states, the number of unknown parameters, and the external disturbances acting on the system. In recent years, a considerable effort has been focused on developing new advanced control techniques that ensure optimal and robust control of these systems. Sliding mode control dedicated to the control of nonlinear systems is well known for its robustness qualities needed in a large number of applications. However, the constraints imposed by the apriori knowledge of the uncertainty bounds that affect the system model limit its application. Recently, the concept of barrier function-based adaptive higher order sliding mode control has appeared which allows to overcome this difficulty.

4 Thesis objectives

The objectives of this thesis are multiple:

Develop adaptive and predictive control and estimation strategies that ensure optimal energy management while guaranteeing the sustainability of generation and storage sources. Sustainability is a key issue to ensure optimal system performance and lifetime. Thus, the state of health of the sources will be integrated in the synthesis of the energy management laws to ensure both accomplished performance of the device and optimal aging of the sources.

5 Background required from the applicant

The applicant should have a solid background in energy and control theory.

6 Expected collaboration

This thesis will be conducted in close collaboration with Professor Leonid FRIDMAN (UNAM, Mexico) and Professor Yacine CHITOUR (Paris-Saclay University).

7 Références

[1] S. Laghrouche, M. Harmouche, Y. Chitour, H. Obeid and L. Fridman. *Barrier Function-Based Adaptive Higher Order Sliding Mode Controllers*, **Automatica**, Volume 123, pp. 109355, 2021.

[2] H. Obeid, S. Laghrouche, L. Fridman, Y. Chitour, M. Harmouche. *Barrier Function-Based Adaptive Super-Twisting Controller*, *IEEE Transactions on Automatic Control*, Volume 65, Issue 11, pp. 4928- 4933, 2020.

[3] H. Obeid, L. Fridman, S. Laghrouche, M. Harmouche. *Barrier function-based adaptive sliding mode control*, **Automatica**, Volume 93, pp. 540-544, 2018.

[4] S. Laghrouche, M. Harmouche, Y. Chitour, Higher Order Super-Twisting for Perturbed Chains of Integrators, **IEEE Transactions on Automatic Control**, Volume 62, Issue 7, pp. 3588-3593, 2017.

[5] H. Obeid, S. Laghrouche, and L. Fridman. *Dual layer barrier functions based adaptive higher order sliding mode*, **International Journal of Robust and Nonlinear Control**, doi.org/10.1002/rnc.5387.

[6] M. Harmouche, S. Laghrouche, Y. Chitour, M. Hamerlain, *Stabilisation of perturbed chains of integrators using Lyapunov-based homogeneous controllers*, **International Journal of Control**, Volume 90, Issue 12, pp. 2631-2640, 2017.

[7] S. Laghrouche, J. X. Liu, F. S. Ahmed, M. Harmouche, M.Wack, *Adaptive Second Order Sliding Mode Observer Based Fault Reconstruction for PEM Fuel Cell Air-Feed System*, **IEEE Transactions on Control Systems Technology**, Volume 23, Issue 3, pp. 1098-1109, 2015.