

PhD Proposal 2022

School - Location: Université Paris-Saclay (CentraleSupélec and Univ. Evry), France	
Laboratory: L2S and IBISC	Web site: https://l2s.centralesupelec.fr/ https://www.ibisc.univ-evry.fr/
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Title: Distributed Event-Triggered Fault-Tolerant Control of Multi-Agents Systems under Constraints
Scientific field: Engineering & Technology: Electrical, Electronic and Telecommunication Engineering
Free Key words: Event-triggered control/estimation, Multi-Agents Systems (MAS), Constraints, Fault-Tolerant Control, Lyapunov method, Linear Matrix Inequality (LMI), (quasi)- Linear Parameter Varying (LPV) systems

Application web site: <https://gec-csc.fr/>

Deadline: 5 JANUARY 2022

Details for the subject:

General context: Control of Multi-Agent Systems (MAS) has been studied in order to achieve a common objective of several agents cooperating with each other in order to fulfil a common goal. In this sense, an agent is defined as an element of the system that autonomously performs actions through its actuators according to the measurements obtained from its environment through sensors. Recently, fault detection algorithms (FDI) for MAS have been explored in order to increase the reliability and safety of such systems. Nevertheless, fault-tolerant control systems (FTC) for MAS in case of sensors and actuators faults have not been fully addressed.

Description of the work: In this context, the proposed academic subject considers the event-triggered control problem for nonlinear Multi-Agent Systems under constraints. The communication aspect is considered from a theoretical point of view of the quality of data exchanges between agents; the packet losses and delays will be particularly taken into account. The investigated event-triggered controller should be able of accelerating the speed of convergence in the presence of packet losses, delays and sensor/actuator faults for cooperative agents, and also guarantee the energy saving of each agent when possible. In order to maintain overall performances with high availability when faults/delays/packet losses occur, the extension of Fault Tolerant Control works to a class of nonlinear MAS (such as Linear Parameter Varying – LPV/quasi-LPV –qLPV) agents, will be also considered.

An international collaboration is envisaged with Youmin ZHANG from Concordia University, Canada.

References:

- R. Olfati-Saber and R. M. Murray, "Consensus problems in networks of agents with switching topology and time-delays," *IEEE Transactions on Automatic Control*, vol. 49, no. 9, pp. 1520–1533, 2004.
- V. Dolk, M. Heemels. Event-triggered control systems under packet losses. *Automatica* 80, 143–155, 2017.
- C. Viel, S. Bertrand, M. Kieffer, H. Piet-Lahanier. Distributed event-triggered control strategies for multi-agent formation stabilization and tracking. *Automatica* 106 110–116, 2019.
- G. Wang, M. Chadli, H. Chen, Z. Zhou. Event-triggered control for active vehicle suspension systems with network-induced delays. *Journal of the Franklin Institute* 356 (1), 147-172, 2019.
- E. Kokiopoulou and P. Frossard, "Polynomial filtering for fast convergence in distributed consensus," *IEEE Transactions on Signal Processing*, vol. 57, no. 1, pp. 342–354, 2009.
- Z. P. Jin and R. Murray, "Multi-hop relay protocols for fast consensus seeking," in *Proceedings of the 45th IEEE Conference on Decision and Control*, pp. 1001–1006, 2006.
- H. Pan, X. Nian, and L. Guo, "Second-order consensus in multiagent systems based on second-order neighbours' information," *International Journal of Systems Science*, vol. 45, no. 5, pp. 902–914, 2014.
- X. Wang, M. Lemmon, "On event design in event-triggered feedback systems," *Automatica*, vol. 47, no. 10, pp. 2319–2322, 2011.
- M. Chadli, M. Davoodi, N. Meskin. Distributed State Estimation, Fault Detection and Isolation Filter Design for Heterogeneous Multi-Agent LPV Systems. *IET Control Theory & Applications*, Vol. 11 (2), 254-262. 2016.
- C. Wu, Synchronization and convergence of linear dynamics in random directed networks, *IEEE Transaction on Automatic Control*, 51, 7,1207–1210, 2006.
- M. Porfiri and D. J. Stilwell, "Consensus seeking over random weighted directed graphs," *IEEE Transaction on Automatic Control*, 52, 9, 1767–1773, 2007.
- X. Yin and D. Yue, "Event-triggered tracking control for heterogeneous multi-agent systems with Markov communication delays," *Journal of the Franklin Institute*, vol. 350, no. 5, pp. 1312–1334, 2013.
- A. Chibani, M. Chadli, S. X. Ding. Design of Robust Fault Detection Filter for Polynomial Systems with New Finite Frequency Specifications. *Automatica*, 93, 42–54. 2018.
- R. Wang, Y. H. Li, H. Sun, and Y. M. Zhang, Freshness Constraints of AoI-Based Event-Triggered Kalman Consensus Filter Algorithm over a WSN, *Frontiers of Information Technology & Electronic Engineering*, 22(1): 51-67, 2021.