**Doctoral proposal**

**Thesis:** Robust fault diagnosis of cooperative non-homogeneous multiagent systems

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**Research line:** Mechatronic systems
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# 1 Introduction

Cooperative control of multiagent systems has attracted ever-increasing attention in recent years due to the fact that multiple agents can provide much more redundancy than a single agent system. In this scenario, an individual control law for each one of the agents cannot provide a satisfactory performance of the global control task, e.g., distributed cooperative control of microgrids (Bidram et al., 2013a,b; Nasirian et al., 2014), cooperative formation control of autonomous underwater vehicles (Das et al., 2016), formation control of unmanned aerial vehicles (UAVs) (Kuriki and Namerikawa, 2014), cooperative control of manipulators (Li et al., 2016), to mention a few. Among different topics of MAS, the leader-following, also called cooperative tracking control, has become the most popular consensus problem. In this case, the leader sends information to the agents, then, the controller tries to reduce the error, so all follower agents can track the desired trajectory generated by the leader (Lewis et al., 2013).

On the other hand, convex Linear Parameter Varying (LPV) models have proven to represent in a better way nonlinear systems, with the additional benefit to develop formal stability proofs that guarantee robustness over a broad set of operating conditions (López-Estrada et al., 2019; Liu et al., 2019). A literature review about the convex model can be consulted in the recent survey López-Estrada et al. (2019), the books Lendek et al. (2010); Briat (2014) and the references therein. In Ma and Zhao (2019) the consensus problem was studied for TS MAS with switching topology. In the work of Fang et al. (2020) was proposed a method for solving the consensus problem of networked LPV MAS with directed long-range interactions. In ur Rehman et al. (2020) was proposed a robust nonlinear adaptive consensus protocol under external perturbations with Lipschitz dynamics; the Lipschitz nonlinearity in the agents' dynamics and the adaptive protocol are reformulated using an LPV approach. For fault diagnosis, there are also fewer works reported; for example, in Chadli et al. (2016) it was proposed a fault diagnosis observer for LPV MAS with sensor fault. This work was extended in the journal version in Chadli et al. (2017) where some numerical examples show the applicability of fault diagnosis observer with LPV formulation. However, it is essential to note that most of the recent works for fault diagnosis and estimation are based on linear models, as discussed in our recent work of Martínez-Villegas et al. (2018); Farrera et al. (2020). This is mainly because the extension of these techniques to LPV is not trivial because due to the fact that the resulting LMIs have conservatism in the feasibility solution. However, this also represents a great opportunity to develop research to guarantee observer convergence, fault estimation, and fault-tolerant control.

## 2 Objectives

### General

Develop a methodology for designing an active robust fault diagnosis algorithm for multiagent nonhomogenus convex systems with time delays subject to partial sensors or actuator faults.

### Specifics

- Develop a fault estimation observer for nonhomogenous systems with linear in order to increase the applicability of the method.
- Test the observer under partial sensor or actuator faults
- In the simulation, apply the proposed methodology to mechatronics systems as a robot mobile and a quadrotor modeled as convex LPV system.

## 3 Financing

The main goal of this work is to develop theoretical algorithms. Therefore, it is not necessary extra financing for the strengthening of the project. The schollarship will be cover the National Council of Science and Technology (CONACYT) of Mexico. The travel expenses to Nancy (Flight ticket + Train) will be covered for the University of Lorraine.

## 4 Collaboration

The work will be done in collaboration with the University of Lorraine. As a result of this collaboration agreement, it is expected as a "cotutelle" student mobility. The thesis will be developed under the double degree modality with which the graduate will obtain the title of Doctor of Engineering Sciences from TecNM and Doctor of Automatic Control from the University of Lorraine.

## 5 About the candidate

We are looking for a student with background solving and analytical skills. The candidate must be detailed oriented, knowledgeable on control (preferential convex LPV or TS), work comfortably under pressure, and deliver tight deadlines. Top candidates will have the ability to reason abstractly and quantitatively while constructing viable arguments and critiquing others' reasoning. It is also important to note that the candidate must stay in Nancy, France, for two years to have both the TecNM and the University of Lorraine's academic degree. Send CV to frlopez@ittg.edu.mx.

## References


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