



Université Lille Nord de France  
Pôle de Recherche  
et d'Enseignement Supérieur

## Ecole doctorale régionale Sciences Pour l'Ingénieur Lille Nord-de-France - 072



**Titre :** Design of uncertain observers

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### **Descriptif :**

Can an observer be uncertain? A priori the answer seems obvious: no; because the information provided must be used in the control part and therefore must be reliable. However, excepted the "easy" cases of perfect models and signals with nice properties; faced to model uncertainties, neglected dynamics, disturbances, delays, missing data, an observer is very rarely able to provide the exact unmeasurable state.

In fact, the answer is finally not trivial. A different answer can be given: consider a possible domain of estimation and guarantee that the correct estimate of the unmeasurable state remains in the domain. In this sense the data provided by the observer are uncertain, hence the name: uncertain observer.

Observation/estimation area provided a lot of interesting results: robust Kalman filter for noise, linear and nonlinear observers with unknown inputs to reconstruct disturbances... Closed to the thesis area, "uncertain" estimation based on the theory of intervals have emerged recently (Mazenc & Bernard, 2011, Automatica). One of their interests is the possibility to take into account missing data. A number of algebraic transformations are necessary to produce solutions of interval estimation.

The thesis will consider the use of a more general arithmetic. The latter, called phi-calculus is able to deal with uncertainty modeling via monotone increasing functions. It is based on an extension of fuzzy numbers (Dubois et Prade 1979, Fuzzy Sets & Systems; L. Stefanini, L. Sorini, M.L. Guerra, Fuzzy Sets & Systems 2006) and allows solving equations where the coefficients are fuzzy numbers. It has been used successfully applied to determine approximate solutions of nonlinear models inverse (family of quasi-LPV) (H. Lamara, Thesis UVHC 2007). The idea pursued in this thesis is to use the potential of this arithmetic to derive an "uncertain" domain of estimation of state variables. Application to missing data appears to be "direct"; a trust in the quality of the estimated domain should also be calculated. Several applications to diagnosis are possible.

An international mobility of 6 months is planned as part of the thesis at the University of Sonora (Mexico Dr. M. Bernal).

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