Thesis proposal : Analysis and control of 2D implicit linear models

Multidimensional systems (or nD systems) are models where information propagates not only along one dimension, traditionally time, but across several dimensions, which can be represented by a combination of spatial or temporal variables. In this respect, they belong to the class of infinite-dimensional systems and present new theoretical challenges. To understand these new difficulties, the case of 2D systems (with two dimensions) alone is a reservoir of theoretical problems.

The two most studied linear 2D models in the literature are the Roesser model and the Fornasini-Marchesini model, for which the team has, in recent years, analyzed three notions of stability in the case where both dimensions are discrete: asymptotic stability, exponential stability, and structural stability, as well as the existing relationships between these three notions. Ongoing work is currently being done to establish a continuous counterpart to the results obtained in the discrete case.

However, "more concrete" cases, such as those based on simple partial differential equations, highlight the need to introduce generalized models, particularly an implicit version of the Roesser model. This model leads, among other things, to intermediate definitions of stability, which do not exactly correspond to the notions defined in the classical (explicit) case. Indeed, if one dimension is spatial and the other temporal, stability can be understood as convergence along the temporal dimension only, even though the model remains intrinsically 2D. Thus, the notion of structural stability becomes too strong because it treats both dimensions equally, and it should be relaxed to give meaning to the study. Furthermore, the concept of causality in space does not exist, which clearly shows that the two dimensions should not always be approached in the same way.

Work has already been carried out on this subject, but the A&S team of LIAS would like to continue in this direction by further exploring the implicit model and deepening the various definitions of stability.

The doctoral work will consist of:

- Reviewing the existing literature and state of the art;
- Possibly revisiting the defined notions and the associated formalism to bring more coherence to the study;
- Extending the class of models under study;
- Proposing relevant and numerically applicable stability analysis tools;
- Proposing synthesis methods for reasonably complex control laws;
- Optionally, proposing concrete applications for the proposed tools.

Supervisors:

- Olivier Bachelier (PhD supervisor)
- Nima Yeganefar (co-supervisor)

Laboratory of Computer Science and Systems Automation
LIAS - Bât. B25 - 2, Rue Pierre Brousse - BP 633
86022 Poitiers Cedex – France

Tel. +33 (0)549 45 35 09 – Fax +33 (0)549 45 40 34
Website: http://lias-lab.fr – Email: lias@univ-poitiers.fr

Desired profile:

- Master's degree in automation or applied mathematics, engineer in automatic control
- Strong mathematical background in algebra and analysis
- Strong desire to "dig into" somewhat mathematical problems
- Proficiency in programming, particularly in Matlab
- Good communication skills in English
- Ability to conduct research independently

To apply, please send the requested documents to Nima Yeganefar (nima.yeganefar@univ-poitiers.fr):

1. Your CV and list of publications (if any);
2. A cover letter (a first contact is recommended before writing this letter);
3. At least two reference letters.