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UNIVERSITÉ MONTPELLIER 2
SCIENCES ET TECHNIQUES

DIVISION DE LA RECHERCHE
ET DES ETUDES DOCTORALES
Bureau des Thèses et HDR

HABILITATION A DIRIGER

DES RECHERCHES

FICHE D'EVALUATION

(A renvoyer avec le rapport)

NOM : **MAZENC**   Prénom : **Frédéric**

Nombre total de publications : **40**

Nombre de publications après la thèse : **30**

Qualité des journaux :

- ☒ Excellent
- ☐ Bon
- ☐ Moyen

Nombre de cosignataires du même laboratoire : **1**

Changement de thématique après la thèse : ☒ Oui   ☐ Non

Stage Post-doctorat : ☒ Oui   ☐ Non   Durée : .....

Encadrements (nombre) :   - DEA : **1**   - Thèse : **2**

- Post-Doctorat : **0**   - Stagiaire : **0**

Accepteriez-vous ce candidat dans votre laboratoire ?   ☒ Oui   ☐ Non

Confieriez-vous un de vos thésards au candidat ?   ☒ Oui   ☐ Non

Avis :

- ☒ Très favorable
- ☐ Favorable
- ☐ Réservé

Date, Nom et Signature du Rapporteur

Eduardo D. Sontag, 13 Oct 2006

Report on F. Mazenc's HDR, by E.D. Sontag

This HDR is organized into several sections, describing Mazenc's theoretical work on time-invariant systems, systems with delay, and time-varying systems, as well as his applied research dealing with cart-pendulum systems, stability analysis of a class of TCP-like congestion control models, and applications to underactuated surface vessels and output feedback tracking for a bioreactor.

Let me first describe the sections dealing with theoretical results.

Results for time-invariant systems

The first part addresses the problem of global asymptotic stabilization, by dynamic output feedback, of feedforward systems. This part constitutes a link between the results of Mazenc's Ph.D. thesis and those that he obtained thereafter.

The second part is based on a paper jointly authored with D. Nesic: for systems satisfying the invariance conditions of LaSalle, and extra weak Lie algebraic conditions, Mazenc constructs a Lyapunov function whose derivative is negative definite along the solutions. This is an important result for being able to find stability margins of systems.

Results for systems with delay

The first part presents a construction, for an oscillator with an arbitrarily large delay in the input, of bounded feedbacks which globally asymptotically stabilize the system. It turns out that this main result is intimately related to the output feedback stabilization problem: as a byproduct, Mazenc shows that for any (non-trivial) linear output, one can find a delay τ such that, the system with the delay τ in the input can be stabilized by a bounded static output feedback.

The second part of this section is devoted to feedforward systems with an arbitrarily large delay in the input. Mazenc obtains explicit expressions of globally asymptotically stabilizing feedbacks. The key ingredients are, on the one hand, several modifications of the system by changes of coordinates, input, and time scale and, on the other hand, the use of feedbacks based on nested saturations.

The last part contains a backstepping result for systems with an arbitrarily large delay in the input. The construction is of great interest because it can be adapted to other contexts, and it is one of the most interesting results in the HDR for systems with delay.

Results for time-varying systems

The first part of this section presents Mazenc's construction of a strict Lyapunov function based on the knowledge of a Lyapunov function V such that $\dot{V} \leq -p(t)W(x)$, with W

positive definite and $p(t)$ periodic, nonnegative (but possibly zero for some t). This work is of great interest because of applications to input to state stability, and has been expanded in several papers with Malisoff.

The second part of this section is based on a paper Mazenc wrote with his student Bowong (co-supervised by G. Sallet). This paper presents an extention of the backstepping approach: this technique is adapted to the problem of constructing bounded feedbacks for time-varying systems. This result relies on a new change of coordinates and the construction of strict Lyapunov functions of the first part.

I now turn to describing the more applied part of Mazenc's HDR.

Cart-pendulum system

The cart pendulum system with the variables of position as output is considered. After a change of coordinates, the system admits a feedforward form. The theoretical technique of dynamic output feedback stabilization for feedforward systems presented at the beginning of the previous chapter applies and provides with explicit dynamic output feedbacks.

TCP-like congestion model

Studied here is a model based on a nonlinear system with a delay, which is globally asymptotically stable when the delay is equal to zero. Mazenc discovered a Lyapunov functional which allows to determine an upper bound for the delay which ensures that all the possible solutions of the system converge to the equilibrium point of the system when the delay is smaller than this upper bound.

Underactuated surface vessel

Explicit formulas of time-varying state feedbacks which make the origin of an underactuated surface vessel globally uniformly asymptotically stable are proposed in this section. The construction of the feedbacks extensively relies on the backstepping approach and on the technique of " strictification " of Lyapunov functions presented in the last part of his chapter devoted to theoretical results. This part is based on papers written with Nijmeijer and Pettersen. Pettersen performed an experiment in her laboratory at Trondheim: she implemented the control law for control of an offshore supply vessel, scale 1:70, moving on a pool at the Guidance, Navigation and Control Laboratory, NTNU.

Output feedback tracking for a bioreactor

This work has to do with a chemostat controlled by means of a recirculation loop. An output feedback tracking problem is solved. The output to be tracked is of relative degree zero. The input substrate concentration is the unknown variable. The approach

relies on the construction of an observer, which converges when the input satisfies a persistency of excitation condition and when the input substrate concentration is constant. When the input substrate concentration is time-varying, with a bounded first derivative, then "practical" convergence is obtained, in the sense that the error variables enter an arbitrary small neighborhood of the origin. It is also shown that the coupling of the observer to a control law proposed in another work satisfies the required persistency of excitation property.

Conclusion

To conclude, my opinion is that, due to the high quality of his research activities, the number and the quality of his publications, and his co-supervision of two Phd students, Frédéric Mazenc deserves without any doubt to be granted an Habilitation à Diriger des Recherches.