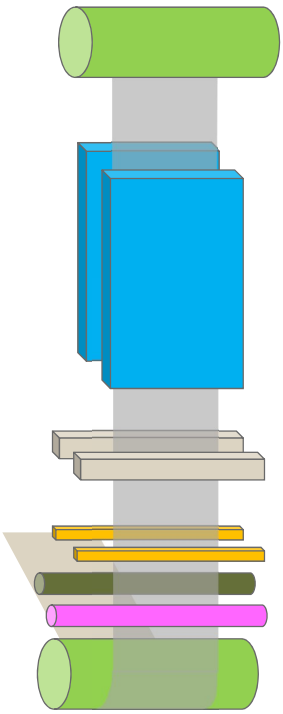
PhD Position proposal

ArcelorMittal
Centre de Recherche en Automatique de Nancy

▷ PhD subject

Sensor and actuator optimal location for dynamic controller design. Application to active vibration reduction in a galvanizing process.

▷ Detailed description of the expected researches



Industrial context. In galvanizing lines, the steel strip, after being heated and cooled in an annealing furnace, is immersed in a liquid zinc bath and then wrung out by means of air-jet nozzles to form a thin layer of zinc on the surface of the strip. The properties of the steel's surface depend on the thickness of the coating layer, therefore, its control is of great interest.
However, some disturbances generate vibrations on the strip that can significantly degrade the quality of the coating layer. To limit the impact of these disturbances, electromagnets associated with an active control system are installed above the wiping system to actively reduce these vibrations.

As a first step, it will be necessary to develop a behavioral model [Kim, 2003, Li, 2012] of the steel strip in the galvanizing line that takes into account the presence and propagation of the strip vibrations. Once this model has been established, one of the key problems of this device is the search for the optimal placement of the sensor(s), to measure the strip vibrations most effectively, but also of the actuator(s) to minimize the amplitude of these vibrations by an adapted control law. These optimal location problems, which can be solved one after the other or jointly, are at the heart of active vibration control themes and are found in many application areas [Gawronski, 2002, Starek, 2010, Zhang, 2018].

Thesis' interest The proposed project combines theoretical reflection and practical implementation. The thesis work will take place partly on a R&D (research and development) site where *ArcelorMittal Maizières Research* has an industrial-scale benchmark, adapted

and dedicated to carrying out full-scale tests to validate the strip model and the optimal placement strategy for sensor(s) and actuator (s).

Expected researches. From a fundamental point of view, the problem raised concerns the optimization of the placement of sensors and actuators in a dynamic system according to observability and controllability criteria. A first approach aims to maximize the controllability (respectively observability) of the system state by positioning the actuators (respectively the sensors). The second and more global approach aims to optimize the controllability of outputs by inputs by jointly positioning sensors and actuators. The optimization of the sensors and/or actuators location should also take into account the minimization of the disturbance influence (strip vibrations, unmodelled dynamics, etc.). Obviously, cost and positioning constraints will have to be taken into consideration. One of the paths to be explored is to solve the problem of optimal location of sensors or actuators by maximizing the grammians of observability or controllability. In the case of joint placement of sensors and actuators, the maximization of balanced grammians can be considered [Manohar, 2018, Marx, 2004]. This technique has the advantage of not depending on the command used [Van de Wal, 2001]. Moreover, it can be generalized and applied to nonlinear systems [Georges, 1995], singular systems [Marx, 2004], etc.

References

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[Zhang, 2018] X.Y. Zhang, R.X. Wang, S.Q. Zhang, Z.X. Wang, X.S. Qin, R. Schmidt. Generalized-Disturbance Rejection Control for Vibration Suppression of Piezoelectric Laminated Flexible Structures, Shock and Vibration, 2018.

▷ Job offer

Contract. PhD Thesis CIFRE[1] founded by the ANRT[2].

Contract duration. 36 monthes

Start date of the contract. September/October 2019

Salary. 27 k€ / year + ArcelorMittal executive benefits.

Environment. The thesis work will take place within the two partners of the project: partly at the Centre de Recherche en Automatique de Nancy (UMR 7039 UL[3]-CNRS[4]) and partly at the R&D centre of ArcelorMittal Maizières Research. In the heart of of these two structures, the recruited person will be supervised by a team of researchers from the University of Lorraine and from ArcelorMittal R&D.

Application profile.
Qualification:
- M2 level : engineer and/or master.

Know how:
- system control;
- modeling and identification;
- signal processing;
- software tools: Matlab - Simulink and standard office software.

Soft skills:
- scientific curiosity and rigour;
- autonomy;
- good interpersonal skills to join the work team;
- a good knowledge of the English language to integrate into a multicultural environment.

People to contact at the CRAN :
Benoît Marx (e-mail : benoit.marx@univ-lorraine.fr)
Didier Maquin (e-mail : didier.maquin@univ-lorraine.fr)

[1] Conventions Industrielles de Formation par la REcherche (industrial conventions for training through research)

[2] Association Nationale de la Recherche et de la Technologie (National Association for Research and Technology

[3] Université de Lorraine (University of Lorraine)

[4] Centre National de la Recherche Scientifique (National Center for Scientific Research)