Dr. Stéphane Victor
IMS UMR 5210 CNRS / Université de Bordeaux
Contact: stephane.victor@ims-bordeaux.fr

Prof. Pierre Melchior
IMS UMR 5210 CNRS / Bordeaux INP
Contact: pierre.melchior@ims-bordeaux.fr

The general theme of the work enables to handle a system, from identification to robust control. Flatness principles tackle path planning unless knowing the system model, hence the system parameter identification necessity. The principal contribution of this conference deals with system identification by non-integer models and with robust path tracking by the use of flatness principles for fractional models.

First, the definitions and properties of a fractional operator and also the various representation methods of a fractional system. The stability theorem is also brought to mind. Fractional polynomial and fractional polynomial matrix algebras are introduced for the extension of flatness principles for fractional systems.

Then, non-integer model identification is proposed after a state of the art on system identification by non-integer model. Two optimal (in variance and bias sense) estimators are put forward: one, when considering a known model structure with fixed differentiating orders, and another one by combining nonlinear programming technics for the optimization of coefficients and differentiation orders.

Motion planning is then established through the extension of flatness principles to fractional systems. Flatness of linear fractional systems are studied while considering different approaches such as transfer functions or pseudo-state-space representations with polynomial matrices. Path tracking robustness is ensured with CRONE control.

Finally, all contributions are applied on a real thermal fractional application:

- first, heat rod models linking temperature to heat flux density are obtained from system identification using fractional order systems;
- then, motion planning of the nominal system is achieved through an open-loop control stemming from flatness principles (usually, each model should have its own control reference in order to follow a desired output reference);
- thanks to a third-generation CRONE controller, the nominal control reference is sufficient, and robust control is also guaranteed regarding model uncertainties and input/output disturbances.