informatics mathematics

IN PARTNERSHIP WITH:
CNRS

Université des sciences et technologies de Lille (Lille 1)

Ecole Centrale de Lille

Activity Report 2013

Project-Team NON-A

Non-Asymptotic estimation for on-line systems

RESEARCH CENTER
Lille - Nord Europe

THEME
Optimization and control of dynamic systems

Table of contents

Project-Team NON-A

Keywords: Estimation, Numerical Differentiation, Control, Robotics

Creation of the Team: 2011 January 01*, updated into Project-Team:* 2012 July 01.

1. Members

Research Scientists

Denis Efimov [Inria, Researcher, HdR]
Thierry Floquet [CNRS, Researcher, HdR]
Andrey Polyakov [Inria, Researcher, since Oct 2013]
Gang Zheng [Inria, Researcher]

Faculty Members

Jean-Pierre Richard [Team leader, Ecole Centrale de Lille, Professor, HdR]
Lotfi Belkoura [Univ Lille I, Professor, HdR]
Wilfrid Perruquetti [Permanent Head, Ecole Centrale de Lille, Professor, HdR]
Rosane Ushirobira [Inria, Associate Professor, HdR]

External Collaborators

Samer Riachy [ENSEA, Associate Professor]
Stéphane Thiery [ENSAM, Associate Professor]
Jean-Pierre Barbot [ENSEA, Professor, HdR]
Olivier Gibaru [ENSAM, Professor, HdR]
Cédric Join [Univ Nancy I, Associate Professor, HdR]
Mamadou Mboup [Univ Reims, Professor, HdR]

Engineers

Xin Jin [Ecole Centrale de Lille, Engineer]
Georges Palos Ladeiro [Inria, Senior Engineer]
Zhaopeng Qiu [Inria, Engineer]
Rahma Yangui [Inria, Engineer, until Jan 2013]

PhD Students

Hafiz Ahmed [Inria, PhD Student, CORDI-S, from Oct 2013]
Emmanuel Bernuau [Ecole Centrale de Lille, PhD Student, until Dec 2013]
Matteo Guerra [Ecole Centrale de Lille, PhD Student]
Sonia Maalej [Univ Lille I, PhD Student]
Diego Mincarelli [Inria, PhD Student, CORDI-S, until Nov 2013]
Marouene Oueslati [ENSAM, PhD Student, until Sep 2013]

Post-Doctoral Fellows

Romain Delpoux [Univ Lille I, until Aug 2013]
Jose Antonio Estrada Torres [Inria, Post-doc, CORDI-S]
Anja Korporal [Inria, Post-doc, CORDI-S, from Nov 2013]

Visiting Scientists

Leonid Fridman [UNAM, Mexico, Professor, from Jun 2013 until Jul 2013]
Héctor Rios Barajas [UNAM, Mexico, PhD Student, from Jun 2013 until Jul 2013]
Emmanuel Cruz Zavala [UNAM, Mexico, PhD Student, from Nov 2013 until Dec 2013]
Tonametl Sanchez Ramirez [UNAM, Mexico, PhD Student, from Nov 2013 until Dec 2013]
Lucas Langwagen [Universidad de la Republica, Urugay, PhD Student, from Apr 2013 until Jul 2013]
Mimia Benhadri [Skikda University, Algeria, PhD Student, from Nov 2013 until Dec 2013]

Administrative Assistant

Corinne Jamroz [Inria]

2. Overall Objectives

2.1. Objectives

For engineers, a wide variety of information cannot be directly obtained through measurements. Some parameters (constants of an electrical actuator, delay in a transmission, etc.) or internal variables (robot's posture, torques applied to a robot, localization of a mobile robot, etc.) are unknown or unmeasured. In addition, usually the signals from sensors are distorted and tainted by measurement noises. In order to simulate, to control or to supervise processes, and to extract information conveyed by the signals, one has to estimate parameters or variables.

Estimation techniques are, under various guises, present in many parts of control, signal processing and applied mathematics. Such an important area gave rise to a huge international literature. From a general point of view, the performance of an estimation algorithm can be characterized by three indicators:

- The computation time (the time needed to obtain the estimation). Obviously, the estimation algorithms should have as small as possible computation time in order to provide fast, real-time, on-line estimations for processes with fast dynamics (for example, a challenging problem is to make an Atomic Force Microscope work at GHz rates).
- The algorithm complexity (the easiness of design and implementation). Estimation algorithms should have as low as possible algorithm complexity, in order to allow an embedded real-time estimation (for example, in networked robotics, the embedded computation power is limited and can be even more limited for small sensors/actuators devices). Another question about complexity is: can an engineer appropriate and apply the algorithms? For instance, an algorithm application is easier if the parameters have a physical meaning w.r.t. the process under study.
- The robustness. The estimation algorithms should exhibit as much as possible robustness with respect to a large class of measurement noises, parameter uncertainties, discretization steps and other issues of numerical implementation. A complementary point of view on robustness is to manage a compromise between existence of theoretical proofs versus universalism of the algorithm. In the first case, the performance is guaranteed in a particular case (a particular control designed for a particular model). In the second case, an algorithm can be directly applied in "most of the cases", but it may fail in few situations.

Within the very wide area of estimation, *Non-A* addresses 3 particular theoretical challenges (see the upper block "Theory" of Figure 1):

1) Design annihilators for some general class of perturbations;

2) Estimate on-line the derivatives of a signal;

3) Control without sophisticated models.

All of them are connected with the central idea of designing or exploiting algorithms with the finite-time convergence property. In particular, the *non-asymptotic* estimation techniques (numerical differentiation, finite-time differentiators or observers) constitute a central objective of the project, explaining the name *Non-Asymptotic estimation for on-line systems*. Below, these 3 challenges will be shortly described in relation to the above indicators.

The researches developed by *Non-A* are within the continuity of the project-team *ALIEN* in what concerns the *algebraic tools* that are developed for finite-time estimation purposes. However, *Non-A* also aims at developing complementary estimation techniques, still aiming at the finite-time performance but based on the so-called *higher-order sliding mode* algorithms, interval estimation techniques and, as well as, fixed-time algorithms.

Non-A also wants to confront these theoretical challenges with some application fields (shown on the bottom of Figure 1): Networked robots, Nano/macro machining, Multicell chopper, *i*-PID for industry. Today, most of our effort (*i.e.*, engineering staff) is devoted to the first item, according to the theme 'Internet of Things' promoted by Inria in its Strategic Plan for the Lille North-Europe research center. Indeed, WSNR (Wireless Sensor and Robot Networks) integrate mobile nodes (robots) that extends various aspects of the sensor network.

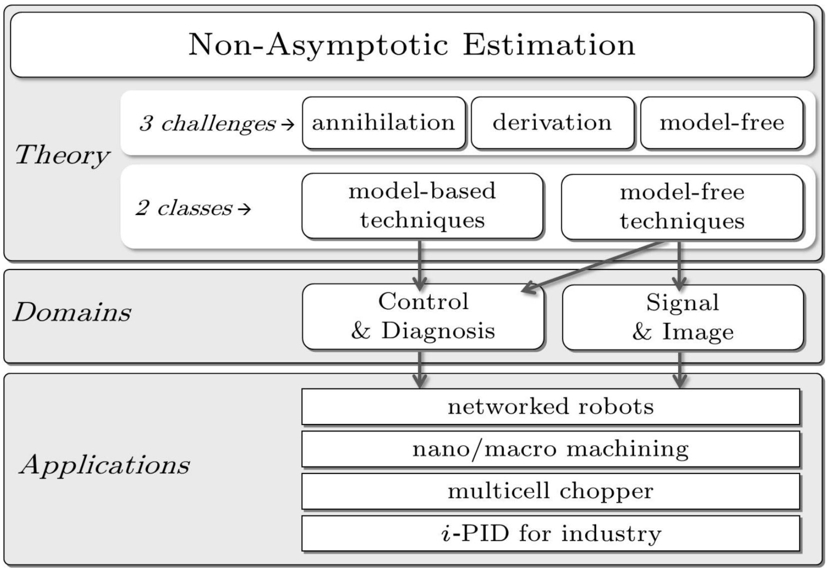


Figure 1. Non-A is a method-driven project, centered around non-asymptotic estimation techniques (i.e. providing estimates in finite-time), and connected to applications.

2.2. Members complementarity

The members of the Non-A project work in different places: Lille, Cergy, Reims and Nancy. They share a common algebraic tool and the non-asymptotic estimation goal, which constitute the natural kernel of the project. Each of them contributes to both theoretical and applied sides of the global project. The following table draws up a scheme of some of their specialities.

	Upstream Researches	*Application Fields*
Reims CReSTIC	Signal - Numerical analysis	De-noising - Demodulation - Biomedical signal processing
Cergy ECS	Nonlinear observers - Hybrid systems	Cryptography - Multi-cell chopper/converter
Lille ENSAM	Applied mathematics	High performance machining - Precision sensors, AFM [1]
Lille LAGIS	Delay systems - Nonlinear control - Observers (finite-time/unknown input)	Magnetic bearings - Friction estimation - Networked control - Robotics
Nancy CRAN	Diagnosis - Control - Signal	Industrial processes - Signal & image processing

[1] Atomic Force Microscope, for which fast filtering is required

2.3. Highlights of the Year

- The Implicit Lyapunov Function (ILF) method for non-asymptotic (finite-time and fixed-time) stability analysis of ordinary differential equations has been developed in [75]. The new principles for design of non-asymptotic controls based on ILF are presented.
- New developments for interval estimation of time-delay systems [22], [56] and control of systems with unknown time-varying input delays based on interval predictors [34], [76].
- New results for control of linear [59] or nonlinear [73] systems using asynchronous sampling.
- New book on fault detection and isolation in aerospace systems [86].
- New application has been addressed dealing with the networked control of haptic systems.
- New concrete application of homogeneous, finite-time control, to a pneumatic actuator [36].
- A patent with Airbus has been deposed for a fault detection in actuators of an airplane [87].

3. Research Program

3.1. General annihilators

Estimation is quite easy in the absence of perturbations. It becomes challenging in more realistic situations, faced to measurement noises or other unknown inputs. In our works, as well as in the founding text of *Non-A*, we have shown how our estimation techniques can successfully get rid of perturbations of the so-called *structured* type, which means the ones that can be annihilated by some linear differential operator (called the annihilator). *ALIEN* already defined such operators by integral operators, but using more general convolution operators is an alternative to be analyzed, as well as defining the “best way to kill” perturbations. Open questions are:

OQ1) Does a normal form exist for such annihilators?

OQ2) Or, at least, does there exist an adequate basis representation of the annihilator in some adequate algebra?

OQ3) And lastly, can the annihilator parameters be derived from efficient tuning rules?

The two first questions will directly impact Indicators 1 (time) and 2 (complexity), whereas the last one will impact indicator 3 (robustness).

3.2. Numerical differentiation

Estimating the derivative of a (noisy) signal with a sufficient accuracy can be seen as a key problem in domains of control and diagnosis, as well as signal and image processing. At the present stage of our research, the estimation of the n-th order time derivatives of noisy signals (including noise filtering for $n = 0$) appears as a common area for the whole project, either as a research field, or as a tool that is used both for model-based and model-free techniques. *One of the open questions is about the robustness issues (Indicator 3) with respect to the annihilator, the parameters and the numerical implementation choices.*

Two classes of techniques are considered here (**Model-based** and **Model-free**), both of them aiming at non-asymptotic estimation.

In what we call *model-based techniques*, the derivative estimation is regarded as an observation problem, which means the software-based reconstruction of unmeasured variables and, more generally, a left inversion problem [2]. This involves linear/homogeneous/nonlinear state models, including ordinary equations, systems with delays, hybrid systems with impulses or switches[3], which still has to be exploited in the finite-time and fixed-time context. Power electronics is already one of the possible applications.

[2]Left invertibility deals with the question of recovering the full state of a system (“observation”) together with some of its inputs (“unknown input observers”), and also refers to algebraic structural conditions.

[3]Note that hybrid dynamical systems (HDS) constitute an important field of investigation since, in this case, the discrete state can be considered as an unknown input.

Model-free techniques concern the works initiated by *ALIEN*, which rely on the only information contained in the output signal and its derivatives. The corresponding algorithms rely on our algebraic annihilation viewpoint. *One open question is: How to provide an objective comparison analysis between Model-based and Model-free estimation techniques? For this, we will only concentrate on Non-Asymptotic ones. This comparison will have to be based on the three Indicators 1 (time), 2 (complexity) and 3 (robustness).*

3.3. Model-free control

Industry is keen on simple and powerful controllers: the tuning simplicity of the classical PID controller explains its omnipresence in industrial control systems, although its performances drop when working conditions change. The last challenge we consider is to define control techniques which, instead of using sophisticated models (the development of which may be expensive), use the information contained in the output signal and its estimated derivatives, which can be regarded as "signal-based" controllers. *Such design should take into account the Indicators 1 (time), 2 (complexity) and 3 (robustness).*

3.4. Applications

Keeping in mind that we will remain focused at developing and applying fundamental methods for non-asymptotic estimation, we intend to deal with 4 main domains of application (see the lower part of Figure 1). The Lille context offers interesting opportunities in WSAN (wireless sensor and actuator networks and, more particularly, networked robots) at Inria, as well as nano/macro machining at ENSAM. A power electronics platform will be developed in ENSEA Cergy. Last, in contact with companies, several grants, patents and collaborations are expected from the applications of $i-$PID. Each of these four application domains was presented in the *Non-A* proposal:

- Networked robots, WSAN [Lille]
- Nano/macro machining [Lille]
- Multicell chopper [Lille and Cergy]
- i-PID for industry

In the present period, we choose to give a particular focus to the first item (Networked robots), which already received some development. It can be considered as the objective 4.

These applications are described with more details below.

4. Application Domains

4.1. Networked robots

Both economically and scientifically, cooperation in robot swarms represents an important issue since it concerns many service applications (health, handicap, urban transports...) and can increase the potential of sensor networks [4]. It involves several challenges such as:
- Because autonomy is a key for being able to increase the network size, maximize the autonomy of the robots in their different tasks of localization, motion, communication;
- Aiming at making 1+1 be more than 2, extend the global potential of the swarm by introducing collaboration (exchanging information with other robots) and cooperation (acting with other robots);
- Include time and energy saving considerations at the design stage.

The self deployment of autonomous groups of mobile robots in an unknown environment (including different kinds of static or moving obstacles) involves localization, path planning and robust control problems. Both the control and signal aspects of our researches are oriented to solve some problems coming from – or taking advantage of – such collaboration frameworks. To mention a few:

[4] Integrating wireless sensor networks and multi-robot systems increases the potential of the sensors: robots, in comparison, are resource-rich and can be involved in taking decisions and performing appropriate actions on themselves on sensors and/or the environment.

- Localization using as few as possible landmarks and exteroceptive information by means of derivative estimates;
- Image-based sensing algorithms inspired by our multidimensional estimation techniques;
- Detection and adaptation to sudden loss of communication, time-varying topology, or communication delays;
- Robust, autonomous, energy-aware controllers based on either model-free or model-based techniques.

Several algorithms have already been applied to the control of formations of mobile robots: an illustrative platform is currently developed at EuraTechnologie center within the framework of *Non-A* [5]. They are now being extended to medical devices (such as wheelchairs) within the European project *SYSIASS* (see http://www.sysiass.eu), in collaboration with partners from hospital settings.

Another future application concerns Wireless Sensor and Robot Networks (WSRN, Fig. 2), dedicated to the surveillance of zones, to the exploration of hostile areas, or to the supervision of large scale sensor networks. The main idea here is to integrate mobile nodes (the mobile robots) within the sensor network, allowing to overcome a sensor defection, to maintain the connectivity of the network, or to extend the coverage area during a random deployment. This involves consideration about mobile actuators within a mobile network of sensors and control networks (wireless) with strong constraints on the possibilities of communication in a noisy and non-homogeneous environment. This work is made in close collaboration with the Inria project-team *POPS* (Lille), which brings its expertise in terms of sensor networks. It takes place in the framework of the Inria ADT *SENSAS* and represents our contribution to the LABEX proposal *ICON*.

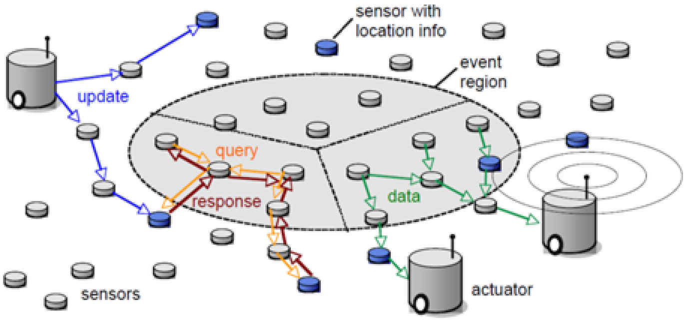


Figure 2. An illustration of collaboration in a Wireless Sensor and Robot Network.

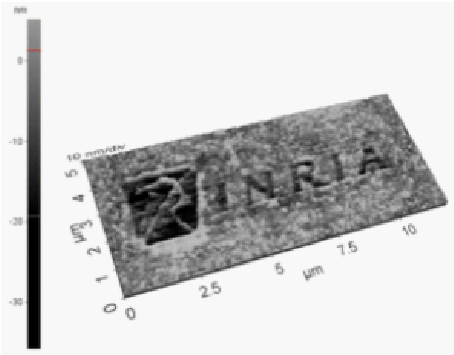
4.2. Nano/macro machining

Nano machining:

Recent research investigations have reported the development of a number of process chains that are complementary to those used for batch manufacturing of Micro Electro Mechanical Systems (MEMS) and, at the same time, broaden the application domain of products incorporating micro and nano scale features. Such alternative process chains combine micro and nano structuring technologies for master making with replication techniques for high volume production such as injection moulding and roll-to-roll imprinting. In association with the Manufacturing Engineering Center of Cardiff, Arts et Metiers ParisTech center of Lille develops a new process chain for the fabrication of components with nano scale features. In particular, AFM probe-based nano mechanical machining is employed as an alternative master making technology to commonly used lithography-based processes (Fig. 3). Previous experimental studies demonstrated the potential of this approach for thermoplastic materials. Such a manufacturing route also represents an attractive prototyping solution to test the functionalities of components with nano scale features prior to their mass fabrication and,

[5] "RobotCity" was exhibited for the first time during the opening ceremony held on April 6th, 2011

thus, to reduce the development time and cost of nano technology-enabled products. Application of our control and estimation techniques improves the trajectory tracking accuracy and the speed of the machining tools.



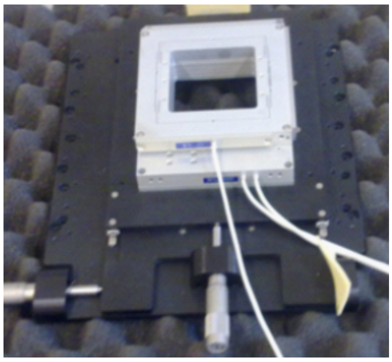


Figure 3. Left: A machined nano structure: 16µm ×8µm × some nm. Right: Nano-positioning system available at Arts et Métiers ParisTech Lille (75 µm range of motion).

Machining with industrial robots:

Industrials are enthusiastic to replace machine-tools with industrial robots: compared to machine-tools, industrial articulated robots are very cheaper, more flexible, and exhibit more important workspaces. They can carry out machining applications like prototyping, cleaning and pre-machining of cast parts, as well as end-machining of middle tolerance parts. Such applications require high accuracy in the positioning and path tracking. Unfortunately, industrial robots have a low stiffness and are not that accurate [6] and they deserve an increased quality of control.

We deal with the modelling and the on-line identification of flexible-joint robot models. This can be used both for dynamic simulation and model-based control of industrial robots. We address the problem of real-time identification of the parameters involved in the dynamic linear model of an industrial robot axis. This is possible thanks to a special sensor developed by Arts et Métiers, subject to an EADS project within the FUI (Fonds Unique Interministériel). Control algorithms for other machining actuators such as active magnet bearings are also under study. Within the framework of LAGIS, we also consider the remote control of industrial robots (via internet of Wi-Fi links, for instance), which sets numerous problems in relation with the communication delays.

4.3. Multicell chopper

On the basis of benchmarks developed at ECS-lab (ENSEA Cergy), we intend to work on the control and observation of serial and parallel multicell choppers, as well as more usual power converters. These power electronic systems associated with their respective loads are typical hybrid dynamical systems and many industrial and/or theoretical challenging problems occur. For example, in the industrial problem of power supply for a supercomputer, the parallel multicell chopper appears as a new solution particularly with respect to the power efficiency. Nevertheless, the observation and control of such hybrid dynamical systems is a difficult task, where non asymptotic estimation and control can be useful.

[6] Industrial robots were designed to realize repeatable tasks. The robot repeatability ranges typically from 0.03 to 0.1mm, but the accuracy is often measured to be within several millimetres. Due to their serial structure, articulated robot has lower stiffness (less than 1 N/mm) than classical machine-tools (greater than 50 N/mm). These poor accuracy and stiffness are caused by many factors, such as geometric parameter errors (manufacturing tolerances), wear of parts and components replacement, as well as flexibility of links and gear trains, gear backlashes, encoder resolution errors and thermal effects.

5. Software and Platforms

5.1. SLIM

Multi-robots cooperation can be found as an application in many domains of science and technology: manufacturing, medical robotics, personal assistance, military/security and spatial robots. The market of robots is quickly developing and its capacity is continuously growing. Concerning cooperation of mobile multi-robots, 3 key issues have to be studied: Localization, path planning and robust control, for which Non-A team has worked and proposed new algorithms. Due to the ADT SLIM, we implement our algorithms (localization, path planning and robust control) and integrate them into ROS (Robotic Operating System) as a package, named SLIM.

6. New Results

6.1. Homogeneity theory and analysis of nonlinear systems

Homogeneity is a kind of symmetry, if it is presented in a system model, then it may simplify analysis of stability and performance properties of the system. The new results obtained in 2013 are as follows:

- The notion of geometric homogeneity has been extended for differential inclusions in [44]. This kind of homogeneity provides the most advanced coordinate-free framework for analysis and synthesis of nonlinear discontinuous systems. Theorem of L. Rosier on a homogeneous Lyapunov function existence and an equivalent notion of global asymptotic stability for differential inclusions have been presented. Robustness properties (ISS) of sliding mode systems applying the homogeneity concept have been considered in [46].
- Retraction obstruction for time-varying stabilization on compact manifolds has been revisited in [13].
- Several conditions have been proposed to check different robustness properties (ISS, iISS, IOSS and OSS) for generic nonlinear systems applying the weighted homogeneity concept (global or local) in [14], [45]. The advantages of this result are that, under some mild conditions, the system robustness can be established as a function of the degree of homogeneity.
- A new algorithm for the analysis of strange attractors has been presented in [51]. An application of that results for observability-singularity manifolds in the context of chaos based cryptography has been given in [52].
- Exciting multi-DOF systems by feedback resonance has been considered in [20].
- Some conditions on existence of oscillations in hybrid systems have been established in [23], [57]. An application to a humanoid robot locomotion has been considered.
- Considering two chaotic Rossler systems, the paper [83] presents a study on the forced synchronization of two systems, bidirectionally coupled by transmitting unidirectional signals which explicitly depend on a single state variable (from the emitter) and only affect directly the dynamics corresponding to the transmitted state variable (of the receiver).
- The paper [33] is concerned with the construction of local observers for nonlinear systems without inputs, satisfying an observability rank condition. The aim of this study is, first, to define a homogeneous approximation that keeps the observability property unchanged. This approximation is further used in the synthesis of local observer which is proven to be locally convergent for Lyapunov-stable systems.
- The paper [74] addresses the problem of exact average-consensus reaching in a prescribed time. The communication topology is assumed to be defined by a weighted undirected graph and the agents are represented by integrators. A nonlinear control protocol, which ensures a finite-time convergence, is proposed. With the designed protocol, any prescribed convergence time can be guaranteed regardless of the initial conditions.

- The Implicit Lyapunov Function (ILF) method for finite-time stability analysis has been introduced in [75]. The control algorithm for finite-time stabilization of a chain of integrators has been developed. The scheme of control parameters selection has been presented by LMIs. The robustness of the finite-time control algorithm with respect to system uncertainties and disturbances has been studied. The new high order sliding mode control has been derived as a particular case of the developed finite-time control algorithm. The settling time estimate has been obtained using ILF method. The algorithm of practical implementation of the ILF control scheme has been discussed.

6.2. Model-free control

The model free control techniques form a new and quickly developing area of control theory. It has been established by the team members and nowadays these tools find many practical applications and attract a lot of attention due to their clear advantages for designers: they provide a control law independently in the model knowledge. The achievements obtained in 2013 are as follows:

- A new development of the model-free control theory with application to active magnetic bearing control have been presented in [53].
- ”Model-free control” and the corresponding ”intelligent” PID controllers (iPIDs), which already had many successful concrete applications, have been presented in [27] for the first time in a unified manner, where the new advances have been taken into account.
- In [62], it is shown that the "intelligent" controllers, which are associated to the recently introduced model-free control synthesis, may be easily implemented on cheap and small programmable devices.
- An application of the model-free control for regulation of the water level under several constraints has been reported in [40].

6.3. Algebraic technique for estimation, differentiation and its applications

Elementary techniques from operational calculus, differential algebra, and non-commutative algebra lead to a new algebraic approach for estimation and detection. It is investigated in various areas of applied sciences and engineering. The following lists only some applications:

- Design of a stabilizing feedback based on acceleration measurements and an algebraic state estimation method has been proposed in [54].
- An extension of the algebraic differentiation method to fractional derivatives calculation in continuous and discrete time has been studied in [88] and [89] respectively. Applications to identification and parameter estimation of fractional linear systems have been considered in [67], [68].
- Smoothing noisy data with spline functions is well known in approximation theory. Smoothing splines have been already used to deal with the problem of numerical differentiation. In [43], we extend this method to estimate the fractional derivatives of a smooth signal from its discrete noisy data. We begin with finding a smoothing spline by solving the Tikhonov regularization problem. Then, we propose a fractional order differentiator by calculating the fractional derivative of the obtained smoothing spline.
- In [81], we apply an algebraic method to estimate the amplitudes, phases and frequencies of a biased and noisy sum of complex exponential sinusoidal signals. The obtained estimates are integrals of the noisy measured signal: these integrals act as time-varying filters.

6.4. Observability and observer design for nonlinear systems

Observability analysis and observer design are important issues in the field of control theory. Some recent results are listed below:

- An epistemology of observation theory and its application in the design of software sensor in power electronics have been presented in [42].

- New results on observability and detectability of singular linear systems with unknown inputs have been developed in [12].
- The paper [47] supplies a new algorithm to compute the internal dynamics (or inversion dynamics) of affine MIMO control nonlinear systems.
- The design of observers for nonlinear systems with unknown, time-varying, bounded delays, on both state and input, still constitutes an open problem. In [28], we show how to solve it for a class of nonlinear systems by combining the high gain observer approach with a Lyapunov-Krasovskii functional. Sufficient conditions have been provided to prove the practical stability of the observer.
- An influence of restricted isometry property to the observability under sparse measurements has been analyzed in [65].
- The paper [38], [79] concerns the design of a nonlinear observer through a transformation of a nonlinear system into an observer form that supports a high gain observer. Sufficient geometrical condition has been deduced to guarantee the existence of change of coordinates allowing the transformation of a nonlinear system into the proposed normal form. In [80], the Partial Observability Normal Forms (PONF) of nonlinear dynamical systems have been investigated. Necessary and sufficient conditions for the existence of a diffeomorphism bringing the original nonlinear system into a PONF have been established.

6.5. Sliding mode control and estimation

Sliding mode algorithms are very popular for finite-time estimation and regulation. The recent results obtained by the group are as follows:

- Some constructive approximations and an alternative theoretic characterization of some classes of sliding mode control processes has been presented in [11].
- In [64] we investigate observer design under sparse measurement, i.e. under Nyquist-Shannon frequency. An analysis demonstrates that it is impossible to use only a high order sliding mode observer in the case of sparse measurement. Then it has been shown that a high order sliding mode observer coupled with an impulsive observer is a pertinent solution at least for some particular class of systems.
- Anomaly detection has been an active open problem in the networks community for several years. In [35], we aim at detecting such abnormal signals by control theory techniques. Several classes of sliding mode observers have been proposed for a fluid flow model of the TCP/internet protocol network.
- A sliding mode control has been developed for robust stabilization of fractional-order input-delay linear systems in the presence of uncertainties and external disturbances in [78]. First, a fractional-order state predictor has been used to compensate the delay in the input control. Second, a robust sliding mode control has been proposed in order to stabilize the system and to thwart the effect of model uncertainties and external disturbances. The sliding mode controller has been designed by considering a sliding surface defined by fractional order integral.

6.6. Non-linear, Sampled and Time-delay systems

Nonlinearities, sampling, quantization and time-delays cause serious obstructions for control and observer design in many fields of techniques and engineering (e.g. networked and internet systems, distributed systems etc.). The proposed by the team algebraic approach suits well for estimation and regulation in such a type of systems. The recent results are listed below:

- The work [59] aims at decreasing the number of sampling instants in state feedback control for perturbed linear time invariant systems. The approach is based on linear matrix inequalities obtained thanks to Lyapunov-Razumikhin stability conditions and convexification arguments that guarantee the exponential stability for a chosen decay-rate.

- A novel self-triggered control, which aims at decreasing the number of sampling instants for the state feedback control of perturbed linear time invariant systems, has been proposed in [60]. The approach is based on convex embeddings that allow for designing a state-dependent sampling function guaranteeing the system's exponential stability for a desired decay-rate and norm-bounded perturbations. One of the main contributions of the paper [60] is an LMI based algorithm that optimizes the choice of the Lyapunov function so as to enlarge the lower-bound of the sampling function while taking into account both the perturbations and the decay-rate.
- In [63], we consider the issue of stabilizing a class of linear systems using irregular sampled output measurements.
- The paper [73] is dedicated to the stability analysis of nonlinear sampled-data systems, which are affine in the input. Assuming that a stabilizing continuous-time controller exists and it is implemented digitally, we intend to provide sufficient asymptotic/exponential stability conditions for the sampled-data system. This allows to find an estimate of the upper bound on the asynchronous sampling periods. The stability analysis problem is formulated both globally and locally. The main idea of the paper is to address the stability problem in the framework of dissipativity theory. Furthermore, the result is particularized for the class of polynomial input-affine sampled-data systems, where stability may be tested numerically using sum of squares decomposition and semidefinite programming.
- The problem of output control design for linear system with unknown and time-varying input delay, bounded exogenous disturbances and bounded deterministic measurement noises has been considered in [77]. The prediction technique has been combined with Luenberger-like observer design in order to provide the stabilizing output feedback. The scheme of parameters tuning for reduction of measurement noises effect and exogenous disturbances effects has been developed using the Attractive Ellipsoids Method.
- Using the theory of non-commutative rings, the paper [39] studies the delay identification of nonlinear time-delay systems with unknown inputs. A sufficient condition has been given in order to deduce an output delay equation from the studied system. Then necessary and sufficient conditions have been proposed to judge whether the deduced output delay equation can be used to identify the delay, which is involved in this equation.

6.7. Interval control and estimation

In many cases due to parametric and/or signal uncertainties presented in a plant model it is not possible to design a conventional observer, which provides a point-wise estimate of state in a finite time or asymptotically. In this case it is still frequently possible to design interval observers, which generate an estimate on the interval of the admissible values of the state at the current instant of time. The recent new results in this field are listed below:

- The work [49] is devoted to interval observer design for Linear Parameter-Varying (LPV) systems under assumption that the vector of scheduling parameters is not available for measurements. Stability conditions are expressed in terms of matrix inequalities, which can be solved using standard numerical solvers. Robustness and estimation accuracy with respect to model uncertainty is analyzed. Two solutions are proposed for nonnegative systems and for a generic case. The efficiency of the proposed approach is demonstrated through computer simulations.
- Development of interval observers for time invariant [55] and time-varying [21] discrete-time systems has been presented by the members of the team.
- Interval estimation for uncertain systems with time-varying delays has been considered in [22], [56]. A reduced-order interval observer has been designed, stability and robustness conditions have been obtained.

- The paper [24] is devoted to design of interval observers for Linear Time Varying (LTV) systems and a class of nonlinear time-varying systems in the output canonical form. An interval observer design is feasible if it is possible to calculate the observer gains making the estimation error dynamics cooperative and stable. It has been shown in [24] that under some mild conditions the cooperativity of an LTV system can be ensured by a static linear transformation of coordinates.
- The problem of output stabilization of a class of nonlinear systems subject to parametric and signal uncertainties has been studied in [25]. First, an interval observer has been designed estimating the set of admissible values for the state. Next, it has been proposed to design a control algorithm for the interval observer providing convergence of interval variables to zero, that implies a similar convergence of the state for the original nonlinear system. An application of the proposed technique shows that a robust stabilization can be performed for linear time-varying and LPV systems without assumption that the vector of scheduling parameters is available for measurements.
- The paper [26] deals with the problem of joint state and parameter estimation based on a set adaptive observer design. The problem is formulated and solved for an LPV system. The resolution methodology avoids the exponential complexity obstruction usually encountered in the set-membership parameter estimation.
- The output stabilization problem for a linear system with an unknown bounded time-varying input delay has been considered in [34], [76]. The interval observation technique has been applied in order to obtain guaranteed interval estimate of the system state. The procedure of the interval observer synthesis uses lower and upper estimates of the unknown delay and requires to solve a special Silvester's equation. The interval predictor has been introduced in order to design a linear stabilizing feedback. The control design procedure is based on LMIs.
- The paper [37] describes a robust set-membership-based Fault Detection and Isolation (FDI) technique for a particular class of nonlinear systems, the so-called flat systems. The proposed strategy consists in checking if the expected input value belongs to an estimated feasible set computed using the system model and the derivatives of the measured output vector. The output derivatives are computed using a numerical differentiator. The set-membership estimator design for the input vector takes into account the measurement noise thereby making the consistency test robust.
- The objective of the work [82] is to develop some design methods of interval observers for a class of nonlinear continuous-time systems. It has been assumed that the estimated system can be represented as a superposition of the nominal subsystem (belonged to the class of uniformly observable systems) and a Lipschitz nonlinear perturbation vanishing at the origin. Then it has been shown that there exists an interval observer for the system that estimates the set of admissible values for the state consistent with the output measurements.

6.8. Networked robots

The mobile robots constitute an important area of practical development for the team:

- The paper [71] presents a path planning algorithm for autonomous navigation of non-holonomic mobile robots in complex environment. The irregular contour of obstacles is represented by segments. The goal of the robot is to move towards a known target while avoiding obstacles. The velocity constraints, kinematic robot model and non-holonomic constraint are considered in the problem. The optimal path planning problem is formulated as a constrained receding horizon planning problem and the trajectory is obtained by solving an optimal control problem with constraints. Local minima are avoided by choosing intermediate objectives based on the real time environment.
- The paper [69] presents a cooperative path planning approach for the navigation of non-holonomic mobile robots in environment with obstacles. Shared information can be obtained by sharing the local information between robots, thus the trajectories can be more optimized. Visibility graph approach is used to generate a series of intermediate objectives which guarantee the robots to reach the final objective without local minima. Then the reach of intermediate objectives is ensured by the optimal path planning algorithm. The velocity constraints, kinematic constraints and non-holonomic constraints of the mobile robot are considered in the problem.

- The paper [70] presents the real-time identification of different types of non-holonomic mobile robot systems. Since the robot type is a priori unknown, the robot systems are formulated as a switched singular nonlinear system, and the problem becomes the real-time identification of the switching signal, and then the existence of the input-output functions and the distinguishability of the systems are studied.
- An intelligent PID controller (i-PID controller) has been applied to control the non-holonomic mobile robot with measurement disturbance in [72]. Because of the particularity of the non-holonomic systems, this paper proposes to use a switching parameter α in the i-PID controller.

6.9. Applications

As it was mentioned, Non-A is a kind of "method-driven" project, which deals with different aspects of finite-time estimation and control. Thus different applications are possible, ones touched this year are as follows (skipping the networked robots considered in the previous section):

- A sensorless speed control for a DC series motor has been presented in [41] based on sliding-mode control and estimation algorithms.
- The paper [48] presents a feasibility study, which aims to demonstrate the applicability of the CNC automation philosophy for the process of AFM probe-based nano machining conducted on commercial AFM instruments.
- An oscillatory failure case detection for aircrafts using non-homogeneous sliding-mode differentiator in noisy environment has been considered in [50].
- Sensorless fault tolerant control for induction motors has been developed in [18].
- The problem of an actuator fault detection in aircraft systems has been considered in [19]. A particular attention has been paid to the oscillatory failure case study.
- In [58], we consider a vehicle equipped with active front steer and rear torque vectoring. While the former adds an incremental steer angle to the driver's input, the latter imposes a torque by means of the rear axle. The active front steer control is actuated through the front tires, while the rear torque vectoring can be actuated through the rear tires. A nonlinear controller using the super-twisting algorithm has been designed in order to track in a finite time the lateral and yaw angular velocity references.
- Systematic and multifactor risk models have been revisited via algebraic methods, which were already successfully developed in signal processing and in automatic control, in [61].
- In [84], we address the problem of approximating scattered data points by C1-smooth polynomial spline curves and surfaces using L1-norm optimization. The use of this norm helped us to preserve the shape of the data even near to abrupt changes.
- As capacitor voltages are necessary for the three-cell DC-DC chopper control, the estimation of such voltages by an observer is attractive solution in terms of cost. However, due to the hybrid behaviour of this structure, the capacitor voltages may be partially or even not observable for a given switching configuration. In other words, the observability matrix associated to the capacitor voltages never has a full rank. In order to make the observer conceivable, the paper [29] proposes a new design by establishing sufficient conditions under which the capacitor voltages can be reconstructed within appropriate specific switching sequence and not necessarily instantly.
- The problem of converters coordination of a fuel cell system involving a hydrogen fuel cell with supercapacitors for applications with high instantaneous dynamic power has been addressed in [32]. The problem is solved by using a non-linear controller based on passivity.
- The paper [66] is devoted to development of control algorithms for nonlinear parametrically uncertain systems. Original system dynamics is approximated by a set of local NARX models combined by a special mixing rule. Algorithm for local models' parameters estimation and structure adjustment has been developed. The developed technique has been applied to the problem of regulation of spark ignition engines.

- The paper [36] is dedicated to the problem of pneumatic cylinder control without pressure measurement. Based on the theory of homogeneous, finite time stable, ordinary differential equations, a state feedback nonlinear controller has been proposed. The closed loop system stability has been proven and an attraction domain of the controller has been given.

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Project ARCIR «Estimation distribuée de systèmes dynamiques en réseaux», supervisor Prof. Mihaly Petreczky, URIA – Mines de Douai, 2013–2015
- CPER CIA, "Internet of Things", 2011–2015
- CPER CISIT, "Campus international sur la securite et intermodalite de transport", project "CONTRAERO" with LML and IEMN, 2011–2015
- ADT Inria SLIM "Development of ROS software library for multi-robots cooperation", 2013–2014
- Project Agrégation, Conseil Général du Val d'Oise, (http://www.scilab.org/fr/community/scilabtec/2013/Projet-Agregation-la-simulation-numerique-dans-les-essais)

7.2. National Initiatives

- CNRS GDRI DelSys (http://www.cnrs.fr/ins2i/spip.php?article217)
- CNRS-CONACYT project with Mexico, "Estimation of state for hybrid systems using sliding mode techniques", 2013
- ANR project ChaSliM (Chattering-free Sliding Modes), coordinator Prof. B. Brogliato: 2012-2015
- We are also involved in several technical groups of the GDR MACS (CNRS, "Modélisation, Analyse de Conduite des Systèmes dynamiques", see http://www.univ-valenciennes.fr/GDR-MACS), in particular: Technical Groups "Identification", "Time Delay Systems", "Hybrid Systems" and "Control in Electrical Engineering".
- Model-free control: collaborations with Professor Brigitte D'Andréa-Novel at Mines ParisTech and Professor Emmanuel Delaleau at ENIB (Brest).
- Atomic Force Microscope (AFM): application of new algebraic methods in tapping mode for AFM, collaboration with the National Laboratory of Metrology (LNE) located at Trappes.

7.3. European Initiatives

7.3.1. FP7 Projects

- *HYCON2* (http://www.hycon2.eu/) The FP7 NoE HYCON2, started in September 2010, is a four-year project coordinated by the CNRS (Françoise Lamnabhi-Lagarrigue). It aims at stimulating and establishing a long-term integration in the strategic field of control of complex, large-scale, and networked dynamical systems. It focuses in particular on the domains of ground and aerospace transportation, electrical power networks, process industries, and biological and medical systems.
- *SYSIASS* (http://www.sysiass.eu/) Here is the major issue on which the project SYSIASS seeks to answer by developing new technologies and putting them in the service of patients and health professionals from our regions. Indeed preserve the autonomy of the elderly and disabled people is a major issue in today's society. In Europe, with the progressive ageing of the population policy to support the elderly is increasingly based on the assumption that care must be provided efficiently to the patient where he is based. In addition, special attention is devoted to people with disabilities for their better integration into society. Advances in technology proposed by SYSIASS (SYStème Intelligent et Autonome d'aide aux Soins de Santé / Autonomous and Intelligent Healthcare System)

will be realized in practice through an intelligent wheelchair that can provide better mobility to the patient and to allow health care professionals to easily transport patients to desired locations within a clinic or home environment. Moreover such a system must be able to communicate with the outside world, to adapt to specific patient needs and any special disability that he may have, and to facilitate access to medical data for health professionals.

- *ICityForAll: EU Ambiant Assisted Living Program* (http://www.icityforall.eu/) The project is leaded by CEA and it includes University of Paris Descartes-UPD, CENTICH, Active Audio (SME, France), Tech. Univ of Munich - TUM (Germany), EPFL (Suisse), ENEA (Italy), Centro Ricerche FIAT-CRF (Italy). The goal of I'City for All (Age sensitive ICT systems for Intelligible City for All) is to enhance speech and audio alarms intelligibility in order to improve the sense of well-being of seniors through better social interactions, better security and then improved mobility. Mamadou Mboup is involved as a subcontractor of UPD.

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Informal International Partners

- Professor Emilia Fridman, Tel Aviv University, Israel
- Sliding Mode Control Laboratory, UNAM, Mexico
- Department Control Automatico, CINVESTAV-IPN, Mexico
- Department of Control Systems and Informatics, Saint Petersburg State University of Information Technologies Mechanics and Optics (ITMO), Russia

7.4.2. Inria International Labs

Inria North European Labs 2013, "Dynamical precision improvement for industrial robots", project with Norwegian University of Science and Technology (Tronheim, Norway) and UMEA university (Sweden), 2013–2016

This collaborative project aims on development of algorithms used in software of industrial robots for estimation, regulation and trajectory planning in order to improve accuracy and repeatability of robots in the presence of varying parameters, perturbations and noises. A special attention is paid to the case when it is necessary to realize by robot effector a complex 3D movement with a good precision (3D surface profiling), where conventional calibration procedures fail to guarantee the required technical parameters.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

7.5.1.1. Internships

Lucas Langwagen

Subject: Numerical differentiation of noisy piecewise regular signal

Date: from Apr 2013 until Aug 2013

Institution: University of the Republic (Uruguay)

Leonid Fridman

Subject: State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes

Date: June 2013 until July 2013

Institution: UNAM (Mexico)

Héctor Rios

Subject: State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes

Date: June 2013 until July 2013

Institution: UNAM (Mexico)

Emmanuel Cruz

Subject: State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes

Date: November 2013 until December 2013

Institution: UNAM (Mexico)

Tonametl Sanchez

Subject: State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes

Date: November 2013 until December 2013

Institution: UNAM (Mexico)

Emilia Fridman

Subject: Time-delay and Hybrid Systems

Date: June 2013 until July 2013

Institution: Tel Aviv University (Israel)

7.5.2. Visits to International Teams

- G. Zheng, Zhejiang University, China, May 2013

8. Dissemination

8.1. Scientific Animation

- Organization of conferences
  - J.P. Richard, a memeber of NOC of 20th IFAC World Congress, Toulouse, France, 10-14 July 2017
  - D. Efimov, Invited Session at IEEE CDC 2013, "Interval estimation of uncertain systems"
- Participation at International Programming Committees (IPCs) of conferences
  - J.P. Richard, AE at EUCA-IEEE ECC'13, Zürich, Suisse (12th European Control Conference) July 17-19, 2013
  - J.P. Richard, AE at IFAC 2013 Joint conference SSC-TDS-FDIA, Grenoble, France ("Symposium System Structure and Control", "Workshop Time-Delay Systems" and "Workshop Fractional Differentiation and Its Applications"), February4-6, 2013
  - J.P. Richard, IEEE ICCVE 2013, Las Vegas, Nevada, USA (2nd Int. Conference on Connected Vehicles & Expo), December 2-6, 2013
  - J.P. Richard, IEEE GLOBECOM 2013, Atlanta, Georgia, USA (11th Global Communications Conference), Dec.2013

  - J.P. Richard, IEEE VTC2013, Dresden, Germany (77th IEEE Vehicular Technology Conference), Track 'Mobile Networks, Applications and Services', 3-5 June 2013
  - J.P. Richard, IEEE SaCoNet 2013, Paris, France (4th IEEE Int. Conference on SmArt COmmunications in NEtwork Technologies), 17-19 June 2013
  - W. Perruquetti, IFAC 2013 Joint conference SSC-TDS-FDIA ("Symposium System Structure and Control", "Workshop Time-Delay Systems" and "Workshop Fractional Differentiation and Its Applications"), Grenoble, France, 4-6 February 2013
  - W. Perruquetti, 5th IFAC International Workshop on Periodic Control Systems (PSYCO'2013), Caen, France, 3-5 July 2013
  - W. Perruquetti, National Projects Vice-Chair at ECC 2014, Strasbourg, France, 24-25 June 2014
  - W. Perruquetti and D. Efimov, IFAC World Congress 2014, Cape Town, South Africa
  - A. Polyakov, VSS 2014, Nantes, France
- Plenary talks
  - J.P. Richard, Keynote paper GDRi DelSys CNRS, LAAS, Toulouse, November 2013
  - J.P. Richard and W. Perruquetti, HYCON2-BALCON joint workshop, FP7, Belgrade, Serbie, July 2013
  - D. Efimov, CinvesRob 2013, Cinvestav Guadaljara, Mexico, November 2013
  - O. Gibaru, International Conference on New Trends in Splines and Approximation Theory, June 19-21, 2013
  - R. Ushirobira, Colloquium São Paulo-Lyon "Algebra, Groups and Logic", Lyon, April 2013
- Invited seminars
  - J.P. Richard, GREYC CNRS, EnsiCaen, Caen, "Networked Control Systems: to buff, or not to buff", Novembre 2013
  - J.P. Richard, GT SàR du GDR MACS, Lille, Juin 2013
  - D. Efimov, UNAM, Mexico, November 2013
- National scientific animation
  - T. Floquet is a member of Conseil National des Universités, 61ème Section
  - G. Zheng is a member of Conseil National des Universités, 61ème Section
  - R. Ushirobira is a member of Conseil National des Universités, 25ème Section, a member of the bureau of the "Comission Permanente du CNU"
  - R. Ushirobira is a member of the "Commission de Développement Technologique" of the research center Inria Lille and a member of the "Comité de centre" of the research center Inria Lille
  - J.P. Richard, Scientific Committee of the GdR MACS, CNRS, Group of Research in "Modelling, Analysis and Control of dynamic Systems"
  - J.P. Richard, Scientific Committee of the group "Control and communication networks", created Jan. 2010 within the GdR MACS
  - R. Ushirobira is a member of the GDR CNRS 3395 "Algebraic and geometric Lie theory"
  - W. Perruquetti is a head of ANR Piloting Committee
- International scientific animation
  - J.P. Richard is a member of GDRi DelSys CNRS
  - J.P. Richard is a member of IFAC Technical Committee "Networked Systems" (International Federation of Automatic Control, TC1.5)

- J.P. Richard is a member of IFAC Technical Committee "Linear Control Systems" (International Federation of Automatic Control, TC2.2)
- D. Efimov is a member of IFAC Technical Committee "Adaptive and Learning Systems" (International Federation of Automatic Control, TC1.2)
- W. Perruquetti is a member of IFAC Technical Committee "Non-linear Control Systems" (International Federation of Automatic Control, TC2.3) and a member of IFAC Technical Committee "Discrete and Hybrid Systems" (International Federation of Automatic Control, TC1.3)
- A. Polyakov is a member of IFAC Technical Committee "Non-linear Control Systems" (International Federation of Automatic Control, TC2.3)
- W. Perruquetti is the Chair of IFAC Technical Committee "Social impact of automation" (International Federation of Automatic Control, TC9.2)
- G. Zheng, T. Floquet and D. Efimov are members of IFAC Technical Committee "Social impact of automation" (International Federation of Automatic Control, TC9.2)

The members of Non-A are reviewers for most of the journal of the control and signal communities: IEEE Transactions on Automatic Control, IEEE Transactions on Systems and Control Technologies, IEEE Transactions on Industrial Electronics, IEEE Transactions on Signal Processing, Automatica, SIAM Journal on Control and Optimization, Journal of Computation and Applied Mathematics, Systems & Control Letters, International Journal of Control, International Journal of Robust and Nonlinear Control, International Journal of Systems Science, Journal Européen des Systèmes Automatisés, IET Control Theory & Applications, Fuzzy Sets and Systems, Mathematics and Computers in Simulation, International Journal of Modeling and Simulation, Journal of the Franklin Institute, ...

8.2. Teaching - Supervision - Juries

8.2.1. Teaching

- Licence : Jean-Pierre Richard; Automatique et Intelligence ambiante (12h); L2; EC-Lille; France
- Licence : Lotfi Belkoura; Automatique (systèmes linéaires monovariables)(75h), Introduction à la Robotique (25h); L3; Lille 1; France
- Licence : Denis Efimov; TP Automatic control (16h), L2; EC Lille; France
- Licence : Gang Zheng; TP Automatic control (16h), L2; EC Lille; France
- Licence : Samer Raichy; Systèmes linéaires, Asservissements, Conversion d'énergie, Echantillonnages et systèmes discrets (192h), L3; ENSEA; France
- Licence : Rosane Ushirobira; TP Automatic control (16h); L2; EC-Lille; France
- Licence : Rosane Ushirobira; TP Numerical Analysis (20h); L1; Polytech Lille; France
- Master : Jean-Pierre Richard; Systèmes dynamiques (30h), Métiers de la recherche (4h), Modélisation des systèmes complexes(12h), Commande et observation (12h), Séminaire episteme (24h); L3; EC-Lille; France
- Master : Jean-Pierre Richard; Systèmes dynamiques non linéaires et à retards (30h); M2; Lille 1 – EC-Lille, France
- Master : Lotfi Belkoura; Représentation d'état (55h); M1; Lille 1; France
- Master : Lotfi Belkoura; Projets (10h); M1; Lille 1; France
- Master : Lotfi Belkoura; Introduction aux distributions (10h); M2; Lille 1; France
- Master : Rosane Ushirobira; Probability and Statistics (20h); M2; EC-Lille; France

8.2.2. Supervision

PhD : Emmanuel Bernuau, "Homogeneity theory for analysis and control", EC Lille, 04 October 2013, supervisors are W. Perruquetti and D. Efimov

PhD : Diego Mincarelli, "State estimation for hybrid systems", Lille 1, 19 December 2013, supervisors are L. Belkoura and T. Floquet

PhD : Yingchong Ma, "Path planning and control of non-holonomic mobile robots", EC Lille, 19 December 2013, supervisors are W. Perruquetti and G. Zheng

PhD : Marouene Oueslati, "Contribution à la modélisation dynamique, l'identification et la synthèse de lois de commande adaptées aux axes flexibles d'un robot industriel", Arts et Métiers ParisTech, 18 December 2013, supervisor is O. Gibaru

PhD : Sert H., "Intelligent module decision for autonomous indoor navigation of wheelchair robot", EC Lille, 15 January 2013, supervisors are W. Perruquetti and A.M. Kökösy

PhD in progress : Matteo Guerra, "Supervisory control of collective motion of mobile robots", 2012–..., supervisors are W. Perruquetti, D. Efimov and G. Zheng

PhD in progress : Zilong Shao, "Oscilatory control of robot manipulator", 2013–..., supervisors are W. Perruquetti, D. Efimov and G. Zheng

PhD in progress : Hafiz Ahmed, "Identification and modeling of circadian rhythms for oysters", 2013–..., supervisors are D. Efimov, R. Ushirobira and D. Tran

PhD in progress : Omran Hassan, "Commande et observation des systèmes de contrôle en réseau", 2011–2014, supervisors are J.P. Richard, F. Lamnabhi-Lagarrigue and L. Hetel

PhD in progress : Maalej Sonia, "Algebraic estimation for robust control", 2011–..., supervisors are A. Kruszewski and L. Belkoura

PhD in progress : Essaid Edjekouane, "Cyber-physical systems", 2012–..., supervisors are J.P. Barbot, S. Riachy and Malek Ghanes

8.2.3. Juries

The team members are also involved in numerous examination committees of Theses and Habilitations, recruitment committees, in France and abroad (more than 15).

9. Bibliography

Major publications by the team in recent years

[1] J.-P. BARBOT, D. BOUTAT, T. FLOQUET. *An observation algorithm for nonlinear systems with unknown inputs*, in "Automatica", 2009, vol. 45, n° 8, pp. 1970-1974, http://hal.inria.fr/inria-00391819

[2] L. BELKOURA, J.-P. RICHARD, M. FLIESS. *Parameters estimation of systems with delayed and structured entries*, in "Automatica", 2009, vol. 45, n° 5, pp. 1117-1125, http://hal.inria.fr/inria-00343801

[3] M. FLIESS, C. JOIN. *A mathematical proof of the existence of trends in financial time series*, in "International Conference on Systems Theory: Modelling, Analysis and Control", Maroc, Fes, A. E. JAI, L. AFIFI, E. ZERRIK (editors), Presses Universitaires de Perpignan, 2009, pp. 43-62, Plenary talk, http://hal.inria.fr/inria-00352834

[4] M. FLIESS. *Analyse non standard du bruit*, in "Comptes-Rendus de l'Académie des Sciences, Série 1, Mathématiques", 2006, vol. 342, pp. 797-802, http://hal.inria.fr/inria-00001134

[5] M. FLIESS, M. MBOUP, H. MOUNIER, H. SIRA-RAMIREZ. *Questioning some paradigms of signal processing via concrete examples*, in "Algebraic Methods in Flatness, Signal Processing and State Estimation", H. SIRA-RAMIREZ, G. SILVA-NAVARRO (editors), Editorial Lagares, 2003, pp. 1-21, http://hal.inria.fr/inria-00001059

[6] M. MBOUP, C. JOIN, M. FLIESS. *Numerical differentiation with annihilators in noisy environment*, in "Numerical Algorithms", 2009, vol. 50, n^o 4, pp. 439-467, http://hal.inria.fr/inria-00319240

[7] W. PERRUQUETTI, T. FLOQUET, E. MOULAY. *Finite time observers: application to secure communication*, in "IEEE Transactions on Automatic Control", 2008, vol. 53, n^o 1, pp. 356-360, http://hal.inria.fr/inria-00176758

[8] S. RIACHY, Y. ORLOV, T. FLOQUET, R. SANTIESTEBAN, J.-P. RICHARD. *Second order sliding mode control of underactuated Mechanical systems I: Local stabilization with application to an inverted pendulum*, in "International Journal of Robust and Nonlinear Control", 2008, vol. 18, pp. 529-543, http://hal.inria.fr/inria-00179854

[9] J.-P. RICHARD, T. DIVOUX. , *Systèmes commandés en réseau*, Hermès-Lavoisier, 2007, 234 p. , http://hal.inria.fr/inria-00179831

[10] G. ZHENG, D. BOUTAT, J.-P. BARBOT. *Single Output Dependent Observability Normal Form*, in "SIAM Journal on Control and Optimization", 2007, vol. 46, n^o 6, pp. 2242-2255, http://hal.inria.fr/inria-00179184

Publications of the year

Articles in International Peer-Reviewed Journals

[11] V. AZHMYAKOV, A. POLYAKOV, A. POZNYAK. *Consistent approximations and variational description of some classes of sliding mode control processes*, in "Journal of The Franklin Institute", January 2013 [*DOI :* 10.1016/J.JFRANKLIN.2013.01.011], http://hal.inria.fr/hal-00922390

[12] F. J. BEJARANO, T. FLOQUET, W. PERRUQUETTI, G. ZHENG. *Observability and Detectability of Singular Linear Systems with Unknown Inputs*, in "Automatica", 2013, vol. 49, n^o 2, http://hal.inria.fr/hal-00753706

[13] E. BERNUAU, W. PERRUQUETTI, E. MOULAY. *Retraction obstruction to time-varying stabilization*, in "Automatica", 2013, vol. 49, n^o 6, pp. 1941-1943, http://hal.inria.fr/hal-00862934

[14] E. BERNUAU, A. POLYAKOV, D. EFIMOV, W. PERRUQUETTI. *Verification of ISS, iISS and IOSS properties applying weighted homogeneity*, in "Systems & Control Letters", December 2013, vol. 62, n^o 12, pp. 1159-1167, http://hal.inria.fr/hal-00877148

[15] J. CIESLAK, D. EFIMOV, D. HENRY. *Transient management of a supervisory fault-tolerant control scheme based on dwell-time conditions*, in "International Journal of Adaptive Control and Signal Processing", January 2014 [*DOI :* 10.1002/ACS.2465], http://hal.inria.fr/hal-00924618

[16] R. DELPOUX, M. BODSON, T. FLOQUET. *Parameter estimation of permanent magnet stepper motors without mechanical sensors*, in "Control Engineering Practice", January 2014, http://hal.inria.fr/hal-00933297

[17] R. DELPOUX, T. FLOQUET. *On-line parameter estimation via algebraic method: An experimental illustration*, in "Asian Journal of Control", January 2014, http://hal.inria.fr/hal-00933292

[18] N. DJEGHALI, M. GHANES, S. DJENNOUNE, J.-P. BARBOT. *Sensorless Fault Tolerant Control for Induction Motors*, in "International Journal of Control, Automation, and Systems", July 2013, vol. 11, n^{o} 3, pp. 563-576, http://hal.inria.fr/hal-00923749

[19] D. EFIMOV, J. CIESLAK, A. ZOLGHADRI, D. HENRY. *Actuator fault detection in aircraft systems: Oscillatory Failure Case study*, in "Annual Reviews in Control", 2013, vol. 37, n^{o} 1, pp. 180 - 190 [*DOI :* 10.1016/J.ARCONTROL.2013.04.007], http://hal.inria.fr/hal-00801660

[20] D. EFIMOV, A. FRADKOV, T. IWASAKI. *Exciting multi-DOF systems by feedback resonance*, in "Automatica", May 2013, vol. 49, n^{o} 6, pp. 1782–1789, http://hal.inria.fr/hal-00813506

[21] D. EFIMOV, W. PERRUQUETTI, T. RAISSI, A. ZOLGHADRI. *Interval Observers for Time-Varying Discrete-Time Systems*, in "IEEE Transactions on Automatic Control", December 2013, http://hal.inria.fr/hal-00820937

[22] D. EFIMOV, W. PERRUQUETTI, J.-P. RICHARD. *Interval estimation for uncertain systems with time-varying delays*, in "International Journal of Control", May 2013, http://hal.inria.fr/hal-00813314

[23] D. EFIMOV, W. PERRUQUETTI, A. SHIRIAEV. *On existence of oscillations in hybrid systems*, in "Nonlinear Analysis: Hybrid Systems", June 2014, http://hal.inria.fr/hal-00906088

[24] D. EFIMOV, T. RAISSI, S. CHEBOTAREV, A. ZOLGHADRI. *Interval State Observer for Nonlinear Time Varying Systems*, in "Automatica", February 2013, vol. 49, n^{o} 1, pp. 200–205 [*DOI :* 10.1016/J.AUTOMATICA.2012.07.004], http://hal.inria.fr/hal-00719911

[25] D. EFIMOV, T. RAISSI, A. ZOLGHADRI. *Control of nonlinear and LPV systems: interval observer-based framework*, in "IEEE Transactions on Automatic Control", 2013, http://hal.inria.fr/hal-00664106

[26] D. EFIMOV, T. RAISSI, A. ZOLGHADRI. *Set Adaptive Observers for LPV Systems: Application to Fault Detection*, in "ASME Journal of Dynamic Systems, Measurement and Control", December 2013, http://hal.inria.fr/hal-00843639

[27] M. FLIESS, C. JOIN. *Model-free control*, in "International Journal of Control", December 2013, vol. 86, n^{o} 12, pp. 2228-2252 [*DOI :* 10.1080/00207179.2013.810345], http://hal.inria.fr/hal-00828135

[28] M. GHANES, J. DELEON, J.-P. BARBOT. *Observer design for nonlinear systems under unknown time-varying delays*, in "IEEE Transactions on Automatic Control", June 2013, http://hal.inria.fr/hal-00749682

[29] M. GHANES, M. TRABELSI, X. LIN-SHI, J.-P. BARBOT, J.-M. RÉTIF, K. BUSAWON. *High gain observer for a three-cell chopper: Design and experimental results*, in "International Journal of Robust and Nonlinear Control", September 2013 [*DOI :* 10.1002/RNC.3063], http://hal.inria.fr/hal-00923689

[30] O. GIBARU, L. GAJNY, É. NYIRI. *L1C1 polynomial spline approximation algorithms for large data sets*, in "Numerical Algorithms", November 2013 [*DOI :* 10.1007/S11075-014-9828-X], http://hal.inria.fr/hal-00927555

[31] F. HAMERLAIN, T. FLOQUET, W. PERRUQUETTI. *Experimental Tests of a Sliding Mode Controller for Trajectory Tracking of a Car-like Mobile Robot*, in "Robotica", 2014, vol. 32, n^{o} 1, pp. 63-76, http://hal.inria.fr/hal-00924745

[32] M. HILIARET, M. GHANES, O. BÉTHOUX, J.-P. BARBOT, D. NORMAND-CYROT. *A Passivity-Based Controller for coordination of converters in a Fuel Cell System*, in "Control Engineering Practice", August 2013, vol. 21, n^o 8, pp. 1097-1109 [*DOI :* 10.1109/TVT.2013.2246202], http://hal.inria.fr/hal-00923716

[33] T. MENARD, E. MOULAY, W. PERRUQUETTI. *Homogeneous Approximations and Local Observer Design*, in "ESAIM - Control Optimisation and Calculus of Variations", July 2013, vol. 19, n^o 03, pp. 906-929, http://hal.inria.fr/hal-00787926

[34] A. POLYAKOV, D. EFIMOV, W. PERRUQUETTI, J.-P. RICHARD. *Output Stabilization of Time-Varying Input Delay Systems Using Interval Observation Technique*, in "Automatica", December 2013, http://hal.inria.fr/hal-00847565

[35] S. RAHME, Y. LABIT, F. GOUAISBAUT, T. FLOQUET. *Sliding Modes for Anomaly Observation in TCP Networks: From Theory to Practice*, in "IEEE Transactions on Control Systems Technology", May 2013, vol. 21, n^o 3, pp. 1031-1038 [*DOI :* 10.1109/TCST.2012.2198648], http://hal.inria.fr/hal-00734325

[36] S. RIACHY, M. GHANES. *A nonlinear controller for pneumatic servo systems: Design and experimental tests*, in "IEEE Transactions on Mechatronics", September 2013 [*DOI :* 10.1109/TMECH.2013.2280956], http://hal.inria.fr/hal-00867054

[37] R. SEYDOU, T. RAISSI, A. ZOLGHADRI, D. EFIMOV. *Actuator fault diagnosis for flat systems: A constraint satisfaction approach*, in "International Journal of Applied Mathematics & Computer Science", January 2013, vol. Vol 23, n^o N° 1, http://hal.inria.fr/hal-00694775

[38] R. TAMI, D. BOUTAT, G. ZHENG. *Extended output depending normal form*, in "Automatica", April 2013, vol. 7, pp. 2192-2198 [*DOI :* 10.1016/J.AUTOMATICA.2013.03.025], http://hal.inria.fr/hal-00817332

[39] G. ZHENG, J.-P. BARBOT, D. BOUTAT. *Identification of the delay parameter for nonlinear time-delay systems with unknown inputs*, in "Automatica", March 2013, vol. 6, pp. 1755-1760 [*DOI :* 10.1016/J.AUTOMATICA.2013.02.020], http://hal.inria.fr/hal-00817331

Articles in Non Peer-Reviewed Journals

[40] C. JOIN, G. ROBERT, M. FLIESS. *Une "commande sans modèle" pour aménagements hydroélectriques en cascade*, in "FlashX - La revue scientifique de l'Ecole polytechnique", July 2013, vol. 15, pp. 33-38, http://hal.inria.fr/hal-00843678

Invited Conferences

[41] L. AMET, M. GHANES, J.-P. BARBOT. *Sensorless control of a DC series motor*, in "IFAC ALCOSP", Caen, France, July 2013, http://hal.inria.fr/hal-00923720

[42] J.-P. BARBOT. *An epistemology of observation theory and its application in the design of software sensor in power electronics.*, in "The 5th International Conference on Electronics Engineering (ICEE 2013)", Oran, Algeria, Alipacha Adda, November 2013, http://hal.inria.fr/hal-00908432

[43] D.-Y. LIU, T.-M. LALEG-KIRATI, O. GIBARU, W. PERRUQUETTI. *Fractional Order Numerical Differentiation with B-Spline Functions*, in "The International Conference on Fractional Signals and Systems 2013", Ghent, Belgium, October 2013, http://hal.inria.fr/hal-00859455

International Conferences with Proceedings

[44] E. BERNUAU, D. EFIMOV, W. PERRUQUETTI, A. POLYAKOV. *On an extension of homogeneity notion for differential inclusions*, in "European Control Conference 2013", Zurich, Switzerland, July 2013, http://hal.inria.fr/hal-00801818

[45] E. BERNUAU, A. POLYAKOV, D. EFIMOV, W. PERRUQUETTI. *On ISS and iISS properties of homogeneous systems*, in "European Control Conference 2013", Zurich, Switzerland, July 2013, http://hal.inria.fr/hal-00801817

[46] E. BERNUAU, A. POLYAKOV, D. EFIMOV, W. PERRUQUETTI. *Robustness of finite-time stability property for sliding modes*, in "Joint SSSC, TDS, FDA 2013", Grenoble, France, February 2013, http://hal.inria.fr/hal-00745673

[47] D. BOUTAT, J.-P. BARBOT, M. DAROUACH. *A New Algorithm to Compute Inverse Dynamic of a Class of Nonlinear Systems*, in "52nd IEEE Conference on Decision and Control", Florence, Italy, December 2013, http://hal.inria.fr/hal-00923663

[48] E. BROUSSEAU, B. ARNAL, S. THIERY, É. NYIRI, O. GIBARU, J. MAYOR. *Towards CNC Automation in AFM Probe-Based Nano Machining*, in "8th International Conference on MicroManufacturing (ICOMM 2013)", Canada, University of Wisconsin-Madison, March 2013, pp. 499-506, http://hal.inria.fr/hal-00880967

[49] S. CHEBOTAREV, D. EFIMOV, T. RAISSI, A. ZOLGHADRI. *On Interval Observer Design for a Class of Continuous-Time LPV Systems*, in "IFAC Nolcos 2013", Toulouse, France, September 2013, http://hal.inria.fr/hal-00844390

[50] J. CIESLAK, D. EFIMOV, A. ZOLGHADRI, D. HENRY, P. GOUPIL. *Oscillatory Failure Case Detection for Aircraft using Non-Homogeneous Differentiator in Noisy Environment*, in "2nd CEAS Specialist Conference on Guidance, Navigation & Control", Delft, Netherlands, co-sponsored by IEEE and AIAA, April 2013, http://hal.inria.fr/hal-00787966

[51] O. DATCU, R. TAULEIGNE, J.-P. BARBOT. *A new algorithm for the analysis of strange attractors*, in "International Symposium on Signals, Circuits and Systems (ISSCS)", Iasi, Romania, July 2013, http://hal.inria.fr/hal-00923697

[52] O. DATCU, R. TAULEIGNE, A. VLAD, J.-P. BARBOT. *Observability-singularity manifolds in the context of chaos based cryptography*, in "International Conference on systems and Control (ICSC'13)", Alger, Algeria, October 2013, http://hal.inria.fr/hal-00923700

[53] J. DE MIRAS, C. JOIN, M. FLIESS, S. RIACHY, S. BONNET. *Active magnetic bearing: A new step for model-free control*, in "52nd IEEE Conference on Decision and Control, CDC 2013", Florence, Italy, IEEE, December 2013, CD p. , http://hal.inria.fr/hal-00857649

[54] R. DELPOUX, H. SIRA-RAMIREZ, T. FLOQUET. *Acceleration Feedback via an algebraic state estimation method*, in "52th IEEE Conference on Decision and Control,", Florence, Italy, December 2013, http://hal.inria.fr/hal-00881164

[55] D. EFIMOV, W. PERRUQUETTI, T. RAISSI, A. ZOLGHADRI. *On Interval Observer Design for Time-Invariant Discrete-Time Systems*, in "European Control Conference 2013", Zurich, Switzerland, July 2013, http://hal.inria.fr/hal-00801806

[56] D. EFIMOV, W. PERRUQUETTI, J.-P. RICHARD. *On reduced-order interval observers for time-delay systems*, in "European Control Conference 2013", Zurich, Switzerland, July 2013, http://hal.inria.fr/hal-00801809

[57] D. EFIMOV, W. PERRUQUETTI, A. SHIRIAEV. *Conditions of existence of oscillations for hybrid systems*, in "IFAC Nolcos 2013", Toulouse, France, September 2013, http://hal.inria.fr/hal-00844408

[58] L. ETIENNE, S. DIGENNARO, J.-P. BARBOT. *Active Ground Vehicle Control with use of a Super-Twisting Algorithm in the Presence of Parameter Variations*, in "3d International Conference on Systems and Control (ICSC13)", Alger, Algeria, October 2013, http://hal.inria.fr/hal-00923757

[59] C. FITER, L. HETEL, W. PERRUQUETTI, J.-P. RICHARD. *A Robust Polytopic Approach for State-Dependent Sampling*, in "12th biannual European Control Conference", Zurich, Switzerland, July 2013, http://hal.inria.fr/hal-00849833

[60] C. FITER, L. HETEL, W. PERRUQUETTI, J.-P. RICHARD. *A Self-Triggered Control Based on Convex Embeddings for Perturbed LTI Systems*, in "9th IFAC Symposium on Nonlinear Control Systems", Toulouse, France, September 2013, http://hal.inria.fr/hal-00849840

[61] M. FLIESS, C. JOIN. *Systematic and multifactor risk models revisited*, in "First Paris Financial Management Conference", Paris, France, December 2013, http://hal.inria.fr/hal-00920175, http://khuongnguyen.free.fr/PFMC-2013/Program_Papers.pdf

[62] C. JOIN, F. CHAXEL, M. FLIESS. *"Intelligent" controllers on cheap and small programmable devices*, in "2nd International Conference on Control and Fault-Tolerant Systems, SysTol'13", Nice, France, October 2013, CDROM p. , http://hal.inria.fr/hal-00845795

[63] Y. KHALED, J.-P. BARBOT, K. BUSAWON, D. BENMERZOUK. *Impulsive observer-based control for linear systems using irregularly sampled measurements*, in "IEEE AFRICON 2013", Mauritius, Mauritius, September 2013, http://hal.inria.fr/hal-00923640

[64] Y. KHALED, J.-P. BARBOT, D. BENMERZOUK, K. BUSAWON. *High order sliding mode: is it useful in the design of observer under sparse measurement?*, in "IFAC Joint 2013 SSSC, TDS, FDA", Grenoble, France, February 2013, http://hal.inria.fr/hal-00923765

[65] Y. KHALED, J.-P. BARBOT, K. BUSAWON, D. BENMERZOUK. *From restricted isometry property to observability under sparse measurement*, in "International Conference on Systems and Control", Alger, Algeria, October 2013, http://hal.inria.fr/hal-00923629

[66] S. KOLYUBIN, D. EFIMOV, V. NIKIFOROV, A. BOBTSOV. *Control of Nonlinear Systems Using Multiple Model Black-Box Identification*, in "IFAC Nolcos 2013", Toulouse, France, September 2013, http://hal.inria.fr/hal-00844410

[67] D.-Y. LIU, T.-M. LALEG-KIRATI, O. GIBARU. *Fractional order differentiation by integration: an application to fractional linear systems*, in "6th IFAC Workshop on Fractional Differentiation and its Applications", Grenoble, France, February 2013, http://hal.inria.fr/hal-00759819

[68] D.-Y. LIU, T.-M. LALEG-KIRATI, O. GIBARU, W. PERRUQUETTI. *Identification of fractional order systems using modulating functions method*, in "2013 American Control Conference, 2013", Washington, DC, United States, June 2013, http://hal.inria.fr/hal-00801425

[69] Y. MA, G. ZHENG, W. PERRUQUETTI. *Cooperative path planning for mobile robots based on visibility graph*, in "IEEE 32nd Chinese Control Conference", Xi'an, China, IEEE, July 2013, http://hal.inria.fr/hal-00910186

[70] Y. MA, G. ZHENG, W. PERRUQUETTI. *Real-time Identification of different types of non-holonomic mobile robots*, in "9th IFAC Symposium on Nonlinear Control Systems", Toulouse, France, September 2013, http://hal.inria.fr/hal-00910210

[71] Y. MA, G. ZHENG, W. PERRUQUETTI. *Real-time local path planning for mobile robots*, in "IEEE 9th International Workshop on Robot Motion and Control", Wasowo, Poland, IEEE, July 2013, http://hal.inria.fr/hal-00910182

[72] Y. MA, G. ZHENG, W. PERRUQUETTI, Z. QIU. *Control of nonholonomic wheeled mobile robots via i-PID controller*, in "IEEE/RSJ International Conference on Intelligent Robots and Systems", Tokyo, Japan, IEEE, November 2013, http://hal.inria.fr/hal-00910218

[73] H. OMRAN, L. HETEL, J.-P. RICHARD, F. LAMNABHI-LAGARRIGUE. *On the stability of input-affine nonlinear systems with sampled-data control*, in "ECC'2013", Zurich, Switzerland, July 2013, NC p. , http://hal.inria.fr/hal-00830881

[74] S. PARSEGOV, A. POLYAKOV, P. SHCHERBAKOV. *Fixed-time consensus algorithm for multi-agent systems with integrator dynamics*, in "4th IFAC Workshop on Distributed Estimation and Control in Networked Systems", Koblenz, Germany, IFAC, September 2013, pp. 110-115 [*DOI :* 10.3182/20130925-2-DE-4044.00055], http://hal.inria.fr/hal-00920078

[75] A. POLYAKOV, D. EFIMOV, W. PERRUQUETTI. *Finite-time Stabilization Using Implicit Lyapunov Function Technique*, in "IFAC Nolcos 2013", Toulouse, France, September 2013, http://hal.inria.fr/hal-00844386

[76] A. POLYAKOV, D. EFIMOV, W. PERRUQUETTI, J.-P. RICHARD. *Interval Observer Approach to Output Stabilization of Time-Varying Input Delay System*, in "European Control Conference 2013", Zurich, Switzerland, July 2013, http://hal.inria.fr/hal-00801821

[77] A. POLYAKOV, A. POZNYAK, J.-P. RICHARD. *Robust Output Stabilization of Time-Varying Input Delay Systems using Attractive Ellipsoid Method*, in "IEEE Conference on Decision and Control", Florence, Italy, IEEE, December 2013, pp. 934-939, http://hal.inria.fr/hal-00920047

[78] A. SI AMMOUR, S. DJENNOUNE, M. GHANES, J.-P. BARBOT, M. BETTAYEB. *Sliding mode control for uncertain input delay fractional order systems*, in "IFAC Joint 2013 SSSC, TDS, FDA", Grenoble, France, February 2013, http://hal.inria.fr/hal-00923777

[79] R. TAMI, D. BOUTAT, G. ZHENG. *Nonlinear observer normal form with output injection and extended dynamic*, in "9th IFAC Symposium on Nonlinear Control Systems", Toulouse, Ethiopia, IFAC, September 2013, http://hal.inria.fr/hal-00910212

[80] R. TAMI, G. ZHENG, D. BOUTAT, D. AUBRY. *Partial observability normal form for nonlinear functional observers design*, in "IEEE 32nd Chinese Control Conference", Xi'an, China, IEEE, July 2013, http://hal.inria.fr/hal-00910190

[81] R. USHIROBIRA, W. PERRUQUETTI, M. MBOUP, M. FLIESS. *Algebraic parameter estimation of a multi-sinusoidal waveform signal from noisy data*, in "European Control Conference", Zurich, Switzerland, April 2013, http://hal.inria.fr/hal-00819048

[82] G. ZHENG, D. EFIMOV, W. PERRUQUETTI. *Interval state estimation for uncertain nonlinear systems*, in "IFAC Nolcos 2013", Toulouse, France, September 2013, http://hal.inria.fr/hal-00844397

National Conferences with Proceedings

[83] L. LAVAL, J.-P. BARBOT, C. LETELLIER. *Sur la synchronisation de systèmes chaotiques bidirectionnellement couplés*, in "Rencontre du Non-Linéaire 2013", Paris, France, March 2013, http://hal.inria.fr/hal-00923671

Conferences without Proceedings

[84] L. GAJNY, É. NYIRI, O. GIBARU. *Approximation spline L1C1 par fenêtres glissantes pour le signal et l'image*, in "Journées du Groupe de Travail en Modélisation Géométrique 2013", Marseille, France, March 2013, http://hal.inria.fr/hal-00841326

[85] L. HETEL, E. FRIDMAN, T. FLOQUET. *Sampled-data control of LTI systems with relays: a convex optimization approach*, in "9th IFAC Symposium on Nonlinear Control Systems", Toulouse, France, September 2013, http://hal.inria.fr/hal-00923825

Scientific Books (or Scientific Book chapters)

[86] A. ZOLGHADRI, D. HENRY, J. CIESLAK, D. EFIMOV, P. GOUPIL. , *Fault Diagnosis and Fault-Tolerant Control and Guidance for Aerospace Vehicles From theory to flight tests*, Advances in Industrial Control, Springer London Ltd, September 2013, 216 p. , http://hal.inria.fr/hal-00869253

Patents and standards

[87] P. GOUPIL, R. DAYRE, A. GHEORGHE, D. EFIMOV, J. CIESLAK, A. ZOLGHADRI. , *Procédé et dispositif de détection d'une anomalie sur un aéronef*, 2013, n^{o} FR20130055665, http://hal.inria.fr/hal-00869250

Other Publications

[88] D.-Y. LIU, O. GIBARU, W. PERRUQUETTI, T.-M. LALEG-KIRATI. , *Fractional order differentiation by integration and error analysis in noisy environment: Part 1 continuous case*, January 2013, http://hal.inria.fr/hal-00779176

[89] D.-Y. LIU, O. GIBARU, W. PERRUQUETTI, T.-M. LALEG-KIRATI. , *Fractional order differentiation by integration and error analysis in noisy environment: Part 2 discrete case*, January 2013, http://hal.inria.fr/hal-00779182