On-Line Identification: Applications in Control and Signal Processing

April 22, 2010

Saarbrücken

Alien-InnoLecture Seminar

Organization: Prof. J. Rudolph, Prof. M. Mboup

Chair of Systems Theory and Control Engineering

(Lehrstuhl für Systemtheorie und Regelungstechnik)

Saarland University

InnoLecture

The *Stifterverband für die Deutsche Wissenschaft* and the *Verband der Metall- und Elektroindustrie des Saarlandes e.V.* are funding an InnoLecture Guest Professorship in the Mechatronics Department of the Saarland University.

During the summer semester 2010 the InnoLecture Guest Professor is Prof. Dr. M. Mboup from the Center of Research in Science and Technologies of Information and Communications (CReSTIC) at the *Université de Reims Champagne-Ardenne* (France). Prof. Dr. M. Mboup is also a member of the Project *Alien* at the French National Institute for Research in Computer Science and Control (INRIA).

Together with the Chair of Systems Theory and Control Engineering, the InnoLecture Guest Professor is hosting the 2010 annual seminar of *Alien* on April 22 and 23 which focuses on industrial applications. The aim of the meeting is to further strengthen common projects of the Chair of Systems Theory and Control Engineering and *Alien* and encourage participation with local industry.

Specifically, the program includes an application-oriented public session open to interested members of the regional industry.

Stifterverband
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The Chair

The Chair of Systems Theory and Control Engineering at Saarland University is part of the Mechatronics Department. Professor Rudolph teaches modeling fundamentals of mechatronic systems, their analysis and control, and more advanced topics related to his research.

Research covers development of methods for system analysis and synthesis (modeling, structural analysis, identification, simulation, design of feed-forward and feedback control as well as their technological realization). In addition to the theoretical work the group is continuously solving challenging industrial problems. Mathematically speaking, system classes considered range from finite dimensional linear to infinite dimensional nonlinear systems such as delay systems and distributed parameter systems.

Since systems theory and control engineering are fundemental disciplines, they are not confined to specific applications. Therefore, projects with partners from academia and industry cover many domains.

The public seminar will take place at the auditorium -1.03 in the building A5 1 on the University campus, where you can also find the chair.

There is no registration fee. However, in order to facilitate the organization of the seminar, please register before Friday, April 16 by e-mail (better) or by phone call (only before 12:30) to the secretary of the chair:

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Provisional schedule

14:00 Welcome Session:

Presentation of

- the Chair of Systems Theory and Control Engineering (J. Rudolph),
- the InnoLecture Guest Professorship (M. Mboup),
- and *Alien* (J.-P. Richard).

14:45 *Numerical differentiation*, M. Mboup
Numerical differentiation in a noisy environment is revised with an algebraic approach. For each given order, an explicit formula yielding a pointwise derivative estimation is derived. These expressions are composed of iterated integrals of the noisy observation signal. Applications to neural spike detection and diagnosis are discussed. This is a joint work with C. Join and M. Fliess.

15:20 Break

15:40 *PID control revisited*, M. Fliess
In this joint work with C. Join (*Nancy-Université* & INRIA-*Alien*), we are introducing "intelligent" PID controllers for "complex" systems. The tuning of such systems becomes quite straightforward even when highly nonlinear and/or time-varying. Moreover, we show that with this control design, modeling issues may often be bypassed to a large extent. Several examples will be discussed and the connections with "classic" PID controllers will be investigated.

16:20 *Algebraic parameter identification for an industrial 6 axis robot*, O. Gibaru
We address the problem of real-time identification of dynamic nonlinear model parameters of an axis of an industrial machining robot. Unlike classical methods of conventional identification that totally rely on least squares approaches, we propose a new algebraic real time method based on robust estimation of successive derivatives. The knowledge of the engine torque, the measured angular positions and rates both at the link and the actuator of the axis allow us to estimate these parameters. The efficiency of these identification methods is validated by real-time tests on the second axis of our 6 axis robot STÄUBLI RX170B.

17:00 Canapés and discussions

Speakers

Prof. M. Mboup, InnoLecture Guest Professor
Mamadou.Mboup@univ-reims.fr

M. Mboup is professor at *Université de Reims Champagne-Ardenne* after more than one decade at *Université Paris Descartes*. His research interests are in the fields of signal processing and mathematical theory of systems. He is a member of several international conference program committees and he serves as Associate Editor of the African Diaspora Journal of Mathematics.

Prof. M. Fliess, *Michel.Fliess@polytechnique.fr*

M. Fliess is a Research Director at the Centre National de la Recherche Scientifique (CNRS) and works at the *Ecole Polytechnique* (Palaiseau, France). He is the head of the INRIA project called *Alien* which is devoted to the study and the development of new techniques in identification and estimation. In 1991, with J. Levine, P. Martin, and P. Rouchon, he invented the notion of differentially flat systems which plays a major role in control applications. He was awarded the silver medal from the CNRS in 1991 and the *Michel Montpetit* and *Jacques-Louis Lions* prizes from the French Academy of Sciences in 1987 and 2007, respectively.

Prof. O. Gibaru, *Olivier.Gibaru@ensam.eu*

O. Gibaru is professor in applied mathematics at *Arts et Métiers ParisTech* center of Lille. He is the head of the Laboratory of Metrology and Applied Mathematics. He is also a member of the INRIA project *Alien* which is devoted to the study and the development of new techniques in identification and estimation.

Alien

Alien (Algebra for Digital Identification and Estimation) was created in june 2004, as a project-team of INRIA. It unites researchers from eight different universities and institutes in four different regions of France. The main domains of application for the methods developed lie in the fields of control and signal processing, where identifying the parameters of a model or estimating non-measured variables are common problems.

The *Alien* project team is developing an estimation theory based upon an unusual combination of differential algebra and operational calculus. This new theory leads to simple and fast real-time algorithms: Solutions are provided by explicit formulae, with straightforward implementation, using standard tools from computational mathematics.

A wide variety of applications are under development. They include the control of very high precision systems, networked control systems, and signal processing for biomedical applications.