

Guest Editorial: Special Issue on Positive Polynomials in Control

IT is well-established that numerous problems in control systems involve the use of positive polynomials, i.e., multivariate polynomials that take only positive values over a domain of interest. Indeed, constraint satisfaction is equivalent to the positivity of a suitable function, as well as performance computation amounts to determining the best parameter that makes a suitable function positive. Also, for those cases where such a function is not naturally polynomial, polynomial restrictions can be introduced, and though this is at the expense of either some conservatism or some approximation, one can always count on the fact that these undesired effects can be reduced by increasing the degree of the polynomial. And clearly, these issues are valid for both analysis and synthesis frameworks, in the former case positive polynomials allow to investigate a property of interest, in the latter case they allow to search for a controller satisfying some specifications.

Positive polynomials started to gain a renewed interest in the control community from the nineties when dedicated tools for solving optimization problems based on linear matrix inequalities (LMIs) were firstly developed. The interest was and is still motivated by two reasons. The first is that LMI problems are convex, and hence can be systematically solved being free of local minima. The second reason is that, though polynomial optimizations are known to be NP-hard, they can be approached via suitable relaxations based on sum of squares or moments, which can be formulated in terms of LMI and which are asymptotically non-conservative. Therefore, from that time on, positive polynomials have been largely and usefully exploited in fundamental problems such as stability, robustness, and performance, coming as natural extension of the pioneering techniques based on quadratic functions, and allowing for the development of state-of-the-art methods.

The aim of this Special Issue has been to identify to what extent positive polynomials are currently exploited and can be further exploited in control systems, attempting to provide a significant overview of their application area as well as outline their potentialities and limitations, in both theoretical and practical uses. We have received 27 submissions, and we are very happy to present 16 of them in the sequel. These papers propose new contributions to the characterization of positive polynomials and illustrate novel applications in the areas of uncertain systems, nonlinear systems, time-delay systems, hybrid systems, and model predictive control. We believe that this collection of papers will provide interesting and inspiring insights into the current status of this young and promising field.

We would like to conclude this guest editorial by thanking the Editorial Board of the IEEE TRANSACTIONS ON AUTOMATIC

CONTROL for giving us the opportunity to organize and realize this Special Issue. We also would like to thank all the authors that have responded to our invitation in order to contribute to the Special Issue, included those authors whose paper could not be published. Finally and especially, we would like to thank all reviewers that kindly have given us some of their time, providing comments and suggestions in order to publish high-quality papers. We report hereafter their names.

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He was with the Department of Engineering of the University of Cambridge, UK, (1999 to 2000) and Department of Information Physics and Computing of the University of Tokyo, Japan, (2001 to 2004). He was a Research Associate and an Assistant Professor at the Department of Information Engineering of the University of Siena (2000 to 2006), and he joined the Department of Electrical and Electronic Engineering of the University of Hong Kong in 2006. He is author of the book *Homogeneous Polynomial Forms for Robustness Analysis of Uncertain Systems* (New York: Springer, 2009). His research interests include automatic control, biomedical engineering, computer vision, optimization, and robotics.

Dr. Chesi received the Best Student Award of the Faculty of Engineering of the University of Firenze in 1997. He is in the Editorial Board of several international conferences, moreover he is an Associate Editor of *Automatica*, an Associate Editor of the IEEE TRANSACTIONS ON AUTOMATIC CONTROL, and a Guest Editor of the Special Issue on Positive Polynomials in Control of the IEEE TRANSACTIONS ON AUTOMATIC CONTROL.

Didier Henrion (S'97–A'99–M'03) was born in Creutzwald, France, in 1971. He received the “Diplôme d'Ingénieur” (Engineer's Degree) and the “Diplôme d'Etudes Approfondies” (M.S. degree) with specialization in control from Institut National des Sciences Appliquées (INSA, National Institute for Applied Sciences), Toulouse, France, in 1994, the “Candidate of Sciences” (Ph.D.) degree from Akademie Ved Ceske Republiky (Academy of Sciences of the Czech Republic) in 1998, the “Diplôme de Doctorat” (Ph.D. degree) from INSA Toulouse, France, in 1999, the “Diplôme d'Habilitation à Diriger des Recherches” (French Habilitation) degree from Université Paul Sabatier de Toulouse in 2007, and the “Docent” (Czech Habilitation) degree from Ceske Vysoke Ucení Technické v Praze (CVUT, Czech Technical University in Prague) in 2008.

From 1994 to 1995, he was a Research Assistant at Universidad Simón Bolívar, Caracas, Venezuela. From 1996 to 1998, he was at Ústav Teorie Informace a Automatizace (UTIA, Institute of Information Theory and Automation), Prague, Czech Republic. From 1996 to 1999, he was at the Laboratoire d'Analyse et d'Architecture des Systèmes (LAAS, Laboratory of Analysis and Architecture of Systems), Centre National de la Recherche Scientifique (CNRS, National Center for Scientific Research), Toulouse, France. Since 2000, he has been a CNRS Researcher at LAAS. He is also holding a secondary appointment as an Associate Professor at the Katedra Řidici Techniky (Department of Automatic Control) of Fakulta Elektrotechnická (Faculty of Electrical Engineering), CVUT, Prague.

Dr. Henrion received the Bronze Medal from CNRS in 2004. He has been an Associate Editor of the Conference Editorial Board of the IEEE Control Systems Society (1999 to 2004), an Associate Editor of the IFAC journal *Automatica* (2003 to 2009), an Associate Editor of the IEEE TRANSACTIONS ON AUTOMATIC CONTROL (2005 to 2008), and an Associate Editor of the *European Journal of Control* (2005 to 2008). He has been Vice-Chair of the IFAC Technical Committee on Control Design (2003 to 2008), and Chair of the IEEE Technical Committee on Computer-Aided Control Systems Design (2004 to 2010).