Parameter Estimation and Gradient Descent-based Observers: Application to Electromechanical and Reaction Systems

Romeo Ortega

LSS-CentraleSupelec
France

In the first part of the talk we present a new approach to state observation, called Parameter Estimation-based Observers (PEBO) whose main idea is to translate the state estimation problem into one of estimation of *constant, unknown parameters*. The class of systems for which is applicable is identified via two assumptions related to the transformability of the system into a suitable cascaded form and our ability to estimate the unknown parameters. The first condition involves the solvability of a partial differential equation while the second one requires some persistency of excitation–like conditions. We present also PEBO in a unified framework together with the—by-now classical—Kasantzis-Kravaris-Luenberger and Immersion and Invariance observers.

In the second part we show that, for systems for which a linear regression-like relation is available, it is possible to combine PEBO with a new estimation technique called Dynamic Regressor Extension (DREM). This new technique, called DREMBAO, is used to generate adaptive observers. PEBO and DREMBAO are shown to be applicable to position estimation of a class of electromechanical systems, for the reconstruction of the state of power converters, for speed observation of a class of mechanical systems and for state observation of chemical/bio-chemical reaction systems.

The performance of these observers is compared in two physical examples with high-gain and sliding mode observers. As expected, it is shown that—in the presence of noise—the performance of the two latter designs is significantly below par with respect to the other techniques.

CV Romeo Ortega

Romeo Ortega was born in Mexico. He obtained his BSc in Electrical and Mechanical Engineering from the National University of Mexico, Master of Engineering from Polytechnical Institute of Leningrad, USSR, and the Docteur D'Etat from the Politechnical Institute of Grenoble, France in 1974, 1978 and 1984 respectively.

He then joined the National University of Mexico, where he worked until 1989. He was a Visiting Professor at the University of Illinois in 1987-88 and at McGill University in 1991-1992, and a Fellow of the Japan Society for Promotion of Science in 1990-1991. He has been a member of the French National Research Council (CNRS) since June 1992. Currently he is a Directeur de Recherche in the Laboratoire de Signaux et Systèmes (CentraleSupelec) in Gif-sur-Yvette, France. His research interests are in the fields of nonlinear and adaptive control, with special emphasis on applications.

Dr Ortega has published three books and more than 300 scientific papers in international journals, with an h-index of 79. He has supervised 35 PhD thesis. He is a Fellow Member of the IEEE since 1999 and an IFAC Fellow since 2016. He has served as chairman in several IFAC and IEEE committees and participated in various editorial boards of international journals. Currently he is the Editor in Chief of *Int. J. on Adaptive Control and Signal Processing*and Senior Editor of *Asian Journal of Control*.