Quasilinear Control Theory for Systems with Asymmetric Actuators and Sensors

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Abstract

The theory of Quasilinear Control (QLC) is a set of methods for analytical design of controllers for Linear Plant Nonlinear Instrumentations (LPNI) systems, where the term "instrumentation" is used to denote actuators and sensors. In practice, controllers for LPNI systems are often designed ignoring instrumentation nonlinearities (e.g., saturation, quantization, dead zones, etc.) and then calibrated using hardware-in-the-loop. QLC provides analytical tools to accomplish this. The approach is based on the method of Stochastic Linearization, which reduces static nonlinearities to a quasilinear gain. Unlike the usual (Jacobian) linearization, Stochastic Linearization is global. The price to pay is that the quasilinear gain depends not only on the operating point, but also on the exogenous signals and functional blocks of the closed-loop system. Using this approach, QLC theory has extended practically all methods of Linear Control theory to LPNI systems. This includes the notions of system types, error coefficients, root-locus, LQR/LQG, H_∞, etc. In addition, LPNI-specific problems have been addresses (e.g., partial and complete performance recovery). The main results of QLC have been summarized in a textbook (Cambridge University Press, 2011) and presented at the Technion in 2011. In the current talk, after a brief overview of the previous results, we center on new ones, specifically on the phenomena, arising in systems with asymmetric nonlinearities (i.e., a generic case of tracking problems with saturating actuators).

Bio

Semyon M. Meerkov received his MSEE degree from the Polytechnic of Kharkov, Ukraine, in 1962 and Ph.D. in Systems Science from the Institute of Control Sciences, Moscow, Russia, in 1966. He was with the Institute of Control Sciences until 1977. From 1979 to 1984 he was with the Department of Electrical and Computer Engineering, Illinois Institute of Technology, Chicago, IL. Since 1984 he has been a Professor at the Department of Electrical Engineering and Computer Science of the University of Michigan, Ann Arbor, MI. He held visiting positions at UCLA (1978-1979), Stanford (1991), Technion, Israel (1997-1998, 2008, and 2017), Tsinghua, China (2008), and Ben-Gurion University, Israel (2011). He was the Editor-in-Chief of *Mathematical Problems in Engineering*, Department Editor for Manufacturing Systems of *IIE Transactions* and Associate Editor of several other journals. Presently, he is on the Editorial Board of the *International Journal of Production Research* and Associate Editor of *Automation and Remote Control*. He is Foreign Member of the Russian Academy of Sciences and Life Fellow of IEEE. His current research is in Systems and Control (with applications to production systems) and in Mathematical Theory of Rational Behavior (with applications to resilient monitoring and control).