Resilient Monitoring and Control: Techniques, Analysis, Design, and Performance Evaluation

Semyon M. Meerkov

Department of Electrical Engineering and Computer Science
University of Michigan
Ann Arbor, MI, USA

Abstract

Resilient plant monitoring systems are sensor networks, which degrade gracefully under malicious attacks on their sensors, causing them to project misleading information. This talk is intended to describe recently developed techniques to ensure resiliency and illustrate their application using a power plant. Specific techniques developed are: a method for sensor trustworthiness evaluation (using the probing signals approach); a non-classical statistical procedure for process variable assessment (using the sensors data and their trustworthiness); a method for sensor network adaptation to the optimal state resulting in the minimum entropy of process variable assessment (using the rational controllers approach); a method for sensor network decomposition (as a means for combating the curse of dimensionality and achieving scalability); and a method for subplant condition assessment (using the Jeffrey's rule). Based on these techniques, a five-layer resilient monitoring architecture is developed and analyzed under various cyber-physical attack scenarios. As quantified by the Kullback-Leibler divergence, the system offers effective protection against misleading information and identifies the plant conditions − normal or anomalous − in a reliable manner. In addition, the talk presents two techniques to ensure resiliency of feedback systems, one based on a model predictive control approach and another on a synchronous detection technique.

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).