2016 International Symposium on Nonlinear Theory and Its Applications,
NOLTA2016, Yugawara, Japan, November 27th-30th, 2016

Koopman Operator Theory for Nonlinear Dynamical Systems: An Introduction with Engineering Applications

Yoshihiko Susuki† and Igor Mezić‡

†School of Electrical and Information Systems, Osaka Prefecture University
1-1 Gakuen-cho, Naka-ku, Sakai, Osaka 599-8531, Japan
‡Department of Mechanical Engineering, University of California
Santa Barbara, CA 93106–5070, United States
Email: susuki@eis.osakafu-u.ac.jp, mezic@engineering.ucsb.edu

Abstract—Koopman operator is a composition operator defined for a dynamical system described by nonlinear differential or difference equation. Although the original system is nonlinear and evolves on a finite-dimensional state space, the Koopman operator itself is linear but infinite-dimensional (evolves on a function space). This linear operator captures the full information of the dynamics described by the original nonlinear system. In particular, spectral properties of the Koopman operator play a crucial role in analyzing the original system. In the first part of this presentation, we review the so-called Koopman operator theory for nonlinear dynamical systems, with emphasis on modal decomposition and computation that are direct to wide applications. Then, in the second part, we present a series of applications of the Koopman operator theory to power and energy systems engineering. The applications are established as data-centric methods, namely, how to use massive quantities of data obtained numerically and experimentally, through spectral analysis of the Koopman operator. For the details of this presentation, see our review paper in NOLTA, IEICE (Y. Susuki, I. Mezić, F. Raak, and T. Hikihara, Applied Koopman Operator Theory for Power Systems Technology, vol.7, no.4, October 2016).