<Title>
Feedback Control for Multiple Stable Limit Cycles with Arbitrary Temporal Shapes

<Abstract>
Feedback control design to achieve prescribed oscillations for the closed-loop system is of practical importance for various applications including robotic locomotion. The currently prevalent approach is the output regulation to track a fixed periodic reference signal, which lacks adaptivity and conformance to environmental constraints. This talk presents a new design method that embeds prescribed oscillations within the closed-loop dynamics as stable limit cycles. In particular, we consider linear time-invariant plants and develop a general class of linear controllers that assign an eigenstructure to the closed-loop system. With an appropriate eigenstructure, the controller contains a linear oscillator as an internal model of the target oscillations. A nonlinear controller is then proposed by replacing the internal model with a nonlinear oscillator with stable limit cycles. It is proven that the single nonlinear controller achieves orbital stability of multiple target oscillations comprising arbitrary temporal shapes with a finite number of harmonics for the closed-loop system. Design examples demonstrate the controller performance of autonomous mode transitions with sensory feedback to the oscillator in comparison to output regulation with no sensory feedback to the exosystem.

<Short Bio>
Tetsuya Iwasaki received B.S. and M.S. degrees in Electrical and Electronic Engineering from the Tokyo Institute of Technology in 1987 and 1990, respectively, and a Ph.D. degree in Aeronautics and Astronautics from Purdue University in 1993. He held faculty positions at Tokyo Tech and University of Virginia before joining the University of California, Los Angeles (UCLA), where he is currently Professor of Mechanical and Aerospace Engineering. His research interests include dynamics and control of neuromechanical systems, nonlinear oscillator network, global pattern formation via local interactions, and robust/optimal/distributed control theories and their applications to engineering and medical systems. He has received several awards, including CAREER Award from NSF, Pioneer Prize from SICE, George S. Axelby Outstanding Paper Award from IEEE, and Rudolf Kalman Best Paper Award from ASME. He has served as Senior/Associate Editor of IEEE Transactions on Automatic Control, Systems & Control Letters, IFAC Automatica, International Journal of Robust and Nonlinear Control, and SIAM Journal on Control and Optimization. He is Fellow of IEEE and ASME.