Modeling, Sensing and Control of Unstable Physical Human-Machine Interactions: A Rider-Bicycle Example

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ABSTRACT: Human with trained motor skills can fluidly and flexibly interact with machines while smart machines can also provide motor assistance and enhancement to facilitate human's motor skills learning. However, we currently lack theories and design tools to effectively model and tune human motor control and its interactions with machines. In this talk, I will discuss recent developments modeling, sensing and control of human motor skills through unstable physical human-machine interactions (upHMI). Rider-bicycle interactions is used as an upHMI paradigm to examine a sensorimotor theory for modeling of human motor control relevant to balancing motor activities. I will first present a novel control-theoretic physical/learning modeling framework of extracting and characterizing human control strategies in a lower-dimensional space. Then, I will discuss the development of the in-situ sensing design to estimate the poses of the rider and the bicycle in natural environment with wearable and onboard sensors. Finally, I will briefly present balancing control design and stability analysis for the rider-bicycle interactions.

BIO: Professor Yi is an Associate Professor in mechanical engineering and also a graduate faculty member in electrical and computer engineering at Rutgers University. Dr. Yi has received the 2014 ASCE Charles Pankow Award for Innovation, the 2013 Rutgers Board of Trustees Research Fellowship for Scholarly Excellence, and the 2010 US NSF CAREER Award, etc. He has also co-authored papers that have been awarded the Best Student Papers at the 2012 ASME Dynamic Systems and Control Conference and the 2012 IEEE/ASME International Conference on Advanced Intelligent Mechatronics and the Kayamori Best Paper at the 2005 IEEE International Conference on Robotics and Automation. Dr. Yi is a member of American Society of Mechanical Engineers (ASME) and a senior member of the IEEE. He serves as an Associate Editor of the IEEE Transactions on Automation Science and Engineering, IFAC Journal Control Engineering Practice, and the ASME Journal of Dynamic Systems, Measurement and Control.