SEMINAR SERIES

北京大学工学院 先进制造与机器人系

Machine Learning-enabled Inertial Sensor-based Activity Detection and Pose Estimation for Legged Walkers and Its Applications

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内容简介：

Real-time gait activity detection and pose estimation are critical for enabling many human healthcare automation. In this talk, I will present a machine learning-enabled, wearable inertial measurement unit (IMU)-based design to provide effective and efficient activity detection and pose estimation for legged walkers. The gait event and activity detection are first built on a recurrent neural network (RNN) with long short-term memory (LSTM) cells with IMUs on lower limbs. A learned low-dimensional motion manifold is parameterized by a phase variable with a Gaussian process dynamic model. I will present two case studies to illustrate the design. The first application is related to real-time human walking gait detection and pose estimation for construction workers, and the second application is for horse limb lameness detection and pose estimation. Experimental results show that the RNN-LSTM-based approach achieves gait activity detection with 96% accuracy and the detection latency is within 20 ms using only a single IMU attached to human shank. For horse lameness detection, the design achieves 95% accuracy and the pose estimation scheme can predict the 24 limb joint angles with average errors less than 5 and 10 degs under normal and induced lameness conditions, respectively. I will finally present the use of the design for knee exoskeletons-based balance recovery control under foot slip as an additional application example.

报告人简介：

Professor Jingang Yi received the B.S. degree in electrical engineering from Zhejiang University in 1993, the M.Eng. degree in precision instruments from Tsinghua University in 1996, and the M.A. degree in mathematics and the Ph.D. degree in mechanical engineering from the University of California, Berkeley, in 2001 and 2002, respectively. He is currently a Full Professor in mechanical engineering and Peter D. Cherasia Faculty Scholar at Rutgers University. His research interests include physical human-robot interactions, autonomous robotic and vehicle systems, mechatronics, dynamic systems and control, automation science and engineering. Prof. Yi is a Fellow of ASME and a Senior Member of IEEE. He has received several awards, including the 2018 Japan Society for the Promotion of Science (JSPS) Invitational Fellowship for Research, 2017 Rutgers Chancellor's Scholars, 2014 ASCE Charles Pankow Award for Innovation, the 2013 Rutgers Board of Trustees Research Fellowship for Scholarly Excellence, and the 2010 NSF CAREER Award. He has coauthored several best papers in *IEEE Transactions on Automation Science and Engineering* and at IEEE/ASME AIM, ASME DSCC, and IEEE ICRA, etc. He currently serves as a Senior Editor for *IEEE Transactions on Automation Science and Engineering* and Editor-in-Chief of Conference Editorial Board for IEEE International Conference on Automation Science and Engineering (CASE). He also served as Associate Editor of IFAC journals *Control Engineering Practice, Mechatronics, IEEE/ASME Transactions on Mechatronics, IEEE Transactions on Automation Science and Engineering*, *IEEE Robotics and Automation Letters*, and *ASME Journal of Dynamic Systems, Measurement and Control* and a Senior Editor of *IEEE Robotics and Automation Letters.*

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