

A Bipedal Controller Design to Realize Human Gaits

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Abstract: This research aims to mimic the exact gait of a human. In other words, we try to build a biped digital twin for human locomotion. The biped control has been a popular topic for years, and the various control methods are becoming mutual. Advanced gait control for jumping, step climbing, and recovery from pushing have all been developed. Recent research has also addressed how to conduct a human-like gait. However, these results all used gaits that balance the biped instead of asking the biped to mimic the exact gait of a human. The concept can be helpful when one tries to examine if the gait of a human is normal. It can also be used to monitor the performance of an exoskeleton. The proposed digital twin analyzes the dynamic characteristics of the entire human body and determines the joint torques required for maintaining balance. This study constructed a bipedal robot model that conforms to the human body to simulate human postures. The zero moment point is used as a reference point for the interaction with the ground. We then used a cart table model to balance the bipedal robot. The controller outputs an assistive force at the center of mass position to maintain balance during walking. Finally, we convert the assistive force into ankle joint outputs to enhance gait stability and ensure that the waveform and numerical outputs are close to actual human data in the literature.

Biography

Professor Jia-Yush Yen received his B.S. degree from National Tsing-Hwa University, Taiwan, in 1980, his M.S. degree from the University of Minnesota, USA, in 1983, and his Ph.D. degree from the University of California, Berkeley, in 1989, all in mechanical engineering. He then joined the Mechanical Engineering faculty of National Taiwan University, where he served as the Department Chair, the Director of Tjing-Ling Industrial Research Institute, and the Dean of the College of Engineering until 2017. In 2021, Prof. Yen became a professor in the Department of Mechanical Engineering at the National Taiwan University of Science and Technology. He is also the president of the University. Prof. Yen also served as the Chair of the Automation Area for the Ministry of Science and Technologies, Taiwan. He was the president of the Chinese Institute of Automation Engineers, Taiwan (CIAE), and is now the president of the Chinese



Automatic Control Society, Taiwan. He also served in numerous academic positions, including the Director of the NTU Research and Development Center for Medical Devices and the NTU Research Center for Intelligent Machines. He is a fellow of the ASME, the Chinese Society of Mechanical Eng., the CIAE, the Robotics Society of Taiwan, and the Chinese Society of Mechanical Engineering.

Dr. Yen received the Outstanding Research Award twice from the Ministry of Science and Technologies, Taiwan. He also received numerous compliments from the government for his public service. His research interests are in mechatronic systems, computer peripherals, and nano-manipulations.