Mechatronics Considerations for Assisting Humans

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Abstract

Mechatronics technologies are now steadily penetrating in our daily lives. We are surrounded by mechatronic products and interact with them in many ways. In particular, mechatronics devices may potentially improve the quality of life of elderly people and patients with impairments. In this talk, several key technologies that we have developed for assisting such people in walking are introduced. These technologies include sensing technologies for identifying the intent of human, decision making algorithms to decide the right amount of assistance to the human and actuation technologies to provide forces and torques to selected human joints. In the design of mechatronic devices interacting with humans, the dynamics of human is an important element and the compatibility between machine and human must be optimized. If the device is interacting with normal and healthy humans, the design may take advantages of robust and intelligent controllability of a human. In case of assistive devices for elderly and people with impairments, such approaches will not be appropriate, and the controller is required to be predictable, precise, robust and intelligent. It is desired to have zero impedance for actuators to realize an ideal force mode actuation. Otherwise, a human will have to make additional efforts to overcome the undesirable resistance. We will present how the Flexible Joint Actuators (FJA) may be controlled to act as a zero impedance actuator. Also, the assistive systems require a means for detecting human intention and monitoring the current status of health or safety. Various sensor technologies are available for this purpose, e.g. EMG sensors, joint angle sensors and so on. For patients and elderly people, however, it is desired that sensors are easy to use and yet reliable and capable to generate relevant information. We will present the idea of smart shoes, which measure the distribution of foot pressures for robust estimation of phases in a human gait and detection of abnormalities. Based on the estimated phase, the control algorithm is adapted for most effective assistance of the user.

Bibliography

Masayoshi Tomizuka was born in Tokyo, Japan in 1946. He received his B.S. and M.S. degrees in Mechanical Engineering from Keio University, Tokyo, Japan and his Ph. D. degree in Mechanical

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He served as Technical Editor of the ASME Journal of Dynamic Systems, Measurement and Control, J-DSMC (1988-93), Editor-in-Chief of the IEEE/ASME Transactions on Mechatronics (1997-99), an Associate Editor of the Journal of the International Federation of Automatic Control, Automatica. He was General Chairman of the 1995 American Control Conference, and served as President of the American Automatic Control Council (1998-99). He is a Fellow of the ASME, the Institute of Electric and Electronics Engineers (IEEE) and the Society of Manufacturing Engineers. He is the recipient of the J-DSMC Best Paper Award (1995), the DSCD Outstanding Investigator Award (1996), the Charles Russ Richards Memorial Award (ASME, 1997), the Rufus Oldenburger Medal (ASME, 2002) and the John R. Ragazzini Award (2006).