Hybrid Assistive Knee Braces with Smart Actuators

Wei-Hsin Liao, Ph.D.
Director, Smart Materials and Structures Laboratory
Professor, Department of Mechanical and Automation Engineering
The Chinese University of Hong Kong
Shatin, N.T., Hong Kong

Abstract:
The percentage of aged persons in society is increasing, and their physical deterioration has become a socioeconomic problem. For example, in late 2004, the population of aged persons in China has reached 143 million. Osteoarthritis (OA) is very prevalent in old people. Studies showed that adequate exercises would generate positive effects to OA patients. Therefore, devices that can help people with weak muscle strength or OA are in great need. Researches were conducted to develop exoskeletons that can provide assistance for elderly and disabled people. These exoskeletons have two limiting factors that prevent them from practical applications: (1) Lack of safety: the leg exoskeleton usually uses motor to directly drive a leg to move, so that has the potential of danger; (2) Short life: it is not energy efficient to only use motor to provide assistance. More energy efficient actuators are desirable. In our research, a new hybrid assistive knee brace was developed utilizing a magneto-rheological (MR) actuator. The MR device can function as a clutch or a brake as needed. While functioning as a clutch, the output inertia can be made small and the system is much safer than the direct use of motor; while functioning as a brake, the MR device can produce large torque while consuming little power. The prototype of the MR actuator was fabricated and experiments were carried out to investigate the characteristics of the MR actuator. The results showed that the MR actuator is able to provide sufficient torque needed for normal human activities. Experiments of the MR actuator under control were performed to study the torque tracking ability of the system. A testing structure was developed for testing the knee brace. The motion of the knee brace in the testing structure was analysed. Experimental results showed that the developed knee brace can provide proper assisting torque as expected.

Biography:
Dr. Wei-Hsin Liao is a Professor in the Department of Mechanical and Automation Engineering, and the Programme Director of MSc Programme in Biomedical Engineering at The Chinese University of Hong Kong (CUHK). He received his Ph.D. in Mechanical Engineering from The Pennsylvania State University, University Park, USA. At Penn State University, he received the Inventor Incentive Award and Sigma Xi Graduate Research Award. Since August 1997, Dr. Liao has been with The Chinese University of Hong Kong, where he is also the founding director of the Smart Materials and Structures Laboratory. He was the Program Chair for the International Symposium on Smart Structures and Microsystems in 2000, as well as the 2005 IEEE International Conference on Information Acquisition. He has also served in the program committees of many international conferences. He is the Conference Chair for the 20th International Conference on Adaptive Structures and Technologies (ICAST 2009), to be held in Hong Kong in October 2009. His research has led to publications of over 90 technical papers in international journals and conference proceedings, two US patents and two other US patent applications. He received the *T A Stewart-Dyer/F H Trevithick Prize 2005*, awarded by the Institution of Mechanical Engineers (IMechE). In 2008, he also received the *Best Paper Award in Structures* from the American Society of Mechanical Engineers (ASME). Dr. Liao is a Fellow of IOP, and an active member of ASME, IEEE, and Sigma Xi. He is an elected member of Technical Committee on Vibration and Sound (TCVS) of the ASME. He has served as a reviewer for various leading journals. Dr. Liao currently serves as an Associate Editor of *Shock and Vibration* (IOS journal), and on the Editorial Board of *Smart Materials and Structures* (IOP journal). His research interests include Smart Materials and Structures, Vibration Control, Medical Devices, Mechatronics, and Precision Machinery.

* Email: whliao@cuhk.edu.hk; Phone: +852 2609 8341; Fax: +852 2603 6002