Mechanical Engineering Department Seminar
3:30pm October 5, 2011
1130 Mechanical Engineering

Enhancing Human Machine Interaction via Mechatronic Actuation

Masayoshi Tomizuka
Cheryl and John Neerhout, Jr. Distinguished Professor, Department of Mechanical Engineering, University of California - Berkeley

Mechatronics technologies are applied to assist humans in many ways. One type of assistance is physical in the sense that actuators supply force and torque so that humans may accomplish certain tasks with smaller muscular force. In this talk, we will examine three different applications involving this kind of assistance: 1) mobility assistance for elderly and partially impaired patients, 2) electric bicycles and 3) variable-gear-ratio steering systems for automobiles. Actuators for mobility assistance must generate reasonably large torque while the size and weight should not be excessive. These requirements make indirect drive motors as opposed to direct drive motors a unique design choice. Another important requirement is that the motor system must be back-drivable for comfort and safety. It will be shown that the mechatronic consideration based on series elastic actuation and disturbance observer makes it possible to design a back-drivable lightweight high-torque actuation system. In electric bicycles, the human pedal torque is measured and a motor supplies an extra torque to assist the rider. One unique feature of the human pedal torque is that it is not constant but varies over a pedal cycle: a human's pedal torque is large or small depending on the pedal angles. If we identify such time varying patterns, the motor torque can be varied so that the variation of total torque, i.e. human torque plus motor torque, becomes smaller. In variable-gear-steering, the gear ratio is varied as a function of the vehicle speed to change operability. One big problem in such steering systems is the unnatural reaction torque caused by the variable actuator. A concept called friction relocation is introduced to overcome this problem.

Electrical Bicycle

Bio Masayoshi Tomizuka received his B.S. and M.S. degrees in Mechanical Engineering from Keio University, Tokyo, Japan and his Ph. D. degree in Mechanical Engineering from the Massachusetts Institute of Technology in February 1974. In 1974, he joined the faculty of the Department of Mechanical Engineering at the University of California at Berkeley, where he currently holds the Cheryl and John Neerhout, Jr., Distinguished Professorship Chair and serves as Associate Dean of Engineering. He teaches courses in dynamic systems and controls. His current research interests are optimal and adaptive control, digital control, signal processing, motion control, and control problems related to robotics and rehabilitation, vehicles and mechatronic systems. He served as Program Director of the Dynamic Systems and Control Program of the National Science Foundation (2002-2004). He has supervised more than 90 PhD students to completion. He has published over 550 articles in professional journals and conference proceedings.