SMU Department of Mechanical Engineering

SEMINAR

ME Dissertation Defense

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3:00 P.M. – 5 P.M.
Huitt Zollars 115 in the Embery building

Abstract: Tremor is a rhythmical and involuntary oscillatory movement of a body part. Along with the social embarrassment, tremor can be debilitating to the accomplishment of daily tasks. Mechanical loading via wearable exoskeletons, orthoses, has been under investigation as a non-invasive tremor suppression alternative to medication or surgery. In this method the challenge is identifying and attenuating the tremorous motion without adding resistance to the patient's intentional motion. In this research, three different control algorithms were designed to calculate the proper suppressive force to be applied by the orthosis to the patient's arm. The first control algorithm is based on a sinusoidal model of the tremor and the controller output, the required suppressive force to attenuate tremor, is sinusoidal. The second method is using an adaptive frequency estimator to find the tremor fundamental frequency in real time. The tremor amplitude is variable and the resistive force estimated by the controller has variable amplitude and the estimated frequency of the tremor. The third method was developed by using the so called backstepping method as a nonlinear control design tool. The main part of the controller is a high-pass filter and the backstepping controller finds the required suppressive force to make the output of the high-pass filter to converge to zero. Stability and robustness of the closed-loop system against the joint parametric uncertainties were analyzed for the proposed control algorithms. An experimental setup was designed and developed to emulate the dynamics of a human arm joint with tremorous motion. A pneumatic cylinder was used to apply orthotic suppressive force. The force produced by the pneumatic cylinder was controlled using a backstepping-sliding mode controller. The algorithm was implemented with a NI cRIO real-time controller for two types of tremorous motion: parkinsonian and essential. In addition to accurate tracking of the tremor frequency, the experimental results show significant tremor suppression in the range of 29.9-38.7 dB (96.8-98.8 %) at the fundamental frequency, and 6.5-14.9 dB (52.7- 82.0 %) at the second harmonic.

Bio: Behzad Taheri received the B.S. degree from Buali-Sina University in 2006, and the M.S. degree from Sharif University of Technology 2008, both in mechanical engineering. He was a designer for medical facilities HVAC systems in Tehran University of Medical Science from 2006 to 2009. He is currently a Ph.D. candidate of mechanical engineering working in the Biomedical Instrumentation and Robotics Laboratory, Bobby B. Lyle School of Engineering, SMU. His current research interests include human arm tremor suppression, orthotic and rehabilitation robotics, fluid power systems, and nonlinear and robust control. He is currently a student member of ASME and IEEE. Behzad has over 13 papers published in ASME and IEEE conferences and 7 journal papers in the areas of biomedical robotics and control systems. He is currently a reviewer for IEEE/ASME Journal Transactions on Mechatronics.