CONTACT ROBOTICS AND NEUROENGINEERING

Neville Hogan
Department of Mechanical Engineering
Department of Brain and Cognitive Sciences
Newman Laboratory for Biomechanics and Human Rehabilitation
Massachusetts Institute of Technology

ABSTRACT

Robots are rapidly becoming commonplace but to realize their true potential requires the perfection of *contact robotics*, machines that physically cooperate with humans. Optimizing machines for human contact requires a quantitative knowledge of human motor and sensory performance, and this intersection of engineering with neuroscience is fundamental to a new bioengineering discipline, *neuroengineering*. I will review pioneering neuroengineering applications, including therapeutic robots for neuro-rehabilitation.

Forceful human-machine interaction engenders surprising challenges. Even the deceptively simple act of pushing on a tool is statically de-stabilizing. Yet humans accomplish contact tasks with consummate ease, due, in part, to skillful control of mechanical impedance. I will show that impedance rather than strength can determine the limits of human force production.

Endowing machines with similar characteristics may enable robots to approach (or exceed) biological performance, but how best to achieve controllable impedance remains a challenge, especially at forces comparable to human strength. Force feedback is appealing but contact imposes severe stability limits. I will review recent progress using quantitative knowledge of human operator impedance to reduce force feedback conservatism, an example of the synergy between motor neuroscience and engineering.

Feedback control may be augmented by engineering novel biomimetic actuators. Electro-active polymers may ultimately achieve muscle-like function but their application requires control-relevant models—minimally complex yet reproducing essential behavior. I will show how an energy-based approach yields real-time computable models that accurately reproduce observed behavior over the full range of excitation while providing new insight.

These examples illustrate how, suitably adapted, existing engineering methods may form the core of the neuroengineering discipline.

Time: Thursday, March 29, 1:30p Institute For Bioengineering & Biosciences,
Parker H. Petit (Suddath Seminar Room 1128)