NUS Graduate School for Integrative Sciences and Engineering
Research Project Write-up

Title of Project :	Next Generation Robotic Exoskeletons for Rehabilitation and Assistance
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Short Description

The rapid advancement of robotics technology in recently years has pushed the development of a distinctive new field of robotic research, the wearable robots or exoskeletons. Robotics exoskeletons have wide range of applications in the military, in industries, and in healthcare.

Due to aging population, more people are suffering from neurological disorders such as stroke yet fewer healthcare personnel are available to perform the rehabilitation therapies. Robotic exoskeletons have the potential to relieve therapists from the tedious manual therapy, provide more intensive training to patients, and provide better quantitative feedback and better functional outcomes for the patients. However, current robotic exoskeletons have serious limitation in actuator design, sensing, and control methodologies.

This research aims to develop the fundamental enabling technologies to create a paradigm shift in the development of the next generation wearable robotics. In particular, we will focus on the following key research areas: a) Bio-inspired compliant and force controllable actuators with variable impedance for safer human robot interaction; b) Novel mechanism design, such as cable drive mechanism to achieve lightweight wearable robotics; c) Novel sensing technologies for human motion intent detection with wearable sensors and machine learning algorithms for gait kinematics and gait phase detection; d) Novel bio-signal processing techniques for both EEG and EMG for brain machine interface and biofeedback; e) Intelligent control systems for better human robot interaction control.

A range of exoskeletons for both of upper limb and lower limb rehabilitation and assistance are being developed. A compact compliant Knee Ankle Foot robot for gait rehabilitation and a lightweight and lower profile elbow assistive robot with cable transmission have already been built and under testing. A full lower limb exoskeleton with cable transmission and compliant structure has also been designed. These robots are been developed in close collaborations with rehab medicine clinicians and industrial partners with a clear pathway of translation and commercialization.

Highly motivated students with Mechanical, Electrical, Biomedical Engineering and Computer Science background who want to build up future careers in the exciting and promising medical robotics field are welcome to join this research.

Keywords:
Neurorehabilitation, Robotic Exoskeleton, Compliant Actuators, Biomechanics, Intelligent Control, Brain Machine Interface, Machine Learning.