The Chinese University of Hong Kong
Department of Biomedical Engineering

Graduate Seminar – PhD Oral Defence

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Date	***:***	22 August 2025
Time	***:***	8:30 am
Venue	***:***	Room 1122, William M W Mong Engineering Building, CUHK

Title: Enhancing Soft Actuators for Stroke Rehabilitation: Innovations in Sensing, Modeling, and Adaptive Control

Soft artificial muscles offer flexibility and safety, making them an excellent fit for wearable robotic devices designed to assist human mobility. These qualities are particularly promising for aiding people recovering from strokes. However, this flexibility comes with its own set of challenges, such as difficulties in precisely sensing movement and exerted forces, and in achieving accurate control of their behavior.

Focusing on the bionic actuator ExoMuscle, advancements have been made in three key areas: modeling, sensing, and control. Initially, modeling involves understanding the dynamic airflow, internal pressure variations, and material properties of the tubular structures within these pneumatic artificial muscles. To tackle the complex "hysteresis" effect, an innovative approach decomposes the muscle's multifaceted responses into simpler, step-by-step calculations, enhancing the predictability of their behavior across various conditions

In addition to modeling, a method has been developed to enable these artificial muscles to essentially "sense" themselves. By detecting shifts in magnetic fields as the muscle moves or exerts force, this system delivers real-time, highly accurate feedback. To further enhance this capability, data-driven techniques, such as neural networks, are utilized, enabling even greater precision in monitoring and control.

Later, an adaptive control method was developed, capable of adjusting to changing conditions in real time. By continuously learning from the muscle's behavior and optimizing its parameters, this control system ensures that the muscles operate with exceptional accuracy, even under varying load conditions. Experimental results highlight the impressive ability of these systems to maintain a margin of error below 5%, ensuring reliable performance in dynamic environments.

The application of these technologies culminates in a compact hip exosuit powered by ExoMuscles. This wearable device addresses the challenges of bulkiness often associated with assistive systems, offering an ultra-thin design while still delivering powerful support—up to 15 Nm of assistive torque. Through its adaptive controls and fine-tuned design, the exosuit enhances key aspects of mobility, including walking speed, joint range of motion, and tailored gait assistance. For those undergoing stroke rehabilitation, this innovation represents a step forward in regaining independence and improving quality of life.

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***** ALL ARE WELCOME *****

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