The Chinese University of Hong Kong
Department of Biomedical Engineering

Graduate Seminar – PhD Oral Defence

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Date	***:***	10 April 2025
Time	***:***	9:00 am
Venue	***:***	Room 1122, William M W Mong Engineering Building, CUHK

Title: Soft Wearable Robot Hand for Robot-assisted Task-oriented Training in Chronic Stroke

Stroke is a major cause of long-term disability, often leading to impaired hand function and loss of fine motor control. Although task-oriented training (TOT) is clinically effective in facilitating upper limb recovery, its real-world implementation faces challenges such as limited therapist resources, insufficient attention to finger and wrist rehabilitation, and difficulty maintaining patient engagement. Traditional rigid exoskeletons are often bulky and lack adaptability, while most existing soft robotic hands struggle with limited torque output and poor spasticity management.

This thesis presents a lightweight, EMG-driven soft robotic hand system designed to deliver personalized, adaptive rehabilitation. The system incorporates bi-directional 3D-printed pneumatic actuators (R-SECA) with individual finger control, enabling a wide range of functional grasps essential for TOT. A randomized controlled trial (n=34) with chronic stroke patients demonstrated that EMG-driven TOT training significantly improved FMA-UE, ARAT, BBT, AROM, and reduced MAS scores. The intervention also led to decreased muscle co-contraction, indicating improved motor coordination. These gains were maintained at the three-month follow-up. To enhance accessibility in daily rehabilitation, an interactive training system was developed for non-EMG users, combining the soft robotic hand with a wireless task board for real-object manipulation. A pilot study (n = 7) demonstrated significant functional improvements and increased grip strength following 20 sessions. Beyond motor recovery, a novel method was proposed to objectively quantify finger joint spasticity by analyzing the pressure–angle relationship of the actuator. This method correlated strongly with clinical assessments, providing a reliable and quantitative tool for evaluating spasticity.

In summary, this work introduces an effective, user-friendly, and clinically relevant soft robotic system that supports both motor recovery and spasticity management, paving the way for more accessible, personalized stroke rehabilitation.

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

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