The Chinese University of Hong Kong
Department of Biomedical Engineering

Graduate Seminar – PhD Oral Defence

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Date	:	21 June, 2021 (Monday)
Time	:	10:00 am
Zoom Link	:	https://cuhk.zoom.us/j/94654741672?pwd=dlpjdy9aMG1odEpJMDNKdzRnOStydz09
Meeting ID	:	946 5474 1672
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Title: Learning-based Control of Soft Robotic Glove for Post-Stroke Hand Rehabilitation

Stroke is a leading cause of long-term disabilities in the world. Soft robots for stroke rehabilitation are increasingly being employed owing to their inherent safety, light weight, and portability. However, the development of control algorithms remains a challenge for soft rehabilitation robots, mainly due to the following difficulties: (1) soft robots exhibit nonlinear characteristics that restrict accurate modeling; (2) wide ranges of design make it difficult to derive a general control framework for soft robots; (3) stroke survivors have different motor function impairments, thus the soft rehabilitation robots should be adaptive to such differences; (4) stroke survivors' voluntary intentions introduce system uncertainties.

In order to address these challenges, we propose learning-based control approaches for soft rehabilitation robots. Firstly, a novel iterative learning model predictive control (ILMPC) method is presented to solve accurate modeling problems. The uniqueness of this approach is that it can achieve satisfactory tracking performance and improve model accuracy simultaneously. Secondly, a probabilistic model-based online learning optimal control (PMOLOC) framework is proposed to overcome various design challenges. The effectiveness of this framework is investigated on soft pneumatic actuators of different designs, during which all soft actuators can achieve good tracking performance.

Furthermore, varied training modalities are adopted in correspondence with practical conditions of stroke survivors. Firstly, a passive finger stretching training modality is designed for stroke survivors who are unable to extend fingers. The ILMPC method is further developed for a wearable soft robotic glove, taking finger conditions into account. The soft robotic glove can be adaptive to different finger conditions for trajectory tracking. Secondly, an active-assisted training modality is utilized for stroke survivors who have detectable motion intentions. The PMOLOC framework is further extended to deal with uncertainties of voluntary intentions. The soft robotic glove can successfully assist stroke survivors to accomplish different ADL tasks. Stroke survivors show improved hand functions and better muscle coordination after training. These experimental results demonstrate the potential of the presented system in hand rehabilitation therapy.

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

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