# PhD project: Deep learning based human modeling in physical human-robot interaction

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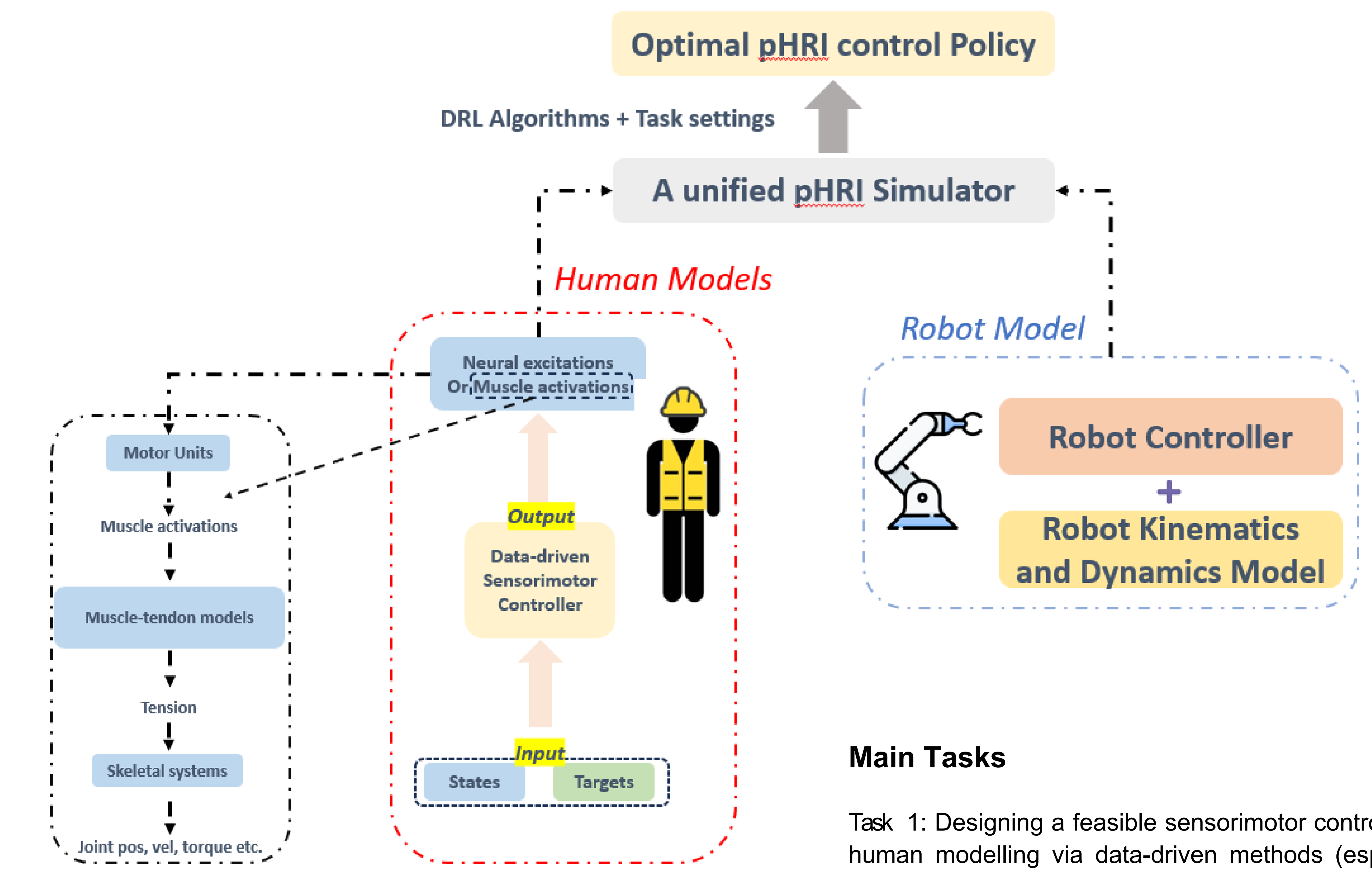
## Background

The rapid development of advanced robotic technology brought robots especially cobots (collaborative robots) like collaborative robotic arms and rehabilitation robots (like exoskeleton robots and prostheses) closer to humans. They have gradually participated in various aspects of production and living activities of human beings to assist human operators to fulfil different tasks. Many advanced techniques and research outputs have already been applied to plenty of industrial scenes to attain more intelligent and efficient performance in physical human-robot interaction (pHRI) tasks, also to ensure safety during the interactions. However, actively incorporating human models with a generalizable sensorimotor controller into the interactions between human and robots usually lacks for pHRI studies. Thus, we aim to design a more accessible and generalizable framework for building the connections between human and robot in a physically coupled way which could be used to simulate human robot interactions in multiple tasks. We also hope the research work could finally unveil the underlying principles in this symbiotic mechanism (when human motor system or sensorimotor control is considered) of pHRI in a complete manner to make a further step from human-robot interaction to human-robot integration in pHRI studies.

## The diagram of the pHRI control framework:




*The hierarchical structure of the neuro-musculoskeletal system*

*The structure of the sensorimotor controller*

## Main Tasks

Task 1: Designing a feasible sensorimotor controller for human modelling via data-driven methods (especially with deep reinforcement learning algorithms) with strong personalization ability given the uncertainty and large variance in the neuro-musculoskeletal models among different individuals.

Task 2: Assessing the performance of the proposed human-robot model on different pHRI tasks in a unified simulator with high computational efficiency and simulation speed and then improving the controller design according to the simulation results.

Task 3: Implementing the controller in real experiments to test its performance and optimizing the entire framework according to the feedback from tests.

## Methodology

Deep reinforcement learning algorithms or deep learning algorithms based on synthesized data or experiment data would be used to train a sensorimotor controller. The assistance of neural/muscle signals collecting equipment would also endows the controller with strong personalization ability. Besides, optimization-based and learning-based methods would be used to identify the parameters in the musculoskeletal models among different individuals more efficiently and effectively

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