Fixed-time Observer-based Controller for the Human-Robot Collaboration with Interaction Force Estimation

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Abstract

An exoskeleton robot is a sample of a wearable robot. One of the most critical challenges in developing wearable robots is the application of the interactive force between human and robot. Force sensors need to be placed on the robot. Consideration in using these sensors needs to be given to factors such as cost, noise, and weight. One way that can be used to help with the operation of the exoskeleton is to support the sensors with observers. This study will estimate the interactive force applied to a human arm model and the exoskeleton robot. The Sliding Mode Control (SMC) method will be employed to design a chattering-free robust fixed-time controller and observer, for estimating the states of the human arm and exoskeleton robot. Utilising this information from state observers, the interactive force is estimated. The state observer and the controller work together in real-time (online estimation). The Lyapunov theory is used to show the fixed-time stability analysis of the controller and the observer. Numerical simulation with three scenarios demonstrates the performance of the proposed design.

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