Adaptive robotic interface for upper limb assistance of Duchenne muscular dystrophy patients

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Abstract

Duchenne muscular dystrophy (DMD) is a genetic disorder that presents in boys in early childhood. This disease causes progressive muscle weakness and ambulation is lost early in the second decade of patients' lives [4]. Treating patients with DMD includes surveillance of expected complications, and the advancements in the last two decades have substantially improved the patients' life expectancy [2]. Consequently, there is now a demanding need for assistive devices to help patients living with severe physical impairments [3]. The distal muscles of patients' upper limbs are the most preserved in terms of motor function [1]. Therefore, our work aims to design an upper-limb assistive robotic device for DMD patients.

To achieve this objective, we are improving an existing upper-limb interface named ESTA. This interface is composed of four Degrees of Freedom (DoF) covering the shoulder and elbow movements. The project's first step was to calculate the kinematic and dynamic models of the robot. The second and current step is implementing an efficient controller to make the robot compliant with the user's desired motion. Accordingly, a force sensor has been installed on the robot's end effector to record the direction and intensity of the user's desired movement during the elbow flexion extension. To transfer these force measurements into a position displacement in the task space, we are implementing an admittance controller.

The next steps of this project include exploring other biofeedback sensors like Electromyography (EMG) to record the muscles' electrical activity. This data is valuable to assess the user's state and it could be used to predict the intention of the motion. In addition, we plan to use OpenSim to model the musculoskeletal system and perform simulations to study human movement. This would help us optimize the design and improve its effectiveness in assisting DMD patients.

References

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