Differentially-Clutched Series Elastic Actuator for Robot-Aided Musculoskeletal Rehabilitation

Brayden DeBoon*, Scott Nokleby*, Nicholas La Delfa', Carlos Rossa* 
* Faculty of Engineering and Applied Science,  Faculty of Health Sciences
brayden.deboon@uoit.net, scott.nokleby@uoit.ca, nicholas.ladelfa@uoit.ca, carlos.rossa@uoit.ca

Goals
- Create an actuator suitable for multiple phases of human-machine interaction with emphasis on rehabilitation
- Combine passive and active actuation methods with series elasticity in a single compact device
- Introduction of the differential clutch: A non-linear clutch that enables active or passive torque transmission

Redefining Multi-Purpose

Why add a spring?
- Can use spring linear range to infer output torque
- Torque sensors are expensive
- Inherent safety feature by decoupling the motor dynamics from the user

SAFETY
- Forgive for impulse impacts
- Inherently stable and can become compliant in a moment's notice
- Active energy can be redirected due to the differential clutch

Control Modes

Elastic Torque Inference

Torque Tracking Results

Why add a spring?
- Can use spring linear range to infer output torque
- Torque sensors are expensive
- Inherent safety feature by decoupling the motor dynamics from the user

Elastic Torque Inference

Torque Tracking Results

Differentially-Clutched SEA

Rehabilitation Timeline

Operating Modes

Control Modes

Elastic Torque Inference

Torque Tracking Results

Differentially-Clutched SEA

Rehabilitation Timeline

Operating Modes

Control Modes

Elastic Torque Inference

Torque Tracking Results