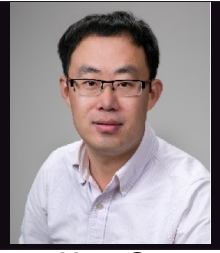
Soft Wearable Robots for Injury Prevention and Performance Augmentation (# 1830613)


Hao Su (PI)


Alessandra Carriero (Co-PI)


Yingli Tian (Co-PI)

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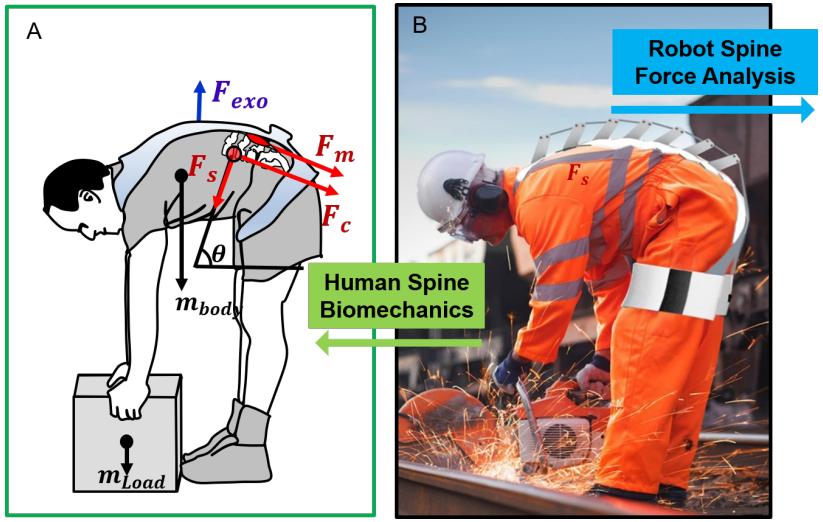
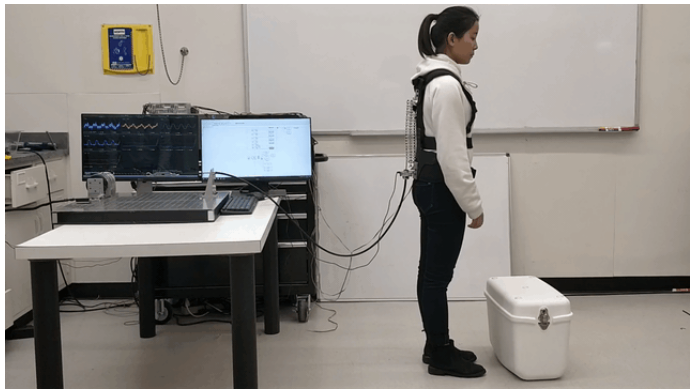
Challenges

- Bulky and Heavy
- Restrict Natural Movement
- Reduce 3 Forces along Spine

Solution

- High Torque Density Motors
- Quasi-Direct Drive Actuation
- Continuum Soft Exoskeleton



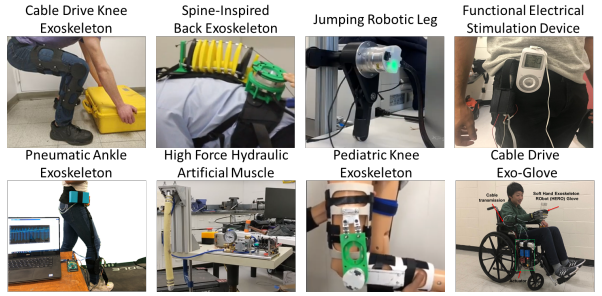


Scientific Impact

- New Actuation Paradigm of Co-robots
- Spine-robot Interaction Model
- Versatile: Lifting + Walking Assistance

Broader Impact

- Toyota Mobility Discovery Award
- Evaluation at BMW and Toyota
- 10+ Publication by Undergrad Students



Yang X, Huang TH, Hu H, Yu S, Zhang S, Yue G, Su H. Spine-Inspired Continuum Soft Exoskeleton for Stoop Lifting Assistance. IEEE Robotics and Automation Letters (RA-L), 2019

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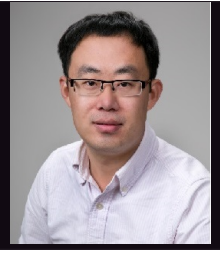


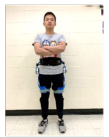
Existing actuators are not able to achieve BOTH

- High compliance
- High bandwidth

Position control

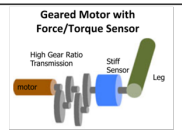
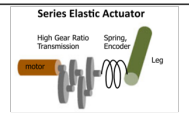
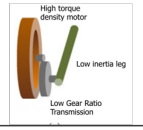
Geared Motor with Force/Torque Sensor

Series Elastic Actuator [MIT1999]

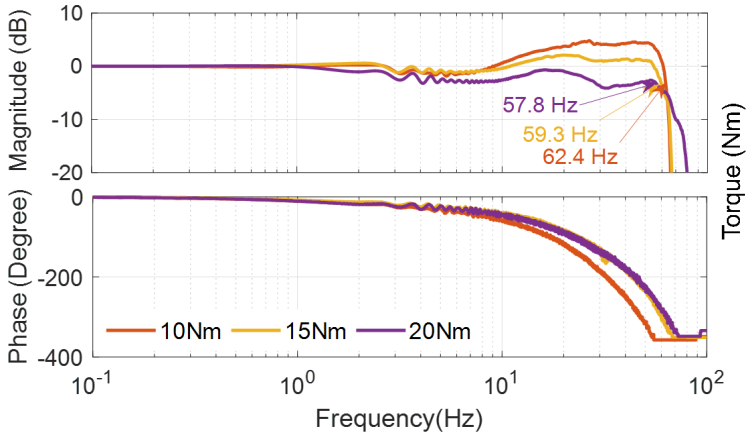


Quasi Direct Drive Actuator [Su2019]

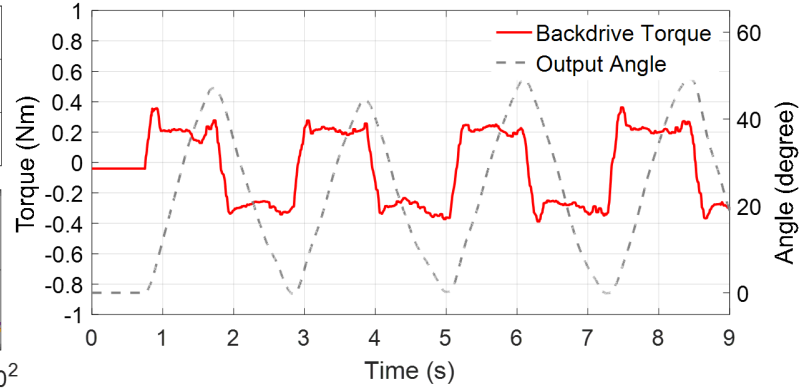
Force control

Compliance	Low	Medium	High (0.4 Nm)
Bandwidth	High	Low	High (62.4 Hz)
Efficiency	Low	Medium	High
Actuation paradigm			

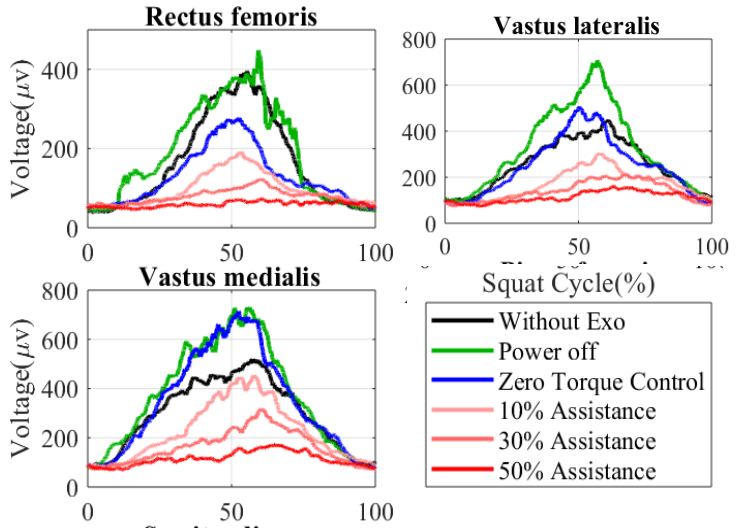
High Control Bandwidth (62.4 Hz)



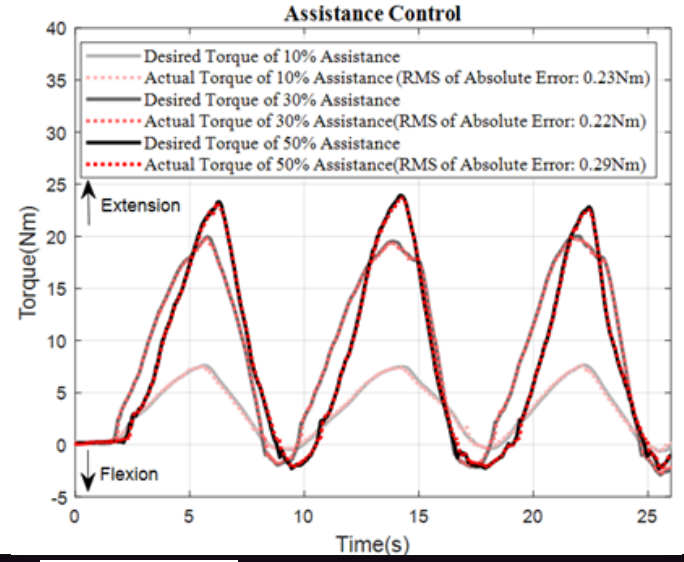
High Backdrivability (0.4 Nm)



75-85% reduction of knee extensor muscles



24 Nm Torque Tracking (1.2% error)



Yu S, Huang TH, Lynn B, Sayd D, Silivanov V, Park YS, Tian Y, Su H. Design and Control of a High-Torque and Highly-Backdrivable Hybrid Soft Exoskeleton for Knee Injury Prevention during Squatting . IEEE Robotics and Automation Letters (RA-L), 2019

The City University of New York

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