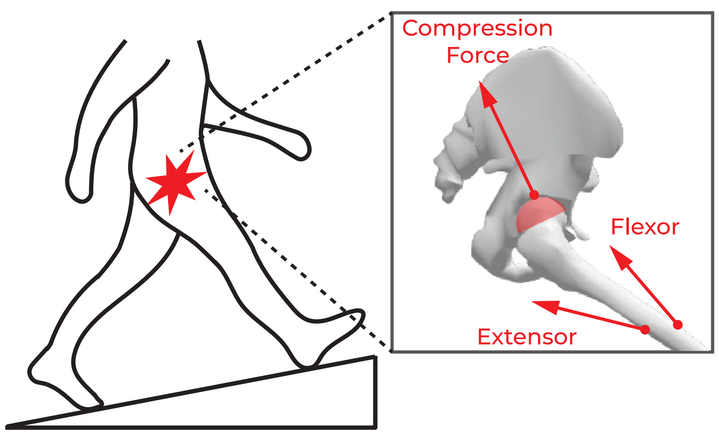
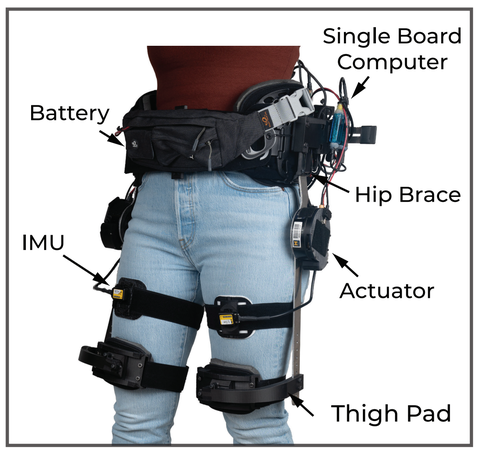
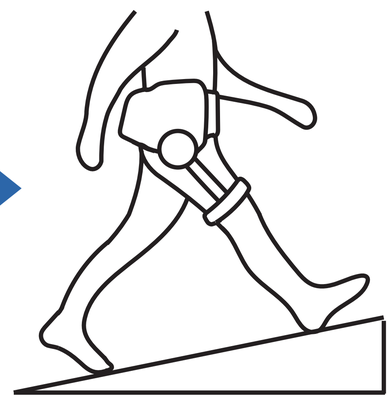
A Task-Agnostic Hip Exoskeleton for Osteoarthritis Pain Relief: Energetic Control across Activities of Daily Life

*Jiefu Zhang, Nikhil Divekar, Ernesto Hernandez Hinojosa, Robert D. Gregg**

Abstract







Reduced pain and difficulty

Increased hip range of motion and walking speed

Hip osteoarthritis (OA) causes pain due to joint load

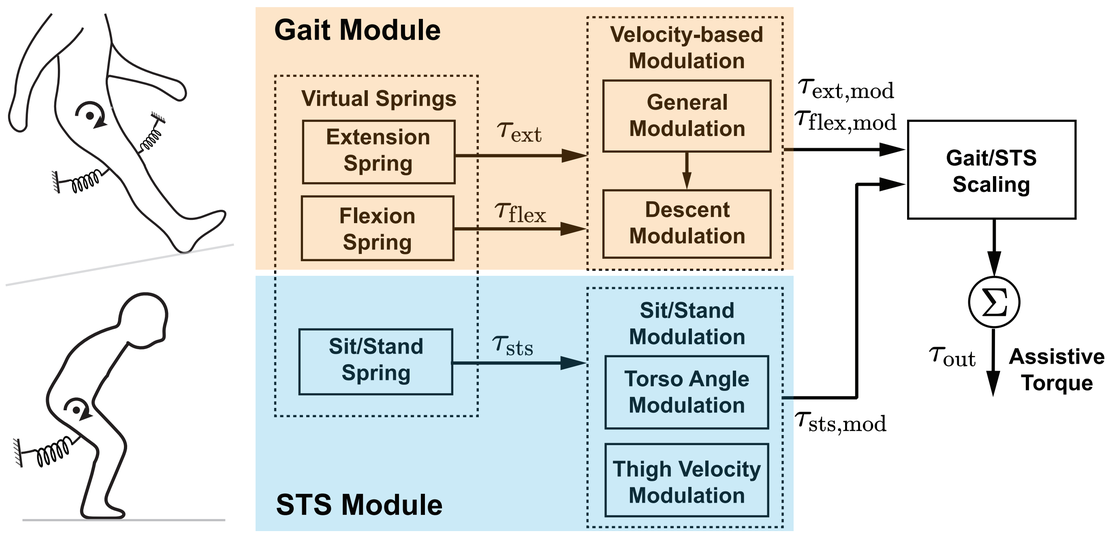
Backdrivable hip exoskeleton + task-agnostic controller can relieve joint pain across activities

Introduction

- Hip OA affects millions globally, but effective non-surgical treatments remain limited [1].
- Conventional frontal-plane braces fail to reduce pain from sagittal-plane muscle forces during movement [2].
- Sagittal powered hip exoskeletons can lower biological hip moments and muscle forces, alleviating OA pain [3], but task-specific controllers restrict their effectiveness [4].

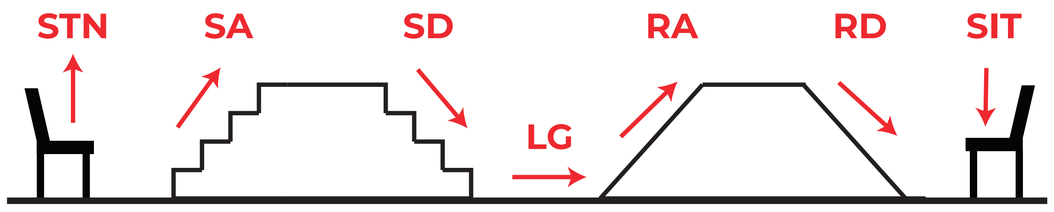
Method

Controller Design

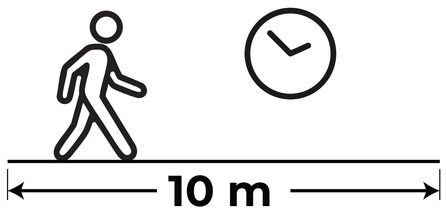


- The physical component-based controller has two modules for different tasks.
- Each module has velocity-modulated virtual springs that map kinematics to torque.
- Torque from the two modules is intergrated to provide task-agnostic assistance.

Experiment Design



- Multi-activity test in different conditions. Pain and difficulty are assessed using questionnaires.



- 10-meter walk test at self-selected and maximum speed in different conditions.

Conditions: No exoskeleton, 0%/50%/100% assistance exoskeleton.

Key Results

Fig. 1

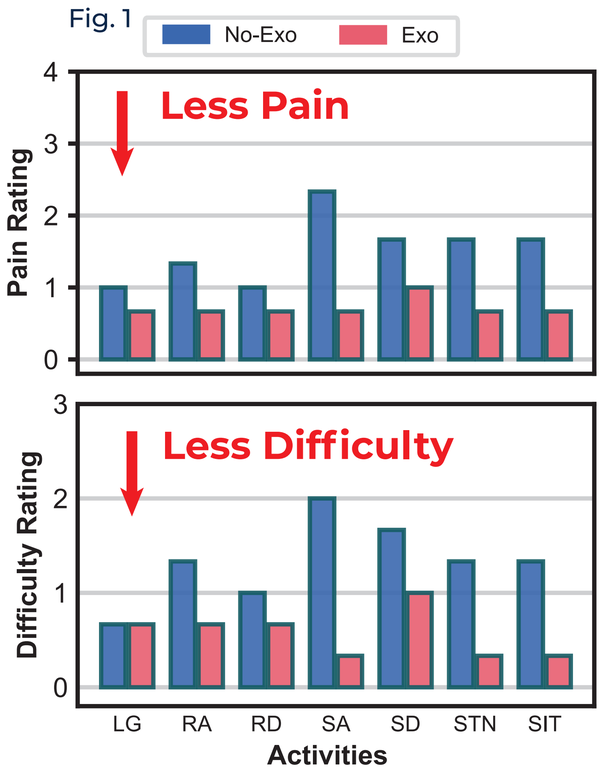
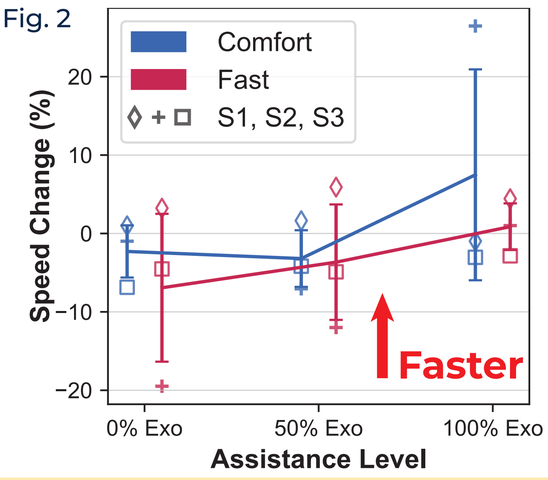


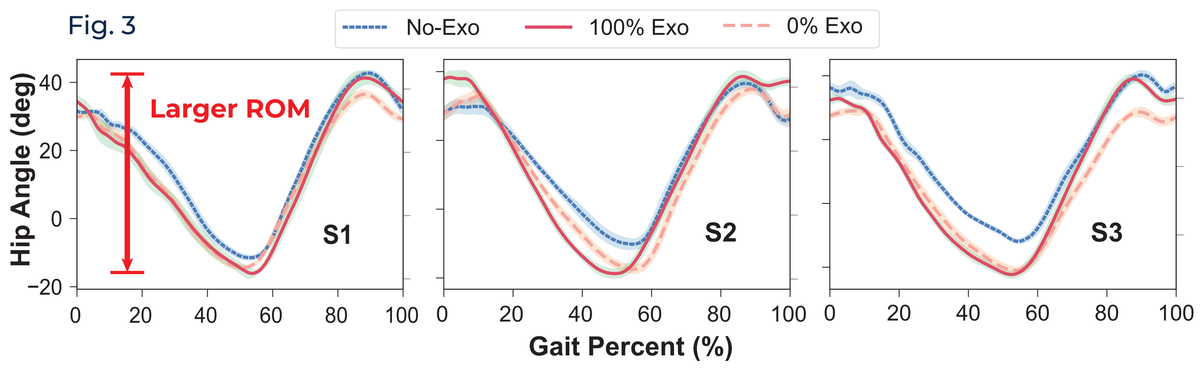
Fig. 2



On average, Active exoskeleton:

- Reduces pain by **53%** and difficulty by **57%** (Fig. 1)
- Increases comfort speed by **7.5%** and fast speed by **0.9%** (Fig. 2)
- Increases sagittal hip range of motion by **16.3%** (Fig. 3)

Fig. 3



Conclusion

- The physical component-based hip exoskeleton controller can provide task-agnostic assistance across activities.
- Hip exoskeleton may offer a novel convervative intervention for managing hip OA.

References

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Acknowledgement

National Institute of Biomedical Imaging and Bioengineering

NIH R01EB031166

Full Text

Video