CAREER: Bio-inspired Multi-joint Design and Control of Wearable Robots

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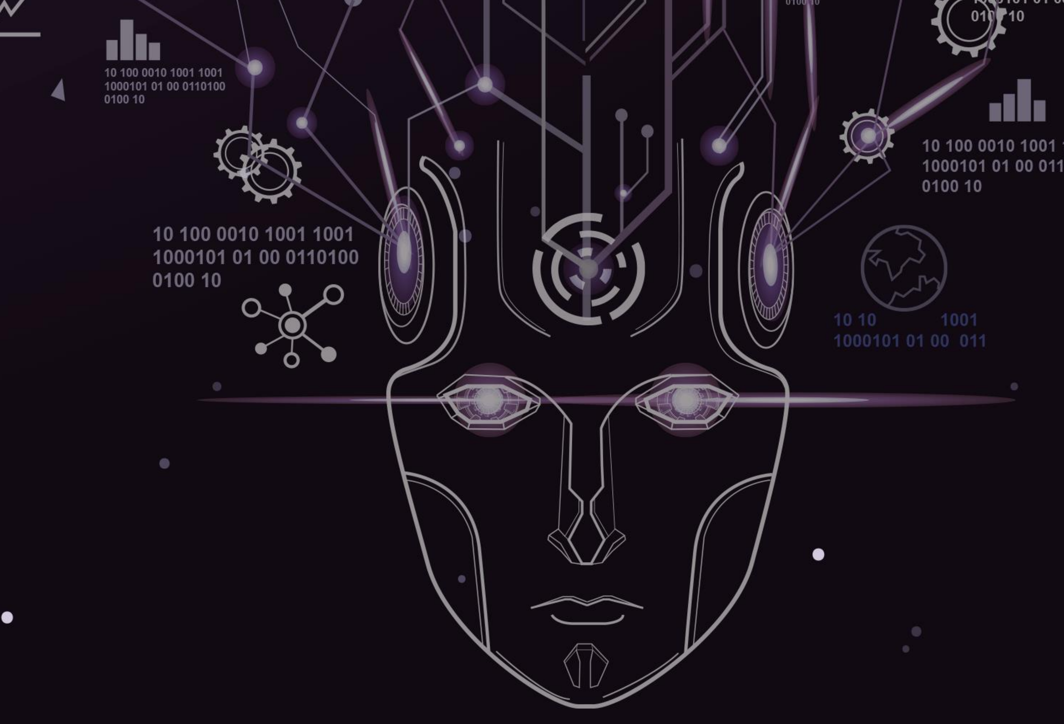


Problem Statement

Powered exoskeletons promise to improve our productivity, health, and independence by augmenting, preserving, and restoring our ability to move. However, existing powered exoskeletons are heavy and inefficient, which largely prevents them from being used in real life. Ambulation requires considerable energy to accelerate and decelerate the limb segments and to dynamically support the body against gravity. Human ambulation is highly efficient and stable because of the passive dynamics of the leg and the elastic properties of the muscles, and also because many muscles span multiple joints, actively transferring energy between joints. In contrast, powered exoskeletons are typically designed and controlled considering each actuated joint as a separate unit, independent from the others, even when multiple joints are actuated.

Solution Statement

The goal of this proposal is to address fundamental gaps in wearable robotics by developing energy-conserving mechanisms and control algorithms inspired by human ambulation..

- **Optimal control of multi-joint assistance.** Determine the optimal way to control assistance across and between multiple joints and planes during different ambulation activities, such as walking, stairs ambulation, and standing up.
- **Design of multi-joint powered exoskeletons.** test novel designs for powered exoskeletons that can transfer energy between multiple actuated joints, conserving energy within the system.

Central Hypothesis

optimizing the dynamic exchange of energy between multiple joints will result in superior powered exoskeletons—in terms of size, weight, and performance—compared to considering each actuated joint separately.

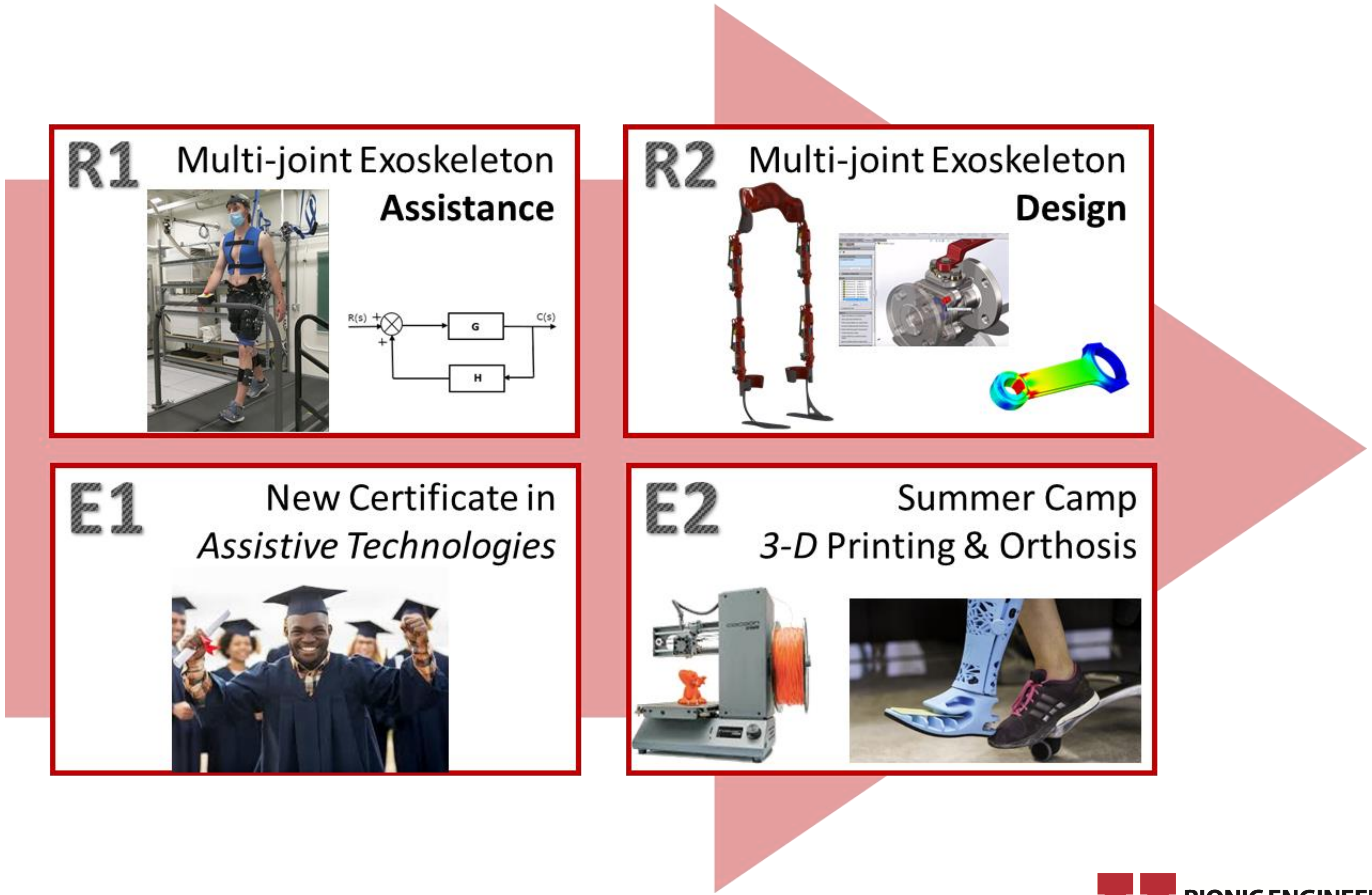
Scientific Impact

The intellectual merit of this proposal is the optimization of energy exchange across multiple joints for the design and control of powered exoskeletons inspired by human ambulation. Cumulatively, this research has transformative potential, enabling wearable robots to break the barrier of laboratory use and transition into real life, improving our productivity, health, and independence.

Broader Impact

Societal Impact: enabling the development of a new generation of powered exoskeletons that will provide greater mobility and independence to individuals with physical impairments--Thirty-three million Americans.

Educational Impact: increasing diversity in STEM by recruiting from underrepresented groups, especially those with physical disabilities.



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