

PI:

N/A

 Title:

Control of FES and an Electric Motor Drive for a hybrid gait neuroprosthesis
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Please evaluate this proposal according to the two merit: intellectual merit and broader impact.

There are three (3) parts to the evaluation:

1. Rating and Summary Statement,
2. Intellectual Merit,
3. Broader Impacts.

See the discussion at the end of this document for guidance. Your substantive written comments on the proposal's strengths and weaknesses are critical to the evaluation. You may continue on additional sheets if necessary.

Rating

Excellent ☒ | Very Good ☐ | Good ☐ | Fair ☐ | Poor ☐

Excellent	Outstanding in all respects; deserves highest priority for support.
Very Good	High quality in nearly all respects; should be supported if at all possible.
Good	A quality proposal, worthy of support.
Fair	Lacking in one or more critical aspects; key issues need to be addressed.
Poor	Has serious deficiencies.

Summary Statement

Please summarize your evaluation of this proposal, including the extent to which the proposal meets both criteria.

This proposal is asking for support to pursue a new type of powered exoskeleton to help disabled persons walk while also providing additional support when required with an electric motor. This proposal mixes functional electrical stimulation with additional motor support. Functional electrical stimulation is useful because it acts as a surrogate for nerves controlling muscle. This way, the muscles on people who are paralyzed can still be trained and strengthened. This is a huge deal in my opinion. But even, then, the system can add additional power to allow the individual to keep moving even when this muscle power is fatigued.

The way they plan on doing this is by implementing model predictive control, which is a nonlinear control methodology. The PI has experience in developing nonlinear controllers, and clearly outlines the research tasks. The two main tasks are: Physically validating the model predictive control method in a modified hybrid leg extension machine, and to physically validate the MPC method to elicit walking in people with a spinal cord injury.

This research will include human participants, but has several letters of support from various experts in the field, including medical doctors at UPMC.

Criterion 1: Intellectual Merit

What are the strengths and weaknesses of the the intellectual merit of the proposed activity?

Strengths

- The use of FES + an alectric motor is an innovative technology. This is closer to a device that someone could use to completely change their mobility after a spinal cord injury.
- Model predictive control is a relatively new control method that has not been used in this field. The use of the MPC for load balancing is new.

Weaknesses

I anticipate it may be challenging to really know when muscles are fatigued for individuals who are paralyzed. Can FES hurt individuals if control is not applied correctly?

Criterion 2: Broader Impact

What are the strengths and weaknesses of the the broader impacts of the proposed activity?

Strengths

This exoskeleton may enable people who are paraplegic to walk again. This is a gamechanger for mobility and could significantly improve the quality of life for these individuals. Let alone mobility, general health through the exercise of the lower extremities could significantly reduce comorbidities.

Weaknesses

How much money is spent on complications for paraplegics unable to walk? How does this change the day to day life of a paraplegic if they can use this technology? These seem like layups that were not described.

Merit Review Criteria

When evaluating proposals, please consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, evaluate all proposals against two merit criteria, given below. Both criteria are to be given full consideration during the review and decision-making processes. Each criterion is necessary but neither, by itself, is sufficient; therefore, proposers must fully address both criteria.

- What is the **Intellectual Merit** of the proposed activity?

The intellectual merit criterion encompasses the potential to advance knowledge. How important is the proposed activity to advancing knowledge and understanding within its own field and across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, please comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

- What are the **Broader Impacts** of the proposed activity?

The broader impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes. How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

The following elements should be considered in the review for both criteria:

- What is the potential for the proposed activity to:
 1. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
 2. Benefit society or advance desired societal outcomes (Broader Impacts)?
- To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
- Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
- How well qualified is the individual, team, or organization to conduct the proposed activities?
- Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?