REHAB WEEK2023
24-28 SEPTEMBER 2023
SINGAPORE

rehabweek
Singapore '23

Category: Development and Implementation of Technology

Workshop Title: Balance Control for Lower-Limb Prostheses and Exoskeletons

Workshop Organizer(s): Maura Eveld & Edwin van Asseldonk

In person Speaker(s):

- Aaron Young, Georgia Tech
- Eloise Dalin, Wandercraft
- Nidhi Seethapathi, MIT
- Michael Raitor, Stanford University

Workshop Time: 10:30 - 12:00

Attendee Engagement:

Below, find a sample schedule for this workshop. First, four distinguished speakers will give a short presentation on their contributions to this field (note that we currently have prosthesis, exoskeleton, and human movement control experts in our potential speaker list, all actively doing balance work), with 3-4 minutes of audience questions allowed after each talk. These speaker presentations will provide the foundation for this workshop by introducing the audience to current ongoing work, challenges in this field, and various approaches taken to address these challenges. With this foundation in place, the remaining time (a full 30 minutes) will be dedicated to a Panel Discussion. During the Panel Discussion, the moderator will ask prepared questions (see below), and speakers will be encouraged to discuss with each other as well as audience members. The goal is to allow speakers and audience members to learn from each others' experiences and ultimately to arrive at some key takeaways and action items for future work in this field.

9:00-9:05: Introduction
9:05-10:00: Speaker Presentations
- 10-minute talk + ~3 minutes audience questions for each of four speakers

10:00-10:30: Panel Discussion
- Potential questions:
- On a scale from 1 to 10, where are we in having lower-limb devices that are robust enough to prevent falls?
- What is the biggest barrier to getting to 10?
- Do you favor a universal control law that can account for balance loss, or a detect & assist strategy? Why?
- Who has involved their target (patient) population in development? What have you learned? How do you go about testing?
- How can exoskeleton and prosthesis developments help each other?
- Which control laws seem most promising? XCoM, FPE, NM, MBC?
- How do we get more researchers involved?
- Who else should we get involved?
- Audience questions

Abstract:

The development of robotic lower-limb prostheses and exoskeletons has seen great advances in the past two decades, as both rehabilitation or assistive devices for walking-impaired populations and augmentation devices for healthy users. While these devices have shown great potential for increasing mobility, ability, and independence as well as decreasing injury risk, to date their widespread adoption in the real world is still hampered by a crucial barrier: balance control [1-3].

Making a lower-limb prosthesis or exoskeleton robust to perturbations is no trivial task. There are many open questions in this regard:

Detection:

How do we detect perturbations and loss of balance? Or, do we need to?

How do we account for trips, slips, and pushes?

What sensors are required?

Control strategy:

Should we seek a universal control law, or a detect & assist approach? Or, a hybrid?

To what extent should the user be involved?

How important/useful is EMG or neural control for this application?

Implementation:

What are the torque and speed requirements for balance recovery assistance?

Can passive elements help?

Which joints should be assisted?

Assessment:

In what environment do we test these devices? With whom?

What is the best metric to quantify balance improvement?

Should subjective user feedback be included?

In this symposium, we have invited four experts who are currently tackling these questions in ongoing research. Each speaker will present on their experiences, with a few minutes for audience questions after each talk. We will conclude with a panel discussion for an informal conversation with the speakers. We've asked the speakers to be candid about what they've tried, what went well, and what didn't. With this symposium, we hope to bring together prosthesis, exoskeleton, and balance enthusiasts (in both the presenters and audience members) to work toward safer devices whose benefits can truly be realized in the real world.