**Category:** Development and Implementation of Technology

**Workshop Title:** Instrumented Dummy Limbs for the Assessment of Safety and Performance of Wearable Robots

**Workshop Organizer(s):** David Rodriguez-Cianca

**In person Speaker(s):**

- Torricelli, Diego, Spanish National Research Council (CSIC)
- Prange, Gerdienke, Roessingh Research and Development (RRD)
- Veneman, Jan, Hocoma
- Kwan-Woong, Gwak, Sejong University
- Been, Bernard, Humanetics
- Yoshida, Eiichi, Tokio University of Science (TUS)

**Workshop Time:** 13:45 - 15:15

**Attendee Engagement:**

Given the success of the workshop we organized at Rehabweek 2022 on a related topic: "Assessing Internal Joint Forces due to Misalignment of Rehabilitation Robots Using Instrumented Dummy Limbs in Context of Safety Testing",  the main aspects of attendee interaction will be similar and about: 1) Exchange of experiences between audience and speakers related to the use of instrumented limbs, or dummies, for the assessment of wearable robots and human-robot interactions, kick-started by presentations of specific examples by the speakers, and fostering exchange of ideas between clinicians/clinical researchers (e.g., about safe limit values) and developers/engineers (e.g., about ways to measure and minimize misalignment); 2) Identification of best practices from the wider rehab robotics community, as represented by the attendees.

This will be done in various ways: a) by creating a dedicated webpage with information regarding the workshop; b) by sharing a survey prior to and at the beginning of the workshop to gather information about participants' background, interests, previous experiences, attitude towards the topic and questions for the speakers. Results from the survey will be presented at the end of the workshop; c) by posing questions to the audience during/after each of the presentations and discussing them in an open debate (potentially using online voting app/online forms), addressing needs from different stakeholders in the audience for WR assessment using dummy limbs, experience with applied testing procedures of misalignment or other human-robot interaction forces, current gaps and challenges encountered.

**Abstract:**

The availability of reliable and objective methods to evaluate the performance and safety of wearable robots (WRs) is an urgent need in the field. Despite ongoing efforts, e.g., the one promoted by the H2020 projects EUROBENCH and COVR, a standardized framework for evaluating these aspects is still lacking to date. Currently, most evaluation schemes focus primarily on WR

performance without considering the quality of the physical interaction provided by the WR to the human. However, studies show that, when a WR does not fit well, is uncomfortable, or is unsafe, users prefer not to wear it despite the potential benefits it may bring in terms of performance. Indeed, the assessment of WR safety is a vital aspect of its development process but often experienced as difficult, partly due to the limited availability of best practices and safety standards. Besides, the reported evidence is strongly limited by human variability. The physical, mental and neurological conditions of the human pilot, as well as his/her familiarity with the device, introduce uncontrolled variables that limit the ability to identify reliable cause-effect relationships between engineering choices and resulting performance, or to compare solutions under equal conditions. Another complicating factor is the ethical implications: can we safely test the safety of a WR on a person?

The use of sensorized dummies has been recently proposed to improve the objectiveness, reproducibility and safety of the evaluation of WR's physical human-robot interactions. In this workshop, we want to inform the audience about the context of safety and performance testing with dummies, and share latest experiences with developing and testing instrumented dummy limbs with existing WRs. The workshop will end with an open debate between the speakers and the audience, including researchers, developers and clinicians, to discuss the potential advantages, limitations, needs and challenges of dummy-based WR assessments.