Lampe Joint Department of Biomedical Engineering
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Coulter Seminar Series Presents

Rehabilitation Engineering

Sensors in muscles: The unsung heroes in motor control

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Francisco Valero-Cuevas, PhD, earned a BS in Engineering from Swarthmore College (1984-88) and a Master's in Mechanical Engineering from Queen's University, Ontario, where he researched wrist joint kinematics. He completed his PhD at Stanford University in 1997, developing a biomechanical model of human digits with Dr. Felix Zajac.

He joined Stanford's Biomechanical Engineering Division as a Research Associate and Lecturer, then became Assistant Professor at Cornell University in 1999, achieving tenure in 2005. In 2007, he moved to USC, where he was promoted to Full Professor in 2011. He was elected Senior Member of IEEE in 2013, inducted into the American Institute for Medical and Biological Engineering's College of Fellows in 2014, and awarded an Honorary Doctorate in Biology from Swarthmore in 2018. In 2024, he became Associate Editor at *Science Advances* and was named Fellow of the National Academy of Inventors in 2025. He was also appointed as the Dean's Professor of Biomedical Engineering at USC.

ABSTRACT

We stand at the threshold of a paradigm shift in sensorimotor neuroscience thanks to a century of fundamental work we can leverage via recent advances in machine learning and molecular engineering. The coming tsunami of domain-specific data across the molecular, organ, limb, neural circuit, whole-person and societal scales will open unimaginable opportunities. However, the important lesson of physics-informed machine learning will still apply: Data must be interpreted in context, and hypotheses must have precedent logic and be interpretable.

It is as this junction that we should critically evaluate at least some of the fundamental tenets of our field to enable "neuromechanics-informed machine learning." Case in point is the nature of muscle redundancy in the context of their sensory signals (i.e., muscle spindles) regulated at the level of the spinal cord and brainstem. Understanding the interplay between muscles and their sensors will provide a sound conceptual basis to understand unimpaired and unimpaired function, and enhance human performance and rehabilitation. Lastly, I will touch upon my lab's efforts to implement these fundamental neuromechanical concepts to build versatile autonomous robots.

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