MAE SEMINAR SERIES

Thursday,
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3:30 p.m.
104 Knox Hall

PRESENTED BY

Dr. Victor Duenas

**Assistant Professor,
Mechanical and
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Closed-loop Switching Control for Physical Human-Robot Interaction using Powered Lower-limb Exoskeletons

ABSTRACT:

Powered exoskeletons and soft robots are becoming ubiquitous in our daily lives at home, the workplace and in clinical settings. Robotic exoskeletons are now fully wearable, lightweight, and portable, which are revolutionizing how humans and machines interact in different environments. Ultimately, the integration of wearable devices during physical human tasks poses challenges for the control design and analysis of the emerging coupled human-robot system. Such systems are nonlinear, time-varying, and contain intrinsically uncertain parameters. Further, human-robot interactions inherently yield a mix of discrete and continuous dynamics that motivate the design of closed-loop switching controllers to engage and disengage human and machine inputs while guaranteeing stability and desired performance of the overall system. In this talk, I will introduce recent strategies developed in our lab to design switching nonlinear controllers for treadmill walking by artificially activating muscle groups via functional electrical stimulation and a powered lower-limb exoskeleton, which can inform future gait therapies. Subsequently, we develop adaptive-based switching controllers for cycling in which the control system estimates uncertain parameters of the rider and adjust the power demand in real-time, which can enable customized exercise modalities. Finally, I will briefly highly the development of other devices in our lab that can be used to examine the underlying neurophysiology of the user during walking and provide a new stretching tool for people in hospitals and at home. I will close by summarizing the next steps for potential translation of these approaches from the lab to the end users.

BIO SKETCH:

Victor Duenas is an Assistant Professor in the Department of Mechanical and Aerospace Engineering at Syracuse University. Dr. Duenas is the director of the Bionics, Systems and Control Laboratory, which focuses on the design, analysis, and experimental implementation of control systems for human-robot interaction in the context of assistive devices and lower-limb rehabilitation. Major recent topics include nonlinear and adaptive control of powered exoskeletons, wearable robotic devices, and functional electrical stimulation (FES) cycling. He received his MS (2016) and PhD (2018) in mechanical engineering from the University of Florida, in which he was awarded a MAE Department Best Dissertation Award. In 2016, he received a Vodovnik Best Student Paper Award by the International Functional Electrical Stimulation Society. He was part of a research team that received the 2019 IEEE Control Systems Technology Award for their work on closed-loop FES control methods. He has active research projects in partnership with the Syracuse VA Medical Center and the Medical University of South Carolina and funded by the National Science Foundation and the VA system.

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