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DEPARTMENT OF BIOMEDICAL ENGINEERING
2025 Fall Seminar Series

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ABSTRACT:

Current physiological signal processing approaches often fail to capture the complex nonlinear dynamics inherent in biomedical signals, limiting their effectiveness in critical applications such as emotion recognition and medical diagnosis. This dissertation proposal presents a comprehensive framework of advanced nonlinear methodologies for physiological signal analysis across four interconnected aims. First, we will develop and validate multiple nonlinear approaches for emotion recognition using electrodermal activity (EDA), including systematic comparison of symbolic approximation, complexity analysis, topological methods, and network-based techniques, complemented by multi-scale fractal analysis frameworks. Second, we will develop machine learning methodologies for stroke lesion detection using multi-modal MRI data, exploring approaches that incorporate anatomical knowledge to provide interpretable diagnostic decisions. Third, we will investigate physiological markers of AI trustworthiness through controlled experiments examining how psychological distance and construal level influence trust dynamics during human-AI interactions. Finally, we will explore applications of developed methodologies to neurological disorder detection using electroretinographic signals from individuals with Autism Spectrum Disorder, ADHD, and OCD. Through rigorous evaluation on established datasets (CASE, DEAP, SOOP) and newly collected data, this work aims to demonstrate performance improvements compared to traditional approaches while providing clinically meaningful interpretability for healthcare applications. The proposed research establishes new benchmarks for nonlinear signal processing with broad implications for affective computing, medical imaging, human-AI interaction, and clinical neuroscience.

BIOGRAPHY:

Luis Roberto Mercado Diaz is a PhD candidate in Biomedical Engineering at the University of Connecticut, working under the supervision of Dr. Hugo Posada-Quintero. His research focuses on developing advanced nonlinear signal processing methodologies for physiological signal analysis, with applications spanning emotion recognition, medical imaging, AI trustworthiness assessment, and neurological disorder detection. He holds a B.Sc. from Instituto Tecnológico Metropolitano in Colombia (2021) and an M.Sc. from the University of Connecticut (2025).