Thesis Defense

Computer Science Master's Program

"A Step Toward Real-World Human Locomotion Modeling Using Deep Learning"

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Abstract:

Gait analysis provides valuable insight into health status, mobility impairments, injury prevention, and fall risk. Traditional approaches require controlled laboratory environments with marker-based motion capture systems or fixed camera configurations, though this is expensive, time consuming, and infeasible for daily use. Recent advances in markerless pose estimation have permitted video-based gait analysis without extra participant cooperation, yet existing models remain largely confined to laboratory settings with treadmill or fixed-path walking, constrained viewing angles, and stationary cameras. These constraints limit applicability to real-world health monitoring, where individuals move freely throughout natural environments.

This thesis addresses step detection, step counting, and activity classification tasks through the use of unconstrained, real-world video captured by a following camera operator during participants' natural daily activity. This setting introduces challenges absent in typical gait analysis tasks: camera motion that impacts perceived limb movement, frequent occlusions, varying viewing angles, and non-linear motion.

A data processing pipeline was designed to extract pose keypoints via Mediapipe and visual embeddings via a Convolutional Vision Transformer (CvT); these features were then used to train multiple deep sequence models over temporal windows centered on each frame. We also apply a "peaky focal" loss function to address severe class imbalance and push the system towards localized peaks during step detection. The resulting system offers a scalable, low-cost, and lightweight solution for real-world gait analysis applications and establishes a baseline for future work in unconstrained biomechanics analysis from video.

Date: Wednesday, February 4th, 2026
Time: 2:10 PM – 4:00 PM

Location: 14-238b
Committee: Dr. Ventura, Dr. Dekhtyar, Dr. Keadle