COMPUTER SCIENCE & ENGINEERING
UNIVERSITY OF MICHIGAN

DISSERTATION DEFENSE

Matthew Perez

Machine Learning Approaches for Quantitative Analysis and Characterization of Pathological Speech Disorders

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1:00pm – 3:00pm
3941 Beyster
Hybrid – Zoom

ABSTRACT: Automatic quantitative analyses have the potential to aid medical professionals in assessing pathological speech disorders. Pathological speech disorders manifest in various ways, creating opportunities for speech-based biomarkers to capture these differences. Developing quantitative measurements and machine learning models for tracking disease progression is critical in developing intelligent systems for that can aid clinicians with evaluation and treatment planning. However, challenges such as limited data, high inter- and intra-speaker variability, abnormal speech patterns, and the presence of co-morbidities make it difficult to apply traditional deep learning methods.

In this thesis, I introduce different machine learning approaches that characterize, recognize, and analyze pathological speech. First, I focus on feature sets that characterize Huntington's Disease (HD), a neurodegenerative disease that causes motor dysfunction and speech production difficulties. Automated feature extraction of text-based features from automatic speech recognition (ASR) scripts can classify the presence of HD and track disease severity. Additionally, I investigate low-level speech features from the frequency domain to measure vocal tract coordination, demonstrating their scalability and superior performance over transcript-based features.

Next, I explore acoustic model improvements for recognizing aphasic speech. ASR is critical for automatic speech analysis, as many downstream features rely on accurate speech transcriptions. I address challenges such as data scarcity and high speaker variability by using a mixture-of-experts acoustic model that improves acoustic modeling performance by modeling variability across speakers' speech intelligibility. Lastly, I investigate methods for improving the analysis of aphasic speech through automatic paraphasia detection. I demonstrate the effectiveness of end-to-end machine learning models in identifying different types of speech errors, known as paraphasias, among individuals with aphasia, showing significant performance improvements over existing multi-step approaches. The goal of my thesis is to develop speech-based biomarkers and intelligent systems that aid clinicians in quantitative pathological speech assessment.

CHAIR: Prof. Emily Mower Provost