PANDwriting: An Accessible Parkinson's and Alzheimer's Novel Diagnostic Framework Using Vision-Based Handwriting Kinematic Analysis and Machine Learning

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PANDwriting is a novel system for diagnostic assessment of neurodegenerative diseases (NDs) using handwriting kinematic analysis, particularly targeted to increase Alzheimer's Disease (AD) and Parkinson's Disease (PD) diagnostic access in lower-income areas and resource-poor health systems. The developed diagnostic framework uses a smartphone camera to record videos of patients performing handwriting tasks. These videos are analyzed using recurrent region of interest feature matching to extract pen coordinates and kinematic information. This system for quantifying kinematic features pioneers vision-based fine motor movement analysis, achieving a mean position error of 0.5 mm, and speed and acceleration errors below 1.1% (n=146). Furthermore, an initial proof of concept of pen pressure estimation using convolutional neural networks achieved a mean error less than 9%, demonstrating the potential of vision-based systems to estimate pressure in addition to kinematic features (n=41,391). To test the diagnostic accuracy of this vision-based system, the PaHaW dataset of 38 healthy controls and 37 PD patients was down-sampled to simulate vision-based data. An ensemble classifier consisting of a neural network, support vector machine, and random forest was trained with 10-fold cross-validation, achieving a classification accuracy of 74% in distinguishing PD patients from healthy controls (n=75). The developed PANDwriting system can be leveraged to screen for PD, AD, mild cognitive impairments, and any health conditions with biomarkers displayed in fine motor movements. The PANDwriting system successfully demonstrates that accurate kinematic data of fine motor movements can be collected using computer vision and leveraged for diagnostic assessment of NDs with machine learning.

Awards Won:
Second Award of $2,000
Zeiss: ZEISS First Award in Disease Detection and Diagnosis - ZEISS Primostar Microscope