Towards a comprehensive solution for vision-based digital neurological examination

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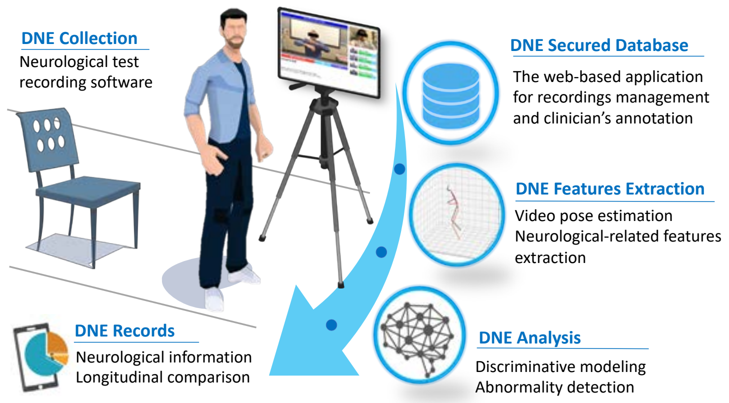
Live Presentation



Objective: Teleneurology systems have gained significant adoption over the past decades due to their potential in expanding access to neurology care despite the existing workforce shortages. Current teleneurology pipelines are narrowed down to specific neurological screening examinations and are not designed for home application. In this project, we propose an accessible vision-based tele-exam and documentation solution called Digital Neurological Examination (DNE) to address those limitations.

Method: Through our DNE software, clinical personnel and people at home are enabled to video capture an examination while performing instructed neurological tests, including finger tapping, finger to finger, forearm roll, and stand-up and walk. Our modular design of the DNE software supports the integration of additional examinations. Using off-the-shelf deep learning-based pose estimation solutions such as OpenPose and VideoPoe3D, we extract the 2D/3D human pose in each video recording. The estimated pose is then used to compute a set of kinematic and spatio-temporal features. We believe these features advance clinicians' disease documentation while promoting self-monitoring and early symptom detection. Furthermore, collecting patients' recordings alongside the quantified features at different time points facilitates supervision and monitoring of disease progression in the long run.

Results: Our DNE system includes a web server and a user interface for viewing the recorded videos, feature visualizations, and annotation. The DNE was tested on a collected data set of 21 subjects containing normal and simulated-impaired movements. Analyzing this dataset allows us to have a normal self-baseline for each abnormal recording and test the power of the extracted features in distinguishing normal from abnormal performance. The overall accuracy of the system is demonstrated by classifying the recorded movements using various machine learning models. Our tests show an accuracy beyond 90% for both upper-limb tests and 88% for the stand-up and walk tests.

Future work: We list several future directions for our project as 1) Extending DNE's support for other tests, including eye movement, facial activation, and phonation; 2) Expanding our dataset with recordings from real patients with different quantified severity levels. 3) Validating the use of DNE in real-world settings."