Scalable Next-Generation Smartphone Gait Assessment for Early Detection of AD/ADRD

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Project Overview

Mobile App

Instrumented Lower Extremity Assessment

Short Physical Performance Battery (SPPB)

- Balance Test
  - 0-4 Points
- Gait Speed Test
  - 0-4 Points
- Chair Stand Test
  - 0-4 Points
- Dual-Task Test
  - 0-4 Points

Computer Vision

Artificial Intelligence

- AI Supervision
- Motion Tracking
- SPPB Scoring

Phone Camera

Assessment

3D Motion Sequences

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Project Overview

Target Data (N=120): 60 MCI vs. 60 HC

- Developing the App
- CV algorithms based on preliminary data

Evaluation of Preliminary Clinical Validity of Select Markers

HC := Healthy Control
MCI := Mild Cognitive Impairment
CV := Computer Vision
Our Team

**PI: Ehsan Adeli**
- Computational Neuroscientist
- Expert in Computer Vision for Health

**Christine Gould**
- Geropsychologist
- Expert in technology interventions for older adults

**Narayan Schütz**
- Biomedical Engineer
- Expert in remote digital health assessments

**Victor Henderson**
- Neurologist
- Director Stanford ADRC and expert in AD/ADRD

**Shrinidhi Lakshmikanth**
- Biomedical and Computer Vision Data Engineer

**Fei-Fei Li**
- Computer Vision
- Director of Stanford Institute for Human-Centered AI (HAI)

**Vijaya Kolachalama**
- Computational Biomedicine
- Boston University ADRC

**Adam Staffaroni**
- Clinical Neuropsychologist
- UCSF ADRC

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Impact - Unmet Need

- Availability of disease-modifying drugs makes AD/ADRD large-scale early detection highly relevant

- Need for cost-effective, scalable, and easily administrable screening tools

- Gait and postural control characteristics among key early indicators of neurodegeneration

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Impact – Innovation

Resulting Digital Measures and Candidate Biomarkers

- SPPB Scores
- Gait Parameters (e.g. gait-speed)
- Balance Parameters (e.g. sway)
- Joint Positions
- Dual Task Costs
- ...
Impact - Innovation

1. Do you feel safe walking 4 meters?
   - Yes!

2. Ok, please take a step back so I can see you fully.


4. Good, once you are ready, I will count down from 3. You will then start walking 4 meters straight ahead in your regular pace.

5. 3. 2. 1. Go!

6. Ready!

Large Vision-Language Model Supervision
Impact – Accessibility, Inclusion, Diversity

- Reliance on smartphone-only reduces barriers
- Use of extensive assistive AI technology to combat the digital divide

Smartphone adoption in seniors is skyrocketing!

Statista, 2024
Feasibility

Preliminary Data

Smartphone based Gait and Posture
- 63 HC vs 41 MCI\textsubscript{AD} differences in, e.g., double-support time and torso inclination angle (preliminary data from Stanford)
- Estimation of gait impairment in PD\textsuperscript{[1,2,3]}

SPPB Scores
- Associations with cognitive assessment scores\textsuperscript{[6,7]}

Technical Feasibility

Smartphone-based Gait and Posture
- Track record in the field\textsuperscript{[1,2,3,7]}
- US Patent #11,918,370 with Stanford OTL\textsuperscript{[4]}

AI Assessment Supervision
- Our team brings leading expertise in large vision-language models\textsuperscript{[5]}

IRB Status
- Stanford IRB #33727 for SPPB video recording
- Mobile app development IRB under review
- Will develop a new IRB for Multi-ADRC project

PD := Parkinson’s Disease
OTL := Office of Technology Licensing

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\textsuperscript{[1]} Lu, ..., Adeli "Quantifying Parkinson’s disease motor severity under uncertainty using MDS-UPDRS videos.” Medical Image Analysis 2021.
\textsuperscript{[2]} Endo, ..., Adeli “GaitForemer: Self-supervised pre-training of transformers via human motion forecasting for few-shot gait impairment severity estimation.” MICCAI 2022.
\textsuperscript{[3]} Endo, ..., Adeli, “Data-Driven Discovery of Movement-Linked Heterogeneity in Neurodegenerative Diseases.”, Nature Machine Intelligence (under review, revised), 2024.
\textsuperscript{[7]} Adeli, "Automated Physical Performance Battery as a Digital Marker for Alzheimer’s Disease and Mild Cognitive Impairment “ AAI 2024
Scalability

- Will fit and scale well to the current ADRC programs with minimum additional effort for personnel
- Extracted measurements can be tracked repeatedly over time to ensure timely diagnosis
- We plan on collecting validation data during this project and start early communication with the FDA to certify SPPB++ as SaMD

**Deployment strategies**
- Licensing the underlying technology (white-label)
- Direct commercialization of the app to healthcare providers, pharmaceuticals, and possibly insurers

**Other applications**
- Fall-risk
- Rehabilitation
- Integrating with other digital measures of interest by ADRCs

SaMD := Software as a Medical Device
Thank you!

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