

Smartphone-Based Sit-to-Stand Power Assessment for Frailty Risk Screening

Project Category: Application

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Motivation

Frailty affects approximately 10% of adults over 65 and is a major predictor of falls, hospitalization, and mortality. The 30-second chair stand test is a clinically validated assessment of lower-limb function, but traditional administration only counts repetitions and therefore overlooks critical information about movement quality that research shows better predicts adverse outcomes. Studies demonstrate that sensor-derived parameters like peak acceleration and movement velocity differentiate frailty levels even when repetition counts are identical (Millor et al., 2013). We propose developing a smartphone application that transforms the standard chair stand test into a comprehensive frailty screening tool by combining machine learning-based repetition detection with clinically validated power scoring.

Method

We will train a Random Forest classifier to detect sit-to-stand transitions from smartphone accelerometer and gyroscope data. The model will be trained on the UCI Human Activity Recognition dataset, which contains labeled instances of postural transitions from 30 participants wearing waist-mounted sensors. We will use Leave-One-Subject-Out Cross-Validation (LOSO-CV) to ensure the model generalizes to new users rather than memorizing individual movement patterns. From detected repetitions, we will calculate relative muscle power using the validated Alcázar equation: $\text{Power (W/kg)} = [0.9 \times 9.81 \times (\text{height} \times 0.5 - \text{chair_height})] / (\text{time_per_rep} \times 0.5)$. Additionally, we will extract quality features including peak vertical acceleration, angular velocity, and coefficient of variation across repetitions, comparing these against published reference values from frail and non-frail populations.

Intended Experiments

We will evaluate our approach by assessing sit-to-stand detection accuracy using LOSO-CV on the UCI Human Activity Recognition dataset, targeting >95% precision.

Dataset

UCI Human Activity Recognition dataset: <https://archive.ics.uci.edu/dataset/341/smartphone-based-recognition-of-human-activities-and-postural-transitions>

Prior Research

Millor, N., Lecumberri, P., Gómez, M., Martínez-Ramírez, A., & Izquierdo, M. (2013). "An evaluation of the 30-s chair stand test in older adults: frailty detection based on kinematic parameters from a single inertial unit." *Journal of NeuroEngineering and Rehabilitation*, 10, 86.

Alcázar, J., et al. (2021). "Relative sit-to-stand power: aging trajectories, functionally relevant cut-off points, and normative data in a large European cohort." *Journal of Cachexia, Sarcopenia and Muscle*, 12(4), 1013-1028.