Real-time human activity recognition (HAR) using minimal biomechanics features and IMU-based classification

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Introduction

- Human activity recognition (HAR) is essential for health monitoring, mobility assessment, and improving quality of life.
- Traditional HAR methods often involve high computational costs and extensive datasets, limiting real-time use [1].
- Minimal biomechanical extracted features can be efficient and accurate [2].

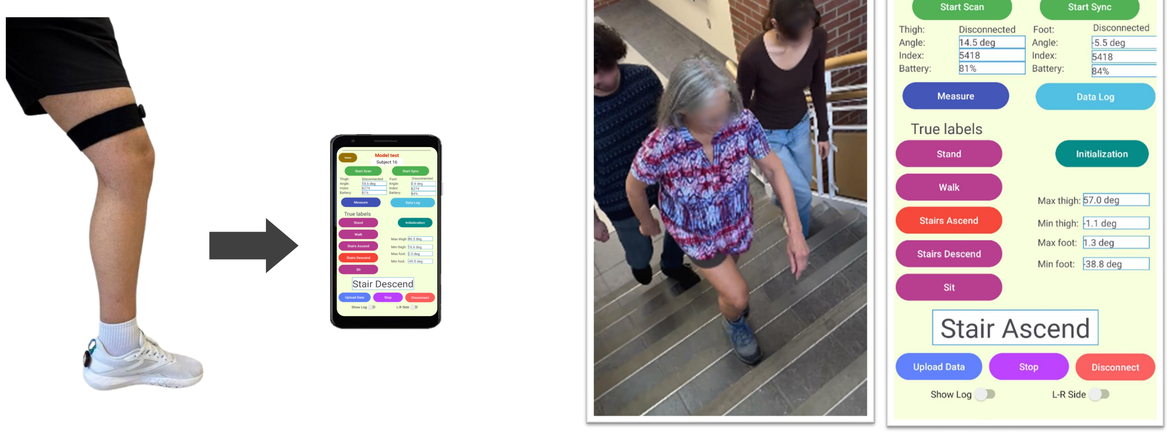


Fig 1. Smartphone application for HAR using IMUs

Objectives

- Classifying **Standing**, **Sitting**, **Walking**, **Stairs Ascending/Descending**
- 10 young adults (age: 20-35) for training the model
- 10 older adults (age: >65) for testing the model
- To develop a real-time, lightweight HAR model using minimal biomechanical features.
- Two IMUs: Thigh and Foot Angles
- Implemented on an Android smartphone.
- Biomechanical features in the segmented window.
- The toe-off moment is used for segmentation
- Classifiers such as KNN, SVM, and NB were used.

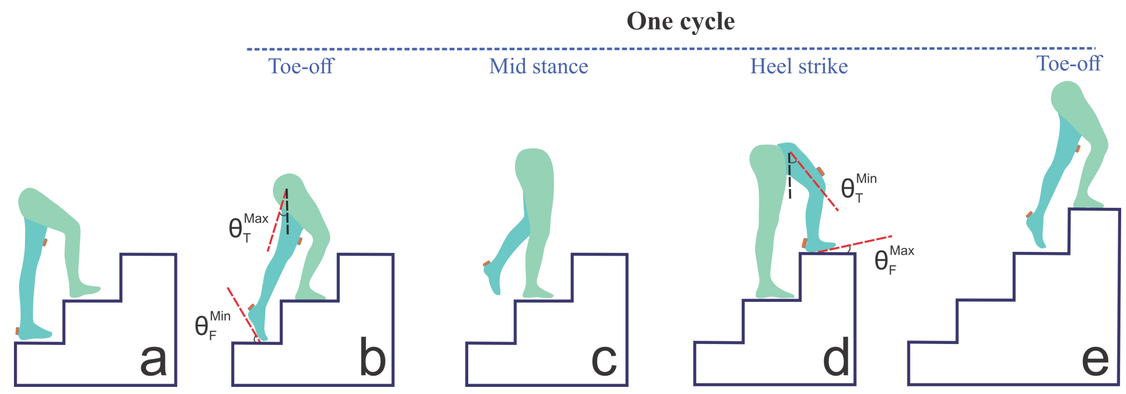


Fig 2. Selected features using IMUs for training the model

Results

Offline Training:

- KNN classifier achieved 100% accuracy.
- Statistical analysis showed no significant differences between young and older adults' biomechanical features, validating the model's generalizability.

Real-time Model Performance:

- Young Adults: 99.4%, Older Adults: 99.3% accuracy.
- Biomechanical feature analysis revealed that thigh angles were consistently significant across activities, underscoring their importance for classification.
- Average computational delay was approximately 52 ms.

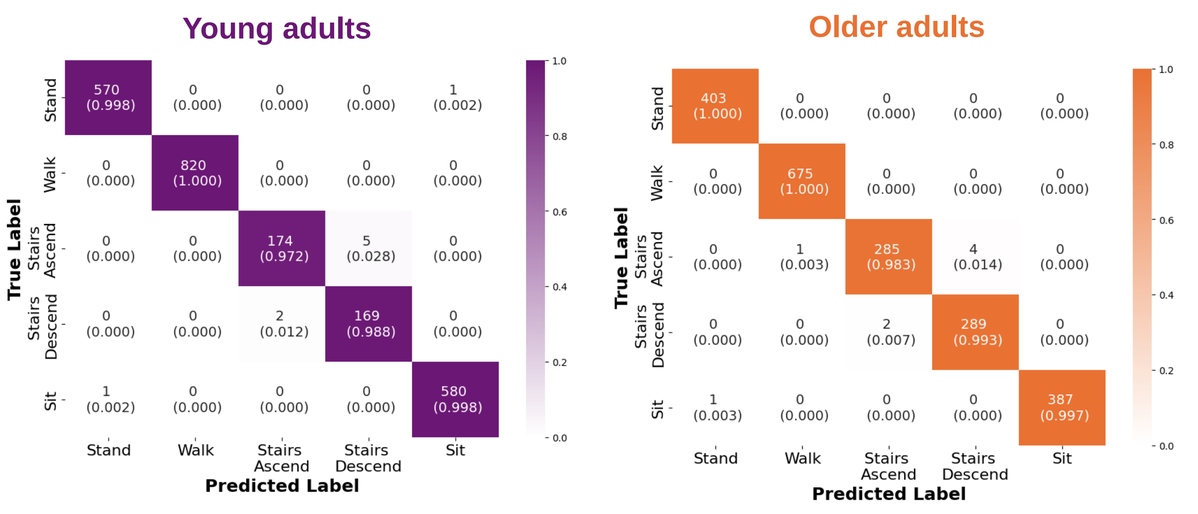


Fig 3. Confusion matrices of accuracy of the model for participants

Conclusion

- A minimal-feature, IMU-based HAR model can achieve high accuracy (≥99%) with significantly reduced computational demands.
- The developed model effectively generalizes from younger adults to older adults.
- Real-time deployment on smartphones supports potential home-based use.

Future Work

- Explore the model's robustness over prolonged home-based monitoring.
- Scalability across larger, more diverse populations.

References:

[1]: Mascret, Quentin, et al. "*Real-time human physical activity recognition with low latency prediction feedback using raw IMU data*." *2018 40th EMBC* IEEE, 2018

[2]: Cheng, Shihao. "*Real-time activity recognition with instantaneous characteristic features of thigh kinematics*." IEEE TNSRE 2021

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