CLASSIFYING PHYSICAL ACTIVITY LEVEL VIA KINEMATIC GAIT DATA

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Introduction

Objective analysis of gait abilities (Gait Analysis, GAn) in clinic is useful for motor assessment and physical activity level (PAL) monitoring in rehabilitation [1]. GAn represents a valuable tool for assessing gait disorders, levels of impairment, and gait parameters that are directly affected by PAL [2]. GAn is based on wearable motion sensors [3] or camera-based systems, generating an extensive set of data difficult to be managed, analysed, and interpreted. Machine Learning (ML) techniques can provide a viable solution to make GAn more manageable in clinic [4]. This study aims to correctly classify subjects' PAL, via ML techniques driven by GAn data.

Methods

Kinematic gait data were collected from 37 healthy subjects (24 male and 13 female, 23 years old ± standard deviation (std_dev) of 3 years) while walking on a treadmill at natural speed. Motion data were acquired from wearable wireless Inertial Measurement Unit (IMU) sensors using as ground-truth a self-reported questionnaire (International Physical Activity Questionnaire - IPAQ). For each subject, consecutive windows of 6 gait cycles were considered for data augmentation. Statistical feature extraction was performed and reduced to the most significant ones via the Neighbourhood Component Analysis (NCA) [5] (20 features retained from lower limbs). **Figure 1** shows the proposed data analysis process.

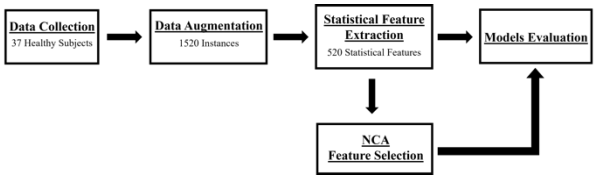

Figure 1: Data analysis process

K-Nearest Neighbors (KNN), Random Forest (RF), Gradient Boosting (GBoost) and Support Vector Machine (SVM) models, have been trained and tested to validate the effectiveness of the approach.

Results

Applying systematic feature selection leads to increased classification performance for the considered models. A 4-Fold Cross Validation evaluated the models' classification ability on unseen data. **Table 1** shows the results in terms of means and std_dev of accuracy.

Model	mean	std_dev
KNN	0.82	0.06
RF	0.86	0.08
GBoost	0.82	0.03
SVM	0.87	0.05

Table 1: 4-Fold Cross Validation models' performances

Discussion

The retained features can be extracted using only seven lower body sensors (pelvis, thighs, shanks, and feet), proving sufficient to predict the PAL with good accuracy. The presented work served as a preliminary test on using ML techniques to extract clinically relevant information from kinematic data for future approaches to discriminate across levels of impairment.

References

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