Evaluation of center of mass energetics during locomotion using computer vision

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Summary

Computer vision techniques have emerged as a reliable approach for estimating gait kinematics. However, the estimation of center of mass (*CoM*) energetic parameters using markerless methods remains unvalidated. This study assessed the accuracy of this techniques in estimating *CoM* energetic parameters by comparing them to a gold-standard motion capture system. Six subjects walked at different speeds on a treadmill while being recorded using both methods. *CoM* energetic parameters were computed and analysed to determine the error between approaches. Results showed relative errors below 5% for energy recovery during walking, suggesting that computer vision techniques hold promise for estimating *CoM* energetic parameters in gait analysis**.**

Introduction

Clinical gait analysis is usually performed using specialized motion capture and processing systems (*MOCAP*). Computer vision techniques have been proposed as an option to extract kinematic features from RGB videos (*Markerless workflow*). The results were similar to those obtained with *MOCAP*, mainly in joint kinematic parameters [1]. To our knowledge, no studies have reported the error level of markerless methods in estimating the energetic parameters of center of mass (CoM) movement during gait. In this study, we analyzed and compared CoM mechanical energy parameters during walking at different speeds using both MOCAP and a markerless approach.

Methods

Six subjects (3 females and 3 males, mass = 66.0 ± 11.65, height = 1.69 ± 0.059) walk at 3, 4, 5, 6 and 7 km/h on a treadmill summarizing 5 trials for subject. All participants signed an informed consent agreement approved by Comité de Ética of CENUR Litoral Norte Universidad de la República, Uruguay (Exp. No 311170-000054-24). Images were captured in each trial using four smartphones (iPhone SE, Apple, USA) at 60 fps for *Markerless workflow* and at 100 Hz eight cameras (Vicon Motion Systems, UK) for *MOCAP*. Images captured with smartphones were processed using Pose2Sim workflow to acquire 3D position of 26 keypoints [1], which were resampled at 100 Hz. MOCAP data were processed using Nexus 2.15 to obtain 3D coordinates of 18 markers and conform the 3D reconstruction based on an 11-segment skeleton model [2]. Segmental method was used to estimate *CoM* 3D position in both approaches, and energy recovery (*Recovery*) was computed according to [3].

Results and Discussion

The results of the differences between both methods reported a mean relative error of 4% in *Recovery.*

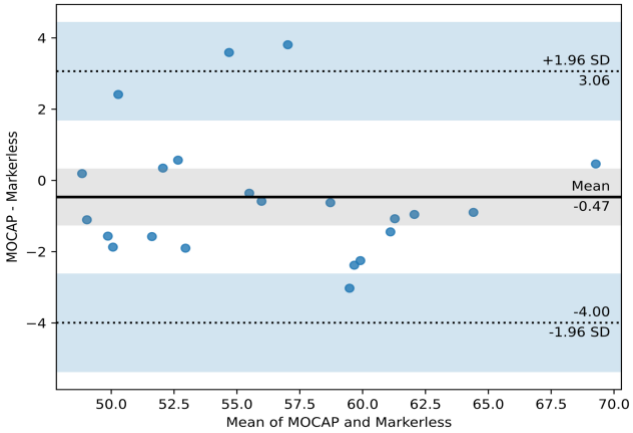

Figure 1: Bland-Altman plot of energy recovery.

Future work should include additional experiments to validate these trends, incorporating data from subjects running at different velocities and individuals with pathological conditions. Additionally, the post processing workflow for markerless data can be further optimized.

Conclusions

This work reports *Recovery* values comparable with those obtained using gold standard techniques, showing acceptable values in a wide speed range during walking.

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References

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