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AUTOMATIC ESTIMATION OF CENTER OF MASS FROM MULTI-CAMERA VIDEO SYSTEM

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1. Introduction

Estimation of Center of mass (CoM) is essential in analysing human movement and posture, and is widely estimated using anthropometric tables (AT) [1]. These tables are, however, based on a population of normal weights, without accounting for high variability in age and body shapes. Alternatively, body segments' volume can not only provide reliable estimation of subject-specific CoM, but also take into account segment deformability. Here we propose an automatic method for estimating CoM from 3D meshes of body envelope computed with a multi-camera video system in different posture.

2. Materials and Methods

Three subjects participated in this study, with mean age: 26.7 ± 2 years and mean BMI: 28 ± 1.8 kg/m². Data collection was performed using a calibrated markerless video camera system (10 RGB full HD cameras, 60 fps). Participants were asked to perform a T-pose and a squat-pose. The multi-stage approach for recovering 3D human meshes from the video-data are: (i) *2D keypoints estimation*, (ii) *Person re-identification*, (iii) *Silhouette extraction*, and (iv) *3D pose and shape estimation*. On the recovered meshes, a predefined segmented template (16 body-segments with anatomical landmarks (AL) as in [1]) was used. Segment coordinate systems (SCS) were defined from the AL [1]. Assuming homogeneous density (1 g/cm³), CoM positions were estimated from volumetric data of each segment derived from the meshes, and expressed in respective SCS. Whole-body CoM was also computed. They were compared to segmental and whole-body CoM positions estimated based on AT [1].

3. Results

In T-pose, CoM differences for all segments (except Pelvis) remain in the range 0-3 cm, indicating good shape approximation from the silhouette. For the squat pose, these differences remain similar except abdomen (~5cm) and thighs (~7cm along SI), possibly due to erroneous pelvis pose (too large pelvis tilt) that should be further investigated. Nevertheless, less than 1.5 cm of difference was observed for the whole-body CoM.

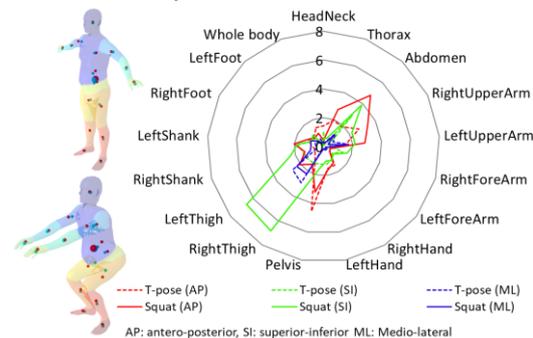


Figure 1: Mean absolute difference between CoM positions (in cm) obtained with volume-based and AT-based method, across all subjects.

4. Discussion and Conclusions

As a first study, we proposed an approach for automatic estimation of CoM positions obtained with volumetric-based method and assessed with classical AT. Preliminary results are promising, yet further investigation is necessary to confirm these results with larger population.

5. References

1. Dumas and Wojtusich, Handbook of Human Motion; 47-77 (2018).

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