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

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### 1. Introduction

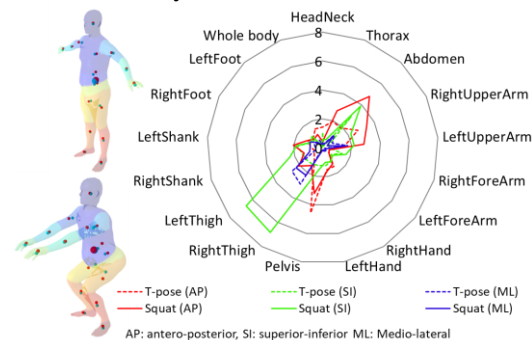
Estimation of Center of mass (CoM) is essential in analysing human movement and posture, and is widely estimated using anthropometric tables (AT) [1]. These tables are, however, based on a population of normal weights, without accounting for high variability in age and body shapes. Alternatively, body 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:  $26.7 \pm 2$  years and mean BMI:  $28 \pm 1.8$  kg/m<sup>2</sup>. 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/cm<sup>3</sup>), 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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