

Estimating Body Segment Inertial Parameters using a Kinect[®]

Pawel Kudzia and Geneviève Dumas

Department of Mechanical and Materials Engineering, Queen's University

Background

Accounting for specific geometric and inertial parameters of body segments increases the accuracy in characterizing the body.

- Body segment inertial parameters (BSIPs) can be influenced by ethnicity, sex and age of the subject [1].
- Inverse or forward dynamic solutions to estimate movement characteristics requires the input of BSIP's specifically:
 - Segment volume
 - Mass
 - Position of center of mass
 - Principal moments of inertia
 - Orientation of principal axes.
- Common estimation methods include: Direct, Mathematical and Photographic each with varying cost, time and accuracy [1].
 - More cost effective and efficient means should be investigated to allow researchers to obtain more accurate biomechanical parameters in their labs without greatly increasing experimental cost.

Purpose

- Develop an inexpensive and simple protocol for researchers seeking to determine subject specific BSIP estimates
- Evaluate the precision of scanning and segmenting 3D bodies
- Evaluate the reliability of estimating BSIPs using a Kinect[®]

Methods

Equipment and Software (\$200)

- Kinect V2[®] camera mounted on a tripod
- Free Software: Meshlab, Netfabb, 3D Builder

Scanning (15 min prep, 20-30 seconds/scan)

- Subjects are weighed and instrumented with anatomical markers placed on bony landmarks used later in post processing
- A clear platform elevated from ground used as standing platform
- Using 3D Builder, Kinect is revolved around subject at 1.5-2m distance. Subject asked to remain still during scan.

Post Processing (20-30min/subject)

- 3D scan saved in color to aid in segmentation process (Fig. 1a)
- Watertight mesh is created to ensure any small holes are filled a combination of Meshlab and Netfabb software.
- Segmentation using markers done in Meshlab (Fig.1b-c)
- Inertial parameters determined about center of mass for each body segment and compared to literature

References

[1] Pearsall, D.J., and Reid, J.G. (1994). The study of human body segment parameters in biomechanics: A historical review and current status report. *Sports Medicine (Auckland, N.Z.)*, 18(2), 126-140.

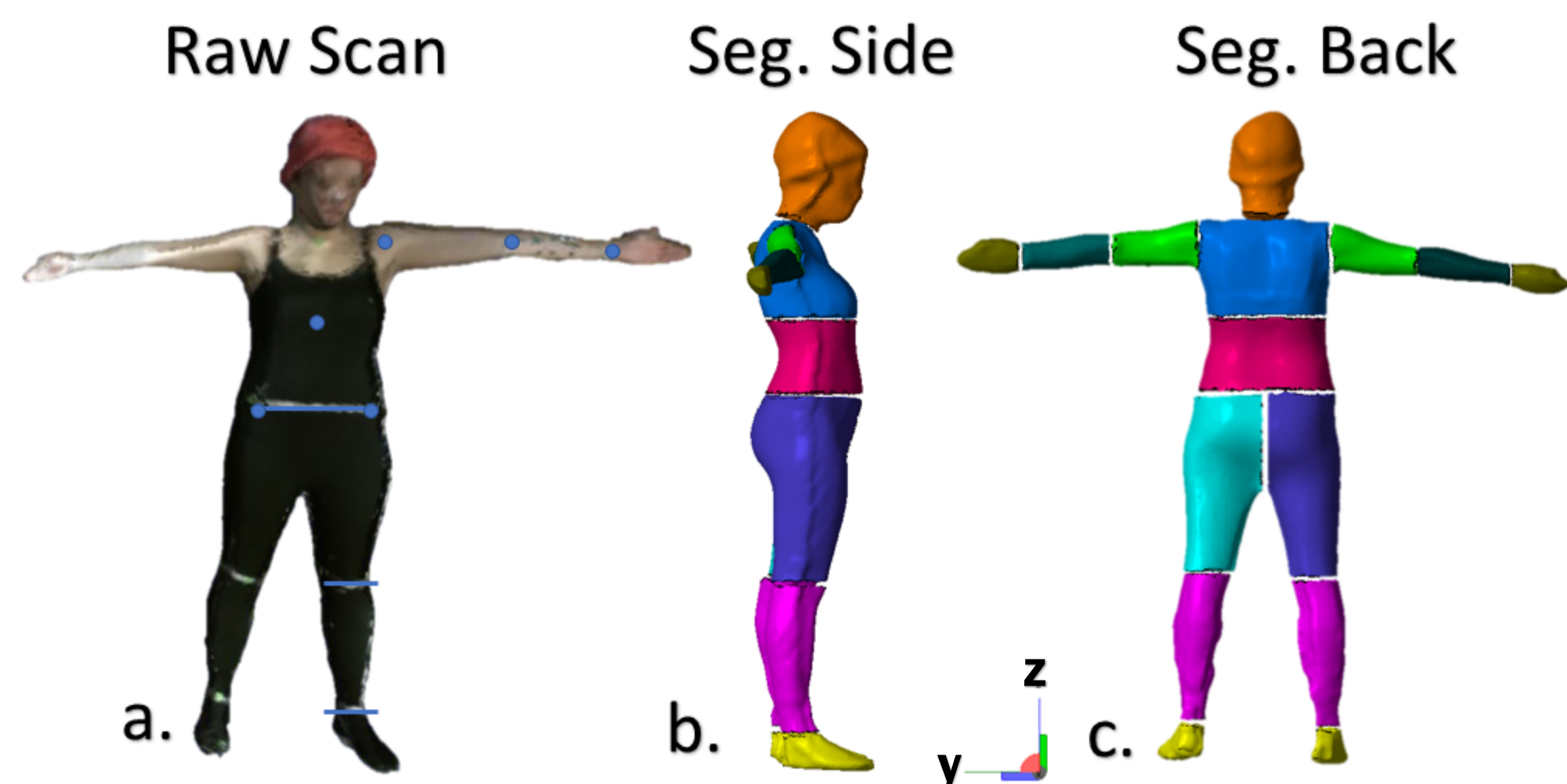


Figure 1: Example raw 3D scan (a) showing segmentation in sagittal (b) and frontal plane (c).

Preliminary Results

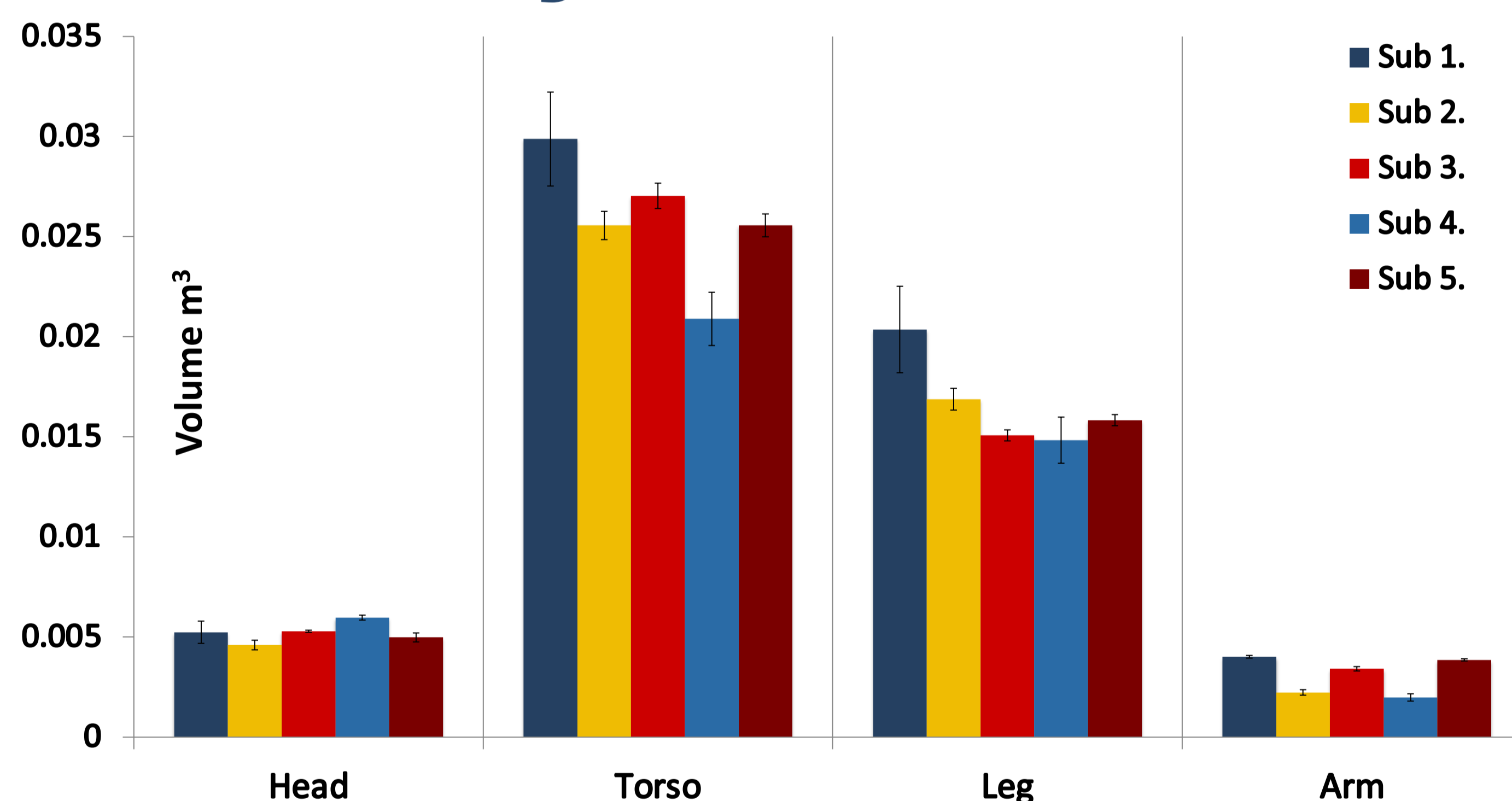


Figure 2: Average volumetric data of Head, Torso, Right Leg and Right Arm of 5 subjects. Standard deviation shown as error bars

A preliminary study of 5 subjects scanned 3 times shows promising results for the volume estimates, with small standard deviations (Figure 2).

- Segmentation markers have shown poor visibility on scans. Using a high contrast band on anatomical landmarks could result in greater precision in segmentation.
- Results show poor precision for foot and hand segments.

Next Steps

- Finalize segmentation protocol
- Determine density values which will be applied to models
- Determine and evaluate wide range of BSIP's for 20 subjects
- Compare results to those obtained using other methods and published results available in literature