

Adjusted Zatsiorsky-Seluyanov's segment inertia parameters

While the original Zatsiorsky-Seluyanov segment inertia parameters (1983) used bony landmarks as reference points, [de Leva \(1996\)](#) adjusted these parameters using joints centres instead, more commonly used in biomechanics. This page lists these adjusted parameters and describes how to use them in Visual3D.

The Adjusted Parameters

Segment Mass (Relative to total body mass)									
Segment				Female	Male				
Head				0.0668	0.0694				
Trunk				0.4257	0.4346				
Upper arm				0.0255	0.0271				
Forearm				0.0138	0.0162				
Hand				0.0056	0.0061				
Thigh				0.1478	0.1416				
Shank				0.0481	0.0433				
Foot				0.0129	0.0137				
Segment centre of mass location (relative to the segment's proximal endpoint)									
Segment								Female	Male
Head								0.4841	0.5002
Trunk								0.4964	0.5138
Upper arm								0.5754	0.5772
Forearm								0.4559	0.4574
Hand								0.7474	0.7900
Thigh								0.3612	0.4095
Shank								0.4352	0.4395
Foot								0.4014	0.4415
Segment radii of gyration									
	Female			Male					
Segment	IXX	IYY	IZZ	IXX	IYY	IZZ			
Head	0.271	0.295	0.261	0.303	0.315	0.261			
Trunk	0.307	0.292	0.147	0.328	0.306	0.169			
Upper arm	0.278	0.260	0.148	0.285	0.269	0.158			
Forearm	0.261	0.257	0.094	0.276	0.265	0.121			
Hand	0.631	0.454	0.335	0.628	0.513	0.401			
Thigh	0.369	0.364	0.162	0.329	0.329	0.149			
Shank	0.267	0.263	0.092	0.251	0.246	0.102			
Foot	0.299	0.279	0.139	0.257	0.245	0.124			

Modifying Inertial Values within Visual3D

The images below show the default segment properties on the left and the modified segment properties on the right. The modified segment properties reflect Zatsiorsky's adjusted segment properties for a female's right thigh.

ORIGINAL

This is an example of the **original** properties using Hanavan's geometric model.

Segments | Segment Properties | IK Constraints | Right Hand

Segment Name: Right Thigh ☐ Kinematic Only

2. Segment Mass: 0.1*Mass = 7.5 kgs

Segment Length: 0.477296 Meters

1. Segment Geometry: CONE

3. Inertial Values* 4. Center of Mass (Meters)*

Expression	Value	Expression	Value
IXX: 0.148669	0.148669	ML: 0*RTH_SEG_	0
IYY: 0.148669	0.148669	AP: 0*RTH_SEG_	0
IZZ: 0.0250052	0.0250052	Axial: 0.432443*RTI	-0.206403

*May be modified for custom geometry

Model File: rthigh.v3g

Material File:

MODIFIED

This is an example of the **modified** properties using De Leva's values.

Segments | Segment Properties | IK Constraints | Right Hand

Segment Name: Right Thigh ☐ Kinematic Only

2. Segment Mass: 0.1478*Mass = 11.085 kgs

Segment Length: 0.477296 Meters

1. Segment Geometry: CUSTOM_SEG

3. Inertial Values* 4. Center of Mass (Meters)*

Expression	Value	Expression	Value
IXX: 0.1478*Mass*((RT	0.343846	ML: 0*RTH_SEG_	0
IYY: 0.1478*Mass*((RT	0.334591	AP: 0*RTH_SEG_	0
IZZ: 0.1478*Mass*((RT	0.0662737	Axial: 0.3612*RTH_	-0.172399

*May be modified for custom geometry

Model File: rthigh.v3g

Material File:

1. Change the **segment geometry** to CUSTOM_SEG

2. To modify the **Mass**, replace the mass factor from the current equation (0.1* Mass) to Zatsiorsky-Seluyanov mass value(For example: "0.1478 * Mass" for a female thigh segment).

3. To modify the **Inertia Values**, the expression has to be entered as: "m*r^2"

Where m is the segment's mass parameter, and r is the IXX, IYY or IZZ radius of gyration parameter. The radius of gyration in De Lava's paper is presented as a percent of segment length, so this value must be multiplied by the length of the segment.

For example, to use the Zatsiorsky-Seluyanov's Inertia Values for the right thigh for a female subject, the following expressions would have to be entered in the IXX, IYY and IZZ fields.

$$\begin{aligned} IXX &= (0.1478*Mass) * ((RTH_SEG_LENGTH * 0.369)^2) \\ IYY &= (0.1478*Mass) * ((RTH_SEG_LENGTH * 0.364)^2) \\ IZZ &= (0.1478*Mass) * ((RTH_SEG_LENGTH * 0.162)^2) \end{aligned}$$

4. To modify the location of the **center of mass** according to Zatsiorsky-Seluyanov's parameters, replace the factor from the current equation (0.444004 * RTH_Seg_Length in the above image) with the corresponding Centre of Mass location parameter (for example: "0.3612 * RTH_Seg_Length" for a

female thigh segment).

The segment length (RTH_SEG_LENGTH) is listed under the Subject Data / Metrics tabs. This value is automatically created when a segment is created.

See Also

Visual3D's default segment parameters are derived from [Dempster's 1955 equations](#).

Reference

- de Leva (1996) Adjustments to Zatsiorsky-Seluyanov's segment Inertia Parameters. **Journal of Biomechanics** Vol.29 No. 9. pp.1223-1230. [DOI](#)
- Dempster, W. T. (1955). Space requirements of the seated operator, geometrical, kinematic, and mechanical aspects of the body with special reference to the limbs (No. WADCTR55159) [link](#)
- Zatsiorsky, V. M., & Seluyanov, V. (1983). The mass and inertial characteristics of the main segments of the human body. In H. Matsui & K. Kobayashi (Eds.), *Biomechanics VIII-B* (pp. 1152-1159). Baltimore: University Park Press.

From:
<https://has-motion.com/wiki/> - Wiki Documentation Site

Permanent link:
https://has-motion.com/wiki/doku.php?id=visual3d:documentation:definitions:adjusted_zatsiorsky-seluyanov_s_segment_inertia_parameters

Last update: 2026/06/12 17:11

