Segment Geometry

Visual3D models segments as cones, cylinders, spheres, and ellipsoids and uses this geometry to inform several quantities relevant for kinetic analyses.

Default Segments

For segments created using a valid default name, the segmental mass is determined from the total body mass and Dempster's regression equations. The user can use the MASS qualifier to override the default value or to specify the mass of a segment with a non-default name. This segmental mass should be entered in kilograms.

The principle moments of inertia are determined from the segmental mass and geometry. The user can use the IXX, IYY and IZZ qualifiers to override the default values or specify the inertia of a segment with a non-default name. The moments of inertia should be entered kg*m 2.

Finally, each segment's centre of gravity location is determined from the segment geometry and expressed relative to the segment's proximal end.

Defining Default Segments

Although these segment types differ geometrically, they all require defined distal and proximal radii to define joints for 6DOF tracking.

Cones - Frusta of right cones

Segments modelled as frusta of right cones require both the proximal and distal segment radii.

- If both a medial and a lateral target are used at the end of a segment during the subject calibration, then the radius at that end is determined to be one-half of the distance between these targets.
- If only a single target is used at a segment end, then a qualifier, either DIST_RAD or PROX_RAD, must be used.

Cylinders - Right elliptical cylinders

Segments modelled as right elliptical cylinders require a proximal segment radius, a distal segment radius (major axis), and a segment depth (minor axis radius).

- The inertial properties of the segment are calculated using the distal radius, the depth and the computed segment length. However, the proximal radius is still required to determine the location of the proximal segment end.
- If both a medial and lateral targets are used at one end of a segment during subject calibration, then the radius at that end is determined to be one-half of the distance between these targets.

- If only a single target is used at the end of a segment then a qualifier, either DIST_RAD or PROX_RAD, must be used.
- The depth of cylindrical segments must always be specified. The cylindrical depth is equal to one-half the distance from anterior to posterior. The qualifier DEPTH is used to specify this distance.

Spheres

Segments modelled as spheres require a proximal segment radius and a distal segment radius.

- The inertial properties of the segment are calculated using only the distal radius. However, the proximal radius is still required to determine the location of the proximal segment end.
- If both a medial and a lateral target are used at one end of a segment during subject calibration, then the radius at that end is determined to be one-half of the distance between these targets.
- If only a single target is used at the end of a segment then a qualifier, either DIST_RAD or PROX_RAD, must be used.

Note: One notable difference arises when creating spherical segments as Visual3D expects the distal targets to be located at 50% of the distance between segment ends. This allows the distal radius to produce a realistic measure of the dimension of the sphere.

Ellipsoids

Segments modelled as ellipsoids require a proximal segment radius and a distal segment radius.

- The inertial properties of the segment are calculated using the distal radius and the computed segment length. However, the proximal radius is still required to determine the location of the proximal segment end.
- If both a medial and lateral targets are used at one end of a segment during subject calibration, then the radius at that end is determined to be one-half of the distance between these targets.
- If only a single target is used at the end of a segment then a qualifier, either DIST_RAD or PROX_RAD, must be used.

Note: One notable difference arises when creating elliptical segments as Visual3D expects the distal targets to be located at 50% of the distance between segment ends. This allows the distal radius to produce a realistic measure of the elliptical dimensions.

Segment Geometry Settings

Radius at the distal segment end (DIST_RAD)

A distal segment radius is required for all segments. It will be used to determine both the locations of the distal segment end and the segmental anthropometric properties. If both medial and lateral targets are used at the distal end of the segment during subject calibration, then the radius at that end is determined to be one-half of the distance between these targets. If only a single target is then

the DIST_RAD qualifier must be used.

Radius at the proximal segment end (PROX_RAD)

A proximal segment radius is required for all segments. It will be used to determine the location of the proximal segment end. If both medial and lateral targets are used at the proximal end of the segment during subject calibration, then the radius at that end is determined to be one-half of the distance between these targets. If only a single target is then the PROX_RAD qualifier must be used. In addition, the proximal segment radius will be used to estimate the anthropometric properties for some geometries.

Depth of Cylindrical Segments (DEPTH)

Visual3D requires the depth of all cylinders to be specified in order to compute the moments of inertia for segments with a cylindrical geometry. The cylindrical depth is equal to one-half the distance from anterior to posterior. The qualifier DEPTH is used to specify this distance.

Custom Segments

Custom segment may be created by selecting “CUSTOM_SEG” and directly modifying the segment properties using the Set_Segment_Properties pipeline command.

References

1. Dempster W.T. (1955) Space requirements of the seated operator : geometrical, kinematic, and mechanical aspects of the body, with special reference to the limbs. Technical Report, Wright-Patterson Air Force Base.
2. Hanavan E. (1964) A Mathematical Model for the Human Body. Technical Report, Wright-Patterson Air Force Base.

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