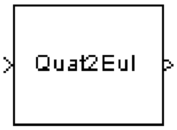
Quaternions to Euler Angles

Convert quaternion vector to Euler angles

Library

Transformations/Axes

Description



The Quaternions to Euler Angles block converts the four-element unit quaternion (q_0,q_1,q_2,q_3) into the equivalent three Euler angle rotations (roll, pitch, yaw).

The conversion is generated by comparing elements in the direction cosine matrix (DCM), as functions of the Euler rotation angles, with elements in the DCM, as functions of a unit quaternion vector.

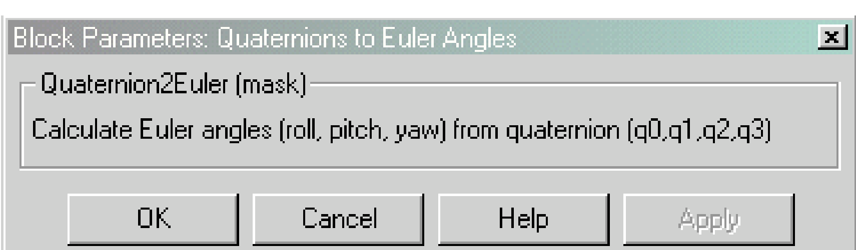
$$DCM = \begin{bmatrix} \cos\theta\cos\psi & \cos\theta\sin\psi & -\sin\theta \\ (\sin\phi\sin\theta\cos\psi - \cos\phi\sin\psi) & (\sin\phi\sin\theta\sin\psi - \cos\phi\cos\psi) & \sin\phi\cos\theta \\ (\cos\phi\sin\theta\cos\psi + \sin\phi\sin\psi) & (\cos\phi\sin\theta\sin\psi - \sin\phi\cos\psi) & \cos\phi\cos\theta \end{bmatrix}$$

$$DCM = \begin{bmatrix} (q_0^2 + q_1^2 - q_2^2 - q_3^2) & 2(q_1q_2 + q_0q_3) & 2(q_1q_3 - q_0q_2) \\ 2(q_1q_2 - q_0q_3) & (q_0^2 - q_1^2 + q_2^2 - q_3^2) & 2(q_2q_3 + q_0q_1) \\ 2(q_1q_3 + q_0q_2) & 2(q_2q_3 - q_0q_1) & (q_0^2 - q_1^2 - q_2^2 + q_3^2) \end{bmatrix}$$

From the preceding, you can derive the following relationships between DCM elements and individual Euler angles:

$$\begin{aligned} \phi &= \mathrm{atan}(DCM(2,3), DCM(3,3)) \\ &= \mathrm{atan}(2(q_2q_3 + q_0q_1), (q_0^2 - q_1^2 - q_2^2 + q_3^2)) \\ \theta &= \mathrm{asin}(-DCM(1,3)) \\ &= \mathrm{asin}(-2(q_1q_3 - q_0q_2)) \\ \psi &= \mathrm{atan}(DCM(1,2), DCM(1,1)) \\ &= \mathrm{atan}(2(q_1q_2 + q_0q_3), (q_0^2 + q_1^2 - q_2^2 - q_3^2)) \end{aligned}$$

Dialog Box



Inputs and Outputs

The input is a 4-by-1 quaternion vector.

The output is a 3-by-1 vector of Euler angles.

Assumptions and Limitations

This implementation generates a pitch angle that lies between ± 90 degrees, and roll and yaw angles that lie between ± 180 degrees.

Examples

See `aero_six_dof.mdl` for an example of the use of the Quaternions to Euler Angles block in an implementation of the equations of motion of a rigid body.

See Also

Direction Cosine Matrix to Euler Angles

Direction Cosine Matrix to Quaternions

Euler Angles to Direction Cosine Matrix

Euler Angles to Quaternions

Quaternions to Direction Cosine Matrix