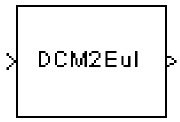
Direction Cosine Matrix to Euler Angles

Convert direction cosine matrix to Euler angles

Library

Transformations/Axes

Description



The Direction Cosine Matrix to Euler Angles block converts a 3-by-3 direction cosine matrix (DCM) into three Euler rotation angles. The DCM matrix performs the coordinate transformation of a vector in inertial axes (ox_0, oy_0, oz_0) into a vector in body axes (ox_3, oy_3, oz_3). The order of the axis rotations required to bring (ox_3, oy_3, oz_3) into coincidence with (ox_0, oy_0, oz_0) is first a rotation about ox_3 through the roll angle (ϕ) to axes (ox_2, oy_2, oz_2). Second a rotation about oy_2 through the pitch angle (θ) to axes (ox_1, oy_1, oz_1), and finally a rotation about oz_1 through the yaw angle (ψ) to axes (ox_0, oy_0, oz_0).

$$\begin{bmatrix} ox_3 \\ oy_3 \\ oz_3 \end{bmatrix} = DCM \begin{bmatrix} ox_0 \\ oy_0 \\ oz_0 \end{bmatrix}$$

$$\begin{bmatrix} ox_3 \\ oy_3 \\ oz_3 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\phi & \sin\phi \\ 0 & -\sin\phi & \cos\phi \end{bmatrix} \begin{bmatrix} \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \\ \sin\theta & 0 & \cos\theta \end{bmatrix} \begin{bmatrix} \cos\psi & \sin\psi & 0 \\ -\sin\psi & \cos\psi & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} ox_0 \\ oy_0 \\ oz_0 \end{bmatrix}$$

Combining the three axis transformation matrices defines the following DCM.

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

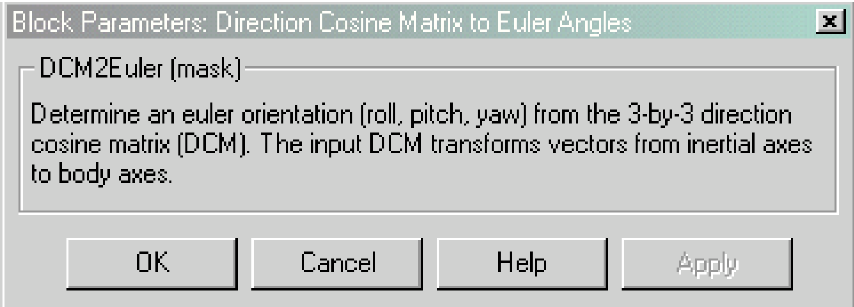
To determine Euler angles from the DCM, the following equations are used:

$$\phi = \operatorname{atan}\left(\frac{DCM(2,3)}{DCM(3,3)}\right)$$

$$\theta = \operatorname{asin}(-DCM(1,3))$$

$$\psi = \operatorname{atan}\left(\frac{DCM(1,2)}{DCM(1,1)}\right)$$

Dialog Box



Inputs and Outputs

The input is a 3-by-3 direction cosine matrix.

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.

See Also

Direction Cosine Matrix to Quaternions

Euler Angles to Direction Cosine Matrix

Euler Angles to Quaternions

Quaternions to Direction Cosine Matrix

Quaternions to Euler Angles