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Type Package

Title Conversion Between Attitude Representations of DCM, Euler Angles, Quaternions, and Euler Vectors

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Description Conversion between attitude representations: DCM, Euler angles, Quaternions, and Euler vectors. Plus conversion between 2 Euler angle set types (xyx, zyz, zxz, xzx, yxy, zyz, xyz, yzx, zxy, xzy, yxz, zyx). Fully vectorized code, with warnings/errors for Euler angles (singularity, out of range, invalid angle order), DCM (orthogonality, not proper, exceeded tolerance to unity determinant) and Euler vectors(not unity). Also quaternion and other useful functions. Based on SpinCalc by John Fuller and SpinConv by Paolo de Leva.

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Contents

DCM2EA	2
DCM2EV	4
DCM2Q	5
DCMrandom	6

EA2DCM	6
EA2EA	8
EA2EV	9
EA2Q	10
EArandom	12
EV2DCM	12
EV2EA	13
EV2Q	15
EVrandom	16
isPureRotationMatrix	16
Q2DCM	17
Q2EA	18
Q2EV	20
Q2GL	21
QangularDifference	22
Qconj	22
Qinv	23
Qlerp	24
Qlog	24
Qnorm	25
Qnormalize	26
Qrandom	26
Qrot	27
Qzero	28
vectQrot	28
z1	29
z2	30
z3	30
z4	31
z5	32
Index	33

DCM2EA

Convert from Direction Cosine Matrix to Euler Angles

Description

DCM2EA converts from Direction Cosine Matrix (DCM) to Euler Angles (EA).

Usage

```
DCM2EA(DCM, EulerOrder='zyx', tol = 10 * .Machine$double.eps, ichk = FALSE,
ignoreAllChk = FALSE)
```

Arguments

DCM	Direction Cosine Matrix (DCM) is a rotation matrix 3x3 (N=1) or an array 3x3xN
EulerOrder	Euler Angles (EA) is a vector [psi, theta, phi]
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Details

Euler Angles (EA) $xyz \Leftrightarrow x(\text{roll}) y(\text{pitch}) z(\text{yaw})$ Type 1 Rotations (Tait-Bryan angles): $xyz - xzy - yxz - yzx - zyx - zxy$ Singular if second rotation angle is -90 or 90 degrees. Type 2 Rotations (proper Euler angles): $xyx - xzx - yxy - yzy - zxz - zyz$ Singular if second rotation angle is 0 or 180 degrees.

Euler angles [psi, theta, phi] range from -90 to 90 degrees. Tait-Bryan angles [psi, theta, phi] range from 0 to 180 degrees. Angles about Euler vectors range from 0 to 180 degrees.

Value

Euler Angles (EA) vector [psi, theta, phi]

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[EA2DCM](#)

Examples

```
DCM <- matrix(c(-0.3573404, -0.1515663, 0.9215940, 0.6460385, 0.6724915,
0.3610947, -0.6744939, 0.7244189, -0.1423907),3,3,byrow=TRUE)
DCM2EA(DCM, 'xyz')
```

DCM2EV

Convert from Direction Cosine Matrix to Euler Vectors

Description

DCM2EV converts from Direction Cosine Matrix (DCM) to Euler Vectors (EV).

Usage

```
DCM2EV(DCM, tol = 10 * .Machine$double.eps, ichk = FALSE, ignoreAllChk = FALSE)
```

Arguments

DCM	Direction Cosine Matrix (DCM) is a rotation matrix 3x3 (N=1) or an array 3x3xN.
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Value

Euler Vectors (EV) vector [m1, m2, m3, MU]

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[EV2DCM](#)

Examples

```
DCM <- matrix(c(-0.3573404, -0.1515663, 0.9215940, 0.6460385, 0.6724915,  
0.3610947, -0.6744939, 0.7244189, -0.1423907),3,3,byrow=TRUE)  
DCM2EV(DCM)
```

DCM2Q*Convert from Direction Cosine Matrix to rotation Quaternions*

Description

DCM2Q converts from Direction Cosine Matrix (DCM) to Quaternions (Q).

Usage

```
DCM2Q(DCM, tol = 10 * .Machine$double.eps, ichk = FALSE, ignoreAllChk = FALSE)
```

Arguments

DCM	Direction Cosine Matrix (DCM) is a rotation matrix 3x3 (N=1) or an array 3x3xN
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Value

Quaternion (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[Q2DCM](#)

Examples

```
DCM <- matrix(c(-0.3573404, -0.1515663, 0.9215940, 0.6460385, 0.6724915,  
0.3610947, -0.6744939, 0.7244189, -0.1423907),3,3,byrow=TRUE)  
DCM2Q(DCM)
```

 DCMrandom

Generate uniform random direction cosine matrices

Description

DCMrandom generates uniform random direction cosine matrices.

Usage

```
DCMrandom(n=NA, tol = 10 * .Machine$double.eps, ignoreAllChk=FALSE)
```

Arguments

n	Optional integer for the number of generated direction cosine matrices, default = 1.
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Value

DCM Direction cosine matrix or array (DCM).

Author(s)

Jose Gama

Examples

```
DCMrandom()
DCMrandom(5)
```

 EA2DCM

Convert from Euler Angles to Direction Cosine Matrix

Description

EA2DCM converts from Euler Angles (EA) to Direction Cosine Matrix (DCM).

Usage

```
EA2DCM(EA, EulerOrder='zyx', tol = 10 * .Machine$double.eps, ichk = FALSE,
ignoreAllChk = FALSE)
```

Arguments

EA	Euler Angles (EA) vector [psi, theta, phi].
EulerOrder	Euler Order (xyx, yzy, zxz, xzx, yxy, yz, xyz, yzx, zxy, xzy, yxz, zyx)
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Details

Euler Angles (EA) $xyz \Leftrightarrow x(\text{roll}) y(\text{pitch}) z(\text{yaw})$ Type 1 Rotations (Tait-Bryan angles): $xyz - xzy - yxz - yzx - zyx - zxy$ Singular if second rotation angle is -90 or 90 degrees. Type 2 Rotations (proper Euler angles): $xyx - xzx - yxy - yzy - zxz - zyz$ Singular if second rotation angle is 0 or 180 degrees.

Euler angles [psi, theta, phi] range from -90 to 90 degrees. Tait-Bryan angles [psi, theta, phi] range from 0 to 180 degrees. Angles about Euler vectors range from 0 to 180 degrees.

Value

Direction Cosine Matrix (DCM) $3 \times 3 \times N$.

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[DCM2EA](#)

Examples

```
EAxyx <- c(-170.6607, 110.937, 136.2344) * (pi/180)
EA2DCM(EAxyx, 'xyx')
```

EA2EA

*Convert from Euler Angles to Euler Angles***Description**

EA2EA converts from Euler Angles (EA) to Euler Angles (EA).

Usage

```
EA2EA(EA, EulerOrder1='zyx', EulerOrder2='zyx', tol = 10 * .Machine$double.eps,
      ichk = FALSE, ignoreAllChk = FALSE)
```

Arguments

EA	Euler Angles (EA) vector [psi, theta, phi].
EulerOrder1	Euler Order 1 (xyx, yzy, zxz, xzx, yxy, zyz, xyz, yzx, zxy, xzy, yxz, zyx)
EulerOrder2	Euler Order 2 (xyx, yzy, zxz, xzx, yxy, zyz, xyz, yzx, zxy, xzy, yxz, zyx)
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Details

Euler Angles (EA) $xyz \Leftrightarrow x(\text{roll}) y(\text{pitch}) z(\text{yaw})$ Type 1 Rotations (Tait-Bryan angles): xyz - xzy - yxz - yzx - zyx - zxy Singular if second rotation angle is -90 or 90 degrees. Type 2 Rotations (proper Euler angles): xyx - xzx - yxy - yzy - zxz - zyz Singular if second rotation angle is 0 or 180 degrees.

Euler angles [psi, theta, phi] range from -90 to 90 degrees. Tait-Bryan angles [psi, theta, phi] range from 0 to 180 degrees. Angles about Euler vectors range from 0 to 180 degrees.

Value

Euler Angles (EA) vector [psi, theta, phi].

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[EA2DCM](#), [EA2Q](#), [EA2EV](#)

Examples

```
## Not run:
EAxyx <- c(-170.6607, 110.937, 136.2344)
EA2EA(EAxyx, 'xyx', 'xyz')
EA2EA(EAxyx, 'xyx', 'zzy')
EA2EA(EAxyx, 'xyx', 'yzx')
EA2EA(EAxyx, 'xyx', 'yxz')
EA2EA(EAxyx, 'xyx', 'zxy')
EA2EA(EAxyx, 'xyx', 'zyx')
EA2EA(EAxyx, 'xyx', 'xzx')
EA2EA(EAxyx, 'xyx', 'yxy')
EA2EA(EAxyx, 'xyx', 'yzy')
EA2EA(EAxyx, 'xyx', 'zxz')
EA2EA(EAxyx, 'xyx', 'zyz')

## End(Not run)
```

EA2EV

Convert from Euler Angles to Euler Vectors

Description

EA2EV converts from Euler Angles (EA) to Euler Vectors (EV).

Usage

```
EA2EV(EA, EulerOrder='zyx', tol = 10 * .Machine$double.eps, ichk = FALSE,
ignoreAllChk = FALSE)
```

Arguments

EA	Euler Angles (EA) vector [psi, theta, phi].
EulerOrder	Euler Order (xyx, yzy, zxz, xzx, yxy, zyz, xyz, yzx, zxy, xzy, yxz, zyx)
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Details

Euler Angles (EA) $xyz \Leftrightarrow x(\text{roll}) y(\text{pitch}) z(\text{yaw})$ Type 1 Rotations (Tait-Bryan angles): $xyz - xzy - yxz - yzx - zyx - zxy$ Singular if second rotation angle is -90 or 90 degrees. Type 2 Rotations (proper Euler angles): $xyx - xzx - yxy - yzy - zxz - zyz$ Singular if second rotation angle is 0 or 180 degrees.

Euler angles $[\psi, \theta, \phi]$ range from -90 to 90 degrees. Tait-Bryan angles $[\psi, \theta, \phi]$ range from 0 to 180 degrees. Angles about Euler vectors range from 0 to 180 degrees.

Value

Euler Vectors (EV) vector $[m1, m2, m3, MU]$.

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[EV2EA](#)

Examples

```
EAxyx <- c(-170.6607, 110.937, 136.2344) * (pi/180)
EA2EV(EAxyx, 'xyx')
```

EA2Q

Convert from Euler Angles to rotation Quaternions

Description

EA2Q converts from Euler Angles (EA) to Quaternions (Q).

Usage

```
EA2Q(EA, EulerOrder='zyx', ichk = FALSE, ignoreAllChk = FALSE)
```

Arguments

EA	Euler Angles (EA) vector [psi, theta, phi].
EulerOrder	Euler Order (xyx, yzy, zxz, xzx, yxy, zyz, xyz, yzx, zxy, xzy, yxz, zyx)
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Details

Euler Angles (EA) $xyz \Leftrightarrow x(\text{roll}) y(\text{pitch}) z(\text{yaw})$ Type 1 Rotations (Tait-Bryan angles): xyz - xzy - yxz - yzx - zyx - zxy Singular if second rotation angle is -90 or 90 degrees. Type 2 Rotations (proper Euler angles): xyx - xzx - yxy - yzy - zxz - zyz Singular if second rotation angle is 0 or 180 degrees.

Euler angles [psi, theta, phi] range from -90 to 90 degrees. Tait-Bryan angles [psi, theta, phi] range from 0 to 180 degrees. Angles about Euler vectors range from 0 to 180 degrees.

Value

Quaternions (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[Q2EA](#)

Examples

```
EAxyx <- c(-170.6607, 110.937, 136.2344) * (pi/180)
EA2Q(EAxyx, 'xyx')
```

EArandom *Generate uniform random Euler Angles*

Description

EArandom generates uniform random Euler Angles.

Usage

```
EArandom(n=NA, EulerOrder='zyx', tol = 10 * .Machine$double.eps, ignoreAllChk=FALSE)
```

Arguments

n	Optional integer for the number of generated Euler Angles, default = 1.
EulerOrder	Euler Order (xyx, yzy, zxz, xzx, yxy, zyz, xyz, yzx, zxy, xzy, yxz, zyx).
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Value

EA	Euler Angles (EA).
----	--------------------

Author(s)

Jose Gama

Examples

```
EArandom()
EArandom(5)
```

EV2DCM *Convert from Euler Vectors to Direction Cosine Matrix*

Description

EV2DCM converts from Euler Vectors (EV) to Direction Cosine Matrix (DCM).

Usage

```
EV2DCM(EV, tol = 10 * .Machine$double.eps, ichk = FALSE, ignoreAllChk = FALSE)
```

Arguments

EV	Euler Vectors (EV) vector [m1, m2, m3, MU].
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Value

Direction Cosine Matrix (DCM) 3x3xN.

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[DCM2EV](#)

Examples

```
EV <- c(-0.1995301, -0.8765382, -0.4380279, 114.4324 * (pi/180))
EV2DCM(EV, 1e-7)
#EV2DCM(EV)
```

EV2EA

Convert from Euler Vectors to Euler Angles

Description

EV2EA converts from Euler Vectors (EV) to Euler Angles (EA).

Usage

```
EV2EA(EV, EulerOrder='zyx', tol = 10 * .Machine$double.eps, ichk = FALSE,
ignoreAllChk = FALSE)
```

Arguments

EV	Euler Vectors (EV) vector [m1, m2, m3, MU].
EulerOrder	Euler Order (xyx, yzy, zxz, xzx, yxy, zyz, xyz, yzx, zxy, xzy, yxz, zyx)
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Details

Euler Angles (EA) $xyz \Leftrightarrow x(\text{roll}) y(\text{pitch}) z(\text{yaw})$ Type 1 Rotations (Tait-Bryan angles): xyz - xzy - yxz - yzx - zyx - zxy Singular if second rotation angle is -90 or 90 degrees. Type 2 Rotations (proper Euler angles): xyx - xzx - yxy - yzy - zxz - zyz Singular if second rotation angle is 0 or 180 degrees.

Euler angles [psi, theta, phi] range from -90 to 90 degrees. Tait-Bryan angles [psi, theta, phi] range from 0 to 180 degrees. Angles about Euler vectors range from 0 to 180 degrees.

Value

Euler Angles (EA) vector [psi, theta, phi].

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[EA2EV](#)

Examples

```
## Not run:
EV <- c(-0.1995301, -0.8765382, -0.4380279, 114.4324 * (pi/180))
EV2EA(EV, 'xyx')

## End(Not run)
```

EV2Q*Convert from Euler Vectors to rotation Quaternions*

Description

EV2Q converts from Euler Vectors (EV) to Quaternions (Q).

Usage

```
EV2Q(EV, tol = 10 * .Machine$double.eps, ichk = FALSE, ignoreAllChk = FALSE)
```

Arguments

EV	Euler Vectors (EV) vector [m1, m2, m3, MU].
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Value

Quaternions (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[Q2EV](#)

Examples

```
EV <- c(-0.1995301, -0.8765382, -0.4380279, 114.4324 * (pi/180))
EV2Q(EV, 1e-7)
#EV2Q(EV)
```

EVrandom	<i>Generate uniform random Euler Vectors</i>
----------	--

Description

EVrandom generates uniform random Euler Vectors.

Usage

```
EVrandom(n=NA, tol = 10 * .Machine$double.eps, ignoreAllChk=FALSE)
```

Arguments

n	Optional integer for the number of generated Euler Vectors, default = 1.
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Value

EV	Euler Vectors (EV).
----	---------------------

Author(s)

Jose Gama

Examples

```
EVrandom()  
EVrandom(5)
```

isPureRotationMatrix	<i>Determine if the variable is a pure rotation matrix</i>
----------------------	--

Description

isPureRotationMatrix determines if a matrix is pure rotation matrix (proper orthogonal matrix) with $\det(m)=1$. isPureQuaternion determines if a quaternion is a pure quaternion. isRealQuaternion determines if a quaternion is a real quaternion. isUnitQuaternion determines if a quaternion is a unit quaternion.

Usage

```
isPureRotationMatrix(DCM, tol = 0.01)
```


Arguments

DCM	Direction Cosine Matrix (DCM) is a rotation matrix 3x3 (N=1) or an array 3x3xN.
tol	Tolerance value.

Value

Logical, TRUE = matrix is pure rotation matrix.

Author(s)

Jose Gama

See Also

[Q2GL](#)

Examples

```
isPureRotationMatrix(matrix(rep(0,9),3,3,byrow=TRUE),.1)
isPureRotationMatrix(matrix(rep(1,9),3,3,byrow=TRUE),.1)
isPureRotationMatrix(matrix(c(0,0,-1,0,1,0,1,0,1),3,3,byrow=TRUE),.1)
DCMx10 <- DCMrandom(10)
isPureRotationMatrix(DCMx10)
```

Q2DCM

Convert from rotation Quaternions to Direction Cosine Matrix

Description

Q2DCM converts from Quaternions to Direction Cosine Matrix (DCM).

Usage

```
Q2DCM(Q, tol = 10 * .Machine$double.eps, ichk = FALSE, ignoreAllChk = FALSE)
```

Arguments

Q	Quaternion (Q) vector [q1, q2, q3, q4].
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Value

Direction Cosine Matrix (DCM) 3x3xN.

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[DCM2Q](#)

Examples

```
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Q2DCM(Q)
```

Q2EA

Convert from rotation Quaternions to Euler Angles

Description

Q2EA converts from Quaternions (Q) to Euler Angles (EA) based on D. M. Henderson (1977). Q2EA.Xiao is the algorithm by J. Xiao (2013) for the Princeton Vision Toolkit - included here to allow reproducible research.

Usage

```
Q2EA(Q, EulerOrder='zyx', tol = 10 * .Machine$double.eps, ichk = FALSE,
ignoreAllChk = FALSE)
```

Arguments

Q	Quaternion (Q) vector [q1, q2, q3, q4].
EulerOrder	Euler Order (xyx, yzy, zxz, xzx, yxy, zyz, xyz, yzx, zxy, xzy, yxz, zyx).
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Details

Euler Angles (EA) $xyz \Leftrightarrow x(\text{roll}) y(\text{pitch}) z(\text{yaw})$ Type 1 Rotations (Tait-Bryan angles): $xyz - xzy - yxz - yzx - zyx - zxy$ Singular if second rotation angle is -90 or 90 degrees. Type 2 Rotations (proper Euler angles): $xyx - xzx - yxy - yzy - zxz - zyz$ Singular if second rotation angle is 0 or 180 degrees.

Euler angles $[\psi, \theta, \phi]$ range from -90 to 90 degrees. Tait-Bryan angles $[\psi, \theta, \phi]$ range from 0 to 180 degrees. Angles about Euler vectors range from 0 to 180 degrees.

Value

Euler Angles (EA) vector $[\psi, \theta, \phi]$.

Author(s)

Jose Gama

References

D. M. Henderson, 1977 Shuttle Program. Euler Angles, Quaternions, and Transformation Matrices Working Relationships. National Aeronautics and Space Administration (NASA), N77-31234/6

J. Xiao, 2013 Princeton Vision Toolkit. Available from: <http://vision.princeton.edu/code.html> <http://vision.princeton.edu/pvt/GCBreader/quaternion.m>

John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-between-dcm-euler-angles-quaternions-and-euler-vectors>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[EA2Q](#)

Examples

```
## Not run:
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Q2EA(Q, 'xyx')

## End(Not run)
```

Q2EV

Convert from rotation Quaternions to Euler Vectors

Description

Q2EV converts from Quaternions (Q) to Euler Vectors (EV).

Usage

```
Q2EV(Q, tol = 10 * .Machine$double.eps, ichk = FALSE, ignoreAllChk = FALSE)
```

Arguments

Q	Quaternion (Q) vector [q1, q2, q3, q4].
tol	Tolerance from deviations from unity for the determinant of rotation matrices or the the vector length for unitary vectors.
ichk	Logical, FALSE=disables near-singularity warnings.
ignoreAllChk	Logical, TRUE=disables all warnings and error checks (use with caution!).

Value

Euler Vectors (EV) vector [m1, m2, m3, MU].

Author(s)

Jose Gama

References

by John Fuller, 14 Jul 2008 SpinCalc, Function to Convert between DCM, Euler angles, Quaternions, and Euler vectors. <http://www.mathworks.com/matlabcentral/fileexchange/20696-function-to-convert-b>

Paolo de Leva, 01 May 2013 SpinConv, Conversion from a rotation representation type to another. <http://www.mathworks.com/matlabcentral/fileexchange/41562-spinconv>

See Also

[EV2Q](#)

Examples

```
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Q2EV(Q)
```

Q2GL

Convert from rotation Quaternions to OpenGL rotation matrix

Description

DCM2EA converts from Quaternions (Q) to OpenGL rotation matrix.

Usage

Q2GL(Q)

Arguments

Q rotation Quaternions (Q) vector [q1, q2, q3, q4].

Value

OpenGL rotation matrix 4x4xN.

Author(s)

Jose Gama

References

Python - IMU Brick 2012 http://www.tinkerforge.com/doc/Software/Bricks/IMU_Brick_Python.html

See Also

[isPureRotationMatrix](#)

Examples

```
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Q2GL(Q)
```


Value

Q Conjugate quaternion (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

Examples

```
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Qconj(Q)
```

Qinv

Quaternion inverse

Description

Qinv calculated the quaternion inverse.

Usage

```
Qinv(Q)
```

Arguments

Q Quaternion (Q) vector [q1, q2, q3, q4].

Value

Q Quaternion inverse (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

Examples

```
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Qinv(Q)
```

Qlerp *Linear quaternion interpolation*

Description

Qlerp linear quaternion interpolation. Qslerp spherical linear interpolation. QslerpNoInvert version of slerp, used by squad, that does not check for $\theta > 90$. Qspline spherical cubic interpolation. Qsquad spherical and Quadrangle linear interpolation. Qbezier Shoemake-Bezier interpolation using De Casteljau algorithm. Qspline for 3 quaternions, q_{n-1} , q_n and q_{n+1} , calculate a control point to be used in spline interpolation.

Usage

```
Qlerp(Q1, Q2, fract)
```

Arguments

Q1	Quaternion (Q) vector [q1, q2, q3, q4].
Q2	Quaternion (Q) vector [q1, q2, q3, q4].
fract	Fraction of .

Value

Q Zero or one-valued quaternion (Q) vector [q1, q2, q3, q4] or matrix $n \times 4$.

Author(s)

Jose Gama

Examples

```
Q1 <- Qrandom()
Q2 <- Qrandom()
Qlerp(Q1, Q2, 0.1)
```

Qlog *Quaternion logarithm*

Description

Qlog performs a quaternion logarithm operation. Qexp performs a quaternion exponential operation.

Usage

```
Qlog(Q)
Qexp(Q)
```


Arguments

Q Quaternion (Q) vector [q1, q2, q3, q4].

Value

Q Result quaternion (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

Examples

```
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Qlog(Q)
Qexp(Q)
```

Qnorm *Norm of a quaternion*

Description

Qnorm calculates the norm of a quaternion.

Usage

```
Qnorm(Q)
```

Arguments

Q Quaternion (Q) vector [q1, q2, q3, q4].

Value

Norm of the quaternion.

Author(s)

Jose Gama

Examples

```
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Qnorm(Q)
```

Qnormalize

Quaternion normalization

Description

Qnormalize performs a quaternion normalization.

Usage

```
Qnormalize(Q)
```

Arguments

Q Quaternion (Q) vector [q1, q2, q3, q4].

Value

Q Normalized quaternion (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

Examples

```
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Qnormalize(Q)
```

Qrandom

Generate uniform random unit quaternions

Description

Qrandom generates uniform random unit quaternions.

Usage

```
Qrandom(n=NA)
```

Arguments

n Optional integer for the number of generated quaternions, default = 1.

Value

Q Uniform random unit quaternion (Q) vector [q1, q2, q3, q4] or matrix n x 4.

Author(s)

Jose Gama

Examples

```
Qrandom()  
Qrandom(5)
```

Qrot*Updates current attitude quaternion*

Description

Qrot updates the current attitude quaternion.

Usage

```
Qrot(Q, w, dT)
```

Arguments

Q	Quaternion (Q) vector [q1, q2, q3, q4].
w	Angular rate values [wx, wy, wz].
dT	Inverse of update rate.

Value

Q	Updated quaternion (Q) vector [q1, q2, q3, q4].
---	---

Author(s)

Jose Gama

Examples

```
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)  
w <- c(0.1, 0.2, 0.3)  
dT <- -.12  
Qrot(Q,w,dT)
```

Qzero *Generate zero-valued quaternions*

Description

Qzero generates zero-valued quaternions. Qone generates one-valued quaternions.

Usage

Qzero(n=NA)

Arguments

n Optional integer for the number of generated quaternions, default = 1.

Value

Q Zero or one-valued quaternion (Q) vector [q1, q2, q3, q4] or matrix n x 4.

Author(s)

Jose Gama

Examples

```
Qzero()
Qzero(5)
Qone()
Qone(5)
```

vectQrot *Rotate a vector by a quaternion*

Description

vectQrot performs a vector rotation by a quaternion.

Usage

vectQrot(Q, rr)

Arguments

Q Quaternion (Q) vector [q1, q2, q3, q4].
rr Vector [x, y, z].

Value

Rotated vector [x, y, z].

Author(s)

Jose Gama

Examples

```
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
v <- c(1, 2, 3)
vectQrot(Q, v)
```

z1

Quaternion multiplication

Description

`%Q*` performs a quaternion multiplication.

Usage

```
Q1 %Q*% Q2
```

Arguments

Q1 Quaternion (Q) vector [q1, q2, q3, q4].
 Q2 Quaternion (Q) vector [q1, q2, q3, q4].

Value

Q Quaternion result of multiplication (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

Examples

```
## Not run:
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Q %Q*% Q

## End(Not run)
```

z2 *Quaternion division*

Description

`%Q/%` performs a quaternion division.

Usage

`Q1 %Q/% Q2`

Arguments

Q1 Quaternion (Q) vector [q1, q2, q3, q4].
 Q2 Quaternion (Q) vector [q1, q2, q3, q4].

Value

Q Quaternion result of division (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

Examples

```
## Not run:
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Q %Q/% Q

## End(Not run)
```

z3 *Quaternion subtraction*

Description

`%Q-%` performs a quaternion subtraction.

Usage

`Q1 %Q-% Q2`

Arguments

Q1 Quaternion (Q) vector [q1, q2, q3, q4].
 Q2 Quaternion (Q) vector [q1, q2, q3, q4].

Value

Q Quaternion result of subtraction (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

Examples

```
## Not run:
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Q %Q-% Q

## End(Not run)
```

z4

Quaternion addition

Description

%Q+% performs a quaternion addition.

Usage

Q1 %Q+% Q2

Arguments

Q1 Quaternion (Q) vector [q1, q2, q3, q4].
Q2 Quaternion (Q) vector [q1, q2, q3, q4].

Value

Q Quaternion sum (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

Examples

```
## Not run:
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)
Q %Q+% Q

## End(Not run)
```

z5

Quaternion dot product

Description

`%Q.%` performs a quaternion dot product.

Usage

`Q1 %Q.% Q2`

Arguments

`Q1` Quaternion (Q) vector [q1, q2, q3, q4].

`Q2` Quaternion (Q) vector [q1, q2, q3, q4].

Value

`Q` Quaternion result of dot product (Q) vector [q1, q2, q3, q4].

Author(s)

Jose Gama

Examples

```
## Not run:  
Q <- c(-0.1677489, -0.7369231, -0.3682588, 0.5414703)  
Q %Q.% Q  
  
## End(Not run)
```


Index

* programming

- DCM2EA, 2
- DCM2EV, 4
- DCM2Q, 5
- DCMrandom, 6
- EA2DCM, 6
- EA2EA, 8
- EA2EV, 9
- EA2Q, 10
- EArandom, 12
- EV2DCM, 12
- EV2EA, 13
- EV2Q, 15
- EVrandom, 16
- isPureRotationMatrix, 16
- Q2DCM, 17
- Q2EA, 18
- Q2EV, 20
- Q2GL, 21
- QangularDifference, 22
- Qconj, 22
- Qinv, 23
- Qlerp, 24
- Qlog, 24
- Qnorm, 25
- Qnormalize, 26
- Qrandom, 26
- Qrot, 27
- Qzero, 28
- vectQrot, 28
- z1, 29
- z2, 30
- z3, 30
- z4, 31
- z5, 32
- %Q*% (z1), 29
- %Q+% (z4), 31
- %Q-% (z3), 30
- %Q.% (z5), 32
- %Q/% (z2), 30
- DCM2EA, 2, 7
- DCM2EV, 4, 13
- DCM2Q, 5, 18
- DCMrandom, 6
- EA2DCM, 3, 6, 9
- EA2EA, 8
- EA2EV, 9, 9, 14
- EA2Q, 9, 10, 19
- EArandom, 12
- EV2DCM, 4, 12
- EV2EA, 10, 13
- EV2Q, 15, 20
- EVrandom, 16
- isPureQuaternion
 - (isPureRotationMatrix), 16
- isPureRotationMatrix, 16, 21
- isRealQuaternion
 - (isPureRotationMatrix), 16
- isUnitQuaternion
 - (isPureRotationMatrix), 16
- Q2DCM, 5, 17
- Q2EA, 11, 18
- Q2EV, 15, 20
- Q2GL, 17, 21
- QangularDifference, 22
- Qbezier (Qlerp), 24
- Qconj, 22
- Qexp (Qlog), 24
- Qinv, 23
- Qlerp, 24
- Qlog, 24
- Qnorm, 25
- Qnormalize, 26
- Qone (Qzero), 28
- Qrandom, 26

Qrot, [27](#)
Qslerp (Qlerp), [24](#)
QslerpNoInvert (Qlerp), [24](#)
Qspline (Qlerp), [24](#)
Qsquad (Qlerp), [24](#)
Qzero, [28](#)

vectQrot, [28](#)

z1, [29](#)
z2, [30](#)
z3, [30](#)
z4, [31](#)
z5, [32](#)