THUNDER

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Chapter 1

File Index

1.1 File List

Here is a list of all documented files with brief descriptions:

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Chapter 2

File Documentation

2.1 include/Geometry/Euler.h File Reference

some description about Euler.h

```
#include <cmath>
#include <gsl/gsl_math.h>
#include "Macro.h"
#include "Typedef.h"
#include "Precision.h"
#include "Random.h"
#include "Functions.h"
```

Functions

- void quaternion_mul (dvec4 &dst, const dvec4 &a, const dvec4 &b)

  Calculate the product of two quaternions.
- dvec4 quaternion_conj (const dvec4 &quat)

  Calculate the conjugate quaternion of a quaternion.
- void angle (double &phi, double &theta, const dvec3 &src)

  Calculate ϕ and θ given a certain direction $\mathbf{v}$.
- void angle (double &phi, double &theta, double &psi, const dmat33 &src)

  Calculate ϕ, θ and ψ of the rotation represented by the rotation matrix $\mathbf{R}$.
- void angle (double &phi, double &theta, double &psi, const dvec4 &src)

  Calculate ϕ, θ and ψ of the rotation represented by the quaternion $\mathbf{q}$.
- void quaternion (dvec4 &dst, const double phi, const double theta, const double psi)

  Calculate the quaternion $\mathbf{q}$ for representing the rotation, given 3 Euler angles ϕ, θ and ψ.
- void quaternion (dvec4 &dst, const double phi, const dvec3 &axis)

  Calculate the quaternion $\mathbf{q}$ for representing the rotation, given the rotation axis $\mathbf{r}$ and the rotation angle around this axis ϕ.
- void quaternion (dvec4 &dst, const dmat33 &src)

  Calculate the quaternion $\mathbf{q}$ for representing the rotation, given the rotation matrix $\mathbf{R}$.
- void rotate2D (dmat22 &dst, const dvec2 &vec)

  Calculate the rotation matrix (2D) $\mathbf{R}$, which rotates the unit vector $\mathbf{v_0} = \{1, 0\}$ to the given unit vector $\mathbf{v}$.
- void rotate2D (dmat22 &dst, const double phi)

Calculate the rotation matrix (2D) $\mathbf{R}$, given the rotation angle ϕ.

- void direction (dvec3 &dst, const double phi, const double theta)

  Caclulate the unit direction vector $\mathbf{v}$, given the rotation angle ϕ and θ.
- void rotate3D (dmat33 &dst, const double phi, const double theta, const double psi)

  Caclulate the rotation matrix $\mathbf{R}$, given the rotation angle ϕ, θ and ψ.
- void rotate3D (dmat33 &dst, const dvec4 &src)

  Calculate the rotation matrix $\mathbf{R}$, given the unit quaternion $\mathbf{q}$ which represents this rotation.
- void rotate3DX (dmat33 &dst, const double phi)

  Calculate the rotation matrix $\mathbf{R}$ which represents the rotation along X-axis with rotation angle ϕ.
- void rotate3DY (dmat33 &dst, const double phi)

  Calculate the rotation matrix $\mathbf{R}$ which represents the rotation along Y-axis with rotation angle ϕ.
- void rotate3DZ (dmat33 &dst, const double phi)

  Calculate the rotation matrix $\mathbf{R}$ which represents the rotation along Z-axis with rotation angle ϕ.
- void alignZ (dmat33 &dst, const dvec3 &vec)

  Calculate the rotation matrix $\mathbf{R}$ which aligns a direction vector $\mathbf{v}$ to Z-axis.
- void rotate3D (dmat33 &dst, const double phi, const dvec3 &axis)

  Calculate the rotation matrix $\mathbf{R}$ which represents the rotation along the axis $\mathbf{v}$ with rotation angle ϕ.
- void reflect3D (dmat33 &dst, const dvec3 &plane)

  Calculate the transformation matrix $\mathbf{M}$ of reflection against a certian plane, which is represented by its normal vector $\mathbf{n}$.
- void swingTwist (dvec4 &swing, dvec4 &twist, const dvec4 &src, const dvec3 &vec)

  Calculate the two quaternions $\mathbf{q_s}$ and $\mathbf{q_t}$, which represent swing and twist along axis $\mathbf{v}$ respectively, representing the rotation represented by quaternion $\mathbf{q}$.
- void randRotate2D (dmat22 &rot)

  Sample a 2D rotation matrix $\mathbf{R}$ from even distribution.
- void randRotate3D (dmat33 &rot)

  Sample a 3D rotation matrix $\mathbf{R}$ from even distribution.

2.1.1 Detailed Description

some description about Euler.h

Details about Euler.h

2.1.2 Function Documentation

2.1.2.1 alignZ()

```
void alignZ (
            dmat33 & dst,
            const dvec3 & vec )
```

Calculate the rotation matrix $\mathbf{R}$ which aligns a direction vector $\mathbf{v}$ to Z-axis.

Parameters

out	*dst*	$\mathbf{R}$
in	*vec*	$\mathbf{v}$

2.1.2.2 angle() [1/3]

```
void angle (
            double & phi,
            double & theta,
            const dvec3 & src )
```

Calculate ϕ and θ given a certain direction $\mathbf{v}$.

Parameters

out	*phi*	ϕ
out	*theta*	θ
in	*src*	$\mathbf{v}$

2.1.2.3 angle() [2/3]

```
void angle (
            double & phi,
            double & theta,
            double & psi,
            const dmat33 & src )
```

Calculate ϕ, θ and ψ of the rotation represented by the rotation matrix $\mathbf{R}$.

Parameters

out	*phi*	ϕ
out	*theta*	θ
out	*psi*	ψ
in	*src*	$\mathbf{R}$

2.1.2.4 angle() [3/3]

```
void angle (
            double & phi,
            double & theta,
            double & psi,
            const dvec4 & src )
```

Calculate ϕ, θ and ψ of the rotation represented by the quaternion $\mathbf{q}$.

Parameters

out	*phi*	ϕ
out	*theta*	θ
out	*psi*	ψ
in	*src*	$\mathbf{q}$

2.1.2.5 direction()

```
void direction (
            dvec3 & dst,
            const double phi,
            const double theta )
```

Caclulate the unit direction vector $\mathbf{v}$, given the rotation angle ϕ and θ.

Parameters

out	*dst*	$\mathbf{v}$
in	*phi*	ϕ
in	*theta*	θ

2.1.2.6 quaternion() [1/3]

```
void quaternion (
            dvec4 & dst,
            const double phi,
            const double theta,
            const double psi )
```

Calculate the quaternion $\mathbf{q}$ for representing the rotation, given 3 Euler angles ϕ, θ and ψ.

Parameters

out	*dst*	$\mathbf{q}$
in	*phi*	ϕ
in	*theta*	θ
in	*psi*	ψ

2.1.2.7 quaternion() [2/3]

```
void quaternion (
            dvec4 & dst,
```

```
            const double phi,
            const dvec3 & axis )
```

Calculate the quaternion $\mathbf{q}$ for representing the rotation, given the rotation axis $\mathbf{r}$ and the rotation angle around this axis ϕ.

Parameters

out	*dst*	$\mathbf{q}$
in	*phi*	ϕ
in	*axis*	$\mathbf{r}$

2.1.2.8 quaternion() [3/3]

```
void quaternion (
            dvec4 & dst,
            const dmat33 & src )
```

Calculate the quaternion $\mathbf{q}$ for representing the rotation, given the rotation matrix $\mathbf{R}$.

Parameters

out	*dst*	$\mathbf{q}$
in	*src*	$\mathbf{R}$

2.1.2.9 quaternion_conj()

```
dvec4 quaternion_conj (
            const dvec4 & quat )
```

Calculate the conjugate quaternion of a quaternion.

Returns

the conjugate quaternion

Parameters

in	*quat*	a quaternion

2.1.2.10 quaternion_mul()

```
void quaternion_mul (
```

```
            dvec4 & dst,
            const dvec4 & a,
            const dvec4 & b )
```

Calculate the product of two quaternions.

Parameters

out	*dst*	product, a quaternion
in	*a*	left multiplier, quaternion
in	*b*	right multiplier, quaternion

2.1.2.11 randRotate2D()

```
void randRotate2D (
            dmat22 & rot )
```

Sample a 2D rotation matrix $\mathbf{R}$ from even distribution.

Parameters

out	*rot*	$\mathbf{R}$

2.1.2.12 randRotate3D()

```
void randRotate3D (
            dmat33 & rot )
```

Sample a 3D rotation matrix $\mathbf{R}$ from even distribution.

Parameters

out	*rot*	$\mathbf{R}$

2.1.2.13 reflect3D()

```
void reflect3D (
            dmat33 & dst,
            const dvec3 & plane )
```

Calculate the transformation matrix $\mathbf{M}$ of reflection against a certian plane, which is represented by its normal vector $\mathbf{n}$.

Parameters

out	*dst*	$\mathbf{M}$
in	*plane*	$\mathbf{n}$

2.1.2.14 rotate2D() [1/2]

```
void rotate2D (
            dmat22 & dst,
            const dvec2 & vec )
```

Calculate the rotation matrix (2D) $\mathbf{R}$, which rotates the unit vector $\mathbf{v_0} = \{1, 0\}$ to the given unit vector $\mathbf{v}$.

Parameters

out	*dst*	$\mathbf{R}$
in	*vec*	$\mathbf{v}$

2.1.2.15 rotate2D() [2/2]

```
void rotate2D (
            dmat22 & dst,
            const double phi )
```

Calculate the rotation matrix (2D) $\mathbf{R}$, given the rotation angle ϕ.

Parameters

out	*dst*	$\mathbf{R}$
in	*phi*	ϕ

2.1.2.16 rotate3D() [1/3]

```
void rotate3D (
            dmat33 & dst,
            const double phi,
            const double theta,
            const double psi )
```

Caclulate the rotation matrix $\mathbf{R}$, given the rotation angle ϕ, θ and ψ.

Parameters

out	*dst*	$\mathbf{R}$
in	*phi*	ϕ
in	*theta*	θ
in	*psi*	ψ

2.1.2.17 rotate3D() [2/3]

```
void rotate3D (
            dmat33 & dst,
            const dvec4 & src )
```

Calculate the rotation matrix $\mathbf{R}$, given the unit quaternion $\mathbf{q}$ which represents this rotation.

Parameters

out	*dst*	$\mathbf{R}$
in	*src*	$\mathbf{q}$

2.1.2.18 rotate3D() [3/3]

```
void rotate3D (
            dmat33 & dst,
            const double phi,
            const dvec3 & axis )
```

Calculate the rotation matrix $\mathbf{R}$ which represents the rotation along the axis $\mathbf{v}$ with rotation angle ϕ.

Parameters

out	*dst*	$\mathbf{R}$
in	*phi*	ϕ
in	*axis*	$\mathbf{v}$

2.1.2.19 rotate3DX()

```
void rotate3DX (
            dmat33 & dst,
            const double phi )
```

Calculate the rotation matrix $\mathbf{R}$ which represents the rotation along X-axis with rotation angle ϕ.

Parameters

out	*dst*	$\mathbf{R}$
in	*phi*	ϕ

2.1.2.20 rotate3DY()

```
void rotate3DY (
            dmat33 & dst,
            const double phi )
```

Calculate the rotation matrix $\mathbf{R}$ which represents the rotation along Y-axis with rotation angle ϕ.

Parameters

out	*dst*	$\mathbf{R}$
in	*phi*	ϕ

2.1.2.21 rotate3DZ()

```
void rotate3DZ (
            dmat33 & dst,
            const double phi )
```

Calculate the rotation matrix $\mathbf{R}$ which represents the rotation along Z-axis with rotation angle ϕ.

Parameters

out	*dst*	$\mathbf{R}$
in	*phi*	ϕ

2.1.2.22 swingTwist()

```
void swingTwist (
            dvec4 & swing,
            dvec4 & twist,
            const dvec4 & src,
            const dvec3 & vec )
```

Calculate the two quaternions $\mathbf{q_s}$ and $\mathbf{q_t}$, which represent swing and twist along axis $\mathbf{v}$ respectively, representing the rotation represented by quaternion $\mathbf{q}$.

Parameters

out	*swing*	$\mathbf{q_s}$
out	*twist*	$\mathbf{q_t}$
in	*src*	$\mathbf{q}$
in	*vec*	$\mathbf{v}$

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