vmath

vmath-0.13

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Contents

Chapter 1

Intro

Vector mathematics for computer graphics

1.1 Features

- basic arithmetic operations - using operators
- basic linear algebra operations - such as transpose, dot product, etc.
- aliases for vertex coordinates - it means:

  ```
  Vector3f v;
  // use vertex coordinates
  v.x = 1; v.y = 2; v.z = -1;

  // use texture coordinates
  v.s = 0; v.t = 1; v.u = 0.5;
  // use color coordinates
  v.r = 1; v.g = 0.5; v.b = 0;
  ```

- conversion constructor and assign operators - so you can assign a value of Vector3<T1> type to a variable of Vector3<T2> type for any convertible T1, T2 type pairs. In other words, you can do this:

  ```
  Vector3f f3; Vector3d d3 = f3;
  ...
  f3 = d3;
  ```

1.2 types

- Vector2 Two dimensional vector
  - float — Vector2f
  - double — Vector2d
  - int — Vector2i

- Vector3 Three dimensional vector
  - float — Vector3f
  - double — Vector3d
  - int — Vector3i
- Vector4 Four dimensional vector
  - float — Vector4f
  - double — Vector4d
  - int — Vector4i
- Matrix3 Matrix 3x3
  - float — Matrix3f
  - double — Matrix3d
  - int — Matrix3i
- Matrix4 Matrix 4x4
  - float — Matrix4f
  - double — Matrix4d
  - int — Matrix4i
- Quaternion
  - float — Quatf
  - double — Quatd
- Aabb3 axes-aligned bounding-box
  - float — Aabb3f
  - double — Aabb3d

Chapter 2

License

vmath, set of classes for computer graphics mathematics.

Chapter 3

Class Index

3.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 4

File Index

4.1 File List

Here is a list of all files with brief descriptions:

Chapter 5

Class Documentation

5.1 Aabb3< T > Class Template Reference

Axes-aligned bounding-box (aka AABB) class.

```
#include <vmath.h>
```

Public Member Functions

- Aabb3 ()

  Constructs invalid axes-aligned bounding-box.
- template<typename SrcT >
  Aabb3 (const Vector3< SrcT > &point)

  Constructs axes-aligned bound-box containing one point point.
- template<typename SrcT >
  Aabb3 (SrcT x0, SrcT y0, SrcT z0, SrcT x1, SrcT y1, SrcT z1)

  Constructs axes-aligned bounding-box form two corner points (x0, y0, z0) and (x1, y1, z1)
- template<typename SrcT >
  Aabb3 (SrcT x, SrcT y, SrcT z)

  Constructs axes-aligned bounding-box containing point (x, y, z)
- template<typename SrcT >
  Aabb3 (const Aabb3< SrcT > &src)

  Creates copy of axis-aligned bounding-box.
- template<typename SrcT >
  Aabb3< T > & operator= (const Aabb3< SrcT > &rhs)

  Assign operator.
- bool valid () const

  Checks if bounding-box is valid.
- void invalidate ()

  Makes this bounding-box invalid.
- template<typename SrcT >
  void extend (const Vector3< SrcT > &point)

  Extends this bounding-box by a point point.
- template<typename SrcT >
  void extend (const Aabb3< SrcT > &box)

  Extends this bounding-box by a box box.

- template<typename SrcT >
  Aabb3< T > extended (const Vector3< SrcT > &point) const

  Gets a copy of this bounding-box extend by a point point.
- template<typename SrcT >
  Aabb3< T > extended (const Aabb3< SrcT > &box) const

  Gets a copy of this bounding-box extnended by box box.
- template<typename SrcT >
  bool intersects (const Vector3< SrcT > &point) const

  Tests if the point point is within this bounding-box.
- template<typename SrcT >
  bool intersects (const Aabb3< SrcT > &box) const

  Tests if other bounding-box box intersects (even partially) with this bouding-box.
- template<typename SrcT >
  Aabb3< T > intersection (const Aabb3< SrcT > &other) const

  Gets result of intersection of this bounding-box with other bounding-box.
- Vector3< T > center () const

  Gets center point of bounding-box.
- Vector3< T > extent () const

  Gets extent of bounding-box.
- Vector3< T > size () const

  Gets diagonal size of bounding-box.
- Vector3< T > point (size_t i) const

  Gets all 8 corner-points of bounding box.
- Aabb3< T > transformed (const Matrix4< T > &t) const

  Gets transformed bounding-box by transform t.
- template<typename RhsT >
  bool operator== (const Aabb3< RhsT > &rhs) const

  Tests if rhs is equal to this bounding-box.
- template<typename RhsT >
  bool operator!= (const Aabb3< RhsT > &rhs) const

  Tests if rhs is not equal to this bounding-box.
- Aabb3< T > operator* (const Matrix4< T > &rhs) const

  Gets transformed bounding-box by transform rhs.
- Aabb3< T > & operator*= (const Matrix4< T > &rhs)

  Apply transform rhs to this bounding-box.
- template<typename SrcT >
  Aabb3< T > & operator<< (const Vector3< SrcT > &rhs)

  Extends this bounding-box by point rhs.
- template<typename SrcT >
  Aabb3< T > & operator<< (const Aabb3< SrcT > &rhs)

  Extends this bounding-box by box rhs.
- template<typename RhsT >
  Aabb3< T > operator| (const Aabb3< RhsT > &rhs) const

  Union of this and rhs bounding-boxes.
- template<typename RhsT >
  Aabb3< T > operator & (const Aabb3< RhsT > &rhs) const

  Intersection of this and rhs bounding-boxed.

Public Attributes

- Vector3< T > min

  Position of Min corner of bounding box.
- Vector3< T > max

  Position of Max corner of bounding box.

Friends

- std::ostream & operator<< (std::ostream &lhs, const Aabb3< T > &rhs)
  Outputs string representation of bounding-box rhs to output stream lhs.

5.1.1 Detailed Description

template<typename T>
class Aabb3< T >

Axes-aligned bounding-box (aka AABB) class.

This class provides functionality for:

- creating AABB from point, or other AABB,
- testing if point of other AABB intersects with,
- getting result of intersection with other AABB,
- transforming AABB with 4x4 matrix.

There are also overloaded couple of operators to shorten common operation. For instance you can use `operator<<` on AABB to extend it with passed point or other AABB.

```
Aabb3f aabb;
aabb << Vector3f(1, 1, 2) << Aabb3f(-3,-3,-3, 2, 2, 2);
```

5.1.2 Constructor & Destructor Documentation

5.1.2.1 Aabb3() [1/5]

```
template<typename T>
Aabb3< T >::Aabb3 ( )  [inline]
```

Constructs invalid axes-aligned bounding-box.

See also

valid() for explanation of invalid bounding-box usage.

5.1.2.2 Aabb3() [2/5]

```
template<typename T>
template<typename SrcT >
Aabb3< T >::Aabb3 (
            const Vector3< SrcT > & point )  [inline]
```

Constructs axes-aligned bound-box containing one point *point*.

Parameters

point	

5.1.2.3 Aabb3() [3/5]

```
template<typename T>
template<typename SrcT >
Aabb3< T >::Aabb3 (
             SrcT x0,
             SrcT y0,
             SrcT z0,
             SrcT x1,
             SrcT y1,
             SrcT z1 )  [inline]
```

Constructs axes-aligned bounding-box form two corner points (*x0*, *y0*, *z0*) and (*x1*, *y1*, *z1*)

Parameters

x0	X-coordinate of first point
y0	Y-coordinate of first point
z0	Z-coordinate of first point
x1	X-coordinate of second point
y1	Y-coordinate of second point
z1	Z-coordinate of second point

5.1.2.4 Aabb3() [4/5]

```
template<typename T>
template<typename SrcT >
Aabb3< T >::Aabb3 (
             SrcT x,
             SrcT y,
             SrcT z )  [inline]
```

Constructs axes-aligned bounding-box containing point (*x*, *y*, *z*)

Parameters

x	X-coordinate of point
y	Y-coordinate of point
z	Z-coordinate of point

5.1.2.5 Aabb3() [5/5]

```
template<typename T>
template<typename SrcT >
Aabb3< T >::Aabb3 (
             const Aabb3< SrcT > & src )  [inline]
```

Creates copy of axis-aligned bounding-box.

Parameters

src	Source bounding-box

5.1.3 Member Function Documentation

5.1.3.1 center()

```
template<typename T>
Vector3<T> Aabb3< T >::center ( ) const  [inline]
```

Gets center point of bounding-box.

Returns

A center point of bounding-box.

5.1.3.2 extend() [1/2]

```
template<typename T>
template<typename SrcT >
void Aabb3< T >::extend (
             const Vector3< SrcT > & point )  [inline]
```

Extends this bounding-box by a point *point*.

Parameters

point	A point to extend bounding-box by.

5.1.3.3 extend() [2/2]

```
template<typename T>
```

```
template<typename SrcT >
void Aabb3< T >::extend (
             const Aabb3< SrcT > & box )  [inline]
```

Extends this bounding-box by a box *box*.

Parameters

box	A box to extend this bounding-box by.

5.1.3.4 extended() [1/2]

```
template<typename T>
template<typename SrcT >
Aabb3<T> Aabb3< T >::extended (
             const Vector3< SrcT > & point ) const  [inline]
```

Gets a copy of this bounding-box extend by a point *point*.

Parameters

point	A point to extend the box by

Returns

Copy of extended bounding-box

5.1.3.5 extended() [2/2]

```
template<typename T>
template<typename SrcT >
Aabb3<T> Aabb3< T >::extended (
             const Aabb3< SrcT > & box ) const  [inline]
```

Gets a copy of this bounding-box extnended by box *box*.

Parameters

box	A box to extend the copy be.

Returns

Copy of extended bounding-box

5.1.3.6 extent()

```
template<typename T>
Vector3<T> Aabb3< T >::extent ( ) const  [inline]
```

Gets extent of bounding-box.

Returns

Extent of bounding-box.

5.1.3.7 intersection()

```
template<typename T>
template<typename SrcT >
Aabb3<T> Aabb3< T >::intersection (
              const Aabb3< SrcT > & other ) const  [inline]
```

Gets result of intersection of this bounding-box with *other* bounding-box.

In case the boxes don't intersect, the returned bounding-box is invalid.

Parameters

other	Box to be tested

Returns

Result of intersection.

See also

valid() method for more information on invalid bounding-boxes.

5.1.3.8 intersects() [1/2]

```
template<typename T>
template<typename SrcT >
bool Aabb3< T >::intersects (
              const Vector3< SrcT > & point ) const  [inline]
```

Tests if the point *point* is within this bounding-box.

Parameters

point	A point to be tested

Returns

True if point *point* lies within bounding-box, otherwise false.

5.1.3.9 intersects() [2/2]

```
template<typename T>
template<typename SrcT >
bool Aabb3< T >::intersects (
             const Aabb3< SrcT > & box ) const  [inline]
```

Tests if other bounding-box *box* intersects (even partially) with this bouding-box.

Parameters

box	A box to be tested for intersection.

Returns

True if there's intersection between boxes, otherwise false.

5.1.3.10 invalidate()

```
template<typename T>
void Aabb3< T >::invalidate ( )  [inline]
```

Makes this bounding-box invalid.

So calling valid() gets false.

See also

valid() method for more info on usage of invalid bounding-boxes.

5.1.3.11 operator &()

```
template<typename T>
template<typename RhsT >
Aabb3<T> Aabb3< T >::operator& (
             const Aabb3< RhsT > & rhs ) const  [inline]
```

Intersection of this and *rhs* bounding-boxed.

Parameters

rhs	Right-hand side

Returns

Resulting bouding-box representing the intersection.

5.1.3.12 operator"!=()

```
template<typename T>
template<typename RhsT >
bool Aabb3< T >::operator!= (
            const Aabb3< RhsT > & rhs ) const  [inline]
```

Tests if *rhs* is not equal to this bounding-box.

Parameters

rhs	Right-hand side

Returns

True if *rhs* and this bounding-boxes are not equal, otherwise false

5.1.3.13 operator∗()

```
template<typename T>
Aabb3<T> Aabb3< T >::operator∗ (
            const Matrix4< T > & rhs ) const  [inline]
```

Gets transformed bounding-box by transform *rhs*.

Parameters

rhs	Matrix 4x4 representing the transform

Returns

Transformed bounding-box

5.1.3.14 operator*=()

```
template<typename T>
Aabb3<T>& Aabb3< T >::operator*= (
             const Matrix4< T > & rhs )  [inline]
```

Apply transform *rhs* to this bounding-box.

Parameters

rhs	A transform to be applied

Returns

Reference to this

5.1.3.15 operator<<() [1/2]

```
template<typename T>
template<typename SrcT >
Aabb3<T>& Aabb3< T >::operator<< (
             const Vector3< SrcT > & rhs )  [inline]
```

Extends this bounding-box by point *rhs*.

Parameters

rhs	A point to extend this bounding-box by

Returns

Reference to this

5.1.3.16 operator<<() [2/2]

```
template<typename T>
template<typename SrcT >
Aabb3<T>& Aabb3< T >::operator<< (
             const Aabb3< SrcT > & rhs )  [inline]
```

Extends this bounding-box by box *rhs*.

Parameters

rhs	A box to extend this bounding-box by

Returns

Reference to this

5.1.3.17 operator=()

```
template<typename T>
template<typename SrcT >
Aabb3<T>& Aabb3< T >::operator= (
             const Aabb3< SrcT > & rhs )  [inline]
```

Assign operator.

Parameters

rhs	source bounding-box

Returns

refenrence to this

5.1.3.18 operator==()

```
template<typename T>
template<typename RhsT >
bool Aabb3< T >::operator== (
             const Aabb3< RhsT > & rhs ) const  [inline]
```

Tests if *rhs* is equal to this bounding-box.

Parameters

rhs	Right-hand side

Returns

True if *rhs* and this bounding-boxes are equal, otherwise false

5.1.3.19 operator" | ()

```
template<typename T>
template<typename RhsT >
```

```
Aabb3<T> Aabb3< T >::operator| (
             const Aabb3< RhsT > & rhs ) const  [inline]
```

Union of this and *rhs* bounding-boxes.

Parameters

rhs	Right-hand side of union

Returns

A resulting bounding-box representing union

5.1.3.20 point()

```
template<typename T>
Vector3<T> Aabb3< T >::point (
             size_t i ) const  [inline]
```

Gets all 8 corner-points of bounding box.

Parameters

i	An index of bounding-box corner point. Valid values are 0 .. 7.

Returns

A position of *i-th* corner-point.

Note

The order of points is as follows (where $+$ denotes max-point and $-$ min-point):

1. $(+ + +)$
2. $(- + +)$
3. $(+ - +)$
4. $(- - +)$
5. $(+ + -)$
6. $(- + -)$
7. $(+ - -)$
8. $(- - -)$

5.1.3.21 size()

```
template<typename T>
Vector3<T> Aabb3< T >::size ( ) const  [inline]
```

Gets diagonal size of bounding-box.

Returns

Sizes for particular dimensions.

5.1.3.22 transformed()

```
template<typename T>
Aabb3<T> Aabb3< T >::transformed (
             const Matrix4< T > & t ) const  [inline]
```

Gets transformed bounding-box by transform *t*.

Parameters

t	A transform matrix

Returns

Transformed bounding-box

5.1.3.23 valid()

```
template<typename T>
bool Aabb3< T >::valid ( ) const  [inline]
```

Checks if bounding-box is valid.

Valid bounding-box has non-negative size. If an invalid bounding-box is extended by point or another bounding-box, the target bounding box becomes valid and contains solely the source point or bounding-box respectively.

Returns

True if box is valid, otherwise false

5.1.4 Friends And Related Function Documentation

5.1.4.1 operator<<

```
template<typename T>
std::ostream& operator<< (
             std::ostream & lhs,
             const Aabb3< T > & rhs )  [friend]
```

Outputs string representation of bounding-box *rhs* to output stream *lhs*.

Parameters

lhs	Output stream to write to
rhs	Bounding-box to write to output stream.

Returns

Reference to output stream *lhs*

5.1.5 Member Data Documentation

5.1.5.1 max

```
template<typename T>
Vector3<T> Aabb3< T >::max
```

Position of Max corner of bounding box.

5.1.5.2 min

```
template<typename T>
Vector3<T> Aabb3< T >::min
```

Position of Min corner of bounding box.

The documentation for this class was generated from the following file:

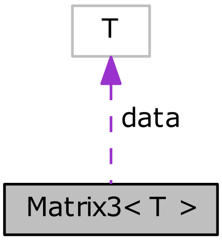
- src/vmath.h

5.2 Matrix3< T > Class Template Reference

Class for matrix 3x3.

```
#include <vmath.h>
```

Collaboration diagram for Matrix3< T >:



Public Member Functions

- Matrix3 ()

  Creates identity matrix.
- Matrix3 (const T ∗dt)

  Copy matrix values from array (these data must be in column major order!)
- Matrix3 (const Matrix3< T > &src)

  Copy constructor.
- template<class FromT >
  Matrix3 (const Matrix3< FromT > &src)

  Copy casting constructor.
- void identity ()

  Resets matrix to be identity matrix.
- bool operator== (const Matrix3< T > &rhs) const

  Equality test operator.
- bool operator!= (const Matrix3< T > &rhs) const

  Inequality test operator.
- T & at (int x, int y)

  Get reference to element at position (x,y).
- const T & at (int x, int y) const

  Get constant reference to element at position (x,y).
- T & operator() (int i, int j)

  Get reference to element at position (i,j), with math matrix notation.
- const T & operator() (int i, int j) const

  Get constant reference to element at position (i,j), with math matrix notation.
- Matrix3< T > & operator= (const Matrix3< T > &rhs)

  Copy operator.
- template<class FromT >
  Matrix3< T > & operator= (const Matrix3< FromT > &rhs)

  Copy casting operator.
- Matrix3< T > & operator= (const T ∗rhs)

  Copy operator.
- Matrix3< T > operator+ (const Matrix3< T > &rhs) const

  Addition operator.
- Matrix3< T > operator- (const Matrix3< T > &rhs) const

  Subtraction operator.
- Matrix3< T > operator+ (T rhs) const

  Addition operator.
- Matrix3< T > operator- (T rhs) const

  Subtraction operator.
- Matrix3< T > operator∗ (T rhs) const

  Multiplication operator.
- Matrix3< T > operator/ (T rhs) const

  Division operator.
- Vector3< T > operator∗ (const Vector3< T > &rhs) const

  Multiplication operator.
- Matrix3< T > operator∗ (Matrix3< T > rhs) const

  Multiplication operator.
- Matrix3< T > transpose ()

  Transpose matrix.
- Matrix3< T > lerp (T fact, const Matrix3< T > &rhs) const

Linear interpolation of two matrices.

- T det ()
- Matrix3< T > inverse ()

  Computes inverse matrix.
- operator T∗ ()

  Conversion to pointer operator.
- operator const T ∗ () const

  Conversion to pointer operator.
- std::string toString () const

  Gets string representation.

Static Public Member Functions

- static Matrix3< T > createRotationAroundAxis (T xDeg, T yDeg, T zDeg)

  Creates rotation matrix by rotation around axis.
- template<class It >
  static Matrix3< T > fromOde (const It ∗mat)

  Creates rotation matrix from ODE Matrix.
- template<class FromT >
  static Matrix3< T > fromRowMajorArray (const FromT ∗arr)

  Creates new matrix 3x3 from array that represents such matrix 3x3 as array of tightly packed elements in row major order.
- template<class FromT >
  static Matrix3< T > fromColumnMajorArray (const FromT ∗arr)

  Creates new matrix 3x3 from array that represents such matrix 3x3 as array of tightly packed elements in column major order.

Public Attributes

- T data [9]

  Data stored in column major order.

Friends

- std::ostream & operator<< (std::ostream &lhs, const Matrix3< T > &rhs)

  Output to stream operator.

5.2.1 Detailed Description

template<class T>
class Matrix3< T >

Class for matrix 3x3.

Note

> Data stored in this matrix are in column major order. This arrangement suits OpenGL. If you're using row major matrix, consider using fromRowMajorArray as way for construction Matrix3<T> instance.

5.2.2 Constructor & Destructor Documentation

5.2.2.1 Matrix3() [1/4]

```
template<class T>
Matrix3< T >::Matrix3 ( )  [inline]
```

Creates identity matrix.

5.2.2.2 Matrix3() [2/4]

```
template<class T>
Matrix3< T >::Matrix3 (
             const T * dt )  [inline]
```

Copy matrix values from array (these data must be in column major order!)

5.2.2.3 Matrix3() [3/4]

```
template<class T>
Matrix3< T >::Matrix3 (
             const Matrix3< T > & src )  [inline]
```

Copy constructor.

Parameters

src	Data source for new created instance of Matrix3

5.2.2.4 Matrix3() [4/4]

```
template<class T>
template<class FromT >
Matrix3< T >::Matrix3 (
             const Matrix3< FromT > & src )  [inline]
```

Copy casting constructor.

Parameters

src	Data source for new created instance of Matrix3

5.2.3 Member Function Documentation

5.2.3.1 at() [1/2]

```
template<class T>
T& Matrix3< T >::at (
             int x,
             int y )  [inline]
```

Get reference to element at position (x,y).

Parameters

x	Number of column (0..2)
y	Number of row (0..2)

5.2.3.2 at() [2/2]

```
template<class T>
const T& Matrix3< T >::at (
             int x,
             int y ) const  [inline]
```

Get constant reference to element at position (x,y).

Parameters

x	Number of column (0..2)
y	Number of row (0..2)

5.2.3.3 createRotationAroundAxis()

```
template<class T>
static Matrix3<T> Matrix3< T >::createRotationAroundAxis (
             T xDeg,
             T yDeg,
             T zDeg )  [inline], [static]
```

Creates rotation matrix by rotation around axis.

Parameters

xDeg	Angle (in degrees) of rotation around axis X.
yDeg	Angle (in degrees) of rotation around axis Y.
zDeg	Angle (in degrees) of rotation around axis Z.

5.2.3.4 det()

```
template<class T>
T Matrix3< T >::det ( )  [inline]
```

5.2.3.5 fromColumnMajorArray()

```
template<class T>
template<class FromT >
static Matrix3<T> Matrix3< T >::fromColumnMajorArray (
             const FromT * arr )  [inline], [static]
```

Creates new matrix 3x3 from array that represents such matrix 3x3 as array of tightly packed elements in column major order.

Parameters

arr	An array of elements for 3x3 matrix in column major order.

Returns

An instance of Matrix3<T> representing *arr*

5.2.3.6 fromOde()

```
template<class T>
template<class It >
static Matrix3<T> Matrix3< T >::fromOde (
             const It * mat )  [inline], [static]
```

Creates rotation matrix from ODE Matrix.

5.2.3.7 fromRowMajorArray()

```
template<class T>
template<class FromT >
static Matrix3<T> Matrix3< T >::fromRowMajorArray (
             const FromT * arr )  [inline], [static]
```

Creates new matrix 3x3 from array that represents such matrix 3x3 as array of tightly packed elements in row major order.

Parameters

arr	An array of elements for 3x3 matrix in row major order.

Returns

An instance of Matrix3<T> representing *arr*

5.2.3.8 identity()

```
template<class T>
void Matrix3< T >::identity ( )  [inline]
```

Resets matrix to be identity matrix.

5.2.3.9 inverse()

```
template<class T>
Matrix3<T> Matrix3< T >::inverse ( )  [inline]
```

Computes inverse matrix.

Returns

Inverse matrix of this matrix.

5.2.3.10 lerp()

```
template<class T>
Matrix3<T> Matrix3< T >::lerp (
              T fact,
              const Matrix3< T > & rhs ) const  [inline]
```

Linear interpolation of two matrices.

Parameters

fact	Factor of interpolation. For translation from positon of this matrix (lhs) to matrix rhs, values of factor goes from 0.0 to 1.0.
rhs	Second Matrix for interpolation

Note

However values of fact parameter are reasonable only in interval [0.0 , 1.0], you can pass also values outside of this interval and you can get result (extrapolation?)

5.2.3.11 operator const T *()

```
template<class T>
Matrix3< T >::operator const T * ( ) const  [inline]
```

Conversion to pointer operator.

Returns

Constant Pointer to internally stored (in management of class Matrix3<T>) used for passing Matrix3<T> values to gl*[fd]v functions.

5.2.3.12 operator T*()

```
template<class T>
Matrix3< T >::operator T* ( )  [inline]
```

Conversion to pointer operator.

Returns

Pointer to internally stored (in management of class Matrix3<T>) used for passing Matrix3<T> values to gl*[fd]v functions.

5.2.3.13 operator"!=()

```
template<class T>
bool Matrix3< T >::operator!= (
             const Matrix3< T > & rhs ) const  [inline]
```

Inequality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Returns

not (lhs == rhs) :-P

5.2.3.14 operator()() [1/2]

```
template<class T>
T& Matrix3< T >::operator() (
            int i,
            int j ) [inline]
```

Get reference to element at position (i,j), with math matrix notation.

Parameters

i	Number of row (1..3)
j	Number of column (1..3)

5.2.3.15 operator()() [2/2]

```
template<class T>
const T& Matrix3< T >::operator() (
            int i,
            int j ) const [inline]
```

Get constant reference to element at position (i,j), with math matrix notation.

Parameters

i	Number of row (1..3)
j	Number of column (1..3)

5.2.3.16 operator*() [1/3]

```
template<class T>
Matrix3<T> Matrix3< T >::operator* (
            T rhs ) const [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.17 operator*() [2/3]

```
template<class T>
Vector3<T> Matrix3< T >::operator* (
            const Vector3< T > & rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.18 operator*() [3/3]

```
template<class T>
Matrix3<T> Matrix3< T >::operator* (
            Matrix3< T > rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.19 operator+() [1/2]

```
template<class T>
Matrix3<T> Matrix3< T >::operator+ (
            const Matrix3< T > & rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.20 operator+() [2/2]

```
template<class T>
```

```
Matrix3<T> Matrix3< T >::operator+ (
              T rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.21 operator-() [1/2]

```
template<class T>
Matrix3<T> Matrix3< T >::operator- (
              const Matrix3< T > & rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.22 operator-() [2/2]

```
template<class T>
Matrix3<T> Matrix3< T >::operator- (
              T rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.23 operator/()

```
template<class T>
Matrix3<T> Matrix3< T >::operator/ (
              T rhs ) const  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.24 operator=() [1/3]

```
template<class T>
Matrix3<T>& Matrix3< T >::operator= (
            const Matrix3< T > & rhs )  [inline]
```

Copy operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.25 operator=() [2/3]

```
template<class T>
template<class FromT >
Matrix3<T>& Matrix3< T >::operator= (
            const Matrix3< FromT > & rhs )  [inline]
```

Copy casting operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.26 operator=() [3/3]

```
template<class T>
Matrix3<T>& Matrix3< T >::operator= (
            const T * rhs )  [inline]
```

Copy operator.

Parameters

rhs	Right hand side argument of binary operator.

5.2.3.27 operator==()

```
template<class T>
bool Matrix3< T >::operator== (
             const Matrix3< T > & rhs ) const  [inline]
```

Equality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Note

Test of equality is based of threshold EPSILON value. To be two values equal, must satisfy this condition all elements of matrix | lhs[i] - rhs[i] | < EPSILON, same for y-coordinate, z-coordinate, and w-coordinate.

5.2.3.28 toString()

```
template<class T>
std::string Matrix3< T >::toString ( ) const  [inline]
```

Gets string representation.

5.2.3.29 transpose()

```
template<class T>
Matrix3<T> Matrix3< T >::transpose ( )  [inline]
```

Transpose matrix.

5.2.4 Friends And Related Function Documentation

5.2.4.1 operator<<

```
template<class T>
std::ostream& operator<< (
             std::ostream & lhs,
             const Matrix3< T > & rhs )  [friend]
```

Output to stream operator.

Parameters

lhs	Left hand side argument of operator (commonly ostream instance).
rhs	Right hand side argument of operator.

Returns

Left hand side argument - the ostream object passed to operator.

5.2.5 Member Data Documentation

5.2.5.1 data

```
template<class T>
T Matrix3< T >::data[9]
```

Data stored in column major order.

The documentation for this class was generated from the following file:

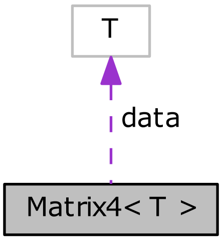
- src/vmath.h

5.3 Matrix4< T > Class Template Reference

Class for matrix 4x4.

```
#include <vmath.h>
```

Collaboration diagram for Matrix4< T >:



Public Member Functions

- Matrix4 ()

  Creates identity matrix.
- Matrix4 (const T *dt)

  Copy matrix values from array (these data must be in column major order!)
- Matrix4 (const Matrix4< T > &src)

  Copy constructor.
- template<class FromT >
  Matrix4 (const Matrix4< FromT > &src)

  Copy casting constructor.
- void identity ()

  Resets matrix to be identity matrix.
- bool operator== (const Matrix4< T > &rhs) const

  Equality test operator.
- bool operator!= (const Matrix4< T > &rhs) const

  Inequality test operator.
- T & at (int x, int y)

  Get reference to element at postion (x,y).
- const T & at (int x, int y) const

  Get constant reference to element at position (x,y).
- T & operator() (int i, int j)

  Get reference to element at position (i,j), with math matrix notation.
- const T & operator() (int i, int j) const

  Get constant reference to element at position (i,j), with math matrix notation.
- void setTranslation (const Vector3< T > &v)

  Sets translation part of matrix.
- Vector3< T > getTranslation () const
- void setRotation (const Matrix3< T > &m)

  Sets rotation part (matrix 3x3) of matrix.
- Vector3< T > getScale () const

  Gets matrix scale.
- void setScale (T s)

  Sets matrix uniform scale values.
- void setScale (T sx, T sy, T sz)

  Sets matrix scale for all axes.
- void setScale (const Vector3< T > &s)

  Sets matrix scale for all axes.
- Matrix4< T > & operator= (const Matrix4< T > &rhs)

  Copy operator.
- template<class FromT >
  Matrix4< T > & operator= (const Matrix4< FromT > &rhs)

  Copy casting operator.
- Matrix4< T > & operator= (const T *rhs)

  Copy operator.
- Matrix4< T > operator+ (const Matrix4< T > &rhs) const

  Addition operator.
- Matrix4< T > operator- (const Matrix4< T > &rhs) const

  Subtraction operator.
- Matrix4< T > operator+ (T rhs) const

  Addition operator.

- Matrix4< T > operator- (T rhs) const

  Subtraction operator.
- Matrix4< T > operator∗ (T rhs) const

  Multiplication operator.
- Matrix4< T > operator/ (T rhs) const

  Division operator.
- Vector4< T > operator∗ (const Vector4< T > &rhs) const

  Multiplication operator.
- Vector3< T > operator∗ (const Vector3< T > &rhs) const

  Multiplication operator.
- Matrix4< T > operator∗ (Matrix4< T > rhs) const

  Multiplication operator.
- T det ()

  Computes determinant of matrix.
- Matrix4< T > inverse ()

  Computes inverse matrix.
- Matrix4< T > transpose ()

  Transpose matrix.
- Matrix4< T > lerp (T fact, const Matrix4< T > &rhs) const

  Linear interpolation of two matrices.
- operator T∗ ()

  Conversion to pointer operator.
- operator const T ∗ () const

  Conversion to pointer operator.
- std::string toString () const

  Gets string representation.

Static Public Member Functions

- static Matrix4< T > createRotationAroundAxis (T xDeg, T yDeg, T zDeg)

  Creates rotation matrix by rotation around axis.
- static Matrix4< T > createTranslation (T x, T y, T z, T w=1)

  Creates translation matrix.
- static Matrix4< T > createScale (T sx, T sy, T sz)

  Create scale matrix with sx, sy, and sz being values of matrix main diagonal.
- static Matrix4< T > createLookAt (const Vector3< T > &eyePos, const Vector3< T > &centerPos, const Vector3< T > &upDir)

  Creates new view matrix to look from specified position eyePos to specified position centerPos.
- static Matrix4< T > createFrustum (T left, T right, T bottom, T top, T zNear, T zFar)

  Creates OpenGL compatible perspective projection according specified frustum parameters.
- static Matrix4< T > createOrtho (T left, T right, T bottom, T top, T zNear, T zFar)

  Creates OpenGL compatible orthographic projection matrix.
- template<class FromT >
  static Matrix4< T > fromRowMajorArray (const FromT ∗arr)

  Creates new matrix 4x4 from array that represents such matrix 4x4 as array of tightly packed elements in row major order.
- template<class FromT >
  static Matrix4< T > fromColumnMajorArray (const FromT ∗arr)

  Creates new matrix 4x4 from array that represents such matrix 4x4 as array of tightly packed elements in column major order.

Public Attributes

- T data [16]

  Data stored in column major order.

Friends

- std::ostream & operator<< (std::ostream &lhs, const Matrix4< T > &rhs)

  Output to stream operator.

5.3.1 Detailed Description

template<class T>
class Matrix4< T >

Class for matrix 4x4.

Note

> Data stored in this matrix are in column major order. This arrangement suits OpenGL. If you're using row major matrix, consider using fromRowMajorArray as way for construction Matrix4<T> instance.

5.3.2 Constructor & Destructor Documentation

5.3.2.1 Matrix4() [1/4]

```
template<class T>
Matrix4< T >::Matrix4 ( )  [inline]
```

Creates identity matrix.

5.3.2.2 Matrix4() [2/4]

```
template<class T>
Matrix4< T >::Matrix4 (
            const T * dt )  [inline]
```

Copy matrix values from array (these data must be in column major order!)

5.3.2.3 Matrix4() [3/4]

```
template<class T>
Matrix4< T >::Matrix4 (
            const Matrix4< T > & src )  [inline]
```

Copy constructor.

Parameters

src	Data source for new created instance of Matrix4.

5.3.2.4 Matrix4() [4/4]

```
template<class T>
template<class FromT >
Matrix4< T >::Matrix4 (
             const Matrix4< FromT > & src )  [inline]
```

Copy casting constructor.

Parameters

src	Data source for new created instance of Matrix4.

5.3.3 Member Function Documentation

5.3.3.1 at() [1/2]

```
template<class T>
T& Matrix4< T >::at (
             int x,
             int y )  [inline]
```

Get reference to element at postion (x,y).

Parameters

x	Number of column (0..3)
y	Number of row (0..3)

5.3.3.2 at() [2/2]

```
template<class T>
const T& Matrix4< T >::at (
             int x,
             int y ) const  [inline]
```

Get constant reference to element at position (x,y).

Parameters

x	Number of column (0..3)
y	Number of row (0..3)

5.3.3.3 createFrustum()

```
template<class T>
static Matrix4<T> Matrix4< T >::createFrustum (
            T left,
            T right,
            T bottom,
            T top,
            T zNear,
            T zFar )  [inline], [static]
```

Creates OpenGL compatible perspective projection according specified frustum parameters.

Parameters

left	Specify the coordinate for the left vertical clipping plane,
right	Specify the coordinate for the right vertical clipping plane.
bottom	Specify the coordinate for the bottom horizontal clipping plane,
top	Specify the coordinate for the top horizontal clipping plane.
zNear	Specify the distance to the near clipping plane. Distance must be positive.
zFar	Specify the distance to the far depth clipping plane. Distance must be positive.

Returns

Projection matrix for specified frustum.

5.3.3.4 createLookAt()

```
template<class T>
static Matrix4<T> Matrix4< T >::createLookAt (
            const Vector3< T > & eyePos,
            const Vector3< T > & centerPos,
            const Vector3< T > & upDir )  [inline], [static]
```

Creates new view matrix to look from specified position *eyePos* to specified position *centerPos*.

Parameters

eyePos	A position of camera
centerPos	A position where camera looks-at
upDir	Direction of up vector

Returns

Resulting view matrix that looks from and at specific position.

5.3.3.5 createOrtho()

```
template<class T>
static Matrix4<T> Matrix4< T >::createOrtho (
            T left,
            T right,
            T bottom,
            T top,
            T zNear,
            T zFar )  [inline], [static]
```

Creates OpenGL compatible orthographic projection matrix.

Parameters

left	Specify the coordinate for the left vertical clipping plane,
right	Specify the coordinate for the right vertical clipping plane.
bottom	Specify the coordinate for the bottom horizontal clipping plane,
top	Specify the coordinate for the top horizontal clipping plane.
zNear	Specify the distance to the nearer depth clipping plane. This value is negative if the plane is to be behind the viewer,
zFar	Specify the distance to the farther depth clipping plane. This value is negative if the plane is to be behind the viewer.

Returns

Othrographic projection matrix.

5.3.3.6 createRotationAroundAxis()

```
template<class T>
static Matrix4<T> Matrix4< T >::createRotationAroundAxis (
            T xDeg,
            T yDeg,
            T zDeg )  [inline], [static]
```

Creates rotation matrix by rotation around axis.

Parameters

xDeg	Angle (in degrees) of rotation around axis X.
yDeg	Angle (in degrees) of rotation around axis Y.
zDeg	Angle (in degrees) of rotation around axis Z.

5.3.3.7 createScale()

```
template<class T>
static Matrix4<T> Matrix4< T >::createScale (
            T sx,
            T sy,
            T sz ) [inline], [static]
```

Create scale matrix with *sx*, *sy*, and *sz* being values of matrix main diagonal.

Parameters

sx	Scale in X-axis
sy	Scale in Y-axis
sz	Scale in Z-axis

Returns

Transform matrix 4x4 with scale transformation.

5.3.3.8 createTranslation()

```
template<class T>
static Matrix4<T> Matrix4< T >::createTranslation (
            T x,
            T y,
            T z,
            T w = 1 ) [inline], [static]
```

Creates translation matrix.

Creates translation matrix.

Parameters

x	X-direction translation
y	Y-direction translation
z	Z-direction translation
w	for W-coordinate translation (implicitly set to 1)

5.3.3.9 det()

```
template<class T>
T Matrix4< T >::det ( ) [inline]
```

Computes determinant of matrix.

Returns

Determinant of matrix

Note

This function does $3*4*6$ muls, $3*6$ adds.

5.3.3.10 fromColumnMajorArray()

```
template<class T>
template<class FromT >
static Matrix4<T> Matrix4< T >::fromColumnMajorArray (
            const FromT * arr ) [inline], [static]
```

Creates new matrix 4x4 from array that represents such matrix 4x4 as array of tightly packed elements in column major order.

Parameters

arr	An array of elements for 4x4 matrix in column major order.

Returns

An instance of Matrix4<T> representing *arr*

5.3.3.11 fromRowMajorArray()

```
template<class T>
template<class FromT >
static Matrix4<T> Matrix4< T >::fromRowMajorArray (
            const FromT * arr ) [inline], [static]
```

Creates new matrix 4x4 from array that represents such matrix 4x4 as array of tightly packed elements in row major order.

Parameters

arr	An array of elements for 4x4 matrix in row major order.

Returns

An instance of Matrix4<T> representing *arr*

5.3.3.12 getScale()

```
template<class T>
Vector3<T> Matrix4< T >::getScale ( ) const  [inline]
```

Gets matrix scale.

Returns

Scales (i.e. first three values from matrix diagonal.

5.3.3.13 getTranslation()

```
template<class T>
Vector3<T> Matrix4< T >::getTranslation ( ) const  [inline]
```

5.3.3.14 identity()

```
template<class T>
void Matrix4< T >::identity ( )  [inline]
```

Resets matrix to be identity matrix.

5.3.3.15 inverse()

```
template<class T>
Matrix4<T> Matrix4< T >::inverse ( )  [inline]
```

Computes inverse matrix.

Returns

Inverse matrix of this matrix.

Note

This is a little bit time consuming operation (16 $*$ 6 $*$ 3 muls, 16 $*$ 5 adds + det() + mul() functions)

5.3.3.16 lerp()

```
template<class T>
Matrix4<T> Matrix4< T >::lerp (
             T fact,
             const Matrix4< T > & rhs ) const  [inline]
```

Linear interpolation of two matrices.

Parameters

fact	Factor of interpolation. For translation from positon of this matrix (lhs) to matrix rhs, values of factor goes from 0.0 to 1.0.
rhs	Second Matrix for interpolation

Note

> However values of fact parameter are reasonable only in interval [0.0 , 1.0], you can pass also values outside of this interval and you can get result (extrapolation?)

5.3.3.17 operator const T ∗()

```
template<class T>
Matrix4< T >::operator const T * ( ) const  [inline]
```

Conversion to pointer operator.

Returns

> Constant Pointer to internally stored (in management of class Matrix4<T>) used for passing Matrix4<T> values to gl∗[fd]v functions.

5.3.3.18 operator T∗()

```
template<class T>
Matrix4< T >::operator T* ( )  [inline]
```

Conversion to pointer operator.

Returns

> Pointer to internally stored (in management of class Matrix4<T>) used for passing Matrix4<T> values to gl∗[fd]v functions.

5.3.3.19 operator"!=()

```
template<class T>
bool Matrix4< T >::operator!= (
             const Matrix4< T > & rhs ) const  [inline]
```

Inequality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Returns

not (lhs == rhs) :-P

5.3.3.20 operator()() [1/2]

```
template<class T>
T& Matrix4< T >::operator() (
             int i,
             int j )  [inline]
```

Get reference to element at position (i,j), with math matrix notation.

Parameters

i	Number of row (1..4)
j	Number of column (1..4)

5.3.3.21 operator()() [2/2]

```
template<class T>
const T& Matrix4< T >::operator() (
             int i,
             int j ) const  [inline]
```

Get constant reference to element at position (i,j), with math matrix notation.

Parameters

i	Number of row (1..4)
j	Number of column (1..4)

5.3.3.22 operator*() [1/4]

```
template<class T>
Matrix4<T> Matrix4< T >::operator* (
             T rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.23 operator*() [2/4]

```
template<class T>
Vector4<T> Matrix4< T >::operator* (
             const Vector4< T > & rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.24 operator*() [3/4]

```
template<class T>
Vector3<T> Matrix4< T >::operator* (
             const Vector3< T > & rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.25 operator*() [4/4]

```
template<class T>
Matrix4<T> Matrix4< T >::operator* (
             Matrix4< T > rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.26 operator+() [1/2]

```
template<class T>
Matrix4<T> Matrix4< T >::operator+ (
             const Matrix4< T > & rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.27 operator+() [2/2]

```
template<class T>
Matrix4<T> Matrix4< T >::operator+ (
             T rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.28 operator-() [1/2]

```
template<class T>
Matrix4<T> Matrix4< T >::operator- (
             const Matrix4< T > & rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.29 operator-() [2/2]

```
template<class T>
Matrix4<T> Matrix4< T >::operator- (
             T rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.30 operator/()

```
template<class T>
Matrix4<T> Matrix4< T >::operator/ (
             T rhs ) const  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.31 operator=() [1/3]

```
template<class T>
Matrix4<T>& Matrix4< T >::operator= (
             const Matrix4< T > & rhs )  [inline]
```

Copy operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.32 operator=() [2/3]

```
template<class T>
template<class FromT >
Matrix4<T>& Matrix4< T >::operator= (
             const Matrix4< FromT > & rhs )  [inline]
```

Copy casting operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.33 operator=() [3/3]

```
template<class T>
Matrix4<T>& Matrix4< T >::operator= (
             const T * rhs )  [inline]
```

Copy operator.

Parameters

rhs	Right hand side argument of binary operator.

5.3.3.34 operator==()

```
template<class T>
bool Matrix4< T >::operator== (
             const Matrix4< T > & rhs ) const  [inline]
```

Equality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Note

Test of equality is based of threshold EPSILON value. To be two values equal, must satisfy this condition all elements of matrix | lhs[i] - rhs[i] | < EPSILON, same for y-coordinate, z-coordinate, and w-coordinate.

5.3.3.35 setRotation()

```
template<class T>
void Matrix4< T >::setRotation (
             const Matrix3< T > & m )  [inline]
```

Sets rotation part (matrix 3x3) of matrix.

Parameters

m	Rotation part of matrix

5.3.3.36 setScale() [1/3]

```
template<class T>
void Matrix4< T >::setScale (
             T s )  [inline]
```

Sets matrix uniform scale values.

Parameters

s	Uniform scale value

5.3.3.37 setScale() [2/3]

```
template<class T>
void Matrix4< T >::setScale (
             T sx,
             T sy,
             T sz )  [inline]
```

Sets matrix scale for all axes.

Parameters

sx	X-axis scale factor
sy	Y-axis scale factor
sz	Z-axis scale factor

5.3.3.38 setScale() [3/3]

```
template<class T>
void Matrix4< T >::setScale (
             const Vector3< T > & s )  [inline]
```

Sets matrix scale for all axes.

Parameters

s	Scale factors for X, Y, and Z coordinate.

5.3.3.39 setTranslation()

```
template<class T>
```

```
void Matrix4< T >::setTranslation (
             const Vector3< T > & v )  [inline]
```

Sets translation part of matrix.

Parameters

v	Vector of translation to be set.

5.3.3.40 toString()

```
template<class T>
std::string Matrix4< T >::toString ( ) const  [inline]
```

Gets string representation.

5.3.3.41 transpose()

```
template<class T>
Matrix4<T> Matrix4< T >::transpose ( )  [inline]
```

Transpose matrix.

5.3.4 Friends And Related Function Documentation

5.3.4.1 operator<<

```
template<class T>
std::ostream& operator<< (
             std::ostream & lhs,
             const Matrix4< T > & rhs )  [friend]
```

Output to stream operator.

Parameters

lhs	Left hand side argument of operator (commonly ostream instance).
rhs	Right hand side argument of operator.

Returns

Left hand side argument - the ostream object passed to operator.

5.3.5 Member Data Documentation

5.3.5.1 data

```
template<class T>
T Matrix4< T >::data[16]
```

Data stored in column major order.

The documentation for this class was generated from the following file:

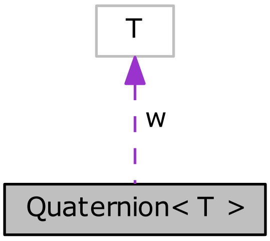
- src/vmath.h

5.4 Quaternion< T > Class Template Reference

Quaternion class implementing some quaternion algebra operations.

```
#include <vmath.h>
```

Collaboration diagram for Quaternion< T >:



Public Member Functions

- Quaternion ()

  Quaternion constructor, sets quaternion to (0 + 0i + 0j + 0k).
- Quaternion (const Quaternion< T > &q)

  Copy constructor.
- template<class FromT >
  Quaternion (const Quaternion< FromT > &q)

  Copy casting constructor.
- Quaternion (T w_, const Vector3< T > &v_)

  Creates quaternion object from real part w_ and complex part v_.
- Quaternion (T w_, T x, T y, T z)

  Creates quaternion object from value (w_ + xi + yj + zk).
- Quaternion< T > & operator= (const Quaternion< T > &rhs)

  Copy operator.
- template<class FromT >
  Quaternion< T > & operator= (const Quaternion< FromT > &rhs)

  Copy convert operator.
- Quaternion< T > operator+ (const Quaternion< T > &rhs) const

  Addition operator.
- Quaternion< T > operator∗ (const Quaternion< T > &rhs) const

  Multiplication operator.
- Quaternion< T > operator∗ (T rhs) const

  Multiplication operator.
- Quaternion< T > operator- (const Quaternion< T > &rhs) const

  Subtraction operator.
- Quaternion< T > & operator+= (const Quaternion< T > &rhs)

  Addition operator.
- Quaternion< T > & operator-= (const Quaternion< T > &rhs)

  Subtraction operator.
- Quaternion< T > & operator∗= (const Quaternion< T > &rhs)

  Multiplication operator.
- Quaternion< T > & operator∗= (T rhs)

  Multiplication operator.
- bool operator== (const Quaternion< T > &rhs) const

  Equality test operator.
- bool operator!= (const Quaternion< T > &rhs) const

  Inequality test operator.
- Quaternion< T > operator- () const

  Unary negate operator.
- Quaternion< T > operator∼ () const

  Unary conjugate operator.
- T length () const

  Get lenght of quaternion.
- T lengthSq () const

  Return square of length.
- void normalize ()

  Normalize quaternion.
- Matrix3< T > rotMatrix ()

  Converts quaternion into rotation matrix.
- Matrix4< T > transform () const

Converts quaternion into transformation matrix.

- Quaternion< T > lerp (T fact, const Quaternion< T > &rhs) const

  Linear interpolation of two quaternions.
- std::string toString () const

  Gets string representation.
- Quaternion< T > slerp (T r, const Quaternion< T > &q2) const

  Computes spherical interpolation between quaternions (this, q2) using coefficient of interpolation r (in [0, 1]).

Static Public Member Functions

- static Quaternion< T > fromEulerAngles (T x, T y, T z)

  Creates quaternion for eulers angles.
- static Quaternion< T > fromAxisRot (Vector3< T > axis, float angleDeg)

  Creates quaternion as rotation around axis.
- static Quaternion< T > fromMatrix (const Matrix4< T > &m)

  Creates quaternion from transform matrix.
- static Quaternion< T > fromMatrix (const Matrix3< T > &m)

  Creates quaternion from rotation matrix.

Public Attributes

- T w

  Real part of quaternion.
- Vector3< T > v

  Imaginary part of quaternion.

Friends

- std::ostream & operator<< (std::ostream &oss, const Quaternion< T > &q)

  Provides output to standard output stream.

5.4.1 Detailed Description

template<class T>
class Quaternion< T >

Quaternion class implementing some quaternion algebra operations.

Quaternion is kind of complex number it consists of its real part (w) and its complex part v. This complex part has three elements, so we can express it as xi + yj + zk . Note that coordinates of (x,y,z) are hold inside v field.

5.4.2 Constructor & Destructor Documentation

5.4.2.1 Quaternion() [1/5]

```
template<class T>
Quaternion< T >::Quaternion ( )  [inline]
```

Quaternion constructor, sets quaternion to (0 + 0i + 0j + 0k).

5.4.2.2 Quaternion() [2/5]

```
template<class T>
Quaternion< T >::Quaternion (
             const Quaternion< T > & q )  [inline]
```

Copy constructor.

5.4.2.3 Quaternion() [3/5]

```
template<class T>
template<class FromT >
Quaternion< T >::Quaternion (
             const Quaternion< FromT > & q )  [inline]
```

Copy casting constructor.

5.4.2.4 Quaternion() [4/5]

```
template<class T>
Quaternion< T >::Quaternion (
             T w_,
             const Vector3< T > & v_ )  [inline]
```

Creates quaternion object from real part w_ and complex part v_.

Parameters

w↩ _↩	Real part of quaternion.
v↩ _↩	Complex part of quaternion (xi + yj + zk).

5.4.2.5 Quaternion() [5/5]

```
template<class T>
Quaternion< T >::Quaternion (
            T w_,
            T x,
            T y,
            T z ) [inline]
```

Creates quaternion object from value (w_ + xi + yj + zk).

Parameters

w↩_↩	Real part of quaternion.
x	Complex coefficient for i complex constant.
y	Complex coefficient for j complex constant.
z	Complex coefficient for k complex constant.

5.4.3 Member Function Documentation

5.4.3.1 fromAxisRot()

```
template<class T>
static Quaternion<T> Quaternion< T >::fromAxisRot (
            Vector3< T > axis,
            float angleDeg ) [inline], [static]
```

Creates quaternion as rotation around axis.

Parameters

axis	Unit vector expressing axis of rotation.
angleDeg	Angle of rotation around axis (in degrees).

5.4.3.2 fromEulerAngles()

```
template<class T>
static Quaternion<T> Quaternion< T >::fromEulerAngles (
            T x,
            T y,
            T z ) [inline], [static]
```

Creates quaternion for eulers angles.

Parameters

x	Rotation around x axis (in degrees).
y	Rotation around y axis (in degrees).
z	Rotation around z axis (in degrees).

Returns

Quaternion object representing transformation.

5.4.3.3 fromMatrix() [1/2]

```
template<class T>
static Quaternion<T> Quaternion< T >::fromMatrix (
            const Matrix4< T > & m )  [inline], [static]
```

Creates quaternion from transform matrix.

Parameters

m	Transform matrix used to compute quaternion.

Returns

Quaternion representing rotation of matrix m.

5.4.3.4 fromMatrix() [2/2]

```
template<class T>
static Quaternion<T> Quaternion< T >::fromMatrix (
            const Matrix3< T > & m )  [inline], [static]
```

Creates quaternion from rotation matrix.

Parameters

m	Rotation matrix used to compute quaternion.

Returns

Quaternion representing rotation of matrix m.

5.4.3.5 length()

```
template<class T>
T Quaternion< T >::length ( ) const  [inline]
```

Get lenght of quaternion.

Returns

Length of quaternion.

5.4.3.6 lengthSq()

```
template<class T>
T Quaternion< T >::lengthSq ( ) const  [inline]
```

Return square of length.

Returns

length ^ 2

Note

This method is faster then length(). For comparison of length of two quaternion can be used just this value, instead of more expensive length() method.

5.4.3.7 lerp()

```
template<class T>
Quaternion<T> Quaternion< T >::lerp (
             T fact,
             const Quaternion< T > & rhs ) const  [inline]
```

Linear interpolation of two quaternions.

Parameters

fact	Factor of interpolation. For translation from position of this vector to quaternion rhs, values of factor goes from 0.0 to 1.0.
rhs	Second Quaternion for interpolation

Note

However values of fact parameter are reasonable only in interval [0.0 , 1.0], you can pass also values outside of this interval and you can get result (extrapolation?)

5.4.3.8 normalize()

```
template<class T>
void Quaternion< T >::normalize ( )  [inline]
```

Normalize quaternion.

5.4.3.9 operator"!=()

```
template<class T>
bool Quaternion< T >::operator!= (
             const Quaternion< T > & rhs ) const  [inline]
```

Inequality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Returns

not (lhs == rhs) :-P

5.4.3.10 operator*() [1/2]

```
template<class T>
Quaternion<T> Quaternion< T >::operator* (
             const Quaternion< T > & rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.4.3.11 operator*() [2/2]

```
template<class T>
Quaternion<T> Quaternion< T >::operator* (
             T rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.4.3.12 operator*=() [1/2]

```
template<class T>
Quaternion<T>& Quaternion< T >::operator*= (
             const Quaternion< T > & rhs )  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.4.3.13 operator*=() [2/2]

```
template<class T>
Quaternion<T>& Quaternion< T >::operator*= (
             T rhs )  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.4.3.14 operator+()

```
template<class T>
Quaternion<T> Quaternion< T >::operator+ (
             const Quaternion< T > & rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.4.3.15 operator+=()

```
template<class T>
Quaternion<T>& Quaternion< T >::operator+= (
             const Quaternion< T > & rhs )  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.4.3.16 operator-() [1/2]

```
template<class T>
Quaternion<T> Quaternion< T >::operator- (
             const Quaternion< T > & rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.4.3.17 operator-() [2/2]

```
template<class T>
Quaternion<T> Quaternion< T >::operator- ( ) const  [inline]
```

Unary negate operator.

Returns

negated quaternion

5.4.3.18 operator-=()

```
template<class T>
Quaternion<T>& Quaternion< T >::operator-= (
             const Quaternion< T > & rhs )  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.4.3.19 operator=() [1/2]

```
template<class T>
Quaternion<T>& Quaternion< T >::operator= (
             const Quaternion< T > & rhs )  [inline]
```

Copy operator.

Parameters

rhs	Right hand side argument of binary operator.

5.4.3.20 operator=() [2/2]

```
template<class T>
template<class FromT >
Quaternion<T>& Quaternion< T >::operator= (
             const Quaternion< FromT > & rhs )  [inline]
```

Copy convert operator.

Parameters

rhs	Right hand side argument of binary operator.

5.4.3.21 operator==()

```
template<class T>
bool Quaternion< T >::operator== (
             const Quaternion< T > & rhs ) const  [inline]
```

Equality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Note

Test of equality is based of threshold EPSILON value. To be two values equal, must satisfy this condition | lhs - rhs | < EPSILON, for all quaternion coordinates.

5.4.3.22 operator∼()

```
template<class T>
Quaternion<T> Quaternion< T >::operator∼ ( ) const  [inline]
```

Unary conjugate operator.

Returns

conjugated quaternion

5.4.3.23 rotMatrix()

```
template<class T>
Matrix3<T> Quaternion< T >::rotMatrix ( )  [inline]
```

Converts quaternion into rotation matrix.

Returns

Rotation matrix expressing this quaternion.

5.4.3.24 slerp()

```
template<class T>
Quaternion<T> Quaternion< T >::slerp (
             T r,
             const Quaternion< T > & q2 ) const  [inline]
```

Computes spherical interpolation between quaternions (this, q2) using coefficient of interpolation r (in [0, 1]).

Parameters

r	The ratio of interpolation form this (r = 0) to q2 (r = 1).
q2	Second quaternion for interpolation.

Returns

Result of interpolation.

5.4.3.25 toString()

```
template<class T>
std::string Quaternion< T >::toString ( ) const  [inline]
```

Gets string representation.

5.4.3.26 transform()

```
template<class T>
Matrix4<T> Quaternion< T >::transform ( ) const  [inline]
```

Converts quaternion into transformation matrix.

Note

This method performs same operation as rotMatrix() conversion method. But returns Matrix of 4x4 elements.

Returns

Transformation matrix expressing this quaternion.

5.4.4 Friends And Related Function Documentation

5.4.4.1 operator<<

```
template<class T>
std::ostream& operator<< (
             std::ostream & oss,
             const Quaternion< T > & q )  [friend]
```

Provides output to standard output stream.

5.4.5 Member Data Documentation

5.4.5.1 v

```
template<class T>
Vector3<T> Quaternion< T >::v
```

Imaginary part of quaternion.

5.4.5.2 w

```
template<class T>
T Quaternion< T >::w
```

Real part of quaternion.

The documentation for this class was generated from the following file:

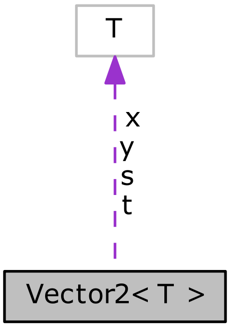
- src/vmath.h

5.5 Vector2< T > Class Template Reference

Class for two dimensional vector.

```
#include <vmath.h>
```

Collaboration diagram for Vector2< T >:



Public Member Functions

- Vector2 ()

  Creates and sets to (0,0)
- Vector2 (T nx, T ny)

  Creates and sets to (x,y)
- Vector2 (const Vector2< T > &src)

  Copy constructor.
- template<class FromT >
  Vector2 (const Vector2< FromT > &src)

  Copy casting constructor.
- template<class FromT >
  Vector2< T > & operator= (const Vector2< FromT > &rhs)

  Copy casting operator.
- Vector2< T > & operator= (const Vector2< T > &rhs)

  Copy operator.
- T & operator[ ] (int n)

  Array access operator.
- const T & operator[ ] (int n) const

  Constant array access operator.
- Vector2< T > operator+ (const Vector2< T > &rhs) const

  Addition operator.
- Vector2< T > operator- (const Vector2< T > &rhs) const

  Subtraction operator.
- Vector2< T > operator* (const Vector2< T > &rhs) const

  Multiplication operator.
- Vector2< T > operator/ (const Vector2< T > &rhs) const

  Division operator.
- Vector2< T > & operator+= (const Vector2< T > &rhs)

  Addition operator.
- Vector2< T > & operator-= (const Vector2< T > &rhs)

  Substraction operator.
- Vector2< T > & operator*= (const Vector2< T > &rhs)

  Multiplication operator.
- Vector2< T > & operator/= (const Vector2< T > &rhs)

  Division operator.
- Vector2< T > operator+ (T rhs) const

  Addition operator.
- Vector2< T > operator- (T rhs) const

  Subtraction operator.
- Vector2< T > operator* (T rhs) const

  Multiplication operator.
- Vector2< T > operator/ (T rhs) const

  Division operator.
- Vector2< T > & operator+= (T rhs)

  Addition operator.
- Vector2< T > & operator-= (T rhs)

  Subtraction operator.
- Vector2< T > & operator*= (T rhs)

  Multiplication operator.
- Vector2< T > & operator/= (T rhs)

Division operator.

- bool operator== (const Vector2< T > &rhs) const

  Equality test operator.
- bool operator!= (const Vector2< T > &rhs) const

  Inequality test operator.
- Vector2< T > operator- () const

  Unary negate operator.
- T length () const

  Get length of vector.
- void normalize ()

  Normalize vector.
- T lengthSq () const

  Return square of length.
- Vector2< T > lerp (T fact, const Vector2< T > &r) const

  Linear interpolation of two vectors.
- operator T∗ ()

  Conversion to pointer operator.
- operator const T ∗ () const

  Conversion to pointer operator.
- std::string toString () const

  Gets string representation.

Public Attributes

- union {
  T x
  First element of vector, alias for X-coordinate.
  T s
  First element of vector, alias for S-coordinate.
  };
- union {
  T y
  Second element of vector, alias for Y-coordinate.
  T t
  Second element of vector, alias for T-coordinate.
  };

Friends

- std::ostream & operator<< (std::ostream &lhs, const Vector2< T > &rhs)

  Output to stream operator.

5.5.1 Detailed Description

template<class T>
class Vector2< T >

Class for two dimensional vector.

There are three ways of accessing vector components. Let's have `Vector2f v`, you can either:

- access as position(x,y) — `v.x = v.y = 3;`
- access as texture coordinate (s,t) — `v.s = v.t = 3;`
- access via operator[] — `v[0] = v[1] = 3;`

5.5.2 Constructor & Destructor Documentation

5.5.2.1 Vector2() [1/4]

```
template<class T>
Vector2< T >::Vector2 ( )  [inline]
```

Creates and sets to (0,0)

5.5.2.2 Vector2() [2/4]

```
template<class T>
Vector2< T >::Vector2 (
             T nx,
             T ny )  [inline]
```

Creates and sets to (x,y)

Parameters

nx	initial x-coordinate value
ny	initial y-coordinate value

5.5.2.3 Vector2() [3/4]

```
template<class T>
Vector2< T >::Vector2 (
             const Vector2< T > & src )  [inline]
```

Copy constructor.

Parameters

src	Source of data for new created instance.

5.5.2.4 Vector2() [4/4]

```
template<class T>
template<class FromT >
```

```
Vector2< T >::Vector2 (
             const Vector2< FromT > & src )  [inline]
```

Copy casting constructor.

Parameters

src	Source of data for new created instance.

5.5.3 Member Function Documentation

5.5.3.1 length()

```
template<class T>
T Vector2< T >::length ( ) const  [inline]
```

Get length of vector.

Returns

lenght of vector

5.5.3.2 lengthSq()

```
template<class T>
T Vector2< T >::lengthSq ( ) const  [inline]
```

Return square of length.

Returns

length ^ 2

Note

This method is faster then length(). For comparison of length of two vector can be used just this value, instead of more expensive length() method.

5.5.3.3 lerp()

```
template<class T>
Vector2<T> Vector2< T >::lerp (
             T fact,
             const Vector2< T > & r ) const  [inline]
```

Linear interpolation of two vectors.

Parameters

fact	Factor of interpolation. For translation from position of this vector to vector r, values of factor goes from 0.0 to 1.0.
r	Second Vector for interpolation

Note

> However values of fact parameter are reasonable only in interval [0.0 , 1.0], you can pass also values outside of this interval and you can get result (extrapolation?)

5.5.3.4 normalize()

```
template<class T>
void Vector2< T >::normalize ( )  [inline]
```

Normalize vector.

5.5.3.5 operator const T ∗()

```
template<class T>
Vector2< T >::operator const T ∗ ( ) const  [inline]
```

Conversion to pointer operator.

Returns

> Constant Pointer to internally stored (in management of class Vector2<T>) used for passing Vector2<T> values to gl∗2[fd] functions.

5.5.3.6 operator T∗()

```
template<class T>
Vector2< T >::operator T∗ ( )  [inline]
```

Conversion to pointer operator.

Returns

> Pointer to internally stored (in management of class Vector2<T>) used for passing Vector2<T> values to gl∗2[fd] functions.

5.5.3.7 operator"!=()

```
template<class T>
bool Vector2< T >::operator!= (
             const Vector2< T > & rhs ) const  [inline]
```

Inequality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Returns

not (lhs == rhs) :-P

5.5.3.8 operator*() [1/2]

```
template<class T>
Vector2<T> Vector2< T >::operator* (
             const Vector2< T > & rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.9 operator*() [2/2]

```
template<class T>
Vector2<T> Vector2< T >::operator* (
             T rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.10 operator*=() [1/2]

```
template<class T>
Vector2<T>& Vector2< T >::operator*= (
             const Vector2< T > & rhs )  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.11 operator*=() [2/2]

```
template<class T>
Vector2<T>& Vector2< T >::operator*= (
             T rhs )  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.12 operator+() [1/2]

```
template<class T>
Vector2<T> Vector2< T >::operator+ (
             const Vector2< T > & rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.13 operator+() [2/2]

```
template<class T>
Vector2<T> Vector2< T >::operator+ (
             T rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.14 operator+=() [1/2]

```
template<class T>
Vector2<T>& Vector2< T >::operator+= (
             const Vector2< T > & rhs )  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.15 operator+=() [2/2]

```
template<class T>
Vector2<T>& Vector2< T >::operator+= (
             T rhs )  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.16 operator-() [1/3]

```
template<class T>
Vector2<T> Vector2< T >::operator- (
             const Vector2< T > & rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.17 operator-() [2/3]

```
template<class T>
Vector2<T> Vector2< T >::operator- (
             T rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.18 operator-() [3/3]

```
template<class T>
Vector2<T> Vector2< T >::operator- ( ) const  [inline]
```

Unary negate operator.

Returns

negated vector

5.5.3.19 operator-=() [1/2]

```
template<class T>
Vector2<T>& Vector2< T >::operator-= (
             const Vector2< T > & rhs )  [inline]
```

Substraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.20 operator-=() [2/2]

```
template<class T>
Vector2<T>& Vector2< T >::operator-= (
             T rhs )  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.21 operator/() [1/2]

```
template<class T>
Vector2<T> Vector2< T >::operator/ (
             const Vector2< T > & rhs ) const  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.22 operator/() [2/2]

```
template<class T>
Vector2<T> Vector2< T >::operator/ (
             T rhs ) const  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.23 operator/=() [1/2]

```
template<class T>
Vector2<T>& Vector2< T >::operator/= (
             const Vector2< T > & rhs )  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.24 operator/=() [2/2]

```
template<class T>
Vector2<T>& Vector2< T >::operator/= (
             T rhs )  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.25 operator=() [1/2]

```
template<class T>
template<class FromT >
Vector2<T>& Vector2< T >::operator= (
            const Vector2< FromT > & rhs )  [inline]
```

Copy casting operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.26 operator=() [2/2]

```
template<class T>
Vector2<T>& Vector2< T >::operator= (
            const Vector2< T > & rhs )  [inline]
```

Copy operator.

Parameters

rhs	Right hand side argument of binary operator.

5.5.3.27 operator==()

```
template<class T>
bool Vector2< T >::operator== (
            const Vector2< T > & rhs ) const  [inline]
```

Equality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Note

Test of equality is based of threshold EPSILON value. To be two values equal, must satisfy this condition | lhs.x - rhs.y | < EPSILON, same for y-coordinate.

5.5.3.28 operator[]() [1/2]

```
template<class T>
T& Vector2< T >::operator[] (
             int n )  [inline]
```

Array access operator.

Parameters

n	Array index

Returns

For n = 0, reference to x coordinate, else reference to y y coordinate.

5.5.3.29 operator[]() [2/2]

```
template<class T>
const T& Vector2< T >::operator[] (
             int n ) const  [inline]
```

Constant array access operator.

Parameters

n	Array index

Returns

For n = 0, reference to x coordinate, else reference to y y coordinate.

5.5.3.30 toString()

```
template<class T>
std::string Vector2< T >::toString ( ) const  [inline]
```

Gets string representation.

5.5.4 Friends And Related Function Documentation

5.5.4.1 operator<<

```
template<class T>
std::ostream& operator<< (
             std::ostream & lhs,
             const Vector2< T > & rhs ) [friend]
```

Output to stream operator.

Parameters

lhs	Left hand side argument of operator (commonly ostream instance).
rhs	Right hand side argument of operator.

Returns

Left hand side argument - the ostream object passed to operator.

5.5.5 Member Data Documentation

5.5.5.1 "@1

```
union { ... }
```

5.5.5.2 "@3

```
union { ... }
```

5.5.5.3 s

```
template<class T>
T Vector2< T >::s
```

First element of vector, alias for S-coordinate.

For textures notation.

5.5.5.4 t

```
template<class T>
T Vector2< T >::t
```

Second element of vector, alias for T-coordinate.

For textures notation.

5.5.5.5 x

```
template<class T>
T Vector2< T >::x
```

First element of vector, alias for X-coordinate.

5.5.5.6 y

```
template<class T>
T Vector2< T >::y
```

Second element of vector, alias for Y-coordinate.

The documentation for this class was generated from the following file:

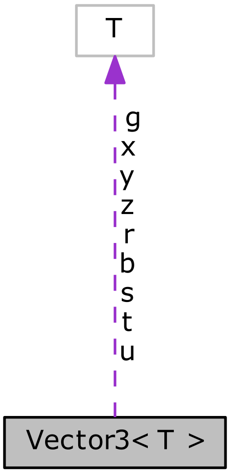
- src/vmath.h

5.6 Vector3< T > Class Template Reference

Class for three dimensional vector.

`#include <vmath.h>`

Collaboration diagram for Vector3< T >:



Public Member Functions

- Vector3 ()

  Creates and sets to (0,0,0)
- Vector3 (T nx, T ny, T nz)

  Creates and sets to (x,y,z)
- Vector3 (const Vector3< T > &src)

  Copy constructor.
- template<class FromT >
  Vector3 (const Vector3< FromT > &src)

  Copy casting constructor.
- Vector3< T > operator= (const Vector3< T > &rhs)

  Copy operator.
- template<class FromT >
  Vector3< T > operator= (const Vector3< FromT > &rhs)

  Copy casting operator.
- T & operator[ ] (int n)

  Array access operator.
- const T & operator[ ] (int n) const

  Constant array access operator.
- Vector3< T > operator+ (const Vector3< T > &rhs) const

  Addition operator.
- Vector3< T > operator- (const Vector3< T > &rhs) const

  Subtraction operator.
- Vector3< T > operator* (const Vector3< T > &rhs) const

  Multiplication operator.
- Vector3< T > operator/ (const Vector3< T > &rhs) const

  Division operator.
- Vector3< T > & operator+= (const Vector3< T > &rhs)

  Addition operator.
- Vector3< T > & operator-= (const Vector3< T > &rhs)

  Subtraction operator.
- Vector3< T > & operator*= (const Vector3< T > &rhs)

  Multiplication operator.
- Vector3< T > & operator/= (const Vector3< T > &rhs)

  Division operator.
- T dotProduct (const Vector3< T > &rhs) const

  Dot product of two vectors.
- Vector3< T > crossProduct (const Vector3< T > &rhs) const

  Cross product operator.
- Vector3< T > operator+ (T rhs) const

  Addition operator.
- Vector3< T > operator- (T rhs) const

  Subtraction operator.
- Vector3< T > operator* (T rhs) const

  Multiplication operator.
- Vector3< T > operator/ (T rhs) const

  Division operator.
- Vector3< T > & operator+= (T rhs)

  Addition operator.
- Vector3< T > & operator-= (T rhs)

Subtraction operator.

- Vector3< T > & operator∗= (T rhs)

  Multiplication operator.

- Vector3< T > & operator/= (T rhs)

  Division operator.

- bool operator== (const Vector3< T > &rhs) const

  Equality test operator.

- bool operator!= (const Vector3< T > &rhs) const

  Inequality test operator.

- Vector3< T > operator- () const

  Unary negate operator.

- T length () const

  Get length of vector.

- T lengthSq () const

  Return square of length.

- void normalize ()

  Normalize vector.

- void rotate (T ax, T ay, T az)

  Rotate vector around three axis.

- Vector3< T > lerp (T fact, const Vector3< T > &r) const

  Linear interpolation of two vectors.

- operator T∗ ()

  Conversion to pointer operator.

- operator const T ∗ () const

  Conversion to pointer operator.

- std::string toString () const

  Gets string representation.

Public Attributes

- union {
  T x
  First element of vector, alias for X-coordinate.
  T s
  First element of vector, alias for S-coordinate.
  T r
  First element of vector, alias for R-coordinate.
  };

- union {
  T y
  Second element of vector, alias for Y-coordinate.
  T t
  Second element of vector, alias for T-coordinate.
  T g
  Second element of vector, alias for G-coordinate.
  };

- union {
  T z
  Third element of vector, alias for Z-coordinate.
  T u
  Third element of vector, alias for U-coordinate.
  T b
  Third element of vector, alias for B-coordinate.
  };

Friends

- std::ostream & operator<< (std::ostream &lhs, const Vector3< T > rhs)
  Output to stream operator.

5.6.1 Detailed Description

template<class T>
class Vector3< T >

Class for three dimensional vector.

There are four ways of accessing vector components. Let's have `Vector3f v`, you can either:

- access as position (x,y,z) — `v.x = v.y = v.z = 1;`
- access as texture coordinate (s,t,u) — `v.s = v.t = v.u = 1;`
- access as color (r,g,b) — `v.r = v.g = v.b = 1;`
- access via operator[] — `v[0] = v[1] = v[2] = 1;`

5.6.2 Constructor & Destructor Documentation

5.6.2.1 Vector3() [1/4]

```
template<class T>
Vector3< T >::Vector3 ( )  [inline]
```

Creates and sets to (0,0,0)

5.6.2.2 Vector3() [2/4]

```
template<class T>
Vector3< T >::Vector3 (
              T nx,
              T ny,
              T nz )  [inline]
```

Creates and sets to (x,y,z)

Parameters

nx	initial x-coordinate value
ny	initial y-coordinate value
nz	initial z-coordinate value

5.6.2.3 Vector3() [3/4]

```
template<class T>
Vector3< T >::Vector3 (
             const Vector3< T > & src )  [inline]
```

Copy constructor.

Parameters

src	Source of data for new created Vector3 instance.

5.6.2.4 Vector3() [4/4]

```
template<class T>
template<class FromT >
Vector3< T >::Vector3 (
             const Vector3< FromT > & src )  [inline]
```

Copy casting constructor.

Parameters

src	Source of data for new created Vector3 instance.

5.6.3 Member Function Documentation

5.6.3.1 crossProduct()

```
template<class T>
Vector3<T> Vector3< T >::crossProduct (
             const Vector3< T > & rhs ) const  [inline]
```

Cross product operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.2 dotProduct()

```
template<class T>
T Vector3< T >::dotProduct (
            const Vector3< T > & rhs ) const  [inline]
```

Dot product of two vectors.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.3 length()

```
template<class T>
T Vector3< T >::length ( ) const  [inline]
```

Get length of vector.

Returns

lenght of vector

5.6.3.4 lengthSq()

```
template<class T>
T Vector3< T >::lengthSq ( ) const  [inline]
```

Return square of length.

Returns

length ^ 2

Note

This method is faster then length(). For comparison of length of two vector can be used just this value, instead of more expensive length() method.

5.6.3.5 lerp()

```
template<class T>
Vector3<T> Vector3< T >::lerp (
             T fact,
             const Vector3< T > & r ) const  [inline]
```

Linear interpolation of two vectors.

Parameters

fact	Factor of interpolation. For translation from positon of this vector to vector r, values of factor goes from 0.0 to 1.0.
r	Second Vector for interpolation

Note

> However values of fact parameter are reasonable only in interval [0.0 , 1.0], you can pass also values outside of this interval and you can get result (extrapolation?)

5.6.3.6 normalize()

```
template<class T>
void Vector3< T >::normalize ( )  [inline]
```

Normalize vector.

5.6.3.7 operator const T ∗()

```
template<class T>
Vector3< T >::operator const T ∗ ( ) const  [inline]
```

Conversion to pointer operator.

Returns

> Constant Pointer to internally stored (in management of class Vector3<T>) used for passing Vector3<T> values to gl∗3[fd] functions.

5.6.3.8 operator T∗()

```
template<class T>
Vector3< T >::operator T∗ ( )  [inline]
```

Conversion to pointer operator.

Returns

Pointer to internally stored (in management of class Vector3<T>) used for passing Vector3<T> values to gl∗3[fd] functions.

5.6.3.9 operator"!=()

```
template<class T>
bool Vector3< T >::operator!= (
            const Vector3< T > & rhs ) const  [inline]
```

Inequality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Returns

not (lhs == rhs) :-P

5.6.3.10 operator∗() [1/2]

```
template<class T>
Vector3<T> Vector3< T >::operator∗ (
            const Vector3< T > & rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.11 operator∗() [2/2]

```
template<class T>
```

```
Vector3<T> Vector3< T >::operator* (
             T rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.12 operator*=() [1/2]

```
template<class T>
Vector3<T>& Vector3< T >::operator*= (
             const Vector3< T > & rhs )  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.13 operator*=() [2/2]

```
template<class T>
Vector3<T>& Vector3< T >::operator*= (
             T rhs )  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.14 operator+() [1/2]

```
template<class T>
Vector3<T> Vector3< T >::operator+ (
             const Vector3< T > & rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.15 operator+() [2/2]

```
template<class T>
Vector3<T> Vector3< T >::operator+ (
             T rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.16 operator+=() [1/2]

```
template<class T>
Vector3<T>& Vector3< T >::operator+= (
             const Vector3< T > & rhs )  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.17 operator+=() [2/2]

```
template<class T>
Vector3<T>& Vector3< T >::operator+= (
             T rhs )  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.18 operator-() [1/3]

```
template<class T>
Vector3<T> Vector3< T >::operator- (
             const Vector3< T > & rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.19 operator-() [2/3]

```
template<class T>
Vector3<T> Vector3< T >::operator- (
             T rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.20 operator-() [3/3]

```
template<class T>
Vector3<T> Vector3< T >::operator- ( ) const  [inline]
```

Unary negate operator.

Returns

negated vector

5.6.3.21 operator-=() [1/2]

```
template<class T>
Vector3<T>& Vector3< T >::operator-= (
             const Vector3< T > & rhs )  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.22 operator-=() [2/2]

```
template<class T>
Vector3<T>& Vector3< T >::operator-= (
             T rhs )  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.23 operator/() [1/2]

```
template<class T>
Vector3<T> Vector3< T >::operator/ (
             const Vector3< T > & rhs ) const  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.24 operator/() [2/2]

```
template<class T>
Vector3<T> Vector3< T >::operator/ (
             T rhs ) const  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.25 operator/=() [1/2]

```
template<class T>
Vector3<T>& Vector3< T >::operator/= (
             const Vector3< T > & rhs )  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.26 operator/=() [2/2]

```
template<class T>
Vector3<T>& Vector3< T >::operator/= (
             T rhs )  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.27 operator=() [1/2]

```
template<class T>
Vector3<T> Vector3< T >::operator= (
             const Vector3< T > & rhs )  [inline]
```

Copy operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.28 operator=() [2/2]

```
template<class T>
template<class FromT >
Vector3<T> Vector3< T >::operator= (
             const Vector3< FromT > & rhs )  [inline]
```

Copy casting operator.

Parameters

rhs	Right hand side argument of binary operator.

5.6.3.29 operator==()

```
template<class T>
bool Vector3< T >::operator== (
             const Vector3< T > & rhs ) const  [inline]
```

Equality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Note

> Test of equality is based of threshold EPSILON value. To be two values equal, must satisfy this condition | lhs.x - rhs.y | < EPSILON, same for y-coordinate, and z-coordinate.

5.6.3.30 operator[]() [1/2]

```
template<class T>
T& Vector3< T >::operator[] (
             int n )  [inline]
```

Array access operator.

Parameters

n	Array index

Returns

> For n = 0, reference to x coordinate, n = 1 reference to y, else reference to z y coordinate.

5.6.3.31 operator[]() [2/2]

```
template<class T>
const T& Vector3< T >::operator[] (
             int n ) const  [inline]
```

Constant array access operator.

Parameters

n	Array index

Returns

For n = 0, reference to x coordinate, n = 1 reference to y, else reference to z y coordinate.

5.6.3.32 rotate()

```
template<class T>
void Vector3< T >::rotate (
            T ax,
            T ay,
            T az )  [inline]
```

Rotate vector around three axis.

Parameters

ax	Angle (in degrees) to be rotated around X-axis.
ay	Angle (in degrees) to be rotated around Y-axis.
az	Angle (in degrees) to be rotated around Z-axis.

5.6.3.33 toString()

```
template<class T>
std::string Vector3< T >::toString ( ) const  [inline]
```

Gets string representation.

5.6.4 Friends And Related Function Documentation

5.6.4.1 operator<<

```
template<class T>
std::ostream& operator<< (
            std::ostream & lhs,
            const Vector3< T > rhs )  [friend]
```

Output to stream operator.

Parameters

lhs	Left hand side argument of operator (commonly ostream instance).
rhs	Right hand side argument of operator.

Returns

Left hand side argument - the ostream object passed to operator.

5.6.5 Member Data Documentation

5.6.5.1 "@5

```
union { ... }
```

5.6.5.2 "@7

```
union { ... }
```

5.6.5.3 "@9

```
union { ... }
```

5.6.5.4 b

```
template<class T>
T Vector3< T >::b
```

Third element of vector, alias for B-coordinate.

For color notation.

5.6.5.5 g

```
template<class T>
T Vector3< T >::g
```

Second element of vector, alias for G-coordinate.

For color notation.

5.6.5.6 r

```
template<class T>
T Vector3< T >::r
```

First element of vector, alias for R-coordinate.

For color notation.

5.6.5.7 s

```
template<class T>
T Vector3< T >::s
```

First element of vector, alias for S-coordinate.

For textures notation.

5.6.5.8 t

```
template<class T>
T Vector3< T >::t
```

Second element of vector, alias for T-coordinate.

For textures notation.

5.6.5.9 u

```
template<class T>
T Vector3< T >::u
```

Third element of vector, alias for U-coordinate.

For textures notation.

5.6.5.10 x

```
template<class T>
T Vector3< T >::x
```

First element of vector, alias for X-coordinate.

5.6.5.11 y

```
template<class T>
T Vector3< T >::y
```

Second element of vector, alias for Y-coordinate.

5.6.5.12 z

```
template<class T>
T Vector3< T >::z
```

Third element of vector, alias for Z-coordinate.

The documentation for this class was generated from the following file:

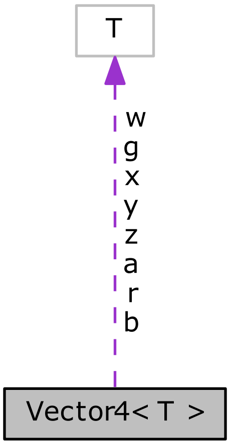
- src/vmath.h

5.7 Vector4< T > Class Template Reference

Class for four dimensional vector.

```
#include <vmath.h>
```

Collaboration diagram for Vector4< T >:



Public Member Functions

- Vector4 ()

  Creates and sets to (0,0,0,0)
- Vector4 (T nx, T ny, T nz, T nw)

  Creates and sets to (x,y,z,z)
- Vector4 (const Vector4< T > &src)

  Copy constructor.
- template<class FromT >
  Vector4 (const Vector4< FromT > &src)

  Copy casting constructor.

- Vector4 (const Vector3< T > &src, T w)
- template<typename FromT >
  Vector4 (const Vector3< FromT > &src, FromT w)
- Vector4< T > operator= (const Vector4< T > &rhs)

  Copy operator.
- template<class FromT >
  Vector4< T > operator= (const Vector4< FromT > &rhs)

  Copy casting operator.
- T & operator[ ] (int n)

  Array access operator.
- const T & operator[ ] (int n) const

  Array access operator.
- Vector4< T > operator+ (const Vector4< T > &rhs) const

  Addition operator.
- Vector4< T > operator- (const Vector4< T > &rhs) const

  Subtraction operator.
- Vector4< T > operator∗ (const Vector4< T > rhs) const

  Multiplication operator.
- Vector4< T > operator/ (const Vector4< T > &rhs) const

  Division operator.
- Vector4< T > & operator+= (const Vector4< T > &rhs)

  Addition operator.
- Vector4< T > & operator-= (const Vector4< T > &rhs)

  Subtraction operator.
- Vector4< T > & operator∗= (const Vector4< T > &rhs)

  Multiplication operator.
- Vector4< T > & operator/= (const Vector4< T > &rhs)

  Division operator.
- bool operator== (const Vector4< T > &rhs) const

  Equality test operator.
- bool operator!= (const Vector4< T > &rhs) const

  Inequality test operator.
- Vector4< T > operator- () const

  Unary negate operator.
- Vector4< T > operator+ (T rhs) const

  Addition operator.
- Vector4< T > operator- (T rhs) const

  Subtraction operator.
- Vector4< T > operator∗ (T rhs) const

  Multiplication operator.
- Vector4< T > operator/ (T rhs) const

  Division operator.
- Vector4< T > & operator+= (T rhs)

  Addition operator.
- Vector4< T > & operator-= (T rhs)

  Subtraction operator.
- Vector4< T > & operator∗= (T rhs)

  Multiplication operator.
- Vector4< T > & operator/= (T rhs)

  Division operator.
- T length () const

Get length of vector.

- void normalize ()

  Normalize vector.
- T lengthSq () const

  Return square of length.
- Vector4< T > lerp (T fact, const Vector4< T > &r) const

  Linear interpolation of two vectors.
- operator T* ()

  Conversion to pointer operator.
- operator const T * () const

  Conversion to pointer operator.
- Vector3< T > xyz () const

  Gets 3D vector.
- std::string toString () const

  Gets string representation.

Public Attributes

- union {
  T r
  First element of vector, alias for R-coordinate.
  T x
  };
- union {
  T g
  Second element of vector, alias for G-coordinate.
  T y
  Second element of vector, alias for Y-coordinate.
  };
- union {
  T b
  Third element of vector, alias for B-coordinate.
  T z
  Third element of vector, alias for Z-coordinate.
  };
- union {
  T a
  Fourth element of vector, alias for A-coordinate.
  T w
  First element of vector, alias for W-coordinate.
  };

Friends

- std::ostream & operator<< (std::ostream &lhs, const Vector4< T > &rhs)

  Output to stream operator.

5.7.1 Detailed Description

template<class T>
class Vector4< T >

Class for four dimensional vector.

There are four ways of accessing vector components. Let's have `Vector4f v`, you can either:

- access as position in projective space (x,y,z,w) — `v.x = v.y = v.z = v.w = 1;`
- access as texture coordinate (s,t,u,v) — `v.s = v.t = v.u = v.v = 1;`
- access as color (r,g,b,a) — `v.r = v.g = v.b = v.a = 1;`
- access via operator[] — `v[0] = v[1] = v[2] = v[3] = 1;`

5.7.2 Constructor & Destructor Documentation

5.7.2.1 Vector4() [1/6]

```
template<class T>
Vector4< T >::Vector4 ( )  [inline]
```

Creates and sets to (0,0,0,0)

5.7.2.2 Vector4() [2/6]

```
template<class T>
Vector4< T >::Vector4 (
            T nx,
            T ny,
            T nz,
            T nw )  [inline]
```

Creates and sets to (x,y,z,z)

Parameters

nx	initial x-coordinate value (R)
ny	initial y-coordinate value (G)
nz	initial z-coordinate value (B)
nw	initial w-coordinate value (Alpha)

5.7.2.3 Vector4() [3/6]

```
template<class T>
Vector4< T >::Vector4 (
            const Vector4< T > & src )  [inline]
```

Copy constructor.

Parameters

src	Source of data for new created Vector4 instance.

5.7.2.4 Vector4() [4/6]

```
template<class T>
template<class FromT >
Vector4< T >::Vector4 (
            const Vector4< FromT > & src )  [inline]
```

Copy casting constructor.

Parameters

src	Source of data for new created Vector4 instance.

5.7.2.5 Vector4() [5/6]

```
template<class T>
Vector4< T >::Vector4 (
            const Vector3< T > & src,
            T w )  [inline]
```

5.7.2.6 Vector4() [6/6]

```
template<class T>
template<typename FromT >
Vector4< T >::Vector4 (
            const Vector3< FromT > & src,
            FromT w )  [inline]
```

5.7.3 Member Function Documentation

5.7.3.1 length()

```
template<class T>
T Vector4< T >::length ( ) const  [inline]
```

Get length of vector.

Returns

lenght of vector

5.7.3.2 lengthSq()

```
template<class T>
T Vector4< T >::lengthSq ( ) const  [inline]
```

Return square of length.

Returns

length ^ 2

Note

This method is faster then length(). For comparison of length of two vector can be used just this value, instead of more expensive length() method.

5.7.3.3 lerp()

```
template<class T>
Vector4<T> Vector4< T >::lerp (
             T fact,
             const Vector4< T > & r ) const  [inline]
```

Linear interpolation of two vectors.

Parameters

fact	Factor of interpolation. For translation from position of this vector to vector r, values of factor goes from 0.0 to 1.0.
r	Second Vector for interpolation

Note

However values of fact parameter are reasonable only in interval [0.0 , 1.0], you can pass also values outside of this interval and you can get result (extrapolation?)

5.7.3.4 normalize()

```
template<class T>
void Vector4< T >::normalize ( )  [inline]
```

Normalize vector.

5.7.3.5 operator const T ∗()

```
template<class T>
Vector4< T >::operator const T ∗ ( ) const  [inline]
```

Conversion to pointer operator.

Returns

Constant Pointer to internally stored (in management of class Vector4<T>) used for passing Vector4<T> values to gl∗4[fd] functions.

5.7.3.6 operator T∗()

```
template<class T>
Vector4< T >::operator T∗ ( )  [inline]
```

Conversion to pointer operator.

Returns

Pointer to internally stored (in management of class Vector4<T>) used for passing Vector4<T> values to gl∗4[fd] functions.

5.7.3.7 operator"!=()

```
template<class T>
bool Vector4< T >::operator!= (
             const Vector4< T > & rhs ) const  [inline]
```

Inequality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Returns

not (lhs == rhs) :-P

5.7.3.8 operator*() [1/2]

```
template<class T>
Vector4<T> Vector4< T >::operator* (
             const Vector4< T > rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.9 operator*() [2/2]

```
template<class T>
Vector4<T> Vector4< T >::operator* (
             T rhs ) const  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.10 operator*=() [1/2]

```
template<class T>
Vector4<T>& Vector4< T >::operator*= (
             const Vector4< T > & rhs )  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.11 operator*=() [2/2]

```
template<class T>
Vector4<T>& Vector4< T >::operator*= (
             T rhs )  [inline]
```

Multiplication operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.12 operator+() [1/2]

```
template<class T>
Vector4<T> Vector4< T >::operator+ (
             const Vector4< T > & rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.13 operator+() [2/2]

```
template<class T>
Vector4<T> Vector4< T >::operator+ (
             T rhs ) const  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.14 operator+=() [1/2]

```
template<class T>
Vector4<T>& Vector4< T >::operator+= (
             const Vector4< T > & rhs )  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.15 operator+=() [2/2]

```
template<class T>
Vector4<T>& Vector4< T >::operator+= (
             T rhs )  [inline]
```

Addition operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.16 operator-() [1/3]

```
template<class T>
Vector4<T> Vector4< T >::operator- (
             const Vector4< T > & rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.17 operator-() [2/3]

```
template<class T>
Vector4<T> Vector4< T >::operator- ( ) const  [inline]
```

Unary negate operator.

Returns

negated vector

5.7.3.18 operator-() [3/3]

```
template<class T>
Vector4<T> Vector4< T >::operator- (
             T rhs ) const  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.19 operator-=() [1/2]

```
template<class T>
Vector4<T>& Vector4< T >::operator-= (
             const Vector4< T > & rhs )  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.20 operator-=() [2/2]

```
template<class T>
Vector4<T>& Vector4< T >::operator-= (
             T rhs )  [inline]
```

Subtraction operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.21 operator/() [1/2]

```
template<class T>
Vector4<T> Vector4< T >::operator/ (
             const Vector4< T > & rhs ) const  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.22 operator/() [2/2]

```
template<class T>
Vector4<T> Vector4< T >::operator/ (
             T rhs ) const  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.23 operator/=() [1/2]

```
template<class T>
Vector4<T>& Vector4< T >::operator/= (
             const Vector4< T > & rhs )  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.24 operator/=() [2/2]

```
template<class T>
Vector4<T>& Vector4< T >::operator/= (
             T rhs )  [inline]
```

Division operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.25 operator=() [1/2]

```
template<class T>
Vector4<T> Vector4< T >::operator= (
             const Vector4< T > & rhs )  [inline]
```

Copy operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.26 operator=() [2/2]

```
template<class T>
template<class FromT >
Vector4<T> Vector4< T >::operator= (
             const Vector4< FromT > & rhs )  [inline]
```

Copy casting operator.

Parameters

rhs	Right hand side argument of binary operator.

5.7.3.27 operator==()

```
template<class T>
bool Vector4< T >::operator== (
             const Vector4< T > & rhs ) const  [inline]
```

Equality test operator.

Parameters

rhs	Right hand side argument of binary operator.

Note

Test of equality is based of threshold EPSILON value. To be two values equal, must satisfy this condition | lhs.x - rhs.y | < EPSILON, same for y-coordinate, z-coordinate, and w-coordinate.

5.7.3.28 operator[]() [1/2]

```
template<class T>
T& Vector4< T >::operator[] (
             int n )  [inline]
```

Array access operator.

Parameters

n	Array index

Returns

For n = 0, reference to x coordinate, n = 1 reference to y coordinate, n = 2 reference to z, else reference to w coordinate.

5.7.3.29 operator[]() [2/2]

```
template<class T>
const T& Vector4< T >::operator[] (
             int n ) const  [inline]
```

Array access operator.

Parameters

n	Array index

Returns

For n = 0, reference to x coordinate, n = 1 reference to y coordinate, n = 2 reference to z, else reference to w coordinate.

5.7.3.30 toString()

```
template<class T>
std::string Vector4< T >::toString ( ) const  [inline]
```

Gets string representation.

5.7.3.31 xyz()

```
template<class T>
Vector3<T> Vector4< T >::xyz ( ) const  [inline]
```

Gets 3D vector.

Note that the output is divided by w coordinate to apply projection transform. If the w coordinate is equal to zero, the result is not divided.

Returns

(x/w, y/w, z/w) iff w != 0 otherwise (x,y,z)

5.7.4 Friends And Related Function Documentation

5.7.4.1 operator<<

```
template<class T>
std::ostream& operator<< (
            std::ostream & lhs,
            const Vector4< T > & rhs )  [friend]
```

Output to stream operator.

Parameters

lhs	Left hand side argument of operator (commonly ostream instance).
rhs	Right hand side argument of operator.

Returns

Left hand side argument - the ostream object passed to operator.

5.7.5 Member Data Documentation

5.7.5.1 "@11

```
union { ... }
```

5.7.5.2 "@13

```
union { ... }
```

5.7.5.3 "@15

```
union { ... }
```

5.7.5.4 "@17

```
union { ... }
```

5.7.5.5 a

```
template<class T>
T Vector4< T >::a
```

Fourth element of vector, alias for A-coordinate.

For color notation. This represnt aplha chanell

5.7.5.6 b

```
template<class T>
T Vector4< T >::b
```

Third element of vector, alias for B-coordinate.

For color notation.

5.7.5.7 g

```
template<class T>
T Vector4< T >::g
```

Second element of vector, alias for G-coordinate.

For color notation.

5.7.5.8 r

```
template<class T>
T Vector4< T >::r
```

First element of vector, alias for R-coordinate.

For color notation. First element of vector, alias for X-coordinate.

5.7.5.9 w

```
template<class T>
T Vector4< T >::w
```

First element of vector, alias for W-coordinate.

Note

> For vectors (such as normals) should be set to 0.0 For vertices should be set to 1.0

5.7.5.10 x

```
template<class T>
T Vector4< T >::x
```

5.7.5.11 y

```
template<class T>
T Vector4< T >::y
```

Second element of vector, alias for Y-coordinate.

5.7.5.12 z

```
template<class T>
T Vector4< T >::z
```

Third element of vector, alias for Z-coordinate.

The documentation for this class was generated from the following file:

- src/vmath.h

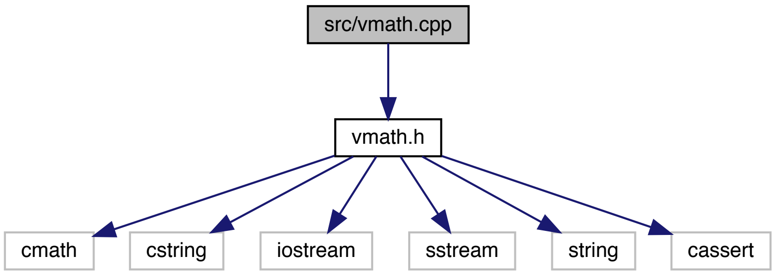
Chapter 6

File Documentation

6.1 src/vmath.cpp File Reference

```
#include "vmath.h"
```

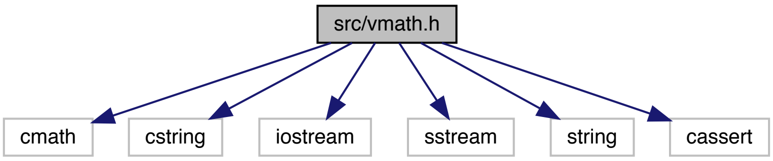
Include dependency graph for vmath.cpp:



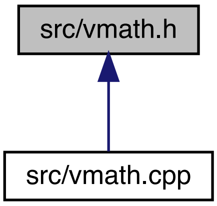
6.2 src/vmath.h File Reference

```
#include <cmath>
#include <cstring>
#include <iostream>
#include <sstream>
#include <string>
#include <cassert>
```

Include dependency graph for vmath.h:



This graph shows which files directly or indirectly include this file:



Classes

- class Vector2< T >

  Class for two dimensional vector.
- class Vector3< T >

  Class for three dimensional vector.
- class Vector4< T >

  Class for four dimensional vector.
- class Matrix3< T >

  Class for matrix 3x3.
- class Matrix4< T >

  Class for matrix 4x4.
- class Quaternion< T >

  Quaternion class implementing some quaternion algebra operations.
- class Aabb3< T >

  Axes-aligned bounding-box (aka AABB) class.

Macros

- #define M_PI 3.14159265358979323846 /∗ pi ∗/
- #define DEG2RAD(x) ((x ∗ M_PI) / 180.0)
- #define EPSILON epsilon
- #define VEC2 Vector2
- #define VEC3 Vector3
- #define VEC4 Vector4

Typedefs

- typedef class Vector2< float > Vector2f

  Two dimensional Vector of floats.
- typedef class Vector2< double > Vector2d

  Two dimensional Vector of doubles.
- typedef class Vector2< int > Vector2i

  Two dimensional Vector of ints.
- typedef Vector3< float > Vector3f

  Three dimensional Vector of floats.
- typedef Vector3< double > Vector3d

  Three dimensional Vector of doubles.
- typedef Vector3< int > Vector3i

  Three dimensional Vector of ints.
- typedef Vector4< float > Vector4f

  Three dimensional Vector of floats.
- typedef Vector4< double > Vector4d

  Three dimensional Vector of doubles.
- typedef Vector4< int > Vector4i

  Three dimensional Vector of ints.
- typedef Matrix3< float > Matrix3f

  Matrix 3x3 of floats.
- typedef Matrix3< double > Matrix3d

  Matrix 3x3 of doubles.
- typedef Matrix3< int > Matrix3i

  Matrix 3x3 of int.
- typedef Matrix4< float > Matrix4f

  Matrix 4x4 of floats.
- typedef Matrix4< double > Matrix4d

  Matrix 4x4 of doubles.
- typedef Matrix4< int > Matrix4i

  Matrix 4x4 of int.
- typedef Quaternion< float > Quatf
- typedef Quaternion< double > Quatd
- typedef Aabb3< float > Aabb3f
- typedef Aabb3< double > Aabb3d

Functions

- template<typename T >
  VEC2< T > std::min (const VEC2< T > &a, const VEC2< T > &b)

  Gets vector containing minimal values of a and b coordinates.
- template<typename T >
  VEC3< T > std::min (const VEC3< T > &a, const VEC3< T > &b)

  Gets vector containing minimal values of a and b coordinates.
- template<typename T >
  VEC4< T > std::min (const VEC4< T > &a, const VEC4< T > &b)

  Gets vector containing minimal values of a and b coordinates.
- template<typename T >
  VEC2< T > std::max (const VEC2< T > &a, const VEC2< T > &b)

  Gets vector containing maximal values of a and b coordinates.

- template<typename T >
  VEC3< T > std::max (const VEC3< T > &a, const VEC3< T > &b)

  Gets vector containing maximal values of a and b coordinates.
- template<typename T >
  VEC4< T > std::max (const VEC4< T > &a, const VEC4< T > &b)

  Gets vector containing maximal values of a and b coordinates.

Variables

- const double epsilon = 4.37114e-05

6.2.1 Macro Definition Documentation

6.2.1.1 DEG2RAD

```
#define DEG2RAD(
              x ) ((x * M_PI) / 180.0)
```

6.2.1.2 EPSILON

```
#define EPSILON epsilon
```

6.2.1.3 M_PI

```
#define M_PI 3.14159265358979323846 /* pi */
```

6.2.1.4 VEC2

```
#define VEC2 Vector2
```

6.2.1.5 VEC3

```
#define VEC3 Vector3
```

6.2.1.6 VEC4

```
#define VEC4 Vector4
```

6.2.2 Typedef Documentation

6.2.2.1 Aabb3d

```
typedef Aabb3<double> Aabb3d
```

6.2.2.2 Aabb3f

```
typedef Aabb3<float> Aabb3f
```

6.2.2.3 Matrix3d

```
typedef Matrix3<double> Matrix3d
```

Matrix 3x3 of doubles.

6.2.2.4 Matrix3f

```
typedef Matrix3<float> Matrix3f
```

Matrix 3x3 of floats.

6.2.2.5 Matrix3i

```
typedef Matrix3<int> Matrix3i
```

Matrix 3x3 of int.

6.2.2.6 Matrix4d

```
typedef Matrix4<double> Matrix4d
```

Matrix 4x4 of doubles.

6.2.2.7 Matrix4f

```
typedef Matrix4<float> Matrix4f
```

Matrix 4x4 of floats.

6.2.2.8 Matrix4i

```
typedef Matrix4<int> Matrix4i
```

Matrix 4x4 of int.

6.2.2.9 Quatd

```
typedef Quaternion<double> Quatd
```

6.2.2.10 Quatf

```
typedef Quaternion<float> Quatf
```

6.2.2.11 Vector2d

```
typedef class Vector2< double > Vector2d
```

Two dimensional Vector of doubles.

6.2.2.12 Vector2f

```
typedef class Vector2< float > Vector2f
```

Two dimensional Vector of floats.

6.2.2.13 Vector2i

```
typedef class Vector2< int > Vector2i
```

Two dimensional Vector of ints.

6.2.2.14 Vector3d

```
typedef Vector3<double> Vector3d
```

Three dimensional Vector of doubles.

6.2.2.15 Vector3f

```
typedef Vector3<float> Vector3f
```

Three dimensional Vector of floats.

6.2.2.16 Vector3i

```
typedef Vector3<int> Vector3i
```

Three dimensional Vector of ints.

6.2.2.17 Vector4d

```
typedef Vector4<double> Vector4d
```

Three dimensional Vector of doubles.

6.2.2.18 Vector4f

```
typedef Vector4<float> Vector4f
```

Three dimensional Vector of floats.

6.2.2.19 Vector4i

```
typedef Vector4<int> Vector4i
```

Three dimensional Vector of ints.

6.2.3 Function Documentation

6.2.3.1 max() [1/3]

```
template<typename T >
VEC2<T> std::max (
             const VEC2< T > & a,
             const VEC2< T > & b )
```

Gets vector containing maximal values of *a* and *b* coordinates.

Returns

Vector of maximal coordinates.

6.2.3.2 max() [2/3]

```
template<typename T >
VEC3<T> std::max (
             const VEC3< T > & a,
             const VEC3< T > & b )
```

Gets vector containing maximal values of *a* and *b* coordinates.

Returns

Vector of maximal coordinates.

6.2.3.3 max() [3/3]

```
template<typename T >
VEC4<T> std::max (
             const VEC4< T > & a,
             const VEC4< T > & b )
```

Gets vector containing maximal values of *a* and *b* coordinates.

Returns

Vector of maximal coordinates.

6.2.3.4 min() [1/3]

```
template<typename T >
VEC2<T> std::min (
             const VEC2< T > & a,
             const VEC2< T > & b )
```

Gets vector containing minimal values of *a* and *b* coordinates.

Returns

Vector of minimal coordinates.

6.2.3.5 min() [2/3]

```
template<typename T >
VEC3<T> std::min (
             const VEC3< T > & a,
             const VEC3< T > & b )
```

Gets vector containing minimal values of *a* and *b* coordinates.

Returns

Vector of minimal coordinates.

6.2.3.6 min() [3/3]

```
template<typename T >
VEC4<T> std::min (
             const VEC4< T > & a,
             const VEC4< T > & b )
```

Gets vector containing minimal values of *a* and *b* coordinates.

Returns

Vector of minimal coordinates.

6.2.4 Variable Documentation

6.2.4.1 epsilon

```
const double epsilon = 4.37114e-05
```

Index