

## MTRX Engine

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# Chapter 1

## MTRXEngine

### 1.1 Author:

Mohamed Kasma

### 1.2 Description:

A basic C++ based physics engine which uses some libraries like GLM, SPDLOG, GLAD, GLFW.

- Implements rigidbody dynamics with force and torque integration.
- Implements force generators that can be used to simulate certain forces like gravity, drag, buoyancy, stiff springs, etc...
- Implements a basic collision detection system with basic bounding volumes (sphere, capsule, box).
- Implements convex shape colliders with GJK Collision detection
- Basic raycasting that can be used to grab a certain collider using a certain ray with the option to filter out certain colliders
- Very rough implementation of Bounding Volume Hierarchies(untested) that can be used to optimize collision detection checks

### 1.3 Book Sources

These are some of the books that i have used as inspiration:

Real-Time Collision Detection - Christer Ericson  
Game Physics Engine Development - Ian Millington  
Game Engine Architecture - Jason Gregory

### 1.4 Fixing timesteps:

[https://web.archive.org/web/20180321070852/https://.gafferongames.com/post/fix↔  
\\_your\\_timestep](https://web.archive.org/web/20180321070852/https://.gafferongames.com/post/fix_your_timestep)

## 1.5 GJK implementation sources:

[https://caseymuratori.com/blog\\_0003](https://caseymuratori.com/blog_0003) <http://www.dyn4j.org/2010/04/gjk-gilbert-johnson-ke>  
<http://vec3.ca/gjk/implementation/> <http://in2gpu.com/2014/05/18/gjk-algorithm-3d/>

## 1.6 Segment-Segment minimum distance implementation:

[http://geomalgorithms.com/a07-\\_distance.html#dist3D\\_Segment\\_to\\_Segment](http://geomalgorithms.com/a07-_distance.html#dist3D_Segment_to_Segment)

## 1.7 TRELLO

<https://trello.com/b/Cwb55iBt/mtrx-engine>

## Chapter 2

# Namespace Index

### 2.1 Namespace List

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

<a href="#">mtx</a> . . . . .	9
<a href="#">mtx::ColliderDetectionUtil</a> Utility namespace used for resolving collision detection algorithms to be used based on collider types . . . . .	12
<a href="#">mtx::CollisionUtil</a> Namespace used to define some collision detection algorithms that are used to check for collision between different colliders. None of these functions require colliders themselves, They use mostly primitive classes instead . . . . .	16
<a href="#">mtx::PhysicsUtil</a> Utility namespace for some basic calculations that are useful for collision detection and other physics related functionality . . . . .	26
<a href="#">mtx::RaycastCollisionUtil</a> Utility namespace used for raycasting functionality . . . . .	35





## Chapter 3

# Hierarchical Index

### 3.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

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mtrx::ConvexShapeCollider . . . . .	66
mtrx::AABBCollider . . . . .	39
mtrx::OOBBCollider . . . . .	89
mtrx::SphereCollider . . . . .	109
mtrx::CollisionSystem . . . . .	65
mtrx::GameTime . . . . .	71
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mtrx::IBoundingBoxVolume . . . . .	78
mtrx::AABBCollider . . . . .	39
mtrx::SphereCollider . . . . .	109
mtrx::Integratable . . . . .	79
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mtrx::LogManager . . . . .	81
mtrx::mtrxDynamicWorld . . . . .	84
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mtrx::rb_ForceGenerationRegistry . . . . .	95
mtrx::RigidbodyManager . . . . .	107
mtrx::Simplex . . . . .	109
mtrx::Transform . . . . .	114
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## Chapter 4

# Class Index

### 4.1 Class List

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

<a href="#">mtx::AABBCollider</a>	Implementation of an Axis Aligned Bounding Box used for collision systems . . . . .	39
<a href="#">mtx::Body</a>	Implementation of a basic particle body . . . . .	43
<a href="#">mtx::BVHNode&lt; BoundingBox &gt;</a>	An implementation of a BVH node used for Bounding Volume Hierarchies . . . . .	50
<a href="#">mtx::CapsuleCollider</a>	Implementation of Capsule colliders . . . . .	54
<a href="#">mtx::Collider</a>	Basic API for all colliders . . . . .	58
<a href="#">mtx::CollisionSystem</a>	The collision detection system of the engine . . . . .	65
<a href="#">mtx::ConvexShapeCollider</a>	Implementation of a Convex Shape collider . . . . .	66
<a href="#">mtx::GameTime</a>	Basic implementation of time values mostly used for the calculation of delta time . . . . .	71
<a href="#">mtx::GJKUtil</a>	Utility class for the implementation of the GJK algorithm used for collision detection between convex shape colliders . . . . .	73
<a href="#">mtx::IBoundingBox</a>	Interface used to define a bounding volume that can be used in a Bounding volume Hierarchy . . . . .	78
<a href="#">mtx::Integratable</a>	Interface for integration PS: Not used that much really . . . . .	79
<a href="#">mtx::IRigidbodyForceGenerator</a>	Force generation interface used to apply forces on rigidbodies . . . . .	80
<a href="#">mtx::LogManager</a>	Logger wrapper for logging functionality in the engine . . . . .	81
<a href="#">mtx::mtxDynamicWorld</a>	Entry point of the user to the engine. This class defines the API that user will be using to interface with the engine . . . . .	84
<a href="#">mtx::ObjectAxes</a>	The axes that define an objects world . . . . .	88
<a href="#">mtx::OOBCCollider</a>	Implementation of OOBs . . . . .	89
<a href="#">mtx::PotentialCollision</a>	Potential collisions struct . . . . .	92

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Implementation of a buoyancy force generator for rigidbodies . . . . .	93
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Registry for force generators used to map a rigidbody to all of the force generators that are to be applied to said rigidbody . . . . .	95
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Implementation of rigidbodies with rigidbody dynamics newtonian force integration and rotational forces . . . . .	99
<a href="#">mtx::RigidbodyManager</a>	
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<a href="#">mtx::Simplex</a>	
Simplest shape that can encapsulate a point in 3d space Used within GJK collision detection algorithm . . . . .	109
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<a href="#">mtx::Transform</a>	
Wrapper implementation of a transform that holds position, orientation, scale values and some functionality based on these values . . . . .	114
<a href="#">mtx::Triangle</a>	
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## Chapter 5

# Namespace Documentation

### 5.1 mtrx Namespace Reference

#### Namespaces

- [ColliderDetectionUtil](#)  
*Utility namespace used for resolving collision detection algorithms to be used based on collider types.*
- [CollisionUtil](#)  
*Namespace used to define some collision detection algorithms that are used to check for collision between different colliders. None of these functions require colliders themselves, They use mostly primitive classes instead.*
- [PhysicsUtil](#)  
*Utility namespace for some basic calculations that are useful for collision detection and other physics related functionality.*
- [RaycastCollisionUtil](#)  
*Utility namespace used for raycasting functionality.*

#### Classes

- class [AABBCollider](#)  
*Implementation of an Axis Aligned Bounding Box used for collision systems.*
- class [Body](#)  
*Implementation of a basic particle body.*
- class [BVHNode](#)  
*An implementation of a BVH node used for Bounding Volume Hierarchies.*
- class [CapsuleCollider](#)  
*Implementation of Capsule colliders.*
- class [Collider](#)  
*Basic API for all colliders.*
- class [CollisionSystem](#)  
*The collision detection system of the engine.*
- class [ConvexShapeCollider](#)  
*Implementation of a Convex Shape collider.*
- class [GameTime](#)  
*Basic implementation of time values mostly used for the calculation of delta time.*
- class [GJKUtil](#)

*Utility class for the implementation of the GJK algorithm used for collision detection between convex shape colliders.*

- class [IBoundingVolume](#)

*Interface used to define a bounding volume that can be used in a Bounding volume Hierarchy.*

- class [IIntegratable](#)

*Interface for integration PS: Not used that much really.*

- class [IRigidbodyForceGenerator](#)

*Force generation interface used to apply forces on rigidbodies.*

- class [LogManager](#)

*Logger wrapper for logging functionality in the engine.*

- class [mtxDynamicWorld](#)

*Entry point of the user to the engine. This class defines the API that user will be using to interface with the engine.*

- struct [ObjectAxes](#)

*The axes that define an objects world.*

- class [OOBCCollider](#)

*Implementation of OOBs.*

- struct [PotentialCollision](#)

*Potential collisions struct.*

- class [Ray](#)

*Implementation of a ray.*

- class [rb\\_BuoyancyForceGenerator](#)

*Implementation of a buoyancy force generator for rigidbodies.*

- class [rb\\_ForceGenerationRegistry](#)

*Registry for force generators used to map a rigidbody to all of the force generators that are to be applied to said rigidbody.*

- class [rb\\_GravityForceGenerator](#)

*Implementation of gravitational force generator.*

- class [Rigidbody](#)

*Implementation of rigidbodies with rigidbody dynamics newtonian force integration and rotational forces.*

- class [RigidbodyManager](#)

*Manager of rigidbodies.*

- struct [Simplex](#)

*Simplest shape that can encapsulate a point in 3d space Used within GJK collision detection algorithm.*

- class [SphereCollider](#)

*Implmentation of a Sphere collider used in collision systems.*

- class [Transform](#)

*Wrapper implementation of a transform that holds position, orientation, scale values and some functionality based on these values.*

- struct [Triangle](#)

*Struct for storing a triangle.*

## Enumerations

- enum [ColliderType](#) : char {  
**Sphere**, **AABB**, **OOBB**, **Capsule**,  
**ConvexShape** }

*Type of colliders that are supported in the engine.*

## Functions

- static int [RandomInt](#) (int min, int max)  
*Generating a random integer between 2 integer values.*
- static glm::mat3 [GenerateCuboidIT](#) (float mass, float \*extents)  
*Generate a cuboid inertia tensor.*
- static glm::mat3 [GenerateSphereIT](#) (float mass, float radius)  
*Generate a sphere inertia tensor.*

## Variables

- static float **gravity** = 9.81f
- static std::string **projectDir** = std::filesystem::current\_path().string()
- static const glm::vec3 **worldUp** = glm::vec3(0.f, 1.f, 0.f)
- static const glm::vec3 **worldSide** = glm::vec3(1.f, 0.f, 0.f)
- static const glm::vec3 **worldForward** = glm::vec3(0.f, 0.f, -1.f)

### 5.1.1 Detailed Description

DEPRECATED DO NOT USE THIS

### 5.1.2 Function Documentation

#### 5.1.2.1 GenerateCuboidIT()

```
static glm::mat3 mtrx::GenerateCuboidIT (
    float mass,
    float * extents ) [static]
```

Generate a cuboid inertia tensor.

##### Parameters

<i>mass</i>	Mass of the cuboid
<i>extents</i>	The extents of the cuboid

##### Returns

glm::mat3 The inertia tensor generated

#### 5.1.2.2 GenerateSphereIT()

```
static glm::mat3 mtrx::GenerateSphereIT (
    float mass,
    float radius ) [static]
```

Generate a sphere inertia tensor.

#### Parameters

<i>mass</i>	The mass of the sphere
<i>radius</i>	The radius of the sphere

#### Returns

glm::mat3 The generated inertia tensor

### 5.1.2.3 RandomInt()

```
static int mtrx::RandomInt (
    int min,
    int max ) [static]
```

Generating a random integer between 2 integer values.

#### Parameters

<i>min</i>	Minimum integer value (inclusive)
<i>max</i>	Maximum integer value (exclusive)

#### Returns

int A random integer within the range of min and max

## 5.2 mtrx::ColliderDetectionUtil Namespace Reference

Utility namespace used for resolving collision detection algorithms to be used based on collider types.

### Functions

- bool [Collide](#) (const [Collider](#) &collider1, const [Collider](#) &collider2)  
*Check for whether 2 colliders collide.*
- bool [SphereCollisionOptions](#) (const [SphereCollider](#) &sphCollider, const [Collider](#) &collider)  
*Collision algorithm options for sphere colliders.*
- bool [AABBCollisionOptions](#) (const [AABBCollider](#) &aabb, const [Collider](#) &collider)  
*Collision algorithm options for AABB colliders.*
- bool [OOBBCollisionOptions](#) (const [OOBBCollider](#) &oobb, const [Collider](#) &collider)  
*Collision algorithm options for OOBB colliders.*
- bool [CapsuleCollisionOptions](#) (const [CapsuleCollider](#) &capCollider, const [Collider](#) &collider)  
*Collision algorithm options for capsule colliders @mtrx::CapsuleCollider.*
- bool [ConvexShapeCollisionOptions](#) (const [ConvexShapeCollider](#) &convexCollider, const [Collider](#) &collider)  
*Collision algorithm options for convex shape colliders.*



### 5.2.1 Detailed Description

Utility namespace used for resolving collision detection algorithms to be used based on collider types.

See also

[mtrx::ColliderType](#)

### 5.2.2 Function Documentation

#### 5.2.2.1 AABBCollisionOptions()

```
bool mtrx::ColliderDetectionUtil::AABBCollisionOptions (
    const AABBCollider & aabb,
    const Collider & collider )
```

Collision algorithm options for AABB colliders.

See also

[mtrx::AABBCollider](#)

##### Parameters

<i>aabb</i>	The aabb collider
<i>collider</i>	The other collider

##### Returns

true The 2 colliders collide  
false The 2 colliders do not collide

#### 5.2.2.2 CapsuleCollisionOptions()

```
bool mtrx::ColliderDetectionUtil::CapsuleCollisionOptions (
    const CapsuleCollider & capCollider,
    const Collider & collider )
```

Collision algorithm options for capsule colliders @mtrx::CapsuleCollider.

##### Parameters

<i>capCollider</i>	The capsule collider
<i>collider</i>	The other collider

**Returns**

true The 2 colliders collide  
 false The 2 colliders do not collide

**5.2.2.3 Collide()**

```
bool mtrx::ColliderDetectionUtil::Collide (
    const Collider & collider1,
    const Collider & collider2 )
```

Check for whether 2 colliders collide.

**Parameters**

<i>collider1</i>	The first collider
<i>collider2</i>	The second collider

**Returns**

true The 2 colliders collide  
 false the 2 colliders do not collide

**5.2.2.4 ConvexShapeCollisionOptions()**

```
bool mtrx::ColliderDetectionUtil::ConvexShapeCollisionOptions (
    const ConvexShapeCollider & convexCollider,
    const Collider & collider )
```

Collision algorithm options for convex shape colliders.

**See also**

[mtrx::ConvexShapeCollider](#)

**Parameters**

<i>convexCollider</i>	The convex shape collider
<i>collider</i>	The other collider

**Returns**

true The 2 colliders collide  
 false The 2 colliders do not collide

### 5.2.2.5 OOBBCollisionOptions()

```
bool mtrx::ColliderDetectionUtil::OOBBCollisionOptions (
    const OOBBCollider & oobb,
    const Collider & collider )
```

Collision algorithm options for OOBb colliders.

See also

[mtrx::OOBBCollider](#)

Parameters

<i>oobb</i>	The OOBb collider
<i>collider</i>	The other collider

Returns

true The 2 colliders collide

false The 2 colliders do not collide

### 5.2.2.6 SphereCollisionOptions()

```
bool mtrx::ColliderDetectionUtil::SphereCollisionOptions (
    const SphereCollider & sphCollider,
    const Collider & collider )
```

Collision algorithm options for sphere colliders.

See also

[mtrx::SphereCollider](#)

Parameters

<i>sphCollider</i>	The sphere collider
<i>collider</i>	The other collider

## Returns

- true The 2 colliders collide
- false The 2 colliders do not collide

## 5.3 mtrx::CollisionUtil Namespace Reference

Namespace used to define some collision detection algorithms that are used to check for collision between different colliders. None of these functions require colliders themselves, They use mostly primitive classes instead.

### Functions

- bool [SphereSphereCollision](#) (const glm::vec3 &center1, const glm::vec3 &center2, float radius1, float radius2)  
*Sphere Sphere collision detection algorithm.*
- bool [SphereCapsuleCollision](#) (const glm::vec3 &center1, const glm::vec3 &center2, float radius1, float radius2, const glm::vec3 &A, const glm::vec3 &B)  
*Sphere Capsule collision detection algorithm.*
- bool [SphereAABBCollision](#) (const glm::vec3 &center, const float radius, const glm::vec3 &center1, const float \*halfExtents)  
*Sphere AABB collider collision detection algorithm.*
- bool [SphereOBBCollision](#) (const glm::vec3 &center, const float radius, const glm::vec3 &center1, const glm::vec3 \*axes, const float \*halfExtents)  
*Sphere OBB collider collision detection algorithm.*
- bool [CapsuleCapsuleCollision](#) (const glm::vec3 &A1, const glm::vec3 &B1, const glm::vec3 &A2, const glm::vec3 &B2, float radius1, float radius2)  
*Capsule Capsule collision detection algorithm.*
- bool [CapsuleAABBCollision](#) (const glm::vec3 &A, const glm::vec3 &B, const float radii, const glm::vec3 &center, const float \*halfExtents)  
*Capsule AABB collision detection algorithm.*
- bool [AABBCollision](#) (const glm::vec3 &center, const float \*halfExtents, const glm::vec3 &center1, const float \*halfExtents1)  
*AABB AABB collision detection algorithm.*
- template<typename Iterator , typename = std::enable\_if\_t<std::is\_same<glm::vec3\*, typename std::iterator\_traits<Iterator>::value\_type>::value>, typename Iterator1 , typename = std::enable\_if\_t<std::is\_same<glm::vec3\*, typename std::iterator\_traits<Iterator1>::value\_type>::value>>>  
bool [ConvexShapeCollision](#) (const Iterator &startVertices1, const Iterator &endVertices1, const Iterator1 &startVertices2, const Iterator1 &endVertices2)  
*Convex Shape collision detection algorithm. Uses GJK collision detection algorithm.*
- template<typename Iterator , typename = std::enable\_if\_t<std::is\_same<glm::vec3\*, typename std::iterator\_traits<Iterator>::value\_type>::value>>>  
bool [ConvexShapeCapsuleCollision](#) (const Iterator &startVertices, const Iterator &endVertices, const int size, const glm::vec3 &A, const glm::vec3 &B, const float radii)  
*Convex Shape Capsule collision detection algorithm.*
- template<typename Iterator , typename = std::enable\_if\_t<std::is\_same<glm::vec3\*, typename std::iterator\_traits<Iterator>::value\_type>::value>>>  
bool [CapsuleOBBCollision](#) (const glm::vec3 &A, const glm::vec3 &B, float radii, const Iterator &startVertices, const Iterator &endVertices, const int size)  
*Capsule OBB Collision detection algorithm.*
- template<typename Iterator , typename = std::enable\_if\_t<std::is\_same<glm::vec3\*, typename std::iterator\_traits<Iterator>::value\_type>::value>, typename Iterator1 , typename = std::enable\_if\_t<std::is\_same<glm::vec3\*, typename std::iterator\_traits<Iterator1>::value\_type>::value>>>  
bool [AABBOBBCollision](#) (const Iterator &startVertices1, const Iterator &endVertices1, const Iterator1 &startVertices2, const Iterator1 &endVertices2)

*AABB and OBB collision detection algorithm.*

- `template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename std::iterator_traits<Iterator>::value_type>::value>, typename Iterator1 , typename = std::enable_if_t<std::is_same<glm::vec3*, typename std::iterator_traits<Iterator1>::value_type>::value>>`  
`bool OBBCollision (const Iterator &startVertices1, const Iterator &endVertices1, const Iterator1 &startVertices2, const Iterator1 &endVertices2)`

*OBB and OBB collision detection algorithm.*

- `template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename std::iterator_traits<Iterator>::value_type>::value>>`  
`bool ConvexShapeSphereCollision (const Iterator &startVertices, const Iterator &endVertices, const int size, const glm::vec3 &center, const float radius)`

*Convex Shape Sphere collision detection algorithm.*

### 5.3.1 Detailed Description

Namespace used to define some collision detection algorithms that are used to check for collision between different colliders. None of these functions require colliders themselves, They use mostly primitive classes instead.

### 5.3.2 Function Documentation

#### 5.3.2.1 AABBCollision()

```
bool mtrx::CollisionUtil::AABBCollision (
    const glm::vec3 & center,
    const float * halfExtents,
    const glm::vec3 & center1,
    const float * halfExtents1 )
```

AABB AABB collision detection algorithm.

#### Parameters

<i>center</i>	Center of the first AABB collider
<i>halfExtents</i>	Half extents of the first AABB collider
<i>center1</i>	Center of the second AABB collider
<i>halfExtents1</i>	Half extents of the second AABB collider

#### Returns

- true The AABB colliders collide
- false The AABB colliders do not collide

### 5.3.2.2 AABBOBBCollision()

```
template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename
std::iterator_traits<Iterator>::value_type>::value>, typename Iterator1 , typename = std::
::enable_if_t<std::is_same<glm::vec3*, typename std::iterator_traits<Iterator1>::value_
type>::value>>
bool mtrx::CollisionUtil::AABBOBBCollision (
    const Iterator & startVertices1,
    const Iterator & endVertices1,
    const Iterator1 & startVertices2,
    const Iterator1 & endVertices2 )
```

AABB and OBB collision detection algorithm.

See also

[mtrx::CollisionUtil::ConvexShapeCollision](#)

#### Template Parameters

<i>Iterator</i>	An iterator type for the data structure that holds the vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*, typename</i>	<i>std::iterator_traits&lt;Iterator&gt;::value_type&gt;::value&gt;</i> Template parameter check
<i>Iterator1</i>	An iterator type for the data structure that holds the vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*, typename</i>	<i>std::iterator_traits&lt;Iterator1&gt;::value_type&gt;::value&gt;</i> Template parameter check

#### Parameters

<i>startVertices1</i>	Iterator to the beginning of the vertex list of the AABB
<i>endVertices1</i>	Iterator to the end of the vertex list of the AABB
<i>startVertices2</i>	Iterator to the beginning of the vertex list of the OBB
<i>endVertices2</i>	Iterator to the end of the vertex list of the OBB

#### Returns

true The AABB and OBB colliders collide  
false The AABB and OBB colliders do not collide

### 5.3.2.3 CapsuleAABBCollision()

```
bool mtrx::CollisionUtil::CapsuleAABBCollision (
    const glm::vec3 & A,
    const glm::vec3 & B,
    const float radii,
    const glm::vec3 & center,
    const float * halfExtents )
```

Capsule AABB collision detection algorithm.

## Parameters

<i>A</i>	Center of the topmost sphere for capsule
<i>B</i>	Center of the bottommost sphere for capsule
<i>radii</i>	Radii of the capsule
<i>center</i>	Center of the AABB collider
<i>halfExtents</i>	Half extents of the AABB collider

## Returns

true The capsule and AABB colliders collide  
false The capsule and AABB colliders do not collide

## 5.3.2.4 CapsuleCapsuleCollision()

```
bool mtrx::CollisionUtil::CapsuleCapsuleCollision (
    const glm::vec3 & A1,
    const glm::vec3 & B1,
    const glm::vec3 & A2,
    const glm::vec3 & B2,
    float radius1,
    float radius2 )
```

Capsule Capsule collision detection algorithm.

## Parameters

<i>A1</i>	Center of topmost sphere for first capsule
<i>B1</i>	Center of bottommost sphere for first capsule
<i>A2</i>	Center of topmost sphere for second capsule
<i>B2</i>	Center of bottommost sphere for second capsule
<i>radius1</i>	Radius of first capsule
<i>radius2</i>	Radius of second capsule

## Returns

true Capsule colliders collide  
false Capsule colliders do not collide

## 5.3.2.5 CapsuleOBBCollision()

```
template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename
std::iterator_traits<Iterator>::value_type>::value>>
bool mtrx::CollisionUtil::CapsuleOBBCollision (
```

```

const glm::vec3 & A,
const glm::vec3 & B,
float radii,
const Iterator & startVertices,
const Iterator & endVertices,
const int size )

```

Capsule OOB Collision detection algorithm.

#### Template Parameters

<i>Iterator</i>	An iterator type for the data structure that holds the vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*, typename</i>	<i>std::iterator_traits&lt;Iterator&gt;::value_type::value&gt;</i> Template parameter check

#### Parameters

<i>A</i>	Center of topmost sphere of capsule collider
<i>B</i>	Center of bottommost sphere of capsule collider
<i>radii</i>	Radii of the capsule collider
<i>startVertices</i>	Iterator to the beginning of the vertices list
<i>endVertices</i>	Iterator to the end of the vertices list
<i>size</i>	Number of vertices

#### Returns

true The capsule and OOB colliders collide  
 false The capsule and OOB colliders do not collide

### 5.3.2.6 ConvexShapeCapsuleCollision()

```

template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename
std::iterator_traits<Iterator>::value_type>::value>>
bool mtrx::CollisionUtil::ConvexShapeCapsuleCollision (
    const Iterator & startVertices,
    const Iterator & endVertices,
    const int size,
    const glm::vec3 & A,
    const glm::vec3 & B,
    const float radii )

```

Convex Shape Capsule collision detection algorithm.

#### Template Parameters

<i>Iterator</i>	An iterator type for the data structure that holds the vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*, typename</i>	<i>std::iterator_traits&lt;Iterator&gt;::value_type::value&gt;</i> Template parameter check



## Parameters

<i>startVertices</i>	Iterator to the beginning of the vertex list
<i>endVertices</i>	Iterator to the end of the vertex list
<i>size</i>	Number of vertices
<i>A</i>	Center of the topmost sphere in the capsule collider
<i>B</i>	Center of the bottommost sphere in the capsule collider
<i>radii</i>	Radii of the capsule collider

## Returns

true The convex shape and capsule colliders collide  
false The convex shape and capsule colliders collide

## 5.3.2.7 ConvexShapeCollision()

```
template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename
std::iterator_traits<Iterator>::value_type>::value>, typename Iterator1 , typename = std::
::enable_if_t<std::is_same<glm::vec3*, typename std::iterator_traits<Iterator1>::value_
type>::value>>
bool mtrx::CollisionUtil::ConvexShapeCollision (
    const Iterator & startVertices1,
    const Iterator & endVertices1,
    const Iterator1 & startVertices2,
    const Iterator1 & endVertices2 )
```

Convex Shape collision detection algorithm. Uses GJK collision detection algorithm.

## See also

[mtrx::GJKUtil](#)

## Template Parameters

<i>Iterator</i>	An iterator type for the data structure that holds the vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*,typename</i>	<i>std::iterator_traits&lt;Iterator&gt;::value_type::value&gt;</i> Template parameter check
<i>Iterator1</i>	An iterator type for the data structure that holds the vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*,typename</i>	<i>std::iterator_traits&lt;Iterator1&gt;::value_type::value&gt;</i> Template parameter check

## Parameters

<i>startVertices1</i>	Iterator to the beginning of the vertex list for first convex collider
<i>endVertices1</i>	Iterator to the end of the vertex list for first convex collider
<i>startVertices2</i>	Iterator to the beginning of the vertex list for the second convex shape collider

## Parameters

<i>endVertices2</i>	Iterator to the end of the vertex list for the second convex shape collider
---------------------	---

## Returns

- true The convex shape colliders collide
- false The convex shape colliders do not collide

## 5.3.2.8 ConvexShapeSphereCollision()

```
template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename
std::iterator_traits<Iterator>::value_type>::value>>
bool mtrx::CollisionUtil::ConvexShapeSphereCollision (
    const Iterator & startVertices,
    const Iterator & endVertices,
    const int size,
    const glm::vec3 & center,
    const float radius )
```

Convex Shape Sphere collision detection algorithm.

## Template Parameters

<i>Iterator</i>	An iterator type for the data structure that holds the vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*,typename</i>	<i>std::iterator_traits&lt;Iterator&gt;::value_type&gt;::value&gt;</i> Template parameter check

## Parameters

<i>startVertices</i>	Iterator to the beginning of the vertex list of the convex shape
<i>endVertices</i>	Iterator to the end of the vertex list of the convex shape
<i>size</i>	Number of vertices of convex shape collider
<i>center</i>	Center of the sphere collider
<i>radius</i>	Radius of the sphere collider

## Returns

- true The convex shape and sphere colliders collide
- false The convex shape and sphere colliders do not collide

## 5.3.2.9 OOBBCollision()

```
template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename
std::iterator_traits<Iterator>::value_type>::value>, typename Iterator1 , typename = std::
```

```

::enable_if_t<std::is_same<glm::vec3*, typename std::iterator_traits<Iterator1>::value_↵
type>::value>>
bool mtrx::CollisionUtil::OOBBCollision (
    const Iterator & startVertices1,
    const Iterator & endVertices1,
    const Iterator1 & startVertices2,
    const Iterator1 & endVertices2 )

```

OOBB and OOBB collision detection algorithm.

See also

[mtrx::CollisionUtil::ConvexShapeCollision](#)

#### Template Parameters

<i>Iterator</i>	An iterator type for the data structure that holds the vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*,typename</i>	<i>std::iterator_traits&lt;Iterator&gt;::value_type::value&gt;</i> Template parameter check
<i>Iterator1</i>	An iterator type for the data structure that holds the vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*,typename</i>	<i>std::iterator_traits&lt;Iterator1&gt;::value_type::value&gt;</i> Template parameter check

#### Parameters

<i>startVertices1</i>	Iterator to the beginning of the vertex list of the first OOBB
<i>endVertices1</i>	Iterator to the end of the vertex list of the first OOBB
<i>startVertices2</i>	Iterator to the beginning of the vertex list of the second OOBB
<i>endVertices2</i>	Iterator to the end of the vertex list of the second OOBB

#### Returns

true The OOBB colliders collide  
false The OOBB colliders do not collide

#### 5.3.2.10 SphereAABBCollision()

```

bool mtrx::CollisionUtil::SphereAABBCollision (
    const glm::vec3 & center,
    const float radius,
    const glm::vec3 & center1,
    const float * halfExtents )

```

Sphere AABB collider collision detection algorithm.

## Parameters

<i>center</i>	Center of the sphere collider
<i>radius</i>	Radius of the sphere collider
<i>center1</i>	Center of the AABB collider
<i>halfExtents</i>	Half Extents of the AABB collider

## Returns

true The sphere and AABB colliders collide  
false The sphere and AABB colliders do not collide

**5.3.2.11 SphereCapsuleCollision()**

```
bool mtrx::CollisionUtil::SphereCapsuleCollision (
    const glm::vec3 & center1,
    const glm::vec3 & center2,
    float radius1,
    float radius2,
    const glm::vec3 & A,
    const glm::vec3 & B )
```

Sphere Capsule collision detection algorithm.

## Parameters

<i>center1</i>	Center of the sphere collider
<i>center2</i>	Center of the capsule collider
<i>radius1</i>	Radius of the sphere collider
<i>radius2</i>	Radius of the capsule collider
<i>A</i>	Topmost sphere center for capsule collider
<i>B</i>	Bottommost sphere center for capsule collider

## Returns

true The sphere and capsule colliders collide  
false The sphere and capsule colliders do not collide

**5.3.2.12 SphereOOBBCollision()**

```
bool mtrx::CollisionUtil::SphereOOBBCollision (
    const glm::vec3 & center,
    const float radius,
    const glm::vec3 & center1,
```

```
const glm::vec3 * axes,  
const float * halfExtents )
```

Sphere OOBB collider collision detection algorithm.

**Parameters**

<i>center</i>	Center of the sphere collider
<i>radius</i>	Radius of the sphere collider
<i>center1</i>	Center of the OOBb collider
<i>axes</i>	Axes that define the OOBb world
<i>halfExtents</i>	Half extent values of OOBb colliders

**Returns**

true Sphere and OOBb colliders collide  
false Sphere and OOBb colliders do not collide

**5.3.2.13 SphereSphereCollision()**

```
bool mtrx::CollisionUtil::SphereSphereCollision (
    const glm::vec3 & center1,
    const glm::vec3 & center2,
    float radius1,
    float radius2 )
```

Sphere Sphere collision detection algorithm.

**Parameters**

<i>center1</i>	Center of the first sphere collider
<i>center2</i>	Center of the second sphere collider
<i>radius1</i>	Radius of the first sphere collider
<i>radius2</i>	Radius of the second sphere collider

**Returns**

true The 2 sphere colliders collide  
false The 2 sphere colliders do not collide

**5.4 mtrx::PhysicsUtil Namespace Reference**

Utility namespace for some basic calculations that are useful for collision detection and other physics related functionality.

**Functions**

- glm::vec3 [TripleCross](#) (const glm::vec3 &a, const glm::vec3 &b, const glm::vec3 &c)  
*Implementation of triple cross product.*

- float [MinDistanceTwoLines](#) (const glm::vec3 &A, const glm::vec3 &B, const glm::vec3 &C, const glm::vec3 &D)  
*Minimum distance squared between 2 infinite line. The square of the minimum distance is used for optimization purposes.*
- float [MinDistanceSquaredTwoSegments](#) (const glm::vec3 &A, const glm::vec3 &B, const glm::vec3 &C, const glm::vec3 &D)  
*Minimum distance squared between 2 line segments. The square of the minimum distance is used for optimization purposes [http://geomalgorithms.com/a07-\\_distance.html#dist3D\\_Segment\\_to\\_Segment](http://geomalgorithms.com/a07-_distance.html#dist3D_Segment_to_Segment).*
- std::pair< float, glm::vec3 > [MinDistanceSquaredPointRay](#) (const glm::vec3 &point, const glm::vec3 &start, const glm::vec3 &rayDirection)  
*Minimum distance squared of a point and ray. The square of the minimum distance is used for optimization purposes.*
- std::pair< float, glm::vec3 > [MinDistanceSquaredPointSegment](#) (const glm::vec3 &A, const glm::vec3 &B, const glm::vec3 &C)  
*Minimum distance squared of a point and a line segment. The square of the minimum distance is used for optimization purposes.*
- float [MinDistanceSquaredLineSegmentRay](#) (const glm::vec3 &a, const glm::vec3 &b, const glm::vec3 &rayStart, const glm::vec3 &rayDirection)  
*Minimum distance squared Line segment and ray. Can be broken down into a line segment minimum distance squared.*
- float [MinDistanceSquaredPointTriangle](#) (const glm::vec3 &pt, const glm::vec3 &a, const glm::vec3 &b, const glm::vec3 &c)  
*Minimum distance squared between a point and triangle. The square of the minimum distance is used for optimization purposes.*
- float [MinDistanceSquaredLineSegmentTriangle](#) (const glm::vec3 &a, const glm::vec3 &b, const glm::vec3 &c, const glm::vec3 &d, const glm::vec3 &e)  
*Minimum distance squared of line segment and triangle. The square of the minimum distance is used for optimization purposes.*
- std::pair< float, glm::vec3 > [MinDistanceSquaredPointAABB](#) (const glm::vec3 &pt, const glm::vec3 &center, const float \*halfExtents)  
*Minimum distance squared between a point and an AABB. The square of the minimum distance is used for optimization purposes.*
- glm::quat [Slerp](#) (const glm::quat &firstRotation, const glm::quat &secondRotation, float t)  
*Implementation of Slerp which is a lerp for rotations.*
- glm::vec3 [Lerp](#) (const glm::vec3 &startingPosition, const glm::vec3 &destination, float t)  
*Implementation of linear interpolation.*
- float [Ease](#) (float t)  
*Easing function for the t parameter to be used for lerp functions. The easing function is a half sin curve that allows for a slow start and a slow end.*
- template<typename Iterator, typename = std::enable\_if\_t<std::is\_same<glm::vec3\*, typename std::iterator\_traits<Iterator>::value\_type>::value>>  
std::vector< [Triangle](#) > [TriangulateConvexShape](#) (const Iterator &startVertices, const Iterator &endVertices, const int size)  
*Triangulating a convex shape by fan triangulation which is using the first vertex as a starting point for all triangles and fanning out to the other vertices.*

### 5.4.1 Detailed Description

Utility namespace for some basic calculations that are useful for collision detection and other physics related functionality.

### 5.4.2 Function Documentation

#### 5.4.2.1 Ease()

```
float mtrx::PhysicsUtil::Ease (
    float t )
```

Easing function for the *t* parameter to be used for lerping functions. The easing function is a half sin curve that allows for a slow start and a slow end.

##### Parameters

<i>t</i>	Parameter between [0, 1]
----------	--------------------------

##### Returns

float New *t* value according to the easing function

#### 5.4.2.2 Lerp()

```
glm::vec3 mtrx::PhysicsUtil::Lerp (
    const glm::vec3 & startingPosition,
    const glm::vec3 & destination,
    float t )
```

Implementation of linear interpolation.

##### Parameters

<i>startingPosition</i>	Start position
<i>destination</i>	End position
<i>t</i>	Parameter between [0, 1]

##### Returns

glm::vec3 A vector between the 2 vectors influenced by the *t* value

#### 5.4.2.3 MinDistanceSquaredLineSegmentRay()

```
float mtrx::PhysicsUtil::MinDistanceSquaredLineSegmentRay (
    const glm::vec3 & a,
    const glm::vec3 & b,
    const glm::vec3 & rayStart,
    const glm::vec3 & rayDirection )
```

Minimum distance squared Line segment and ray. Can be broken down into a line segment minimum distance squared.



**See also**

mtrx::PhysicsUtil::MinimumDistanceSquaredTwoSegments The square of the minimum distance is used for optimization purposes

**Parameters**

<i>a</i>	The first end point of the line segment
<i>b</i>	The second end point of the line segment
<i>rayStart</i>	The starting point of the ray
<i>rayDirection</i>	The normalized direction of the ray

**Returns**

float The minimum distance squared of the line segment and the ray

**5.4.2.4 MinDistanceSquaredLineSegmentTriangle()**

```
float mtrx::PhysicsUtil::MinDistanceSquaredLineSegmentTriangle (
    const glm::vec3 & a,
    const glm::vec3 & b,
    const glm::vec3 & c,
    const glm::vec3 & d,
    const glm::vec3 & e )
```

Minimum distance squared of line segment and triangle. The square of the minimum distance is used for optimization purposes.

**Parameters**

<i>a</i>	The first end point of the line segment
<i>b</i>	The second end point of the line segment
<i>c</i>	First point of the triangle
<i>d</i>	Second point of the triangle
<i>e</i>	Third point of the triangle

**Returns**

float The minimum distance squared between the line segment and the triangle

**5.4.2.5 MinDistanceSquaredPointAABB()**

```
std::pair<float, glm::vec3> mtrx::PhysicsUtil::MinDistanceSquaredPointAABB (
    const glm::vec3 & pt,
    const glm::vec3 & center,
    const float * halfExtents )
```

Minimum distance squared between a point and an AABB. The square of the minimum distance is used for optimization purposes.

## Parameters

<i>pt</i>	The point we want to check the distance for
<i>center</i>	The center of the AABB collider

## See also

[mtrx::AABBCollider](#)

## Parameters

<i>halfExtents</i>	The half extents of the <a href="#">AABBCollider</a>
--------------------	--

## See also

[mtrx::AABBCollider](#)

## Returns

`std::pair<float, glm::vec3>` The minimum distance squared and the closest point

#### 5.4.2.6 MinDistanceSquaredPointRay()

```
std::pair<float, glm::vec3> mtrx::PhysicsUtil::MinDistanceSquaredPointRay (
    const glm::vec3 & point,
    const glm::vec3 & startPointRay,
    const glm::vec3 & rayDirection )
```

Minimum distance squared of a point and ray. The square of the minimum distance is used for optimization purposes.

## Parameters

<i>point</i>	A point in 3d space we want to check the distance for
<i>startPointRay</i>	Start point of the ray
<i>rayDirection</i>	The normalized direction of the ray

## Returns

`std::pair<float, glm::vec3>` The minimum distance squared and the closest point

#### 5.4.2.7 MinDistanceSquaredPointSegment()

```
std::pair<float, glm::vec3> mtrx::PhysicsUtil::MinDistanceSquaredPointSegment (
    const glm::vec3 & A,
```

```
const glm::vec3 & B,
const glm::vec3 & C )
```

Minimum distance squared of a point and a line segment. The square of the minimum distance is used for optimization purposes.

#### Parameters

<i>A</i>	The point we want to check the distance for
<i>B</i>	The first end point of the line segment
<i>C</i>	The second end point of the line segment

#### Returns

std::pair<float, glm::vec3> The minimum distance squared and the closest point

#### 5.4.2.8 MinDistanceSquaredPointTriangle()

```
float mtrx::PhysicsUtil::MinDistanceSquaredPointTriangle (
    const glm::vec3 & pt,
    const glm::vec3 & a,
    const glm::vec3 & b,
    const glm::vec3 & c )
```

Minimum distance squared between a point and triangle. The square of the minimum distance is used for optimization purposes.

#### Parameters

<i>pt</i>	The point we want to check the distance for
<i>a</i>	The first point of the triangle
<i>b</i>	The second point of the triangle
<i>c</i>	The third point of the triangle

#### Returns

float The minimum distance squared

#### 5.4.2.9 MinDistanceSquaredTwoSegments()

```
float mtrx::PhysicsUtil::MinDistanceSquaredTwoSegments (
    const glm::vec3 & A,
    const glm::vec3 & B,
    const glm::vec3 & C,
    const glm::vec3 & D )
```

Minimum distance squared between 2 line segments. The square of the minimum distance is used for optimization purposes [http://geomalgorithms.com/a07-\\_distance.html#dist3D\\_Segment\\_to\\_Segment](http://geomalgorithms.com/a07-_distance.html#dist3D_Segment_to_Segment).

## Parameters

<i>A</i>	First end of the line segment
<i>B</i>	Second end of the line segment
<i>C</i>	First end of the second line segment
<i>D</i>	Second end of the second line segment

## Returns

float The minimum distance squared between 2 line segments

## 5.4.2.10 MinDistanceTwoLines()

```
float mtrx::PhysicsUtil::MinDistanceTwoLines (
    const glm::vec3 & A,
    const glm::vec3 & B,
    const glm::vec3 & C,
    const glm::vec3 & D )
```

Minimum distance squared between 2 infinite line. The square of the minimum distance is used for optimization purposes.

## Parameters

<i>A</i>	Point on first line
<i>B</i>	Point on first line
<i>C</i>	Point on second line
<i>D</i>	Point on second line

## Returns

float The minimum distance squared between the 2 infinite lines

## 5.4.2.11 Slerp()

```
glm::quat mtrx::PhysicsUtil::Slerp (
    const glm::quat & firstRotation,
    const glm::quat & secondRotation,
    float t )
```

Implementation of Slerp which is a lerp for rotations.

## Parameters

<i>firstRotation</i>	start position of the rotation
<i>secondRotation</i>	End position of the rotation
<i>t</i>	parameter between [0, 1] to interpolate between the 2 rotations

**Returns**

glm::quat The rotation interpolated between the 2 rotations

**5.4.2.12 TriangulateConvexShape()**

```
template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename
std::iterator_traits<Iterator>::value_type>::value>>
std::vector<Triangle> mtrx::PhysicsUtil::TriangulateConvexShape (
    const Iterator & startVertices,
    const Iterator & endVertices,
    const int size )
```

Triangulating a convex shape by fan triangulation which is using the first vertex as a starting point for all triangles and fanning out to the other vertices.

**Template Parameters**

<i>Iterator</i>	Iterator type that is used by the collection of vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*,typename</i>	<i>std::iterator_traits&lt;Iterator&gt;::value_type::value&gt;</i> Iterator template check

**Parameters**

<i>startVertices</i>	Iterator to the beginning of the vertex list
<i>endVertices</i>	Iterator to the end of the vertex list
<i>size</i>	The size of the vertex list

**Returns**

std::vector<Triangle> A vector of triangles representing the triangulated mesh

**5.4.2.13 TripleCross()**

```
glm::vec3 mtrx::PhysicsUtil::TripleCross (
    const glm::vec3 & a,
    const glm::vec3 & b,
    const glm::vec3 & c )
```

Implementation of triple cross product.

**Parameters**

<i>a</i>	First vector
<i>b</i>	Second vector
<i>c</i>	Third vector

## Returns

glm::vec3 The result of the triple cross product

## 5.5 mtrx::RaycastCollisionUtil Namespace Reference

Utility namespace used for raycasting functionality.

### Functions

- bool [RaySphereCollision](#) (const glm::vec3 &sphereCenter, float sphereRadius, const glm::vec3 &startPoint, const glm::vec3 &rayDirection)  
*Raycasting onto a sphere collider.*
- bool [RayCapsuleCollision](#) (const glm::vec3 &startPositionRay, const glm::vec3 &direction, const glm::vec3 &A, const glm::vec3 &B, float capsRadius)  
*Raycasting onto a capsule collider.*
- bool [RayBoxCollision](#) (const glm::vec3 &rayStart, const glm::vec3 &rayDirection, const glm::vec3 &center, const glm::vec3 \*axes, const float \*halfExtents)  
*Raycasting onto a box collider.*
- [Collider](#) \* [RaycastFiltered](#) (const std::map< int, [Collider](#) \* > &colliders, const std::vector< [Collider](#) \* > &filterColliders, const glm::vec3 &rayStartPosition, const glm::vec3 &rayDirection)  
*NOT TESTED OR USED.*
- [Collider](#) \* [RaycastUnfiltered](#) (const std::map< int, [Collider](#) \* > &colliders, const glm::vec3 &rayStartPosition, const glm::vec3 &rayDirection)  
*NOT TESTED OR USED.*

### 5.5.1 Detailed Description

Utility namespace used for raycasting functionality.

### 5.5.2 Function Documentation

#### 5.5.2.1 RayBoxCollision()

```
bool mtrx::RaycastCollisionUtil::RayBoxCollision (
    const glm::vec3 & rayStart,
    const glm::vec3 & rayDirection,
    const glm::vec3 & center,
    const glm::vec3 * axes,
    const float * halfExtents )
```

Raycasting onto a box collider.

## See also

[mtrx::OOBBCollider](#)  
[mtrx::AABBCollider](#)  
[mtrx::Ray](#)

## Parameters

<i>rayStart</i>	The starting point of the ray
<i>rayDirection</i>	The normalized direction of the ray
<i>center</i>	The center of the box collider
<i>axes</i>	The axes of the collider
<i>halfExtents</i>	the half extents of the collider

## Returns

true The ray and box collide  
 false The ray and box do not collide

## 5.5.2.2 RayCapsuleCollision()

```

bool mtrx::RaycastCollisionUtil::RayCapsuleCollision (
    const glm::vec3 & startPositionRay,
    const glm::vec3 & direction,
    const glm::vec3 & A,
    const glm::vec3 & B,
    float capsRadius )
  
```

Raycasting onto a capsule collider.

## See also

[mtrx::CapsuleCollider](#)  
[mtrx::Ray](#)

## Parameters

<i>startPositionRay</i>	The starting position of the ray
<i>direction</i>	The normalized direction of the ray
<i>A</i>	The center of the topmost sphere of the capsule
<i>B</i>	The center of the bottommost sphere of the capsule
<i>capsRadius</i>	The radius of the capsule

## Returns

true The ray and the capsule collider collide  
 false The ray and the capsule collider do not collide



### 5.5.2.3 RaycastFiltered()

```
Collider* mtrx::RaycastCollisionUtil::RaycastFiltered (
    const std::map< int, Collider * > & colliders,
    const std::vector< Collider * > & filterColliders,
    const glm::vec3 & rayStartPosition,
    const glm::vec3 & rayDirection )
```

NOT TESTED OR USED.

#### Parameters

<i>colliders</i>	
<i>filterColliders</i>	
<i>rayStartPosition</i>	
<i>rayDirection</i>	

#### Returns

Collider\*

### 5.5.2.4 RaycastUnfiltered()

```
Collider* mtrx::RaycastCollisionUtil::RaycastUnfiltered (
    const std::map< int, Collider * > & colliders,
    const glm::vec3 & rayStartPosition,
    const glm::vec3 & rayDirection )
```

NOT TESTED OR USED.

#### Parameters

<i>colliders</i>	
<i>rayStartPosition</i>	
<i>rayDirection</i>	

#### Returns

Collider\*

### 5.5.2.5 RaySphereCollision()

```
bool mtrx::RaycastCollisionUtil::RaySphereCollision (
    const glm::vec3 & sphereCenter,
    float sphereRadius,
    const glm::vec3 & startPointRay,
    const glm::vec3 & rayDirection )
```

Raycasting onto a sphere collider.

## See also

[mtx::SphereCollider](#)[mtx::Ray](#)

## Parameters

<i>sphereCenter</i>	Center of the sphere collider
<i>sphereRadius</i>	Radius of the sphere collider
<i>startPointRay</i>	Start point of the ray
<i>rayDirection</i>	Normalized direction of the ray

## Returns

true The ray and the sphere collider collide

false The ray and the sphere collider do not collide

## Chapter 6

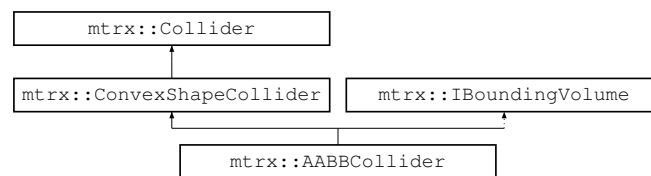
# Class Documentation

### 6.1 mtrx::AABBCollider Class Reference

Implementation of an Axis Aligned Bounding Box used for collision systems.

```
#include <AABBCollider.h>
```

Inheritance diagram for mtrx::AABBCollider:



#### Public Member Functions

- [AABBCollider](#) (const glm::vec3 &center=glm::vec3(), const glm::vec3 &scale=glm::vec3(1, 1, 1))  
*Construct a new [AABBCollider](#) object.*
- virtual [~AABBCollider](#) ()=default  
*Destroy the [AABBCollider](#) object.*
- virtual bool [RaycastCollision](#) (const [Ray](#) &ray) override  
*Collision function between a ray and an AABB.*
- virtual void [SetOrientation](#) (const glm::quat &orientation) override  
*This function should not be used and is empty as AABBs should not change orientations.*
- virtual float [GetSize](#) () override  
*Calculate the size of an AABB defined as length \* width \* height.*
- const glm::vec3 \* [GetAxes](#) () const  
*Get the Axes that define the AABB's world They would constant in this case since the orientation never changes.*
- const float \* [GetHalfExtents](#) () const  
*Get the Half Extents of the AABB (This is the const version)*
- float \* [GetHalfExtents](#) ()
- virtual void [SetScale](#) (const glm::vec3 &scale) override  
*Set the Scale object overriden to modify the halfExtents to represent scale change.*

## Private Attributes

- float **halfExtents** [3]
- [ObjectAxes](#) **axes**

## Additional Inherited Members

### 6.1.1 Detailed Description

Implmentation of an Axis Aligned Bounding Box used for collision systems.

### 6.1.2 Constructor & Destructor Documentation

#### 6.1.2.1 AABBCollider()

```
mtrx::AABBCollider::AABBCollider (
    const glm::vec3 & center = glm::vec3(),
    const glm::vec3 & scale = glm::vec3(1, 1, 1) )
```

Construct a new [AABBCollider](#) object.

#### Parameters

<i>center</i>	Center point of the AABB
<i>scale</i>	Scale vector of the AABB

#### See also

[mtrx::Transform](#)

#### 6.1.2.2 ~AABBCollider()

```
virtual mtrx::AABBCollider::~~AABBCollider ( ) [virtual], [default]
```

Destroy the [AABBCollider](#) object.

### 6.1.3 Member Function Documentation

#### 6.1.3.1 GetAxes()

```
const glm::vec3* mtrx::AABBCollider::GetAxes ( ) const [inline]
```

Get the Axes that define the AABB's world They would constant in this case since the orientation never changes.

##### Returns

const glm::vec3\* pointer to the array of 3 axes

#### 6.1.3.2 GetHalfExtents() [1/2]

```
float* mtrx::AABBCollider::GetHalfExtents ( ) [inline]
```

Non const version of [GetHalfExtents\(\)](#)

##### Returns

float\* pointer to the array of halfExtents

#### 6.1.3.3 GetHalfExtents() [2/2]

```
const float* mtrx::AABBCollider::GetHalfExtents ( ) const [inline]
```

Get the Half Extents of the AABB (This is the const version)

##### Returns

const float\* pointer to the array of half extents values in each dimension

#### 6.1.3.4 GetSize()

```
virtual float mtrx::AABBCollider::GetSize ( ) [inline], [override], [virtual]
```

Calculate the size of an AABB defined as length \* width \* height.

Implements [mtrx::IBoundingVolume](#).

#### 6.1.3.5 RaycastCollision()

```
virtual bool mtrx::AABBCollider::RaycastCollision (
    const Ray & ray ) [inline], [override], [virtual]
```

Collision function between a ray and an AABB.

**Parameters**

<i>ray</i>	The ray that we will be checking collision on
------------	---

**See also**

`mtrx::ray`

**Returns**

true If there is a collision  
false If there is no collision

Reimplemented from [mtrx::ConvexShapeCollider](#).

**6.1.3.6 SetOrientation()**

```
virtual void mtrx::AABBCollider::SetOrientation (
    const glm::quat & orientation ) [inline], [override], [virtual]
```

This function should not be used and is empty as AABBs should not change orientations.

**Parameters**

<i>orientation</i>	
--------------------	--

Reimplemented from [mtrx::ConvexShapeCollider](#).

**6.1.3.7 SetScale()**

```
virtual void mtrx::AABBCollider::SetScale (
    const glm::vec3 & scale ) [inline], [override], [virtual]
```

Set the Scale object overridden to modify the halfExtents to represent scale change.

**Parameters**

<i>scale</i>	The new scale vector of the AABB
--------------	----------------------------------

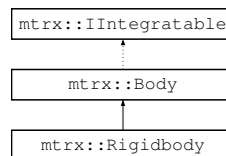
Reimplemented from [mtrx::ConvexShapeCollider](#).

## 6.2 mtrx::Body Class Reference

Implementation of a basic particle body.

```
#include <Body.h>
```

Inheritance diagram for mtrx::Body:



### Public Member Functions

- **Body** (const glm::vec3 &position=glm::vec3(), const glm::quat &orientation=glm::quat(), const glm::vec3 &scale=glm::vec3(), const float mass=MAX\_MASS)  
Construct a new **Body** object.
- virtual **~Body** ()=default  
Destroy the **Body** object.
- void **AddForce** (const glm::vec3 &force)  
Adding a force vector at the center of gravity of the body.
- virtual void **Integrate** (float deltaTime)=0  
Integrating the forces applied to the body.
- virtual void **ClearAccumulators** ()=0  
Clearing the accumulators of the body.
- void **SetInverseMass** (const float inverseMass)  
Set the Inverse Mass of the body.
- void **SetPosition** (const glm::vec3 &position)  
Set the Position of the body.
- void **SetVelocity** (const glm::vec3 &velocity)  
Set the Velocity of the body.
- void **SetAcceleration** (const glm::vec3 &acceleration)  
Set the Acceleration of the body.
- void **SetLinearDamping** (const float damping)  
Set the Linear Damping of the body.
- void **SetMass** (const float mass)  
Set the mass of the body.
- glm::quat & **GetOrientation** ()  
Get the Orientation of the body.
- bool **GetIsInfiniteMass** ()  
Checking whether we this body is of infinite mass by checking that the inverse mass is 0.
- float **GetInverseMass** () const  
Get the Inverse Mass of the body.
- float **GetDamping** () const  
Get the linear damping of the body.
- glm::vec3 & **GetPosition** ()

- *Get the Position of the body.*  
glm::vec3 & [GetVelocity](#) ()
- *Get the Velocity of the body.*  
glm::vec3 & [GetAcceleration](#) ()
- *Get the Acceleration of the body.*  
glm::vec3 & [GetAccumForces](#) ()
- *Get the accumulated forces applied on the body.*  
[Transform](#) & [GetTransform](#) ()
- *Get the [Transform](#) of the body.*  
float [GetMass](#) () const
- *Get the Mass of the body.*

## Protected Attributes

- [Transform](#) transform
- glm::vec3 velocity
- glm::vec3 acceleration
- glm::vec3 accumForces
- float linearDamping
- float inverseMass

## Additional Inherited Members

### 6.2.1 Detailed Description

Implementation of a basic particle body.

### 6.2.2 Constructor & Destructor Documentation

#### 6.2.2.1 Body()

```
mtx::Body::Body (
    const glm::vec3 & position = glm::vec3(),
    const glm::quat & orientation = glm::quat(),
    const glm::vec3 & scale = glm::vec3(),
    const float mass = MAX_MASS )
```

Construct a new [Body](#) object.

#### Parameters

<i>position</i>	The position of the body
<i>orientation</i>	Orientation of the body
<i>scale</i>	Scale of the body
<i>mass</i>	Mass of the body



### 6.2.2.2 ~Body()

```
virtual mtrx::Body::~~Body ( ) [virtual], [default]
```

Destroy the [Body](#) object.

## 6.2.3 Member Function Documentation

### 6.2.3.1 AddForce()

```
void mtrx::Body::AddForce (
    const glm::vec3 & force ) [inline]
```

Adding a force vector at the center of gravity of the body.

#### Parameters

<i>force</i>	The force vector that we will be added to the body's force accumulator
--------------	--

### 6.2.3.2 ClearAccumulators()

```
virtual void mtrx::Body::ClearAccumulators ( ) [pure virtual]
```

Clearing the accumulators of the body.

Implemented in [mtrx::Rigidbody](#).

### 6.2.3.3 GetAcceleration()

```
glm::vec3& mtrx::Body::GetAcceleration ( ) [inline]
```

Get the Acceleration of the body.

#### Returns

glm::vec3& The value of the acceleration

#### 6.2.3.4 GetAccumForces()

```
glm::vec3& mtrx::Body::GetAccumForces ( ) [inline]
```

Get the accumulated forces applied on the body.

##### Returns

glm::vec3& The value of the accumulated forces

#### 6.2.3.5 GetDamping()

```
float mtrx::Body::GetDamping ( ) const [inline]
```

Get the linear damping of the body.

##### Returns

float The value of the linear damping

#### 6.2.3.6 GetInverseMass()

```
float mtrx::Body::GetInverseMass ( ) const [inline]
```

Get the Inverse Mass of the body.

##### Returns

float The value of the inverse mass of the body

#### 6.2.3.7 GetIsInfiniteMass()

```
bool mtrx::Body::GetIsInfiniteMass ( ) [inline]
```

Checking whether we this body is of infinite mass by checking that the inverse mass is 0.

##### Returns

true The body is of infinite mass

false The body is not of infinite mass

### 6.2.3.8 GetMass()

```
float mtrx::Body::GetMass ( ) const
```

Get the Mass of the body.

#### Returns

float The mass of the body

### 6.2.3.9 GetOrientation()

```
glm::quat& mtrx::Body::GetOrientation ( ) [inline]
```

Get the Orientation of the body.

#### Returns

glm::quat& The quaternion orientation value

### 6.2.3.10 GetPosition()

```
glm::vec3& mtrx::Body::GetPosition ( ) [inline]
```

Get the Position of the body.

#### Returns

glm::vec3& The position value of the body

### 6.2.3.11 GetTransform()

```
Transform& mtrx::Body::GetTransform ( ) [inline]
```

Get the [Transform](#) of the body.

#### Returns

[Transform](#)& The transform of the body

#### 6.2.3.12 GetVelocity()

```
glm::vec3& mtrx::Body::GetVelocity ( ) [inline]
```

Get the Velocity of the body.

##### Returns

glm::vec3& The value of the velocity

#### 6.2.3.13 Integrate()

```
virtual void mtrx::Body::Integrate (
    float deltaTime ) [pure virtual]
```

Integrating the forces applied to the body.

##### Parameters

<i>deltaTime</i>	The time elapsed between frames
------------------	---------------------------------

Implements [mtrx::Integratable](#).

Implemented in [mtrx::Rigidbody](#).

#### 6.2.3.14 SetAcceleration()

```
void mtrx::Body::SetAcceleration (
    const glm::vec3 & acceleration ) [inline]
```

Set the Acceleration of the body.

##### Parameters

<i>acceleration</i>	The new acceleration value of the body
---------------------	--

#### 6.2.3.15 SetInverseMass()

```
void mtrx::Body::SetInverseMass (
    const float inverseMass ) [inline]
```

Set the Inverse Mass of the body.

## Parameters

<i>inverseMass</i>	The new value of the inverse mass
--------------------	-----------------------------------

**6.2.3.16 SetLinearDamping()**

```
void mtrx::Body::SetLinearDamping (
    const float damping ) [inline]
```

Set the Linear Damping of the body.

## Parameters

<i>damping</i>	the new linear damping value
----------------	------------------------------

**6.2.3.17 SetMass()**

```
void mtrx::Body::SetMass (
    const float mass )
```

Set the mass of the body.

## Parameters

<i>mass</i>	The new value of the mass
-------------	---------------------------

**6.2.3.18 SetPosition()**

```
void mtrx::Body::SetPosition (
    const glm::vec3 & position ) [inline]
```

Set the Position of the body.

## Parameters

<i>position</i>	The new position of the body
-----------------	------------------------------

### 6.2.3.19 SetVelocity()

```
void mtrx::Body::SetVelocity (
    const glm::vec3 & velocity ) [inline]
```

Set the Velocity of the body.

#### Parameters

<i>velocity</i>	The new velocity value of the body
-----------------	------------------------------------

## 6.3 mtrx::BVHNode< BoundingBoxVolume > Class Template Reference

An implementation of a BVH node used for Bounding Volume Hierarchies.

```
#include <BVHNode.h>
```

### Public Member Functions

- [BVHNode](#) ()  
*Construct a new [BVHNode](#) object.*
- [BVHNode](#) ([BVHNode](#)< [BoundingBoxVolume](#) > \*parent, [BoundingBoxVolume](#) &volume, [Body](#) \*body=nullptr)  
*Construct a new [BVHNode](#) object.*
- [~BVHNode](#) ()  
*Destroy the [BVHNode](#) object.*
- bool [IsLeaf](#) ()  
*Check whether this node is a leaf.*
- bool [IsCollision](#) ([BVHNode](#)< [BoundingBoxVolume](#) > &other)  
*Check whether 2 nodes collide by checking that the bounding volumes collide.*
- bool [DescendA](#) ([BVHNode](#)< [BoundingBoxVolume](#) > &a, [BVHNode](#)< [BoundingBoxVolume](#) > &b)  
*Utility function that allows that helps with figuring out which direction in the structure we want to go down when trying to find potential contacts.*
- void [GetPotentialContacts](#) (std::list< [PotentialCollision](#) > &potentialCollisions)  
*Get the Potential Contacts that could occur from the hierarchy.*
- void [Insert](#) ([Body](#) \*body, [Collider](#) &collider)  
*Insert collider as a leaf of the stucture. We attempt to add it in a position in the tree where we would get the least amount of growth.*
- void [RecalculateBoundingBoxVolume](#) ()  
*Recalculate the bounding volumes after the structure has been modified.*

### Public Attributes

- [BVHNode](#)< [BoundingBoxVolume](#) > \* **parent**
- [BVHNode](#)< [BoundingBoxVolume](#) > \* **children** [2]
- [BoundingBoxVolume](#) **volume**
- [Body](#) \* **body**

### 6.3.1 Detailed Description

```
template<class BoundingBoxVolume>
class mtrx::BVHNode< BoundingBoxVolume >
```

An implementation of a BVH node used for Bounding Volume Hierarchies.

## Template Parameters

<i>BoundingBox</i>	The type of bounding volume that will be used within the hierarchy
--------------------	--

## 6.3.2 Constructor & Destructor Documentation

### 6.3.2.1 BVHNode() [1/2]

```
template<class BoundingBox>
mtrx::BVHNode< BoundingBox >::BVHNode ( )
```

Construct a new [BVHNode](#) object.

### 6.3.2.2 BVHNode() [2/2]

```
template<class BoundingBox>
mtrx::BVHNode< BoundingBox >::BVHNode (
    BVHNode< BoundingBox > * parent,
    BoundingBox & volume,
    Body * body = nullptr )
```

Construct a new [BVHNode](#) object.

## Parameters

<i>parent</i>	Parent of this node
<i>volume</i>	The bounding volume/collider used
<i>body</i>	The body that the <a href="#">BVHNode</a> represents

## See also

[mtrx::Body](#)

### 6.3.2.3 ~BVHNode()

```
template<class BoundingBox>
mtrx::BVHNode< BoundingBox >::~~BVHNode ( )
```

Destroy the [BVHNode](#) object.

### 6.3.3 Member Function Documentation

#### 6.3.3.1 DescendA()

```
template<class BoundingBox>
bool mtrx::BVHNode< BoundingBox >::DescendA (
    BVHNode< BoundingBox > & a,
    BVHNode< BoundingBox > & b ) [inline]
```

Utility function that allows that helps with figuring out which direction in the structure we want to go down when trying to find potential contacts.

##### Parameters

<i>a</i>	
<i>b</i>	

##### Returns

true  
false

#### 6.3.3.2 GetPotentialContacts()

```
template<class BoundingBox>
void mtrx::BVHNode< BoundingBox >::GetPotentialContacts (
    std::list< PotentialCollision > & potentialCollisions )
```

Get the Potential Contacts that could occur from the hierarchy.

##### Parameters

<i>potentialCollisions</i>	Structure to store the potential collisions
----------------------------	---

##### See also

[mtrx::PotentialCollision](#)

#### 6.3.3.3 Insert()

```
template<class BoundingBox>
void mtrx::BVHNode< BoundingBox >::Insert (
```



```

    Body * body,
    Collider & collider )

```

Insert collider as a leaf of the structure. We attempt to add it in a position in the tree where we would get the least amount of growth.

#### Parameters

<i>body</i>	The body that we want to add
<i>collider</i>	The bounding volume that we want to add

#### 6.3.3.4 IsCollision()

```

template<class BoundingBox>
bool mtrx::BVHNode< BoundingBox >::IsCollision (
    BVHNode< BoundingBox > & other ) [inline]

```

Check whether 2 nodes collide by checking that the bounding volumes collide.

#### Parameters

<i>other</i>	The <a href="#">BVHNode</a> that we want to check collision with
--------------	--

#### Returns

true The 2 nodes collide  
 false The 2 nodes do not collide

#### 6.3.3.5 IsLeaf()

```

template<class BoundingBox>
bool mtrx::BVHNode< BoundingBox >::IsLeaf ( ) [inline]

```

Check whether this node is a leaf.

#### Returns

true This node is a leaf  
 false This node is not a leaf and has at least one child

#### 6.3.3.6 RecalculateBoundingBox()

```

template<class BoundingBox>
void mtrx::BVHNode< BoundingBox >::RecalculateBoundingBox ( )

```

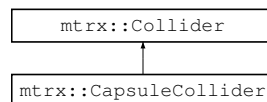
Recalculate the bounding volumes after the structure has been modified.

## 6.4 mtrx::CapsuleCollider Class Reference

Implementation of Capsule colliders.

```
#include <CapsuleCollider.h>
```

Inheritance diagram for mtrx::CapsuleCollider:



### Public Member Functions

- [CapsuleCollider](#) (const glm::vec3 &center=glm::vec3(), const glm::quat &orientation=glm::angleAxis(0.f, worldUp), const glm::vec3 &scale=glm::vec3(1, 1, 1), float radii=0.5f, float height=1.f)  
*Construct a new Capsule Collider object.*
- [CapsuleCollider](#) (const [Transform](#) &transform=[Transform](#)()), float radii=0.5f, float height=1.f)  
*Construct a new Capsule Collider object.*
- virtual [~CapsuleCollider](#) ()=default  
*Destroy the Capsule Collider object.*
- virtual bool [RaycastCollision](#) (const [Ray](#) &ray) override  
*Raycast ray and capsule collider collision detection algorithm.*
- float [GetRadii](#) () const  
*Get the Radii of the capsule collider.*
- float [GetHeight](#) () const  
*Get the Height of the capsule collider.*
- void [SetRadii](#) (float radius)  
*Set the Radii of the capsule collider.*
- void [SetHeight](#) (float height)  
*Set the Height of the capsule collider.*
- virtual void [SetScale](#) (const glm::vec3 &scale) override  
*Set the Scale of the capsule collider Only the X and Y values of the scale are the only applicable values on the collider The Z value is ignored.*
- virtual void [SetPosition](#) (const glm::vec3 &position) override  
*Set the Position of the capsule collider.*
- virtual void [SetOrientation](#) (const glm::quat &orientation) override  
*Set the Orientation of the capsule collider.*

### Public Attributes

- glm::vec3 **A**
- glm::vec3 **B**

### Private Attributes

- float **radii**
- float **height**

## Additional Inherited Members

### 6.4.1 Detailed Description

Implementation of Capsule colliders.

### 6.4.2 Constructor & Destructor Documentation

#### 6.4.2.1 CapsuleCollider() [1/2]

```
mtrx::CapsuleCollider::CapsuleCollider (
    const glm::vec3 & center = glm::vec3(),
    const glm::quat & orientation = glm::angleAxis(0.f, worldUp),
    const glm::vec3 & scale = glm::vec3(1, 1, 1),
    float radii = 0.5f,
    float height = 1.f )
```

Construct a new Capsule [Collider](#) object.

##### Parameters

<i>center</i>	Center of the capsule collider
<i>orientation</i>	Orientation of the capsule collider
<i>scale</i>	Scale of the capsule collider
<i>radii</i>	Radii of the spheres of the capsule collider
<i>height</i>	Height of the capsule collider

#### 6.4.2.2 CapsuleCollider() [2/2]

```
mtrx::CapsuleCollider::CapsuleCollider (
    const Transform & transform = Transform\(\),
    float radii = 0.5f,
    float height = 1.f )
```

Construct a new Capsule [Collider](#) object.

##### Parameters

<i>transform</i>	The transform that the capsule collider will use
------------------	--

See also

[mtrx::Transform](#)

## Parameters

<i>radii</i>	Radii of the spheres of the capsule collider
<i>height</i>	Height of the capsule collider

**6.4.2.3 ~CapsuleCollider()**

```
virtual mtrx::CapsuleCollider::~~CapsuleCollider ( ) [virtual], [default]
```

Destroy the Capsule [Collider](#) object.

**6.4.3 Member Function Documentation****6.4.3.1 GetHeight()**

```
float mtrx::CapsuleCollider::GetHeight ( ) const [inline]
```

Get the Height of the capsule collider.

**Returns**

float The height of the capsule collider

**6.4.3.2 GetRadii()**

```
float mtrx::CapsuleCollider::GetRadii ( ) const [inline]
```

Get the Radii of the capsule collider.

**Returns**

float The radii of the capsule collider

**6.4.3.3 RaycastCollision()**

```
virtual bool mtrx::CapsuleCollider::RaycastCollision (
    const Ray & ray ) [inline], [override], [virtual]
```

Raycast ray and capsule collider collision detection algorithm.

## Parameters

<i>ray</i>	<a href="#">Ray</a> used for raycast check
------------	--

## See also

[mtrx::Ray](#)

## Returns

true The ray and capsule collider collide  
false the ray and the capsule collider do not collide

Implements [mtrx::Collider](#).

**6.4.3.4 SetHeight()**

```
void mtrx::CapsuleCollider::SetHeight (
    float height ) [inline]
```

Set the Height of the capsule collider.

## Parameters

<i>height</i>	The new value of the height
---------------	-----------------------------

**6.4.3.5 SetOrientation()**

```
virtual void mtrx::CapsuleCollider::SetOrientation (
    const glm::quat & orientation ) [inline], [override], [virtual]
```

Set the Orientation of the capsule collider.

## Parameters

<i>orientation</i>	The new orientation of the capsule collider
--------------------	---

Reimplemented from [mtrx::Collider](#).

**6.4.3.6 SetPosition()**

```
virtual void mtrx::CapsuleCollider::SetPosition (
    const glm::vec3 & position ) [inline], [override], [virtual]
```

Set the Position of the capsule collider.

#### Parameters

<i>position</i>	The new position of the capsule collider
-----------------	--

Reimplemented from [mtx::Collider](#).

#### 6.4.3.7 SetRadii()

```
void mtx::CapsuleCollider::SetRadii (
    float radius ) [inline]
```

Set the Radii of the capsule collider.

#### Parameters

<i>radius</i>	The new value of radius
---------------	-------------------------

#### 6.4.3.8 SetScale()

```
virtual void mtx::CapsuleCollider::SetScale (
    const glm::vec3 & scale ) [inline], [override], [virtual]
```

Set the Scale of the capsule collider Only the X and Y values of the scale are the only applicable values on the collider The Z value is ignored.

#### Parameters

<i>scale</i>	The new scale of the collider
--------------	-------------------------------

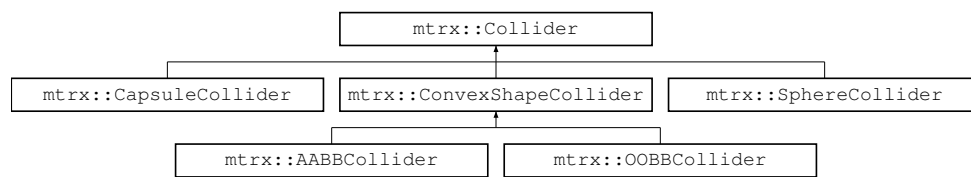
Reimplemented from [mtx::Collider](#).

## 6.5 mtx::Collider Class Reference

Basic API for all colliders.

```
#include <Collider.h>
```

Inheritance diagram for `mtx::Collider`:



## Public Member Functions

- **Collider** (const **ColliderType** &colliderType, const glm::vec3 &center=glm::vec3(), const glm::quat &orientation=glm::angleAxis(0.f, worldUp), const glm::vec3 &scale=glm::vec3(1.f, 1.f, 1.f), bool isConvex=false)  
Construct a new **Collider** object.
- **Collider** (const **ColliderType** &colliderType, const **Transform** &transform, bool isConvex=false)  
Construct a new **Collider** object.
- virtual **~Collider** ()=default  
Destroy the **Collider** object.
- virtual bool **RaycastCollision** (const **Ray** &ray)=0  
Raycasting function that all colliders should have.
- bool **CheckCollision** (const **Collider** &collider)  
Check for collision with another collider.
- const glm::vec3 & **GetPosition** () const  
Get the Position of the collider.
- const glm::vec3 & **GetScale** () const  
Get the Scale of the collider.
- const glm::quat & **GetOrientation** () const  
Get the Orientation of the collider.
- const **ColliderType** & **GetColliderType** () const  
Get the **Collider** Type of collider.
- const int **GetColliderId** () const  
Get the **Collider** Id of the collider.
- const bool **IsConvex** () const  
Is this collider convex.
- const glm::vec3 **GetForward** () const  
Get the Forward axis vector.
- const glm::vec3 **GetSide** () const  
Get the Side axis vector.
- const glm::vec3 **GetUp** () const  
Get the Up axis vector.
- virtual void **SetPosition** (const glm::vec3 &center)  
Set the Position of the collider.
- virtual void **SetScale** (const glm::vec3 &scale)  
Set the Scale of the collider.
- virtual void **SetOrientation** (const glm::quat &orientation)  
Set the Orientation of the collider.

## Protected Attributes

- int **colliderId**
- [ColliderType](#) type
- bool **isConvexShape**
- [Transform](#) transform

## Static Private Attributes

- static int **id**

### 6.5.1 Detailed Description

Basic API for all colliders.

### 6.5.2 Constructor & Destructor Documentation

#### 6.5.2.1 Collider() [1/2]

```
mtrx::Collider::Collider (
    const ColliderType & colliderType,
    const glm::vec3 & center = glm::vec3(),
    const glm::quat & orientation = glm::angleAxis(0.f, worldUp),
    const glm::vec3 & scale = glm::vec3(1.f, 1.f, 1.f),
    bool isConvex = false )
```

Construct a new [Collider](#) object.

#### Parameters

<i>colliderType</i>	The type of the collider
<i>center</i>	Center of the collider
<i>orientation</i>	Orientation of the collider
<i>scale</i>	The scale of the collider
<i>isConvex</i>	Whether collider is a convex shape collider

#### 6.5.2.2 Collider() [2/2]

```
mtrx::Collider::Collider (
    const ColliderType & colliderType,
    const Transform & transform,
    bool isConvex = false )
```

Construct a new [Collider](#) object.



## Parameters

<i>colliderType</i>	The type of the collider
<i>transform</i>	The transform of the collider

## See also

[mtrx::Transform](#)

## Parameters

<i>isConvex</i>	Whether the collider is a convex shape collider
-----------------	---

**6.5.2.3 ~Collider()**

```
virtual mtrx::Collider::~~Collider ( ) [virtual], [default]
```

Destroy the [Collider](#) object.

**6.5.3 Member Function Documentation****6.5.3.1 CheckCollision()**

```
bool mtrx::Collider::CheckCollision (
    const Collider & collider ) [inline]
```

Check for collision with another collider.

## Parameters

<i>collider</i>	The collider that we want to check for collision
-----------------	--

## Returns

true The collider is colliding with this collider  
false The collider is not colliding with this collider

**6.5.3.2 GetColliderId()**

```
const int mtrx::Collider::GetColliderId ( ) const [inline]
```

Get the [Collider](#) Id of the collider.

**Returns**

const int Value of the Id of the collider

**6.5.3.3 GetColliderType()**

```
const ColliderType& mtrx::Collider::GetColliderType ( ) const [inline]
```

Get the [Collider](#) Type of collider.

**Returns**

const ColliderType& Enum collider type value

**6.5.3.4 GetForward()**

```
const glm::vec3 mtrx::Collider::GetForward ( ) const [inline]
```

Get the Forward axis vector.

**Returns**

const glm::vec3 The forward vector of this collider

**6.5.3.5 GetOrientation()**

```
const glm::quat& mtrx::Collider::GetOrientation ( ) const [inline]
```

Get the Orientation of the collider.

**Returns**

const glm::quat& The current orientation of the collider

**6.5.3.6 GetPosition()**

```
const glm::vec3& mtrx::Collider::GetPosition ( ) const [inline]
```

Get the Position of the collider.

**Returns**

const glm::vec3& current position of the collider

#### 6.5.3.7 GetScale()

```
const glm::vec3& mtrx::Collider::GetScale ( ) const [inline]
```

Get the Scale of the collider.

##### Returns

const glm::vec3& The current scale of the collider

#### 6.5.3.8 GetSide()

```
const glm::vec3 mtrx::Collider::GetSide ( ) const [inline]
```

Get the Side axis vector.

##### Returns

const glm::vec3 The side axis vector of the collider

#### 6.5.3.9 GetUp()

```
const glm::vec3 mtrx::Collider::GetUp ( ) const [inline]
```

Get the Up axis vector.

##### Returns

const glm::vec3 the up axis vector of the collider

#### 6.5.3.10 IsConvex()

```
const bool mtrx::Collider::IsConvex ( ) const [inline]
```

Is this collider convex.

##### Returns

true The collider is a convex shape

false The collider is not a convex shape

#### 6.5.3.11 RaycastCollision()

```
virtual bool mtrx::Collider::RaycastCollision (
    const Ray & ray ) [pure virtual]
```

Raycasting function that all colliders should have.

## Parameters

<i>ray</i>	<a href="#">Ray</a> that we want to cast
------------	--

## See also

[mtx::Ray](#)

## Returns

true The ray and the collider collide  
false The ray and the collider do not collide

Implemented in [mtx::ConvexShapeCollider](#), [mtx::SphereCollider](#), [mtx::CapsuleCollider](#), [mtx::OBBCollider](#), and [mtx::AABBCollider](#).

**6.5.3.12 SetOrientation()**

```
virtual void mtx::Collider::SetOrientation (
    const glm::quat & orientation ) [inline], [virtual]
```

Set the Orientation of the collider.

## Parameters

<i>orientation</i>	The new orientation of the collider
--------------------	-------------------------------------

Reimplemented in [mtx::ConvexShapeCollider](#), [mtx::CapsuleCollider](#), and [mtx::AABBCollider](#).

**6.5.3.13 SetPosition()**

```
virtual void mtx::Collider::SetPosition (
    const glm::vec3 & center ) [inline], [virtual]
```

Set the Position of the collider.

## Parameters

<i>center</i>	The center position of this collider
---------------	--------------------------------------

Reimplemented in [mtx::CapsuleCollider](#), and [mtx::ConvexShapeCollider](#).

### 6.5.3.14 SetScale()

```
virtual void mtrx::Collider::SetScale (
    const glm::vec3 & scale ) [inline], [virtual]
```

Set the Scale of the collider.

#### Parameters

<i>scale</i>	The new scale of the collider
--------------	-------------------------------

Reimplemented in [mtrx::SphereCollider](#), [mtrx::CapsuleCollider](#), [mtrx::ConvexShapeCollider](#), [mtrx::AABBCollider](#), and [mtrx::OBBCollider](#).

## 6.6 mtrx::CollisionSystem Class Reference

The collision detection system of the engine.

```
#include <CollisionSystem.h>
```

### Public Member Functions

- [CollisionSystem](#) ()  
*Construct a new Collision System object.*

### Public Attributes

- `std::unordered_set< Collider * > colliders`

### 6.6.1 Detailed Description

The collision detection system of the engine.

### 6.6.2 Constructor & Destructor Documentation

#### 6.6.2.1 CollisionSystem()

```
mtrx::CollisionSystem::CollisionSystem ( )
```

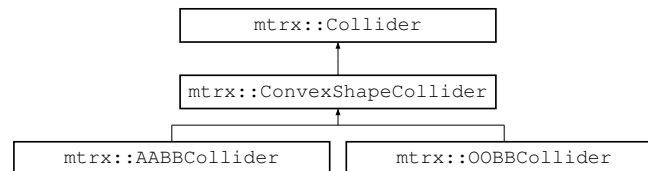
Construct a new Collision System object.

## 6.7 mtrx::ConvexShapeCollider Class Reference

Implementation of a Convex Shape collider.

```
#include <ConvexShapeCollider.h>
```

Inheritance diagram for mtrx::ConvexShapeCollider:



### Public Member Functions

- [ConvexShapeCollider](#) (const [ColliderType](#) &colliderType=ColliderType::ConvexShape, const glm::vec3 &center=glm::vec3(), const glm::quat &orientation=glm::angleAxis(0.f, worldUp), const glm::vec3 &scale=glm::vec3(1, 1, 1))  
Construct a new Convex Shape [Collider](#) object.
- [ConvexShapeCollider](#) (const [ColliderType](#) &colliderType=ColliderType::ConvexShape, const [Transform](#) &transform=[Transform](#)())  
Construct a new Convex Shape [Collider](#) object.
- [ConvexShapeCollider](#) (const [ColliderType](#) &colliderType=ColliderType::ConvexShape, const std::vector< glm::vec3 \* > &vertices=std::vector< glm::vec3 \* >(), const glm::vec3 &center=glm::vec3(), const glm::quat &orientation=glm::angleAxis(0.f, glm::vec3(0, 1, 0)), const glm::vec3 &scale=glm::vec3(1, 1, 1))  
Construct a new Convex Shape [Collider](#) object.
- [ConvexShapeCollider](#) (const [ColliderType](#) &colliderType=ColliderType::ConvexShape, const std::vector< glm::vec3 \* > &vertices=std::vector< glm::vec3 \* >(), const [Transform](#) &transform=[Transform](#)())  
Construct a new Convex Shape [Collider](#) object.
- virtual [~ConvexShapeCollider](#) ()  
Destroy the Convex Shape [Collider](#) object.
- virtual bool [RaycastCollision](#) (const [Ray](#) &ray) override  
Raycast collision check with convex shape colliders.
- std::vector< glm::vec3 \* > \* [GetVertices](#) () const  
Get the Vertices of the convex shape collider.
- glm::mat4 [GetModelMatrix](#) () const  
Get the Model Matrix of the convex shape collider.
- virtual void [SetPosition](#) (const glm::vec3 &pos) override  
Set the Position of the convex shape collider.
- virtual void [SetScale](#) (const glm::vec3 &scale) override  
Set the Scale of the collider.
- virtual void [SetOrientation](#) (const glm::quat &quat) override  
Set the Orientation of the collider.

### Protected Attributes

- std::vector< glm::vec3 \* > **vertices**
- std::vector< glm::vec3 \* > **transformedVertices**
- bool **transformModified**

### 6.7.1 Detailed Description

Implementation of a Convex Shape collider.

### 6.7.2 Constructor & Destructor Documentation

#### 6.7.2.1 ConvexShapeCollider() [1/4]

```
mtrx::ConvexShapeCollider::ConvexShapeCollider (
    const ColliderType & colliderType = ColliderType::ConvexShape,
    const glm::vec3 & center = glm::vec3(),
    const glm::quat & orientation = glm::angleAxis(0.f, worldUp),
    const glm::vec3 & scale = glm::vec3(1, 1, 1) )
```

Construct a new Convex Shape Collider object.

##### Parameters

<i>colliderType</i>	The type of collider we are creating. The default is a convex shape however we can have other type
---------------------	--

See also

[mtrx::AABBCollider](#)

[mtrx::OBBCollider](#)

##### Parameters

<i>center</i>	The center of the collider
<i>orientation</i>	The orientation of the collider
<i>scale</i>	The scale of the collider

#### 6.7.2.2 ConvexShapeCollider() [2/4]

```
mtrx::ConvexShapeCollider::ConvexShapeCollider (
    const ColliderType & colliderType = ColliderType::ConvexShape,
    const Transform & transform = Transform() )
```

Construct a new Convex Shape Collider object.

##### Parameters

<i>colliderType</i>	The type of collider we are creating. The default is a convex shape however we can have other type
---------------------	--

See also

[mtx::AABBCollider](#)

[mtx::OOBBCollider](#)

Parameters

<i>transform</i>	The transform of the collider
------------------	-------------------------------

See also

[mtx::Transform](#)

### 6.7.2.3 ConvexShapeCollider() [3/4]

```
mtx::ConvexShapeCollider::ConvexShapeCollider (
    const ColliderType & colliderType = ColliderType::ConvexShape,
    const std::vector< glm::vec3 * > & vertices = std::vector< glm::vec3 * >(),
    const glm::vec3 & center = glm::vec3(),
    const glm::quat & orientation = glm::angleAxis(0.f, glm::vec3(0, 1, 0)),
    const glm::vec3 & scale = glm::vec3(1, 1, 1) )
```

Construct a new Convex Shape [Collider](#) object.

Parameters

<i>colliderType</i>	The type of collider we are creating. The default is a convex shape however we can have other type
---------------------	--

See also

[mtx::AABBCollider](#)

[mtx::OOBBCollider](#)

Parameters

<i>vertices</i>	The vertices of the convex shape collider
<i>center</i>	The center of the collider
<i>orientation</i>	The orientation of the collider
<i>scale</i>	The scale of the collider

### 6.7.2.4 ConvexShapeCollider() [4/4]

```
mtx::ConvexShapeCollider::ConvexShapeCollider (
    const ColliderType & colliderType = ColliderType::ConvexShape,
```



```
const std::vector< glm::vec3 * > & vertices = std::vector< glm::vec3 * >(),
const Transform & transform = Transform()
```

Construct a new Convex Shape [Collider](#) object.

#### Parameters

<i>colliderType</i>	The type of collider we are creating. The default is a convex shape however we can have other type
---------------------	--

#### See also

[mtrx::AABBCollider](#)

[mtrx::OBBBCollider](#)

#### Parameters

<i>vertices</i>	The vertices of the convex shape collider
<i>transform</i>	The transform of the collider

#### See also

[mtrx::Trnasform](#)

### 6.7.2.5 ~ConvexShapeCollider()

```
virtual mtrx::ConvexShapeCollider::~~ConvexShapeCollider ( ) [virtual]
```

Destroy the Convex Shape [Collider](#) object.

## 6.7.3 Member Function Documentation

### 6.7.3.1 GetModelMatrix()

```
glm::mat4 mtrx::ConvexShapeCollider::GetModelMatrix ( ) const
```

Get the Model Matrix of the convex shape collider.

#### Returns

glm::mat4 The model matrix of the convex shape collider

### 6.7.3.2 GetVertices()

```
std::vector<glm::vec3*>* mtrx::ConvexShapeCollider::GetVertices ( ) const
```

Get the Vertices of the convex shape collider.

#### Returns

std::vector<glm::vec3\*>\* A pointer to the transformed vertices of the collider

### 6.7.3.3 RaycastCollision()

```
virtual bool mtrx::ConvexShapeCollider::RaycastCollision (
    const Ray & ray ) [override], [virtual]
```

Raycast collision check with convex shape colliders.

#### Parameters

<i>ray</i>	The ray that we want to cast
------------	------------------------------

#### Returns

true The ray and the colliders collide  
false The ray and colliders do not collide

Implements [mtrx::Collider](#).

Reimplemented in [mtrx::OBBCollider](#), and [mtrx::AABBCollider](#).

### 6.7.3.4 SetOrientation()

```
virtual void mtrx::ConvexShapeCollider::SetOrientation (
    const glm::quat & quat ) [inline], [override], [virtual]
```

Set the Orientation of the collider.

#### Parameters

<i>quat</i>	The new orientation of the collider
-------------	-------------------------------------

Reimplemented from [mtrx::Collider](#).

Reimplemented in [mtrx::AABBCollider](#).

### 6.7.3.5 SetPosition()

```
virtual void mtrx::ConvexShapeCollider::SetPosition (
    const glm::vec3 & pos ) [inline], [override], [virtual]
```

Set the Position of the convex shape collider.

#### Parameters

<i>pos</i>	The new position of the collider
------------	----------------------------------

Reimplemented from [mtrx::Collider](#).

### 6.7.3.6 SetScale()

```
virtual void mtrx::ConvexShapeCollider::SetScale (
    const glm::vec3 & scale ) [inline], [override], [virtual]
```

Set the Scale of the collider.

#### Parameters

<i>scale</i>	The new scale of the collider
--------------	-------------------------------

Reimplemented from [mtrx::Collider](#).

Reimplemented in [mtrx::AABBCollider](#), and [mtrx::OBBCollider](#).

## 6.8 mtrx::GameTime Class Reference

Basic implementation of time values mostly used for the calculation of delta time.

```
#include <GameTime.h>
```

### Static Public Member Functions

- static double [FindTimeDiffSeconds](#) (const std::chrono::high\_resolution\_clock::time\_point &t1, const std::chrono::high\_resolution\_clock::time\_point &t2)
- static void [Init](#) ()
- static void [Update](#) ()
- static float [GetTimeSeconds](#) ()
- static std::chrono::high\_resolution\_clock::time\_point [GetTime](#) ()

### Static Public Attributes

- static float **deltaTime**

## Static Private Member Functions

- static void [CalculateDeltaTime](#) ()

## Static Private Attributes

- static const std::chrono::high\_resolution\_clock::time\_point **startTime**
- static std::chrono::high\_resolution\_clock::time\_point **currentTime**
- static std::chrono::high\_resolution\_clock::time\_point **prevCurrentTime**

### 6.8.1 Detailed Description

Basic implementation of time values mostly used for the calculation of delta time.

### 6.8.2 Member Function Documentation

#### 6.8.2.1 CalculateDeltaTime()

```
static void mtrx::GameTime::CalculateDeltaTime ( ) [inline], [static], [private]
```

Calculate delta time

#### 6.8.2.2 FindTimeDiffSeconds()

```
static double mtrx::GameTime::FindTimeDiffSeconds (
    const std::chrono::high_resolution_clock::time_point & t1,
    const std::chrono::high_resolution_clock::time_point & t2 ) [inline], [static]
```

##### Returns

The time difference between 2 timepoints in seconds its a double for more precision

#### 6.8.2.3 GetTime()

```
static std::chrono::high_resolution_clock::time_point mtrx::GameTime::GetTime ( ) [inline],
[static]
```

##### Returns

Wrapper for getting the current time

#### 6.8.2.4 GetTimeSeconds()

```
static float mtrx::GameTime::GetTimeSeconds ( ) [inline], [static]
```

##### Returns

time elapsed since the start of the application

#### 6.8.2.5 Init()

```
static void mtrx::GameTime::Init ( ) [inline], [static]
```

Initialization code

#### 6.8.2.6 Update()

```
static void mtrx::GameTime::Update ( ) [inline], [static]
```

Update time values for calculating delta time

## 6.9 mtrx::GJKUtil Class Reference

Utility class for the implementation of the GJK algorithm used for collision detection between convex shape colliders.

```
#include <GJKUtil.h>
```

### Static Public Member Functions

- `template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename std::iterator_traits<Iterator>::value_type>::value>, typename Iterator1 , typename = std::enable_if_t<std::is_same<glm::vec3*, typename std::iterator_traits<Iterator1>::value_type>::value>>`  
`static bool Collision (const Iterator &startVertices1, const Iterator &endVertices1, const Iterator1 &startVertices2, const Iterator1 &endVertices2)`

*Implementation of GJK Collision detection algorithm.*

## Static Private Member Functions

- static bool [UpdateSimplex](#) ([Simplex](#) &simplex, glm::vec3 &direction, glm::vec3 &a)  
*Update the simplex values or return a collision.*
- static bool [TriangleSimplexUpdate](#) ([Simplex](#) &simplex, glm::vec3 &direction, glm::vec3 &a)  
*Updating the simplex values from a triangle simplex.*
- static bool [TetrahedronSimplexUpdate](#) ([Simplex](#) &simplex, glm::vec3 &direction, glm::vec3 &a)  
*Update the simplex based upon a tetrahedron simplex.*
- static void [TetrahedronChecks](#) ([Simplex](#) &simplex, glm::vec3 &AO, glm::vec3 &AB, glm::vec3 &AC, glm::vec3 &ABC, glm::vec3 &direction, glm::vec3 &a)  
*Utility function for updating tetrahedron simplex knowing that there is no collision.*
- template<typename Iterator , typename = std::enable\_if\_t<std::is\_same<glm::vec3\*, typename std::iterator\_traits<Iterator>::value\_type>::value>, typename Iterator1 , typename = std::enable\_if\_t<std::is\_same<glm::vec3\*, typename std::iterator\_traits<Iterator1>::value\_type>::value>>>  
static glm::vec3 [Support](#) (const Iterator &startVertices1, const Iterator &endVertices1, const Iterator1 &startVertices2, const Iterator1 &endVertices2, const glm::vec3 &direction)  
*Support functionality for convex shape collider gives us a point in Minkowski space that is closest to the direction vector given.*
- template<typename Iterator , typename = std::enable\_if\_t<std::is\_same<glm::vec3\*, typename std::iterator\_traits<Iterator>::value\_type>::value>>>  
static glm::vec3 \* [FarthestPointInDirection](#) (const Iterator &startVertices, const Iterator &endVertices, const glm::vec3 &direction)  
*Get a point in the vertex list that is closest (direction-wise) to the direction vector.*

### 6.9.1 Detailed Description

Utility class for the implementation of the GJK algorithm used for collision detection between convex shape colliders.

See also

[mtx::ConvexShapeCollider](#)

Some resources on the algorithm:

<http://www.dyn4j.org/2010/04/gjk-gilbert-johnson-keerthi/#gjk-minkowski> <http://vec3.ca>

### 6.9.2 Member Function Documentation

#### 6.9.2.1 Collision()

```
template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename
std::iterator_traits<Iterator>::value_type>::value>, typename Iterator1 , typename = std::
::enable_if_t<std::is_same<glm::vec3*, typename std::iterator_traits<Iterator1>::value_
type>::value>>>
static bool mtx::GJKUtil::Collision (
    const Iterator & startVertices1,
    const Iterator & endVertices1,
    const Iterator1 & startVertices2,
    const Iterator1 & endVertices2 ) [inline], [static]
```

Implementation of GJK Collision detection algorithm.

See also

[mtx::ConvexShapeCollider](#)

## Template Parameters

<i>Iterator</i>	The type of iterator we will use for vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*, typename</i>	<i>std::iterator_traits&lt;Iterator&gt;::value_type::value&gt;</i> Iterator template checks
<i>Iterator1</i>	The type of iterator we will use for vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*, typename</i>	<i>std::iterator_traits&lt;Iterator1&gt;::value_type::value&gt;</i> Iterator template checks

## Parameters

<i>startVertices1</i>	Iterator to the beginning of the first vertex list for first convex shape
<i>endVertices1</i>	Iterator to the end of the first vertex list of the first convex shape
<i>startVertices2</i>	Iterator to the beginning of the second vertex list for the second convex shape
<i>endVertices2</i>	Iterator to the end of the second vertex list of the second convex shape

## Returns

- true The 2 convex shape colliders collide
- false The 2 convex shape colliders do not collide

## 6.9.2.2 FarthestPointInDirection()

```
template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename
std::iterator_traits<Iterator>::value_type::value>>
static glm::vec3* mtrx::GJKUtil::FarthestPointInDirection (
    const Iterator & startVertices,
    const Iterator & endVertices,
    const glm::vec3 & direction ) [inline], [static], [private]
```

Get a point in the vertex list that is closest (direction-wise) to the direction vector.

## Template Parameters

<i>Iterator</i>	The type of iterator we will use for vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*, typename</i>	<i>std::iterator_traits&lt;Iterator&gt;::value_type::value&gt;</i> Iterator template checks

## Parameters

<i>startVertices</i>	Iterator to the beginning of the vertex list
<i>endVertices</i>	Iterator to the end of the vertex list
<i>direction</i>	The direction vector used to find the farthest point

**Returns**

glm::vec3\* The farthest point with the give direction

**6.9.2.3 Support()**

```
template<typename Iterator , typename = std::enable_if_t<std::is_same<glm::vec3*, typename
std::iterator_traits<Iterator>::value_type>::value>, typename Iterator1 , typename = std::
::enable_if_t<std::is_same<glm::vec3*, typename std::iterator_traits<Iterator1>::value_
type>::value>>
static glm::vec3 mtrx::GJKUtil::Support (
    const Iterator & startVertices1,
    const Iterator & endVertices1,
    const Iterator1 & startVertices2,
    const Iterator1 & endVertices2,
    const glm::vec3 & direction ) [inline], [static], [private]
```

Support functionality for convex shape collider gives us a point in Minkowski space that is closest to the direction vector given.

**Template Parameters**

<i>Iterator</i>	The type of iterator we will use for vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*,typename</i>	<i>std::iterator_traits&lt;Iterator&gt;::value_type&gt;::value&gt;</i> Iterator template checks
<i>Iterator1</i>	The type of iterator we will use for vertices
<i>std::enable_if_t&lt;std::is_same&lt;glm::vec3*,typename</i>	<i>std::iterator_traits&lt;Iterator1&gt;::value_type&gt;::value&gt;</i> Iterator template checks

**Parameters**

<i>startVertices1</i>	Iterator to the beginning of the first vertex list for first convex shape
<i>endVertices1</i>	Iterator to the end of the first vertex list of the first convex shape
<i>startVertices2</i>	Iterator to the beginning of the second vertex list for the second convex shape
<i>endVertices2</i>	Iterator to the end of the second vertex list of the second convex shape
<i>direction</i>	The direction that we want to find a vertex in the direction of

**Returns**

glm::vec3 A vertex in minkowski space in the direction given to be added to the simplex

**6.9.2.4 TetrahedronChecks()**

```
static void mtrx::GJKUtil::TetrahedronChecks (
    Simplex & simplex,
```



```

glm::vec3 & AO,
glm::vec3 & AB,
glm::vec3 & AC,
glm::vec3 & ABC,
glm::vec3 & direction,
glm::vec3 & a ) [static], [private]

```

Utility function for updating tetrahedron simplex knowing that there is no collision.

#### Parameters

<i>simplex</i>	The simplex that we want to modify
<i>AO</i>	Line of the triangle 'AO'
<i>AB</i>	Line of the triangle 'AB'
<i>AC</i>	Line of the triangle 'AC'
<i>ABC</i>	normal of the the plane ABC of the triangle
<i>direction</i>	The direction vector of the search
<i>a</i>	The new vector from the support functionality

#### See also

[mtrx::GJKUtil::Support](#)

#### 6.9.2.5 TetrahedronSimplexUpdate()

```

static bool mtrx::GJKUtil::TetrahedronSimplexUpdate (
    Simplex & simplex,
    glm::vec3 & direction,
    glm::vec3 & a ) [static], [private]

```

Update the simplex based upon a tetrahedron simplex.

#### Parameters

<i>simplex</i>	The simplex we want to update
<i>direction</i>	The direction that we are searching with
<i>a</i>	The new vertex generated from the support function

#### See also

[mtrx::GJKUtil::Support](#)

#### Returns

true The tetrahedron encapsulate the origin signifying a collision

false The tetrahedron does not encapsulate the origin and thus the simplex needs to be modified or recalculated

### 6.9.2.6 TriangleSimplexUpdate()

```
static bool mtrx::GJKUtil::TriangleSimplexUpdate (
    Simplex & simplex,
    glm::vec3 & direction,
    glm::vec3 & a ) [static], [private]
```

Updating the simplex values from a triangle simplex.

#### Parameters

<i>simplex</i>	The simplex we want to update
<i>direction</i>	The direction for the search
<i>a</i>	The new vector that we got from the support function

#### See also

[mtrx::GJKUtil::Support](#)

#### Returns

true N/A as a triangle simplex cannot encapsulate a point in 3d space  
false Always returned

### 6.9.2.7 UpdateSimplex()

```
static bool mtrx::GJKUtil::UpdateSimplex (
    Simplex & simplex,
    glm::vec3 & direction,
    glm::vec3 & a ) [static], [private]
```

Update the simplex values or return a collision.

#### Parameters

<i>simplex</i>	The simplex generated to be modified according the the new vertices
<i>direction</i>	The direction that we will be finding points using
<i>a</i>	The newest point to be added to the simplex

#### Returns

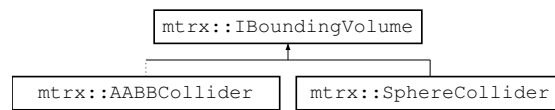
true The simplex encapsulates the origin and thus there exists a collision  
false The simplex does not encapsule the origin and thus modified the simplex to continue search

## 6.10 mtrx::IBoundingBox Class Reference

Interface used to define a bounding volume that can be used in a Bounding volume Hierarchy.

```
#include <IBoundingVolume.h>
```

Inheritance diagram for mtrx::IBoundingVolume:



## Public Member Functions

- virtual float **GetSize** ()=0

### 6.10.1 Detailed Description

Interface used to define a bounding volume that can be used in a Bounding volume Hierarchy.

See also

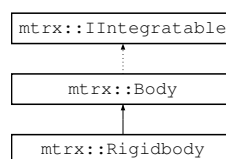
[mtrx::BVHNode](#) PS: This infrastructure is being reworked

## 6.11 mtrx::Integratable Class Reference

Interface for integration PS: Not used that much really.

```
#include <IIntegratable.h>
```

Inheritance diagram for mtrx::Integratable:



## Public Member Functions

- virtual void [Integrate](#) (float deltaTime)=0  
*Integration functionality.*

### 6.11.1 Detailed Description

Interface for integration PS: Not used that much really.

## 6.11.2 Member Function Documentation

### 6.11.2.1 Integrate()

```
virtual void mtrx::IIntegratable::Integrate (
    float deltaTime ) [pure virtual]
```

Integration functionality.

#### Parameters

<i>deltaTime</i>	Time elapsed from previous frame
------------------	----------------------------------

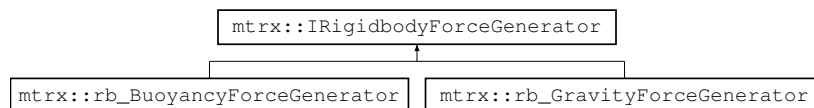
Implemented in [mtrx::Body](#), and [mtrx::Rigidbody](#).

## 6.12 mtrx::IRigidbodyForceGenerator Class Reference

Force generation interface used to apply forces on rigidbodies.

```
#include <IRigidbodyForceGenerator.h>
```

Inheritance diagram for mtrx::IRigidbodyForceGenerator:



### Public Member Functions

- virtual void [UpdateForces](#) ([Rigidbody](#) \*rb, float deltaTime)=0  
*Apply a certain force onto the given rigidbodies.*

### 6.12.1 Detailed Description

Force generation interface used to apply forces on rigidbodies.

### 6.12.2 Member Function Documentation

#### 6.12.2.1 UpdateForces()

```
virtual void mtrx::IRigidbodyForceGenerator::UpdateForces (
    Rigidbody * rb,
    float deltaTime ) [pure virtual]
```

Apply a certain force onto the given rigidbodies.

## Parameters

<i>rb</i>	The rigidbody we want to apply the force onto
<i>deltaTime</i>	The time elapsed since the previous frame

Implemented in [mtrx::rb\\_BuoyancyForceGenerator](#), and [mtrx::rb\\_GravityForceGenerator](#).

## 6.13 mtrx::LogManager Class Reference

Logger wrapper for logging functionality in the engine.

```
#include <LogManager.h>
```

### Public Member Functions

- `template<typename T >`  
`void warn (const T &msg)`  
*Wrapper for logging a warning.*
- `template<typename T >`  
`void info (const T &msg)`  
*Wrapper for logging an info level message.*
- `template<typename T >`  
`void trace (const T &msg)`  
*Wrapper for logging a trace level message.*
- `template<typename T >`  
`void error (const T &msg)`  
*Wrapper for logging an error level message.*
- `template<typename T >`  
`void critical (const T &msg)`  
*Wrapper for logging a critical level message.*

### Static Public Member Functions

- `static LogManager & GetInstance ()`  
*Get the singleton logger instance.*

### Private Member Functions

- `void CreateLogDirectory ()`  
*Create The log directory that we will use for logging if it does not exist.*
- `LogManager ()`  
*Construct a new Log Manager object. This object is a singleton so it will be constructed once.*
- `LogManager (const LogManager &)=delete`
- `LogManager (const LogManager &&)=delete`
- `LogManager & operator= (const LogManager &)=delete`
- `LogManager & operator= (const LogManager &&)=delete`

## Private Attributes

- `std::shared_ptr< spdlog::logger > mtrxLogger`

### 6.13.1 Detailed Description

Logger wrapper for logging functionality in the engine.

### 6.13.2 Constructor & Destructor Documentation

#### 6.13.2.1 LogManager()

```
mtrx::LogManager::LogManager ( ) [private]
```

Construct a new Log Manager object. This object is a singleton so it will be constructed once.

### 6.13.3 Member Function Documentation

#### 6.13.3.1 CreateLogDirectory()

```
void mtrx::LogManager::CreateLogDirectory ( ) [private]
```

Create The log directory that we will use for logging if it does not exist.

#### 6.13.3.2 critical()

```
template<typename T >
void mtrx::LogManager::critical (
    const T & msg ) [inline]
```

Wrapper for logging a critical level message.

#### Template Parameters

<i>T</i>	Type of warning that we will be logging
----------	---

#### Parameters

<i>msg</i>	The message that we log
------------	-------------------------

### 6.13.3.3 error()

```
template<typename T >
void mtrx::LogManager::error (
    const T & msg ) [inline]
```

Wrapper for logging an error level message.

#### Template Parameters

<i>T</i>	Type of warning that we will be logging
----------	---

#### Parameters

<i>msg</i>	The message that we log
------------	-------------------------

### 6.13.3.4 GetInstance()

```
static LogManager& mtrx::LogManager::GetInstance ( ) [inline], [static]
```

Get the singleton logger instance.

#### Returns

[LogManager&](#) The instance of the logger that we will be using

### 6.13.3.5 info()

```
template<typename T >
void mtrx::LogManager::info (
    const T & msg ) [inline]
```

Wrapper for logging an info level message.

#### Template Parameters

<i>T</i>	Type of warning that we will be logging
----------	---

#### Parameters

<i>msg</i>	The message that we log
------------	-------------------------

### 6.13.3.6 trace()

```
template<typename T >
void mtrx::LogManager::trace (
    const T & msg ) [inline]
```

Wrapper for logging a trace level message.

#### Template Parameters

<i>T</i>	Type of warning that we will be logging
----------	---

#### Parameters

<i>msg</i>	The message that we log
------------	-------------------------

### 6.13.3.7 warn()

```
template<typename T >
void mtrx::LogManager::warn (
    const T & msg ) [inline]
```

Wrapper for logging a warning.

#### Template Parameters

<i>T</i>	Type of warning that we will be logging
----------	---

#### Parameters

<i>msg</i>	The message that we log
------------	-------------------------

## 6.14 mtrx::mtrxDynamicWorld Class Reference

Entry point of the user to the engine. This class defines the API that user will be using to interface with the engine.

```
#include <mtrxDynamicWorld.h>
```

### Public Member Functions

- [mtrxDynamicWorld\(\)](#)



- Construct a new mtrx Dynamic World object.*

  - `~mtrxDynamicWorld ()=default`

*Destroy the mtrx Dynamic World object.*
- void `Update` (float dt)

*Update the game world.*
- void `AddRigidbody` (Rigidbody \*rb)

*Add a rigidbody to the rigidbody manager.*
- void `RemoveRigidbody` (Rigidbody \*rb)

*Remove a rigidbody from the rigidbody manager.*
- void `AddForceGenerator` (Rigidbody \*rb, const std::shared\_ptr< IRigidbodyForceGenerator > &forceGenerator)

*Add a force generator to the rigidbody manager.*
- void `RemoveForceGenerator` (Rigidbody \*rb, const std::shared\_ptr< IRigidbodyForceGenerator > &generator)

*Remove a rigidbody from the rigidbody manager.*
- void `AddCollider` (Collider \*col)

*Add a collider to the collision system.*
- void `RemoveCollider` (Collider \*col)

*Remove a collider to the collision system.*

## Public Attributes

- float **accumulator**

## Private Attributes

- `RigidbodyManager` **m\_rbManager**
- `CollisionSystem` **m\_CollisionSystem**

### 6.14.1 Detailed Description

Entry point of the user to the engine. This class defines the API that user will be using to interface with the engine.

### 6.14.2 Constructor & Destructor Documentation

#### 6.14.2.1 mtrxDynamicWorld()

```
mtrx::mtrxDynamicWorld::mtrxDynamicWorld ( )
```

Construct a new mtrx Dynamic World object.

### 6.14.2.2 ~mtrxDynamicWorld()

```
mtrx::mtrxDynamicWorld::~~mtrxDynamicWorld ( ) [default]
```

Destroy the mtrx Dynamic World object.

## 6.14.3 Member Function Documentation

### 6.14.3.1 AddCollider()

```
void mtrx::mtrxDynamicWorld::AddCollider (
    Collider * col ) [inline]
```

Add a collider to the collision system.

#### Parameters

<i>col</i>	The collider that we want to add
------------	----------------------------------

### 6.14.3.2 AddForceGenerator()

```
void mtrx::mtrxDynamicWorld::AddForceGenerator (
    Rigidbody * rb,
    const std::shared_ptr< IRigidbodyForceGenerator > & forceGenerator ) [inline]
```

Add a force generator to the rigidbody manager.

#### Parameters

<i>rb</i>	The rigidbody we want to add the force generator to
<i>forceGenerator</i>	The force generator we want to add

### 6.14.3.3 AddRigidbody()

```
void mtrx::mtrxDynamicWorld::AddRigidbody (
    Rigidbody * rb ) [inline]
```

Add a rigidbody to the rigidbody manager.

## Parameters

<i>rb</i>	The rigidbody we want to add to the manager
-----------	---

### 6.14.3.4 RemoveCollider()

```
void mtrx::mtrxDynamicWorld::RemoveCollider (
    Collider * col ) [inline]
```

Remove a collider to the collision system.

## Parameters

<i>col</i>	The collider that we want to remove
------------	-------------------------------------

### 6.14.3.5 RemoveForceGenerator()

```
void mtrx::mtrxDynamicWorld::RemoveForceGenerator (
    Rigidbody * rb,
    const std::shared_ptr< IRigidbodyForceGenerator > & generator ) [inline]
```

Remove a rigidbody from the rigidbody manager.

## Parameters

<i>rb</i>	The rigidbody we want to remove the rigidbody from
<i>generator</i>	The force generator that we want to remove

### 6.14.3.6 RemoveRigidbody()

```
void mtrx::mtrxDynamicWorld::RemoveRigidbody (
    Rigidbody * rb ) [inline]
```

Remove a rigidbody from the rigidbody manager.

## Parameters

<i>rb</i>	The rigidbody we want to remove
-----------	---------------------------------

### 6.14.3.7 Update()

```
void mtrx::mtrxDynamicWorld::Update (
    float dt )
```

Update the game world.

#### Parameters

<i>dt</i>	The time elapsed since the last frame
-----------	---------------------------------------

## 6.15 mtrx::ObjectAxes Struct Reference

The axes that define an objects world.

```
#include <Defs.h>
```

### Public Member Functions

- glm::vec3 & **operator[]** (int index)
- const glm::vec3 & **operator[]** (int index) const
- **ObjectAxes** (const glm::vec3 &forward=glm::vec3(0, 0, -1), const glm::vec3 &up=glm::vec3(0, 1, 0), const glm::vec3 &side=glm::vec3(1, 0, 0))

### Public Attributes

```
•
union {
    struct {
        glm::vec3 side
        glm::vec3 up
        glm::vec3 forward
    }
    glm::vec3 axes [3]
};
```

### 6.15.1 Detailed Description

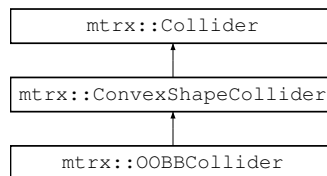
The axes that define an objects world.

## 6.16 mtrx::OOBBCollider Class Reference

Implementation of OOBBS.

```
#include <OOBBCollider.h>
```

Inheritance diagram for mtrx::OOBBCollider:



### Public Member Functions

- [OOBBCollider](#) (const glm::vec3 &center=glm::vec3(), const glm::quat &orientation=glm::angleAxis(0.f, glm::vec3(0, 1, 0)), const glm::vec3 &scale=glm::vec3(1, 1, 1))  
Construct a new [OOBBCollider](#) object.
- [OOBBCollider](#) (const [Transform](#) &transform=[Transform](#)())  
Construct a new [OOBBCollider](#) object.
- virtual [~OOBBCollider](#) ()=default  
Destroy the [OOBBCollider](#) object.
- virtual bool [RaycastCollision](#) (const [Ray](#) &ray) override  
Raycast OOB collision detection algorithm.
- const glm::vec3 \* [GetAxes](#) () const  
Get the Axes of the collider.
- const float \* [GetHalfExtents](#) () const  
Get the Half Extents of the OOB collision.
- float \* [GetHalfExtents](#) ()  
Get the Half Extents of the OOB collision.
- virtual void [SetScale](#) (const glm::vec3 &scale) override  
Set the Scale of the collider.

### Private Attributes

- float **halfExtents** [3]
- [ObjectAxes](#) axes

### Additional Inherited Members

#### 6.16.1 Detailed Description

Implementation of OOBBS.

## 6.16.2 Constructor & Destructor Documentation

### 6.16.2.1 OOBBCollider() [1/2]

```
mtrx::OOBBCollider::OOBBCollider (
    const glm::vec3 & center = glm::vec3(),
    const glm::quat & orientation = glm::angleAxis(0.f, glm::vec3(0, 1, 0)),
    const glm::vec3 & scale = glm::vec3(1, 1, 1) )
```

Construct a new [OOBBCollider](#) object.

#### Parameters

<i>center</i>	Center of the collider
<i>orientation</i>	Orientation of the collider
<i>scale</i>	The scale of the collider

### 6.16.2.2 OOBBCollider() [2/2]

```
mtrx::OOBBCollider::OOBBCollider (
    const Transform & transform = Transform() )
```

Construct a new [OOBBCollider](#) object.

#### Parameters

<i>transform</i>	The transform of the collider @mtrx::Transform
------------------	--

### 6.16.2.3 ~OOBBCollider()

```
virtual mtrx::OOBBCollider::~~OOBBCollider ( ) [virtual], [default]
```

Destroy the [OOBBCollider](#) object.

## 6.16.3 Member Function Documentation

### 6.16.3.1 GetAxes()

```
const glm::vec3* mtrx::OOBBCollider::GetAxes ( ) const [inline]
```

Get the Axes of the collider.

#### Returns

const glm::vec3\* Array of the axes of the OOB

### 6.16.3.2 GetHalfExtents() [1/2]

```
float* mtrx::OOBBCollider::GetHalfExtents ( ) [inline]
```

Get the Half Extents of the OOB collider.

#### Returns

float\* The half extents of the collider

### 6.16.3.3 GetHalfExtents() [2/2]

```
const float* mtrx::OOBBCollider::GetHalfExtents ( ) const [inline]
```

Get the Half Extents of the OOB collider.

#### Returns

const float\* The half extents of the collider

### 6.16.3.4 RaycastCollision()

```
virtual bool mtrx::OOBBCollider::RaycastCollision (
    const Ray & ray ) [inline], [override], [virtual]
```

Raycast OOB collision detection algorithm.

#### Parameters

<i>ray</i>	Ray that we want to check collision for
------------	---

See also

[mtrx::Ray](#)

Returns

true The ray and collider collide

false The ray and collider do not collide

Reimplemented from [mtrx::ConvexShapeCollider](#).

### 6.16.3.5 SetScale()

```
virtual void mtrx::OOBBCollider::SetScale (
    const glm::vec3 & scale ) [inline], [override], [virtual]
```

Set the Scale of the collider.

Parameters

<i>scale</i>	The scale of the collider
--------------	---------------------------

Reimplemented from [mtrx::ConvexShapeCollider](#).

## 6.17 mtrx::PotentialCollision Struct Reference

Potential collisions struct.

```
#include <BVHNode.h>
```

### Public Attributes

- [Body](#) \* **bodies** [2]

#### 6.17.1 Detailed Description

Potential collisions struct.

## 6.18 mtrx::Ray Class Reference

Implementation of a ray.

```
#include <Ray.h>
```



## Public Member Functions

- [Ray](#) (const glm::vec3 &startPos=glm::vec3(), const glm::vec3 &rayDirection=glm::vec3())  
*Construct a new [Ray](#) object.*
- [~Ray](#) ()=default  
*Destroy the [Ray](#) object.*

## Public Attributes

- glm::vec3 **startPosition**
- glm::vec3 **direction**

### 6.18.1 Detailed Description

Implementation of a ray.

### 6.18.2 Constructor & Destructor Documentation

#### 6.18.2.1 Ray()

```
mtrx::Ray::Ray (
    const glm::vec3 & startPos = glm::vec3(),
    const glm::vec3 & rayDirection = glm::vec3() ) [inline]
```

Construct a new [Ray](#) object.

#### Parameters

<i>startPos</i>	The start position of the ray
<i>rayDirection</i>	A normalized vector representing the direction of the ray

#### 6.18.2.2 ~Ray()

```
mtrx::Ray::~Ray ( ) [default]
```

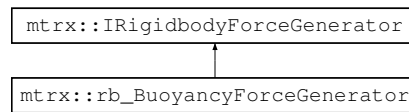
Destroy the [Ray](#) object.

## 6.19 mtrx::rb\_BuoyancyForceGenerator Class Reference

Implementation of a buoyancy force generator for rigidbodies.

```
#include <rb_BuoyancyForceGenerator.h>
```

Inheritance diagram for `mtrx::rb_BuoyancyForceGenerator`:



## Public Member Functions

- [rb\\_BuoyancyForceGenerator](#) (const glm::vec3 &gravity, float volumeBody, float bodyHalfExtent, float liquidHeight=0.f, float density=1000.f)  
*Construct a new rb BuoyancyForceGenerator object.*
- [~rb\\_BuoyancyForceGenerator](#) ()  
*Destroy the rb BuoyancyForceGenerator object.*
- virtual void [UpdateForces](#) ([Rigidbody](#) \*rb, float deltaTime) override  
*The implementation of the buoyancy force.*

## Public Attributes

- float **liquidDensity**
- float **liquidLevel**
- float **bodyHalfExtent**
- float **volumeBody**
- glm::vec3 **gravitationalAcceleration**
- glm::vec3 **centerOfBuoyancy**

## 6.19.1 Detailed Description

Implementation of a buoyancy force generator for rigidbodies.

This force generator generally assumes that the objects behaves more like a AABB We do not calculate the point of collision with the liquid plane and how much of the object is submerged if it is not perpendicular to the liquid plane

## 6.19.2 Constructor & Destructor Documentation

### 6.19.2.1 rb\_BuoyancyForceGenerator()

```

mtrx::rb_BuoyancyForceGenerator::rb_BuoyancyForceGenerator (
    const glm::vec3 & gravity,
    float volumeBody,
    float bodyHalfExtent,
    float liquidHeight = 0.f,
    float density = 1000.f )
  
```

Construct a new rb BuoyancyForceGenerator object.

## Parameters

<i>gravity</i>	The gravitational acceleration used by the generator
<i>volumeBody</i>	The volume of the body
<i>bodyHalfExtent</i>	The half extent of the body
<i>liquidHeight</i>	The height of the liquid that would represent the liquid's plane
<i>density</i>	The density of the liquid

**6.19.2.2 ~rb\_BuoyancyForceGenerator()**

```
mtrx::rb_BuoyancyForceGenerator::~~rb_BuoyancyForceGenerator ( )
```

Destroy the rb BuoyancyForceGenerator object.

**6.19.3 Member Function Documentation****6.19.3.1 UpdateForces()**

```
virtual void mtrx::rb_BuoyancyForceGenerator::UpdateForces (
    RigidBody * rb,
    float deltaTime ) [override], [virtual]
```

The implementation of the buoyancy force.

## Parameters

<i>rb</i>	The rigidbody to apply the buoyancy force
<i>deltaTime</i>	The time elapsed since the last frame

Implements [mtrx::IRigidBodyForceGenerator](#).

**6.20 mtrx::rb\_ForceGenerationRegistry Class Reference**

Registry for force generators used to map a rigidbody to all of the force generators that are to be applied to said rigidbody.

```
#include <rb_ForceGenerationRegistry.h>
```

## Public Member Functions

- `rb_ForceGenerationRegistry()`=default  
*Construct a new rb ForceGenerationRegistry object.*
- `~rb_ForceGenerationRegistry()`=default  
*Destroy the rb ForceGenerationRegistry object.*
- void `AddForceGenerator` (const std::shared\_ptr< [IRigidbodyForceGenerator](#) > &forceGenerator)  
*Add a force generator to the registry.*
- void `RemoveForceGenerator` (const int index)  
*Remove a force generator from registry by index.*
- void `RemoveForceGenerator` (const std::shared\_ptr< [IRigidbodyForceGenerator](#) > &forceGenerator)  
*Remove force generator.*
- void `UpdateForceGenerators` ([Rigidbody](#) \*rb, float deltaTime)  
*Apply the force generators onto the rigidbody.*

## Public Attributes

- std::vector< std::shared\_ptr< [IRigidbodyForceGenerator](#) > > `forceGenerators`

### 6.20.1 Detailed Description

Registry for force generators used to map a rigidbody to all of the force generators that are to be applied to said rigidbody.

### 6.20.2 Constructor & Destructor Documentation

#### 6.20.2.1 `rb_ForceGenerationRegistry()`

```
mtx::rb_ForceGenerationRegistry::rb_ForceGenerationRegistry ( ) [default]
```

Construct a new rb ForceGenerationRegistry object.

#### 6.20.2.2 `~rb_ForceGenerationRegistry()`

```
mtx::rb_ForceGenerationRegistry::~rb_ForceGenerationRegistry ( ) [default]
```

Destroy the rb ForceGenerationRegistry object.

### 6.20.3 Member Function Documentation

#### 6.20.3.1 `AddForceGenerator()`

```
void mtx::rb_ForceGenerationRegistry::AddForceGenerator (
    const std::shared_ptr< IRigidbodyForceGenerator > & forceGenerator ) [inline]
```

Add a force generator to the registry.

## Parameters

<i>forceGenerator</i>	The force generator to be added
-----------------------	---------------------------------

**6.20.3.2 RemoveForceGenerator()** [1/2]

```
void mtrx::rb_ForceGenerationRegistry::RemoveForceGenerator (
    const int index ) [inline]
```

Remove a force generator from registry by index.

## Parameters

<i>index</i>	The position of the force generator
--------------	-------------------------------------

**6.20.3.3 RemoveForceGenerator()** [2/2]

```
void mtrx::rb_ForceGenerationRegistry::RemoveForceGenerator (
    const std::shared_ptr< IRigidbodyForceGenerator > & forceGenerator ) [inline]
```

Remove force generator.

## Parameters

<i>forceGenerator</i>	The force generator that we want to remove
-----------------------	--

**6.20.3.4 UpdateForceGenerators()**

```
void mtrx::rb_ForceGenerationRegistry::UpdateForceGenerators (
    Rigidbody * rb,
    float deltaTime ) [inline]
```

Apply the force generators onto the rigidbody.

## Parameters

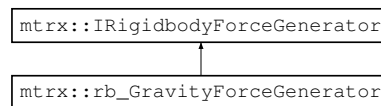
<i>rb</i>	The rigidbody we want to apply the forces to
<i>deltaTime</i>	The time elapsed from last frame

## 6.21 mtrx::rb\_GravityForceGenerator Class Reference

Implementation of gravitational force generator.

```
#include <rb_GravityForceGenerator.h>
```

Inheritance diagram for mtrx::rb\_GravityForceGenerator:



### Public Member Functions

- virtual void [UpdateForces](#) ([Rigidbody](#) \*rb, float deltaTime)  
*Implementation of the force generator.*
- [rb\\_GravityForceGenerator](#) (const glm::vec3 &gravity)  
*Construct a new rb GravityForceGenerator object.*
- [~rb\\_GravityForceGenerator](#) ()  
*Destroy the rb GravityForceGenerator object.*

### Public Attributes

- glm::vec3 **gravitationalAcceleration**

#### 6.21.1 Detailed Description

Implementation of gravitational force generator.

#### 6.21.2 Constructor & Destructor Documentation

##### 6.21.2.1 rb\_GravityForceGenerator()

```
mtrx::rb_GravityForceGenerator::rb_GravityForceGenerator (
    const glm::vec3 & gravity )
```

Construct a new rb GravityForceGenerator object.

##### Parameters

<i>gravity</i>	The gravitational acceleration value that we want to use
----------------	--

### 6.21.2.2 ~rb\_GravityForceGenerator()

```
mtrx::rb_GravityForceGenerator::~~rb_GravityForceGenerator ( )
```

Destroy the rb GravityForceGenerator object.

## 6.21.3 Member Function Documentation

### 6.21.3.1 UpdateForces()

```
virtual void mtrx::rb_GravityForceGenerator::UpdateForces (
    Rigidbody * rb,
    float deltaTime ) [virtual]
```

Implementation of the force generator.

#### Parameters

<i>rb</i>	The rigidbody to apply the force onto
<i>deltaTime</i>	The time elapsed since the last frame

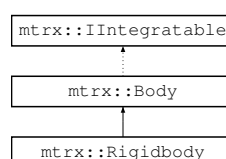
Implements [mtrx::IRigidbodyForceGenerator](#).

## 6.22 mtrx::Rigidbody Class Reference

Implementation of rigidbodies with rigidbody dynamics newtonian force integration and rotational forces.

```
#include <Rigidbody.h>
```

Inheritance diagram for mtrx::Rigidbody:



## Public Member Functions

- [Rigidbody](#) (float mass=MAX\_MASS, bool iskinematic=false, const glm::vec3 &position=glm::vec3(), const glm::quat &orientation=glm::angleAxis(0.f, glm::vec3(0, 1, 0)), const glm::vec3 &scale=glm::vec3(1, 1, 1), const glm::mat3 &inertiaTensor=glm::mat3(1.0f))  
Construct a new [Rigidbody](#) object.
- [~Rigidbody](#) ()=default  
Destroy the [Rigidbody](#) object.
- void [SetInverseInertiaTensor](#) (const glm::mat3 &inertiaTensor)  
Set the Inverse Inertia Tensor of the body.
- void [SetAngularDamping](#) (float angularDamping)  
Set the Angular Damping of the rigidbody Angular damping allows us to dampen torque forces applied to the body as a function of time.
- void [SetOrientation](#) (glm::quat &orientation)  
Set the Orientation of the body.
- void [SetRotation](#) (glm::vec3 &rotation)  
Set the Rotation value of the rigidbody This rotation value is used to generate torque forces.
- void [SetIsKinematic](#) (bool kinematic)  
Set the kinematic value.
- glm::mat3 & [GetInverseInertiaTensor](#) ()  
Get the Inverse Inertia Tensor of the body.
- float [GetAngularDamping](#) () const  
Get the Angular Damping of the body.
- glm::mat3x4 [GetObjToWorldMat](#) ()  
Get the Obj To World Mat.
- glm::vec3 & [GetRotation](#) ()  
Get the Rotation of the body.
- bool [GetIsKinematic](#) ()  
Get whether the body is kinematic.
- glm::mat3 [CalculateITWorld](#) ()  
Calculating the inverse inertia tensor in world space.
- void [AddTorque](#) (const glm::vec3 &torque)  
Add a torque force.
- void [ClearAccumulators](#) () override  
Clear accumulators of rigidbody.
- void [Integrate](#) (float deltaTime) override  
Integrate the values of the rigidbody.
- void [CalculateObjToWorldMat](#) ()  
Calculate object space to world space matrix.
- void [AddForceAtPoint](#) (const glm::vec3 &force, const glm::vec3 &point)  
Add a force at a certain point in space.
- void [CalculateBodyData](#) ()  
Update some of the information of the rigidbody.

## Private Attributes

- glm::vec3 **rotation**
- glm::mat3 **inverseInertiaTensor**
- glm::mat3x4 **objToWorldMat**
- glm::vec3 **accumTorque**
- float **angularDamping**
- bool **isKinematic**
- [ObjectAxes](#) **axes**



## Additional Inherited Members

### 6.22.1 Detailed Description

Implementation of rigidbodies with rigidbody dynamics newtonian force integration and rotational forces.

### 6.22.2 Constructor & Destructor Documentation

#### 6.22.2.1 Rigidbody()

```
mtrx::Rigidbody::Rigidbody (
    float mass = MAX_MASS,
    bool iskinematic = false,
    const glm::vec3 & position = glm::vec3(),
    const glm::quat & orientation = glm::angleAxis(0.f, glm::vec3(0, 1, 0)),
    const glm::vec3 & scale = glm::vec3(1, 1, 1),
    const glm::mat3 & inertiaTensor = glm::mat3(1.0f) )
```

Construct a new [Rigidbody](#) object.

#### Parameters

<i>mass</i>	The mass of the rigidbody
<i>iskinematic</i>	Whether the rigidbody is kinematic. A kinematic object does not affect other rigidbodies in the simulation
<i>position</i>	The position of the rigidbody
<i>orientation</i>	The orientation of the rigidbody
<i>scale</i>	The scale of the rigidbody
<i>inertiaTensor</i>	The inertia tensor of the rigidbody

#### 6.22.2.2 ~Rigidbody()

```
mtrx::Rigidbody::~~Rigidbody ( ) [default]
```

Destroy the [Rigidbody](#) object.

### 6.22.3 Member Function Documentation

### 6.22.3.1 AddForceAtPoint()

```
void mtrx::Rigidbody::AddForceAtPoint (
    const glm::vec3 & force,
    const glm::vec3 & point )
```

Add a force at a certain point in space.

## Parameters

<i>force</i>	The force that we want to add
<i>point</i>	The point upon which to apply the force

**6.22.3.2 AddTorque()**

```
void mtrx::Rigidbody::AddTorque (
    const glm::vec3 & torque ) [inline]
```

Add a torque force.

## Parameters

<i>torque</i>	The torque force that we want to add
---------------	--------------------------------------

**6.22.3.3 CalculateBodyData()**

```
void mtrx::Rigidbody::CalculateBodyData ( )
```

Update some of the information of the rigidbody.

**6.22.3.4 CalculateIITWorld()**

```
glm::mat3 mtrx::Rigidbody::CalculateIITWorld ( ) [inline]
```

Calculating the inverse inertia tensor in world space.

## Returns

glm::mat3 Inverse inertia tensor in world space

**6.22.3.5 CalculateObjToWorldMat()**

```
void mtrx::Rigidbody::CalculateObjToWorldMat ( )
```

Calculate object space to world space matrix.

#### 6.22.3.6 ClearAccumulators()

```
void mtrx::Rigidbody::ClearAccumulators ( ) [override], [virtual]
```

Clear accumulators of rigidbody.

Implements [mtrx::Body](#).

#### 6.22.3.7 GetAngularDamping()

```
float mtrx::Rigidbody::GetAngularDamping ( ) const [inline]
```

Get the Angular Damping of the body.

##### Returns

float The value of the angular damping

#### 6.22.3.8 GetInverseInertiaTensor()

```
glm::mat3& mtrx::Rigidbody::GetInverseInertiaTensor ( ) [inline]
```

Get the Inverse Inertia Tensor of the body.

##### Returns

glm::mat3& The inver inertia tensor

#### 6.22.3.9 GetIsKinematic()

```
bool mtrx::Rigidbody::GetIsKinematic ( ) [inline]
```

Get whether the body is kinematic.

##### Returns

true The body is kinematic

false The body is not kinematic

### 6.22.3.10 GetObjToWorldMat()

```
glm::mat3x4 mtrx::Rigidbody::GetObjToWorldMat ( ) [inline]
```

Get the Obj To World Mat.

#### Returns

glm::mat3x4 The object space to world matrix

### 6.22.3.11 GetRotation()

```
glm::vec3& mtrx::Rigidbody::GetRotation ( ) [inline]
```

Get the Rotation of the body.

#### Returns

glm::vec3& The rotation of the body

### 6.22.3.12 Integrate()

```
void mtrx::Rigidbody::Integrate (
    float deltaTime ) [override], [virtual]
```

Integrate the values of the rigidbody.

#### Parameters

<i>deltaTime</i>	The time elapsed by previous frame
------------------	------------------------------------

Implements [mtrx::Body](#).

### 6.22.3.13 SetAngularDamping()

```
void mtrx::Rigidbody::SetAngularDamping (
    float angularDamping ) [inline]
```

Set the Angular Damping of the rigidbody Angular damping allows us to dampen torque forces applied to the body as a function of time.

## Parameters

<i>angularDamping</i>	The new value of angular damping
-----------------------	----------------------------------

**6.22.3.14 SetInverseInertiaTensor()**

```
void mtrx::Rigidbody::SetInverseInertiaTensor (
    const glm::mat3 & inertiaTensor )
```

Set the Inverse Inertia Tensor of the body.

## Parameters

<i>inertiaTensor</i>	The inertia tensor that we will calculate the inverse of
----------------------	--

**6.22.3.15 SetIsKinematic()**

```
void mtrx::Rigidbody::SetIsKinematic (
    bool kinematic ) [inline]
```

Set the kinematic value.

## Parameters

<i>kinematic</i>	the new value of whether the body is kinematic
------------------	--

**6.22.3.16 SetOrientation()**

```
void mtrx::Rigidbody::SetOrientation (
    glm::quat & orientation ) [inline]
```

Set the Orientation of the body.

## Parameters

<i>orientation</i>	The new orientation of the body
--------------------	---------------------------------

### 6.22.3.17 SetRotation()

```
void mtrx::Rigidbody::SetRotation (
    glm::vec3 & rotation ) [inline]
```

Set the Rotation value of the rigidbody This rotation value is used to generate torque forces.

#### Parameters

<i>rotation</i>	The new value of the rotation
-----------------	-------------------------------

## 6.23 mtrx::RigidbodyManager Class Reference

Manager of rigidbodies.

```
#include <RigidbodyManager.h>
```

### Public Member Functions

- [RigidbodyManager](#) ()=default  
*Construct a new [Rigidbody](#) Manager object.*
- [~RigidbodyManager](#) ()  
*Destroy the [Rigidbody](#) Manager object.*
- void [Integrate](#) (float deltaTime)  
*Integrate all entities of the game world.*
- void [IntegrateRigidbody](#)s (float deltaTime)  
*Integrate rigidbodies.*
- void [UpdateForces](#) (float deltaTime)  
*Update the forces applied to the rigidbodies by updating the force generators.*

### Public Attributes

- std::unordered\_map< [Rigidbody](#) \*, [rb\\_ForceGenerationRegistry](#) > [rigidbodyRegistry](#)

### 6.23.1 Detailed Description

Manager of rigidbodies.

### 6.23.2 Constructor & Destructor Documentation

### 6.23.2.1 RigidBodyManager()

```
mtrx::RigidBodyManager::RigidBodyManager ( ) [default]
```

Construct a new [RigidBody](#) Manager object.

### 6.23.2.2 ~RigidBodyManager()

```
mtrx::RigidBodyManager::~~RigidBodyManager ( )
```

Destroy the [RigidBody](#) Manager object.

## 6.23.3 Member Function Documentation

### 6.23.3.1 Integrate()

```
void mtrx::RigidBodyManager::Integrate (
    float deltaTime )
```

Integrate all entities of the game world.

#### Parameters

<i>deltaTime</i>	The time elapsed between frames
------------------	---------------------------------

### 6.23.3.2 IntegrateRigidbodies()

```
void mtrx::RigidBodyManager::IntegrateRigidbodies (
    float deltaTime )
```

Integrate rigidbodies.

#### Parameters

<i>deltaTime</i>	The time elapsed between frames
------------------	---------------------------------

### 6.23.3.3 UpdateForces()

```
void mtrx::RigidBodyManager::UpdateForces (
```



```
float deltaTime )
```

Update the forces applied to the rigidbodies by updating the force generators.

#### Parameters

<i>deltaTime</i>	The time elapsed between frames
------------------	---------------------------------

## 6.24 mtrx::Simplex Struct Reference

Simplest shape that can encapsulate a point in 3d space Used within GJK collision detection algorithm.

```
#include <Defs.h>
```

### Public Attributes

- glm::vec3 **b**
- glm::vec3 **c**
- glm::vec3 **d**
- unsigned int **size**

### 6.24.1 Detailed Description

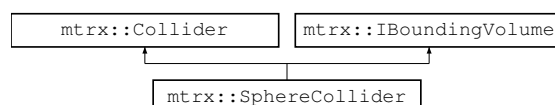
Simplest shape that can encapsulate a point in 3d space Used within GJK collision detection algorithm.

## 6.25 mtrx::SphereCollider Class Reference

Implementation of a Sphere collider used in collision systems.

```
#include <SphereCollider.h>
```

Inheritance diagram for mtrx::SphereCollider:



## Public Member Functions

- [SphereCollider](#) (const glm::vec3 &center=glm::vec3(), const glm::quat &orientation=glm::angleAxis(0.f, worldUp), const glm::vec3 &scale=glm::vec3(1, 1, 1), float radius=0.5)  
*Construct a new Sphere Collider object.*
- [SphereCollider](#) (const [Transform](#) &transform=[Transform](#)(), float radius=0.5)  
*Construct a new Sphere Collider object.*
- [SphereCollider](#) (const [SphereCollider](#) &collider1, const [SphereCollider](#) &collider2)  
*Construct a new Sphere Collider object that encompass 2 sphere colliders (used within the context of BVH construction mainly)*
- virtual [~SphereCollider](#) ()=default  
*Destroy the Sphere Collider object.*
- virtual bool [RaycastCollision](#) (const [Ray](#) &ray) override  
*Raycast collision check for sphere colliders.*
- virtual float [GetSize](#) () override  
*Get the Size of the sphere ( $4/3 * PI * radius^3$ )*
- virtual float [GetGrowth](#) (const [SphereCollider](#) &sphereCollider)  
*Get the Growth when creating a sphere collider between this collider and another sphere collider (for BVH construction)*
- float [GetRadius](#) () const  
*Get the Radius of the collider.*
- void [SetRadius](#) (float radius)  
*Set the Radius of the collider.*
- virtual void [SetScale](#) (const glm::vec3 &scale) override  
*Set the Scale of the sphere collider. Only the X coordinate of the scale affects the collider, other coordinates are ignored.*

## Private Attributes

- float **radius**

## Additional Inherited Members

### 6.25.1 Detailed Description

Implementation of a Sphere collider used in collision systems.

### 6.25.2 Constructor & Destructor Documentation

#### 6.25.2.1 SphereCollider() [1/3]

```
mtrx::SphereCollider::SphereCollider (
    const glm::vec3 & center = glm::vec3(),
    const glm::quat & orientation = glm::angleAxis(0.f, worldUp),
    const glm::vec3 & scale = glm::vec3(1, 1, 1),
    float radius = 0.5 )
```

Construct a new Sphere [Collider](#) object.

## Parameters

<i>center</i>	Center position of the sphere
<i>orientation</i>	The orientation of the sphere
<i>scale</i>	The scale of the sphere (influences the radius of the collider)
<i>radius</i>	The default radius of the sphere

## 6.25.2.2 SphereCollider() [2/3]

```
mtrx::SphereCollider::SphereCollider (
    const Transform & transform = Transform(),
    float radius = 0.5 )
```

Construct a new Sphere Collider object.

## Parameters

<i>transform</i>	The transform of the sphere (position, orientation, scale)
------------------	--

## See also

[mtrx::Transform](#)

## Parameters

<i>radius</i>	the default radius of the sphere
---------------	----------------------------------

## 6.25.2.3 SphereCollider() [3/3]

```
mtrx::SphereCollider::SphereCollider (
    const SphereCollider & collider1,
    const SphereCollider & collider2 )
```

Construct a new Sphere Collider object that encompass 2 sphere colliders (used within the context of BVH construction mainly)

## Parameters

<i>collider1</i>	First sphere collider
<i>collider2</i>	Second sphere collider

#### 6.25.2.4 ~SphereCollider()

```
virtual mtrx::SphereCollider::~~SphereCollider ( ) [virtual], [default]
```

Destroy the Sphere [Collider](#) object.

### 6.25.3 Member Function Documentation

#### 6.25.3.1 GetGrowth()

```
virtual float mtrx::SphereCollider::GetGrowth (
    const SphereCollider & sphereCollider ) [inline], [virtual]
```

Get the Growth when creating a sphere collider between this collider and another sphere collider (for BVH construction)

##### Parameters

<i>sphereCollider</i>	the sphere collider that we want to add
-----------------------	---

##### Returns

float The growth value of the resulting sphere collider

#### 6.25.3.2 GetRadius()

```
float mtrx::SphereCollider::GetRadius ( ) const [inline]
```

Get the Radius of the collider.

##### Returns

float Radius of collider

#### 6.25.3.3 GetSize()

```
virtual float mtrx::SphereCollider::GetSize ( ) [inline], [override], [virtual]
```

Get the Size of the sphere ( $\frac{4}{3} * \text{PI} * \text{radius}^3$ )

##### Returns

float

Implements [mtrx::IBoundingVolume](#).

### 6.25.3.4 RaycastCollision()

```
virtual bool mtrx::SphereCollider::RaycastCollision (
    const Ray & ray ) [inline], [override], [virtual]
```

Raycast collision check for sphere colliders.

#### Parameters

<i>ray</i>	The ray that we are check for collision on
------------	--

#### See also

[mtrx::Ray](#)

#### Returns

true The ray and the sphere collide  
false The ray and the sphere do not collide

Implements [mtrx::Collider](#).

### 6.25.3.5 SetRadius()

```
void mtrx::SphereCollider::SetRadius (
    float radius ) [inline]
```

Set the Radius of the collider.

#### Parameters

<i>radius</i>	The value we want to set the radius to
---------------	--

### 6.25.3.6 SetScale()

```
virtual void mtrx::SphereCollider::SetScale (
    const glm::vec3 & scale ) [inline], [override], [virtual]
```

Set the Scale of the sphere collider. Only the X coordinate of the scale affects the collider, other coordinates are ignored.

#### Parameters

<i>scale</i>	The value of the scale that we want to set the collider to
--------------	--

Reimplemented from [mtx::Collider](#).

## 6.26 mtx::Transform Class Reference

Wrapper implementation of a transform that holds position, orientation, scale values and some functionality based on these values.

```
#include <Transform.h>
```

### Public Member Functions

- [Transform](#) (const glm::vec3 &position=glm::vec3(), const glm::quat &orientation=glm::angleAxis(0.f, worldUp), const glm::vec3 &scale=glm::vec3(1, 1, 1))  
*Construct a new [Transform](#) object.*
- [~Transform](#) ()=default  
*Destroy the [Transform](#) object.*
- void [Translate](#) (const glm::vec3 &translationVec)  
*Translate the position vector.*
- void [Rotate](#) (const glm::quat &rotation)  
*Rotate the orientation value.*
- void [SetPosition](#) (const glm::vec3 &pos)  
*Set the Position vector.*
- void [SetOrientation](#) (const glm::quat &orientation)  
*Set the Orientation quaternion.*
- void [SetScale](#) (const glm::vec3 &scale)  
*Set the Scale vector.*
- const glm::vec3 & [GetPosition](#) () const  
*Get the Position vector.*
- const glm::quat & [GetOrientation](#) () const  
*Get the Orientation quaternion.*
- const glm::vec3 & [GetScale](#) () const  
*Get the Scale vector.*
- glm::vec3 & [GetPosition](#) ()  
*Get the Position vector.*
- glm::quat & [GetOrientation](#) ()  
*Get the Orientation quaternion.*
- glm::vec3 & [GetScale](#) ()  
*Get the Scale vector.*

### Private Attributes

- glm::vec3 **position**
- glm::quat **orientation**
- glm::vec3 **scale**

#### 6.26.1 Detailed Description

Wrapper implementation of a transform that holds position, orientation, scale values and some functionality based on these values.

## 6.26.2 Constructor & Destructor Documentation

### 6.26.2.1 Transform()

```
mtrx::Transform::Transform (
    const glm::vec3 & position = glm::vec3(),
    const glm::quat & orientation = glm::angleAxis(0.f, worldUp),
    const glm::vec3 & scale = glm::vec3(1, 1, 1) ) [inline]
```

Construct a new [Transform](#) object.

#### Parameters

<i>position</i>	
<i>orientation</i>	
<i>scale</i>	

### 6.26.2.2 ~Transform()

```
mtrx::Transform::~~Transform ( ) [default]
```

Destroy the [Transform](#) object.

## 6.26.3 Member Function Documentation

### 6.26.3.1 GetOrientation() [1/2]

```
glm::quat& mtrx::Transform::GetOrientation ( ) [inline]
```

Get the Orientation quaternion.

#### Returns

glm::quat& Orientation value

### 6.26.3.2 GetOrientation() [2/2]

```
const glm::quat& mtrx::Transform::GetOrientation ( ) const [inline]
```

Get the Orientation quaternion.

#### Returns

const glm::quat& Orientation value

### 6.26.3.3 GetPosition() [1/2]

```
glm::vec3& mtrx::Transform::GetPosition ( ) [inline]
```

Get the Position vector.

#### Returns

glm::vec3& Position value

### 6.26.3.4 GetPosition() [2/2]

```
const glm::vec3& mtrx::Transform::GetPosition ( ) const [inline]
```

Get the Position vector.

#### Returns

const glm::vec3& Position value

### 6.26.3.5 GetScale() [1/2]

```
glm::vec3& mtrx::Transform::GetScale ( ) [inline]
```

Get the Scale vector.

#### Returns

glm::vec3& Scale vector



### 6.26.3.6 GetScale() [2/2]

```
const glm::vec3& mtrx::Transform::GetScale ( ) const [inline]
```

Get the Scale vector.

Returns

const glm::vec3& Scale value

### 6.26.3.7 Rotate()

```
void mtrx::Transform::Rotate (
    const glm::quat & rotation ) [inline]
```

Rotate the orientation value.

## Parameters

<i>rotation</i>	The rotation quaternion that we want to rotate the orientation with
-----------------	---

**6.26.3.8 SetOrientation()**

```
void mtrx::Transform::SetOrientation (
    const glm::quat & orientation ) [inline]
```

Set the Orientation quaternion.

## Parameters

<i>orientation</i>	The new orientation value
--------------------	---------------------------

**6.26.3.9 SetPosition()**

```
void mtrx::Transform::SetPosition (
    const glm::vec3 & pos ) [inline]
```

Set the Position vector.

## Parameters

<i>pos</i>	The new position value
------------	------------------------

**6.26.3.10 SetScale()**

```
void mtrx::Transform::SetScale (
    const glm::vec3 & scale ) [inline]
```

Set the Scale vector.

## Parameters

<i>scale</i>	The new scale value
--------------	---------------------

### 6.26.3.11 Translate()

```
void mtrx::Transform::Translate (
    const glm::vec3 & translationVec ) [inline]
```

Translate the position vector.

#### Parameters

<i>translationVec</i>	Vector used to translate the position of the transform
-----------------------	--

## 6.27 mtrx::Triangle Struct Reference

Struct for storing a triangle.

```
#include <Defs.h>
```

### Public Member Functions

- **Triangle** (glm::vec3 \*a, glm::vec3 \*b, glm::vec3 \*c)

### Public Attributes

- ```
union {
    struct {
        glm::vec3 * a
        glm::vec3 * b
        glm::vec3 * c
    }
    glm::vec3 * pts [3]
};
```

### 6.27.1 Detailed Description

Struct for storing a triangle.



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