Bullet 2.3 Physics User Manual

Last updated by Erwin Coumans on Friday, 17 November 2006

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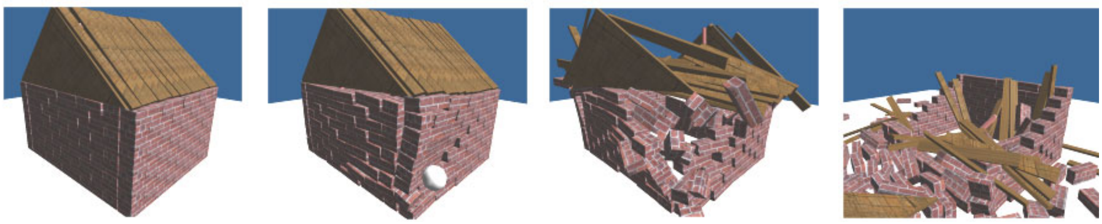
Introduction

Bullet Physics is an open source collision detection and physics library, related tools, demos, applications and a community forum at http://bulletphysics.com

Supported platforms are Windows (32/64 bits), Mac OS X, Linux, Playstation 3 and others. It started as toy project by Erwin Coumans, ex-Havok employee and involved in the port of Ageia to Playstation 3. Several contributions by others have been added. It is free for commercial use under the ZLib license. It is under active development and one of the recent developments is the addition of a GPU Physics and plans for an C# XNA port.

Target audience for this work are game developers, physics enthusiasts and 3d professionals who want to play with collision detection and rigidbody dynamics. There is also a sample integration with COLLADA Physics import and export. 3D Modelers like Maya, Max, XSI, Blender and Ageia's CreateDynamics tools support COLLADA physics xml .dae files. See the References for other integrations and links.

Bullet is also integrated in the free Blender 3D modeler, http://www.blender.org. The integration allows real-time simulation and also baking the simulation into keyframes for rendering.



Main Features

- ✓ Discrete and Continuous collision detection including ray casting
- ✓ Collision shapes include concave and convex meshes and all basic primitives
- ✓ Rigid body dynamics solver with auto deactivation
- ✓ Generic 6 degree of freedom constraint, hinge etc, for Ragdolls
- ✓ Vehicle simulation with tuning parameters
- ✓ COLLADA physics import/export with tool chain
- ✓ Compiles out-of-the-box for all platforms, including COLLADA support
- ✓ Open source C++ code under Zlib license and free for any commercial use

Download and supporting physics Forum

Primary location to download Bullet and for the supporting physics forum is http://bulletphysics.com

Quickstart

Step 1: Download

Windows developers should download the zipped sources from of Bullet from http://bullet.sf.net. Mac OS X, Linux and other developers should download the gzipped tar archive.

Step 2: Building

Bullet should compile out-of-the-box for all platforms, and includes all dependencies. Bullet comes with autogenerated Project Files for Microsoft Visual Studio 6, 7, 7.1 and 8. The main Workspace/Solution is located in Bullet/msvc/8/wksbullet.sln (replace 8 with your version). Under Mac OS X, Linux and other platforms you can compile Bullet using either CMake or jam. **CMake**: Download Cmake from http://www.cmake.org. Just run Cmake . –G Xcode to auto-generate projectfiles for Mac OS X Xcode. Likewise you can autogenerate Linux KDevelop, Unix Makefiles and other build systems.
Jam: Bullet includes jam-2.5 sources from http://www.perforce.com/jam/jam.html. Install jam and run ./configure and then run jam, in the Bullet root directory.

Step 3: Testing demos

Try to run and experiment with CcdPhysicsDemo executable as a starting point. Bullet can be used in several ways, as Full Rigid Body simulation, as Collision Detector Library or Low Level / Snippets like the GJK Closest Point calculation. The Dependencies can be seen in the doxygen documentation under 'Directories'.

Step 4: Integrating Bullet physics in your application

Check out CcdPhysicsDemo how to create a **btDynamicsWorld** , **btCollisionShape**, **btMotionState** and **btRigidBody**, Stepping the simulation and synchronizing the transform for your graphics object. Requirements:
#include "btBulletDynamicsCommon.h" in your source file
Required include path: Bullet /src folder
Required libraries: libbulletdynamics, libbulletcollision, libbulletmath

Step 5 : Integrate only Collision Detection Library

Bullet Collision Detection can also be used without the Dynamics/Extras. Check out the low level demo Collision Interface Demo, in particular the class CollisionWorld. Also in Extras/test_BulletOde.cpp there is a sample Collision Detection integration with Open Dynamics Engine. Requirements:
#include "btBulletCollisionCommon.h" at the top of your file
Add include path: Bullet /src folder
Add libraries: libbulletcollision, libbulletmath

Step 6 : Use Snippets like the GJK Closest Point calculation.

Bullet has been designed in a modular way keeping dependencies to a minimum. The ConvexHullDistance demo demonstrates direct use of **GjkPairDetector**.

Integration overview

If you want to use Bullet in your own 3D application, it is best to follow the steps in the CcdPhysicsDemo. In a nutshell:

- ✓ Create a btDynamicsWorld implementation like btDiscreteDynamicsWorld

This btDynamicsWorld is a high level interface that manages your physics objects and constraints. It also implements the update of all objects each frame. A btContinuousDynamicsWorld is under development to make use of Bullet's Continuous Collision Detection. This will prevent missing collisions of small and fast moving objects, also known as tunneling. Another solution based on internal variable timesteps called btFlexibleStepDynamicsWorld will be added too.

- ✓ Create a btRigidBody and add it to the btDynamicsWorld

To construct a btRigidBody or btCollisionObject, you need to provide:
- Mass, positive for dynamics moving objects and 0 for static objects
- CollisionShape, like a Box, Sphere, Cone, Convex Hull or Triangle Mesh
- btMotionState use to synchronize the World transform to controls the graphics
- Material properties like friction and restitution

- ✓ Update the simulation each frame: stepSimulation

Call the stepSimulation on the btDynamicsWorld. The btDiscreteDynamicsWorld automatically takes into account variable timestep by performing interpolation instead of simulation for small timesteps. It uses an internal fixed timestep of 60 Hertz. stepSimulation will perform collision detection and physics simulation. It updates the world transform for active objecs by calling the btMotionState's setWorldTransform.

There is performance functionality like auto deactivation for objects which motion is below a certain treshold.

A lot of the details are demonstrated in the Demos. If you can't find certain functionality, please use the FAQ or the physics Forum on the Bullet website.

Debugging

You can get additional debugging feedback by registering a derived class from IDebugDrawer. You just need to hook up 3d line drawing with your graphics renderer. See the CcdPhysicsDemo OpenGLDebugDrawer for an example implementation. It can visualize collision shapes, contact points and more. This can help to find problems in the setup. Also the Raytracer demo shows how to visualize a complex collision shape.

Bullet Rigid Body Dynamics

World Transforms and btMotionState

The main purpose of rigid body simulation is calculating the new world transform, position and orientation, of dynamic bodies. Usually each rigidbody is connected to a user object, like graphics object. It is a good idea to derive your own version of btMotionState class.

Each frame, Bullet dynamics will update the world transform for active bodies, by calling the btMotionState::setWorldTransform. Also, the initial center of mass worldtransform is retrieved, using btMotionState::getWorldTransform, to initialize the btRigidBody. If you want to offset the rigidbody center of mass world transform, relative to the graphics world transform, it is best to do this only in one place. You can use btDefaultMotionState as start implementation.

Static, Dynamic and Kinematic Objects using btRigidBody

There are 3 different types of objects in Bullet:

- Dynamic rigidbodies
    - positive mass
    - User should only use apply impulse, constraints or setLinearVelocity/setAngularVelocity and let the dynamics calculate the new world transform
    - every simulation frame and interpolation frame, the dynamics world will write the new world transform using btMotionState::setWorldTransform
- Static rigidbodies
    - cannot move but just collide
    - zero mass
- Kinematic rigidbodies
    - animated by the user
    - only one-way interaction: dynamic objects will be pushed away but there is no influence from dynamics objects
    - every simulation frame, dynamics world will get new world transform using btMotionState::getWorldTransform

All of them need to be added to the dynamics world. The rigid body can be assigned a collision shape. This shape can be used to calculate the distribution of mass, also called inertia tensor.

Simulation frames and interpolation frames

By default, Bullet physics simulation runs at an internal fixed framerate of 60 Hertz (0.01666). The game or application might have a different or even variable framerate. To decouple the application framerate from the simulation framerate, an automatic interpolation method is built into stepSimulation: when the application delta time, is smaller then the internal fixed timestep, Bullet will interpolate the world transform, and send the interpolated worldtransform to the btMotionState, without performing physics simulation. If the application timestep is larger then 60 hertz, more then 1 simulation step can be performed during each 'stepSimulation' call. The user can limit the maximum number of simulation steps by passing a maximum value as second argument.

When rigidbodies are created, they will retrieve the initial worldtransform from the btMotionState, using btMotionState::getWorldTransform. When the simulation is running, using stepSimulation, the new worldtransform is updated for active rigidbodies using the btMotionState::setWorldTransform.

Dynamic rigidbodies have a positive mass, and their motion is determined by the simulation. Static and kinematic rigidbodies have zero mass. Static objects should never be moved by the user.

If you plan to animate or move static objects, you should flag them as kinematic. Also disable the sleeping/deactivation for them. This means Bullet dynamics world will get the new worldtransform from the btMotionState every simulation frame.

```
body->setCollisionFlags( body->getCollisionFlags() |
btCollisionObject::CF_KINEMATIC_OBJECT);
body->setActivationState(DISABLE_DEACTIVATION);
```

Bullet Constraints

There are several constraints implemented in Bullet. See Demos/ConstraintDemo for an example of each of them. All constraints including the btRaycastVehicle are derived from btTypedConstraint. Constraint act between two rigidbodies, where at least one of them needs to be dynamic.

btPoint2PointConstraint

Point to point constraint, also known as ball socket joint limits the translation so that the local pivot points of 2 rigidbodies match in worldspace. A chain of rigidbodies can be connected using this constraint.

btHingeConstraint

Hinge constraint, or revolute joint restricts two additional angular degrees of freedom, so the body can only rotate around one axis, the hinge axis. This can be useful to represent doors or wheels rotating around one axis.

btGeneric6DofConstraint

The generic D6 constraint. This generic constraint can emulate a variety of standard constraints, by configuring each of the 6 degrees of freedom (dof). The first 3 dof axis are linear axis, which represent translation of rigidbodies, and the latter 3 dof axis represent the angular motion. Each axis can be either locked, free or limited. On construction of a new btGenericD6Constraint, all axis are locked. Afterwards the axis can be reconfigured.

Following is convention:

```
btVector3 lowerSliderLimit = btVector3(-10,0,0);
btVector3 hiSliderLimit = btVector3(10,0,0);

	btGeneric6DofConstraint* slider = new
btGeneric6DofConstraint(*d6body0,*fixedBody1,frameInA,frameInB);
	slider->setLinearLowerLimit(lowerSliderLimit);
	slider->setLinearUpperLimit(hiSliderLimit);
```

For each axis:
- Lowerlimit == Upperlimit -> axis is locked.
- Lowerlimit > Upperlimit -> axis is free
- Lowerlimit < Upperlimit -> axis it limited in that range

Bullet Vehicle

btRaycastVehicle

See Demos/VehicleDemo for more details, or check the Bullet forums.

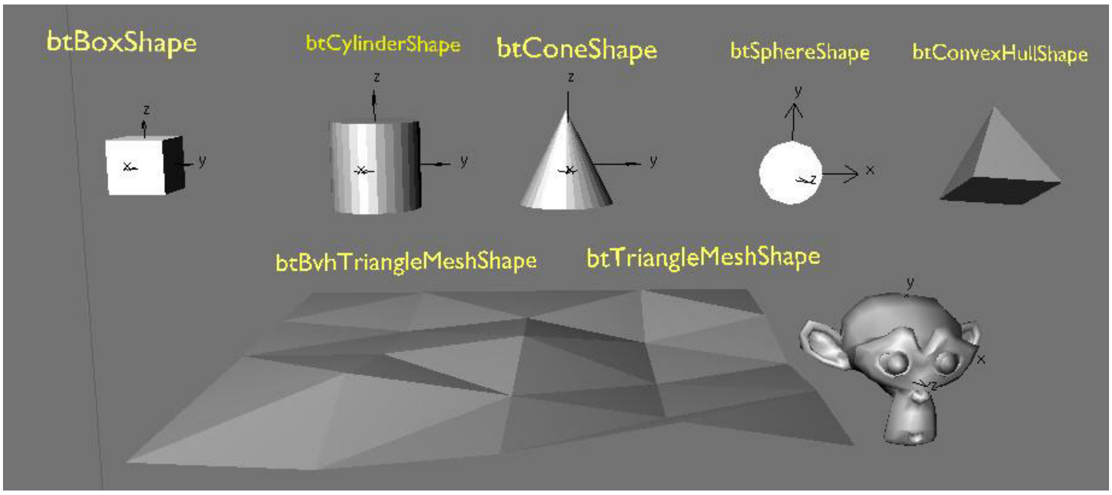
Changing the up axis of a vehicle., see #define FORCE_ZAXIS_UP in VehiceDemo.

Bullet Collision Shapes

Bullet supports a large variety of different collision shapes, and it is possible to add your own.

Convex Primitives

Most primitive shapes are centerd around the origin of their local coordinate frame:



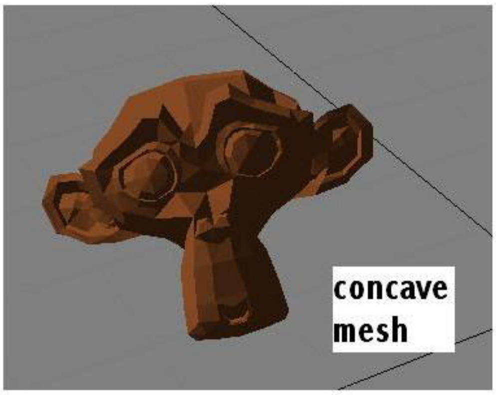
btBoxShape : Box defined by the half extents (half length) of its sides
btSphereShape : Sphere defined by its radius
btCylinderShape : Cylinder around the Y axis. Also `btCylinderShapeX/Z`.
btConeShape : Cone around the Y axis. Also btConeShapeX/Z.
btMultiSphereShape : Convex hull of multiple spheres, that can be used to create a Capsule (by passing 2 spheres) or other convex shapes.

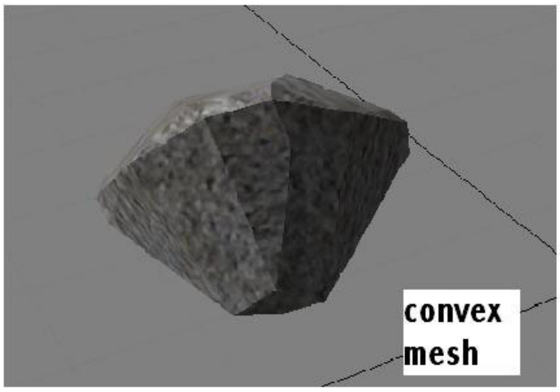
Compound Shapes

Multiple convex shapes can be combined into a composite or compound shape, using the btCompoundShape. This is a concave shape made out of convex sub parts, called child shapes. Each child shape has its own local offset transform, relative to the btCompoundShape.

Convex and Concave Meshes

For moving objects, concave meshes can be passed into btConvexHullShape,. This automatically collides with the convex hull of the mesh, see:





Ideally, concave meshes should only be used for static artwork. Otherwise its convex hull should be used by passing the mesh to btConvexHullShape. If more detail is needed, convex decomposition can be used to decompose the concave mesh into several convex parts. Those can be added to a compound shape. See the ConvexDecompositionDemo for an automatic way of doing convex decomposition. The implementation is taken from Ageia CreateDynamics tool, which can do the same with some fancy user interface. CreateDynamics can export to COLLADA Physics, so Bullet can import that data.

A recent contribution called GIMPACT can handle moving concave meshes. See Demos/MovingConcaveDemo for its usage.

Scaling of Collision Shapes

Some collision shapes can have local scaling applied. Use btCollisionShape::setScaling(vector3). Non uniform scaling with different scaling values for each axis, can be used for btBoxShape, btMultiSphereShape, btConvexShape, btTriangleMeshShape. Uniform scaling, using x value for all axis, can be used for btSphereShape. Note that a non-uniform scaled sphere can be created by using a btMultiSphereShape with 1 sphere.

Collision Matrix

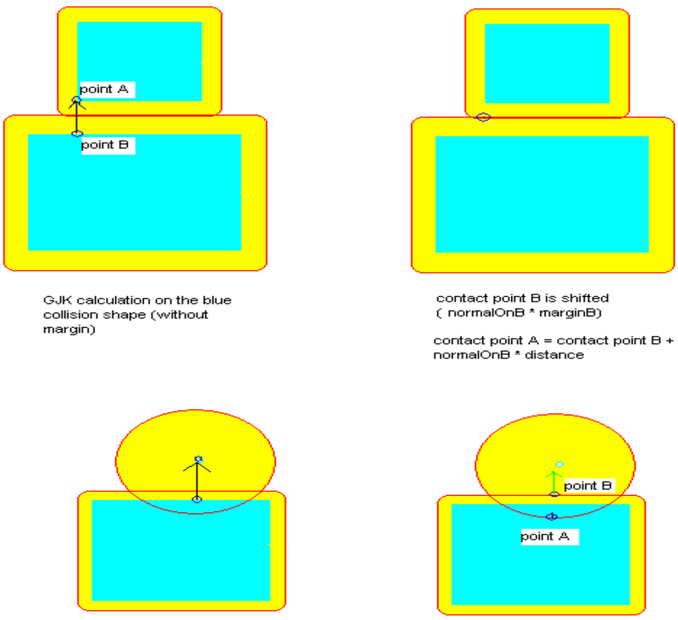
For each pair of shape types, Bullet will dispatch a certain collision algorithm, by using the dispatcher. By default, the entire matrix is filled with the following algorithms. Note that Convex represents convex polyhedron, cylinder, cone and capsule and other GJK compatible primitives. GJK stands for Gilbert Johnson Keethi, the people behind this convex distance calculation algorithm. EPA stands for Expanding Polythope Algorithm by Gino van den Bergen. Bullet has its own free implementation of GJK and EPA.

Bullet Collision Matrix (*= optional)					
Collision Shape:	**Sphere**	**Box**	**Convex**	**Compound**	**Trianglemesh**
Sphere	**GjkEpa /*SphereSphere**	**GjkEpa / *SphereBox**	**GjkEpa**	**Compound**	**ConcaveConvex**
Box	**GjkEpa /*SphereBox**	**GjkEpa / *BoxBox**	**GjkEpa /*SAT**	**Compound**	**ConcaveConvex**
Convex	**GjkEpa**	**GjkEpa / *SAT**	**GjkEpa /*SAT**	**Compound**	**ConcaveConvex**
Compound	**Compound**	**Compound**	**Compound**	**Compound**	**Compound**
Trianglemesh	**ConcaveConvex**	**ConcaveConvex**	**ConcaveConvex**	**Compound**	***GIMPACT**

The user can override any entry in this Collision Matrix by using the btDispatcher::registerCollisionAlgorithm. See UserCollisionAlgorithm for an example, that registers SphereSphere collision algorithm.

Collision Margin

Bullet uses a small collision margin for collision shapes, to improve performance and reliability of the collision detection. Best is to not touch the collision margin, and if you do use a positive value: zero margin might introduce problems. By default this collision margin is set to 0.04, which is 4 centimeter if your units are in meters (recommended).



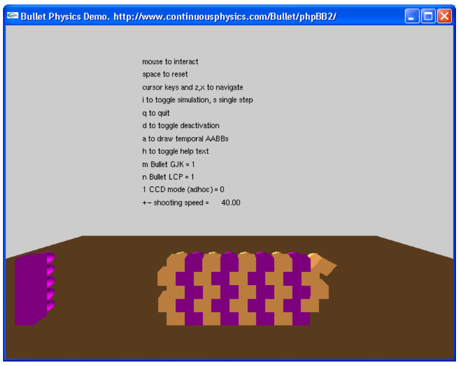
Dependent on which collision shapes, the margin has different meaning. Generally the collision margin will expand the object. This will create a small gap. To compensate for this, some shapes will subtract the margin from the actual size. For example, the btBoxShape subtracts the collision margin from the half extents. For a btSphereShape, the entire radius is collision margin so no gap will occur. Don't override the collision margin for spheres. For convex hulls, cylinders and cones, the margin is added to the extents of the object, so a gap will occur, unless you adjust the graphics mesh or collision size. For convex hull objects, there is a method to remove the gap introduced by the margin, by shrinking the object. See the BspDemo for this advanced use.
The yellow in the following picture described the working of collision margin for internal contact generation.

Basic Demos

Bullet includes several demos. They are tested on several platforms and use OpenGL graphics and glut. Some shared functionality like mouse picking and text rendering is provided in the Demos/OpenGL support folder. This is implemented in the DemoApplication class. Each demo derives a class from DemoApplication and implements its own initialization of the physics in the 'initPhysics' method.

CCD Physics Demo

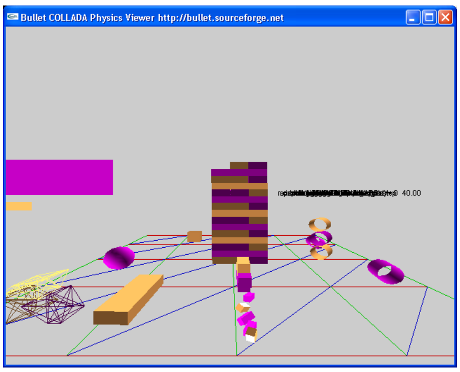
This is the main demo that shows how to setup a physics simulation, add some objects, and step the simulation. It shows stable stacking, and allows mouse picking and shooting boxes to collapse the wall. The shooting speed of the box can be changed, and for high velocities, the CCD feature can be enabled to avoid missing collisions. Try out advanced features using the #defines at the top of CcdPhysicsDemo.cpp



COLLADA Physics Viewer Demo

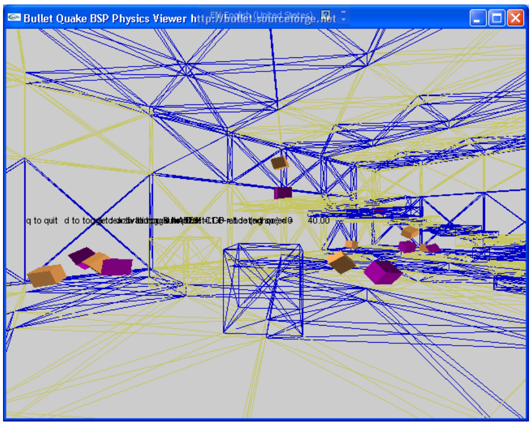
Imports and exports COLLADA Physics files. It uses the included libxml and COLLADA-DOM library.

The COLLADA-DOM imports a .dae xml file that is generated by tools and plugins for popular 3D modelers. ColladaMaya with Nima from FeelingSoftware, Blender, Ageia's free CreateDynamics tool and other software can export/import this standard physics file format. The ColladaConverter class can be used as example for other COLLADA physics integrations.



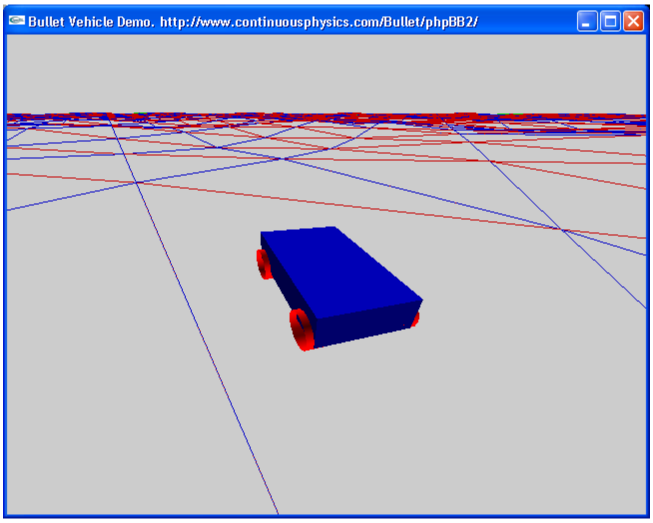
BSP Demo

Import a Quake .bsp files and convert the brushes into convex objects. This performs better then using triangles.



Vehicle Demo

This demo shows the use of the build-in vehicle. The wheels are approximated by ray casts. This approximation works very well for fast moving vehicles. For slow vehicles where the interaction between wheels and environment needs to be more precise the Forklift Demo is more recommended.



Fork Lift Demo

A demo that shows how to use constraints like hinge and generic D6 constraint to build a fork lift vehicle. Wheels are approximated by cylinders.

Low Level Technical Demos

Collision Interfacing Demo

This demo shows how to use Bullet collision detection without the dynamics. It uses the CollisionWorld class, and fills this will CollisionObjects. performDiscreteCollisionDetection method is called and the demo shows how to gather the contact points.

Collision Demo

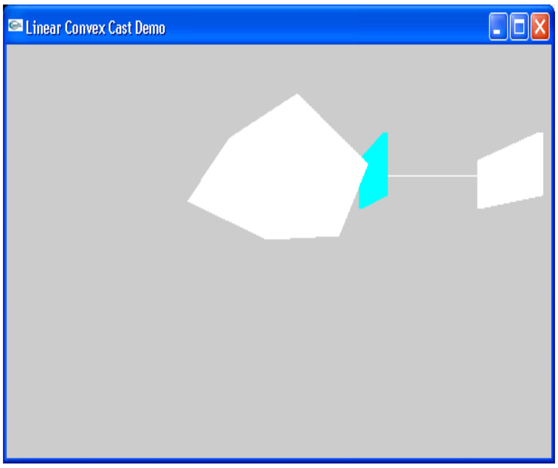
This demo is more low level then previous Collision Interfacing Demo. It directly uses the GJKPairDetector to query the closest points between two objects.

User Collision Algorithm

Shows how you can register your own collision detection algorithm that handles the collision detection for a certain pair of collision types. A simple sphere-sphere case overides the default GJK detection.

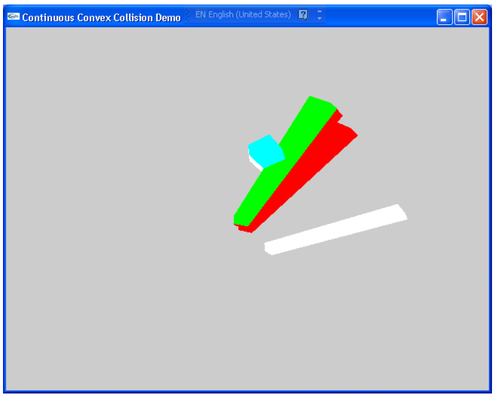
Gjk Convex Cast / Sweep Demo

This demo show how to performs a linear sweep between to collision objects and returns the time of impact. This can be useful to avoid penetrations in camera and character control.



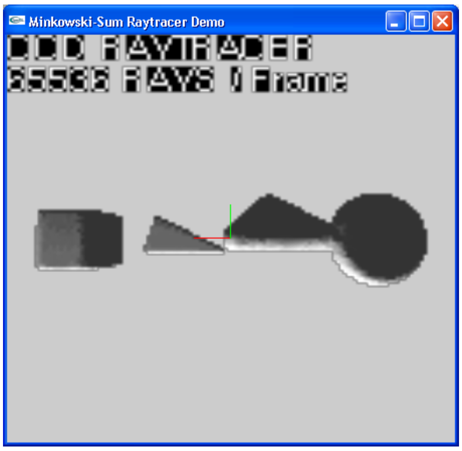
Continuous Convex Collision

Shows time of impact query using continuous collision detection, between two rotating and translating objects. It uses Bullet's implementation of Conservative Advancement.



Raytracer Demo

This shows the use of CCD ray casting on collision shapes. It implements a ray tracer that can accurately visualize the implicit representation of collision shapes. This includes the collision margin, convex hulls of implicit objects, minkowski sums and other shapes that are hard to visualize otherwise.



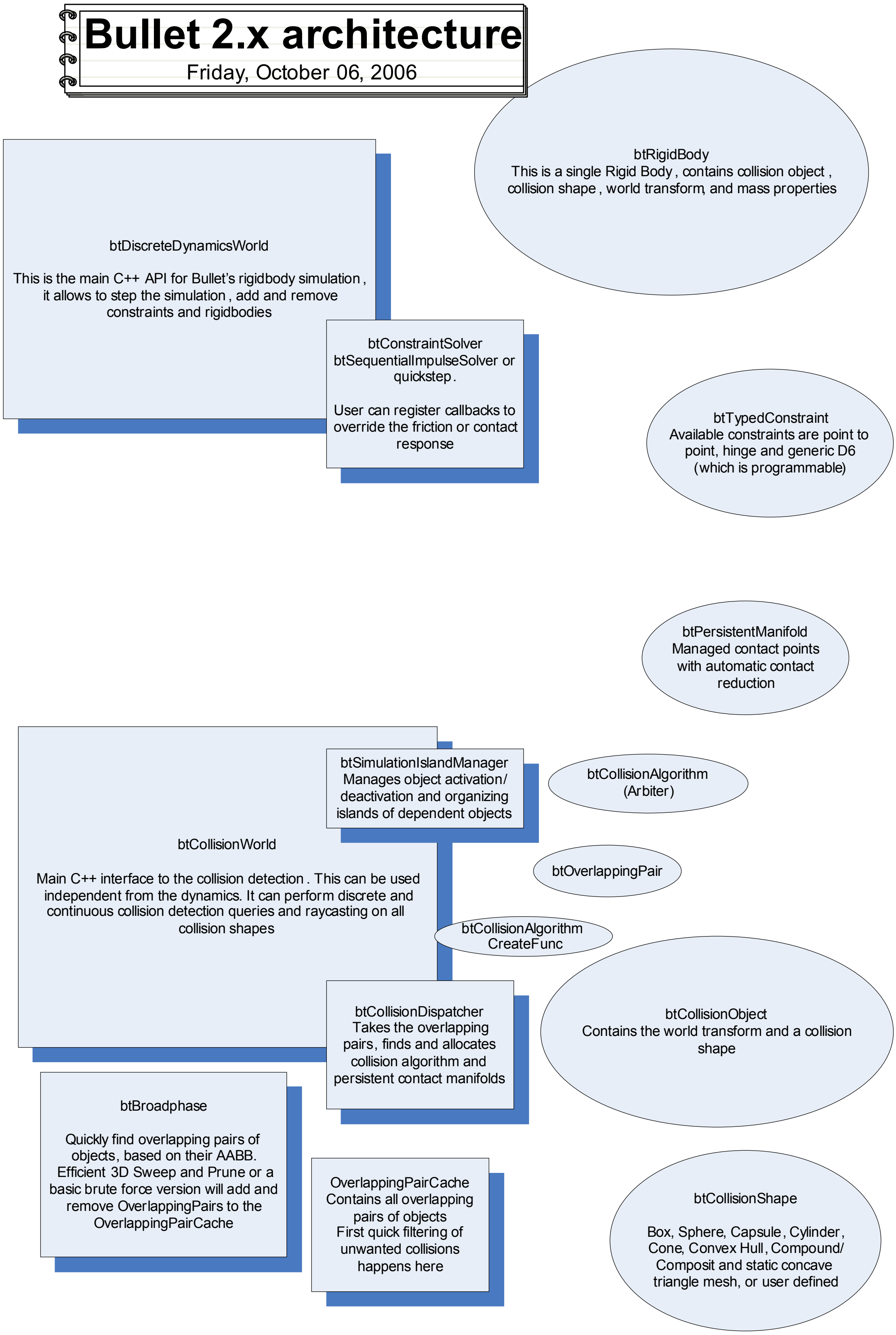
Concave Demo

This advanced demo shows how to implement user defined per-triangle restitution and friction in a static triangle mesh. A callback can be registered and triangle identifiers can be used to modify the friction in each reported contact point.

Simplex Demo

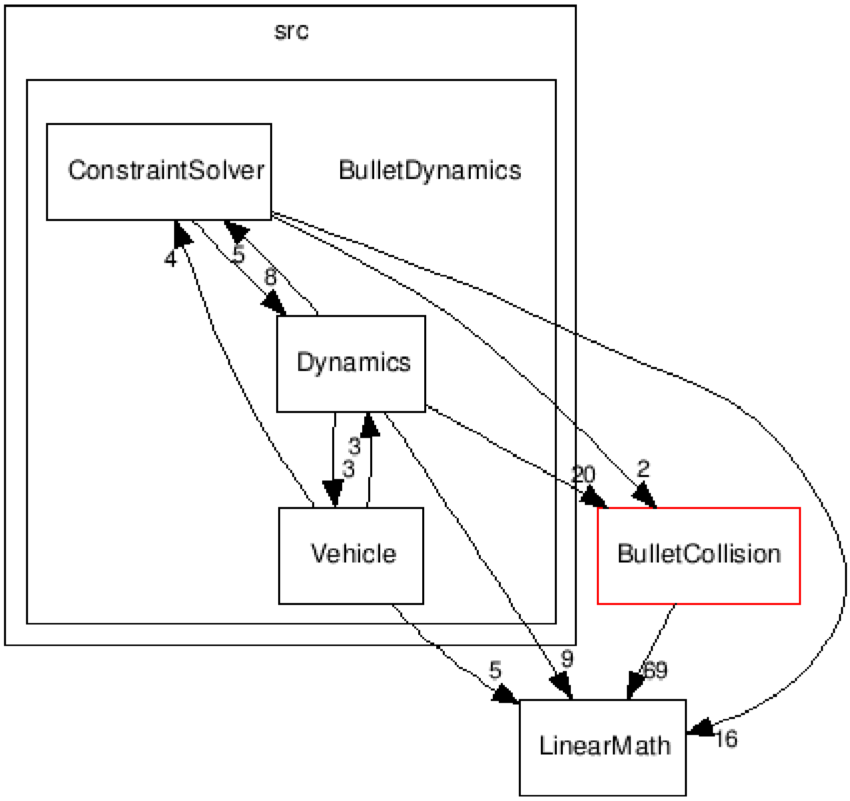
This is a very low level demo testing the inner workings of the GJK sub distance algorithm. This calculates the distance between a simplex and the origin, which is drawn with a red line. A simplex contains 1 up to 4 points, the demo shows the 4 point case, a tegrahedron. The Voronoi simplex solver is used, as described by Christer Ericson in his collision detection book.

Bullet Collision Detection and Physics Architecture



Bullet Library Module Overview

Bullet provides Collision Detection and Rigid Body dynamics. The C++ software is divided into several sub modules with clean dependencies. The division of those modules is reflected in Bullet's directory structure, and further subdirectories are provided per module. This means that the Collision Detection module can be used without using the BulletDynamics module.

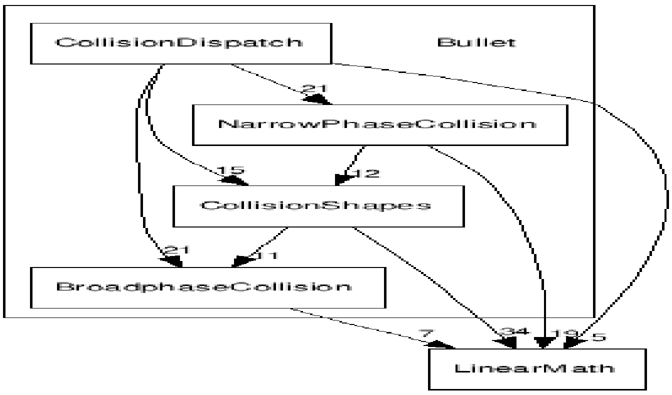


Bullet Collision Detection Library

The main queries provided by the Collision Detection:

- ✓ Closest Distance and closest points
- ✓ Penetration depth calculation
- ✓ Ray cast
- ✓ Sweep API for casting shapes to find Time of Impact (TOI) along a linear path
- ✓ Time of Impact for Continuous Collision Detection including rotations

Supported Collision Shapes include Box, Sphere, Cylinder, Capsule, Minkowski Sum, Convex Hull, (Concave) Triangle Mesh and Compound Shapes and more.



Additional functionality are related to performance and to provide more detail and information useful for the usage in rigid body dynamics and for AI queries in games. The collision pipeline includes 3 stages: Broadphase, Midphase and Narrowphase.

- ✓ Broadphase

Broadphase provides all overlapping pairs based on axis aligned bounding box (AABB). It includes an efficient culling of all potential pairs using the incremental sweep and prune algorithm.

- ✓ Midphase

The midphase performs additional culling for complex collision shapes like compound shapes and static concave triangle meshes. Bullet uses an optimized Bounding Volume Hierarchy, based on a AABB tree and stackless tree traversal. This traversal provides primitives that need to be tested by the Narrowphase.

- ✓ Narrowphase

The Narrowphase perform the actual distance, penetration or time of impact query. Contact points are collected and maintained over several frames in a persistent way. This means that additional information useful for rigid body simulation can be stored in each contact point. Also this means that algorithms that only provide one contact point at a time can still be used, by gathering additional contact points and performing contact point reduction.

Advanced Topics

Per triangle friction and restitution value

By default, there is only one friction value for one rigidbody. You can achieve per shape or per triangle friction for more detail. See the Demos/ConcaveDemo how to set the friction per triangle. Basically, add CF_CUSTOM_MATERIAL_CALLBACK to the collision flags or the rigidbody, and register a global material callback function. To identify the triangle in the mesh, both triangleID and partId of the mesh is passed to the material callback. This matches the triangleId/partId of the striding mesh interface.

Custom Constraint Solver

Bullet uses its btSequentialImpulseConstraintSolver by default. You can use a different constraint solver, by passing it into the constructor of your btDynamicsWorld. For comparison you can use the Extras/quickstep solver from ODE.

Registration of Custom Collision Algorithms

User can override default collision algorithms by registration of his own Collision Algorithm. See example how to do this in Demos/UserCollisionAlgorithm. This will replace the algorithm in the Collision Matrix.

Custom Friction Model

If you want to have a different friction model for certain types of objects, you can register a friction function in the constraint solver for certain body types.

See #define `USER_DEFINED_FRICTION_MODEL` in Demos/CcdPhysicsDemo.cpp.

Collision Filtering

To disable collision detection between certain shapes, collision filter flags are used. Internally, when a rigidbody is added to the btDynamicsWorld, it gets filter flags assigned to an internal broadphase proxy. This prevents collisions between static objects at a very early stage.

```
	if (body->getCollisionShape())
	{
		bool isDynamic = !(body->isStaticObject() || body-
>isKinematicObject());
		short collisionFilterGroup = isDynamic?
btBroadphaseProxy::DefaultFilter : btBroadphaseProxy::StaticFilter;
		short collisionFilterMask = isDynamic?
	btBroadphaseProxy::AllFilter :
	btBroadphaseProxy::AllFilter ^ btBroadphaseProxy::StaticFilter;


	addCollisionObject(body,collisionFilterGroup,collisionFilterMas
k);
	}
```

The broadphase checks those filter flags to determine wether collision detection needs to be performed using the following code:

```
	inline bool needsBroadphaseCollision(btBroadphaseProxy*
proxy0,btBroadphaseProxy* proxy1) const
	{
		bool collides = (proxy0->m_collisionFilterGroup & proxy1-
>m_collisionFilterMask) != 0;
		collides = collides && (proxy1->m_collisionFilterGroup &
proxy0->m_collisionFilterMask);

		return collides;
	}
```

You can override this default filtering behaviour after the rigidbody has been added to the dynamics world by assigning new values to `collisionFilterGroup` and `collisionFilterMask`.

Contributions / people

Thanks everyone on the Bullet forum for feedback.

Following people contributed source code to Bullet:
(random order, please let me on the forum if your name should be in this list)

Gino van den Bergen: LinearMath classes
Christer Ericson: voronoi simplex solver
Simon Hobbs: 3d axis sweep and prune: and Extras/SATCollision
Dirk Gregorius : generic D6 constraint
Erin Catto: accumulated impulse in sequential impulse
Nathanael Presson : EPA penetration depth calculation
Francisco Leon : GIMPACT Concave Concave collision
Erwin Coumans: most other source code

Contact

Use the Bullet forum at http://bulletphysics.com
Use either public message or private message (PM)

Or email to bullet <at> erwincoumans.com

Further documentation and references

Bullet Physics website provides most information:
Visit http://bulletphysics.com which points to http://www.continuousphysics.com

On this website there is online doxygen documentation, a wiki with frequently asked questions and tips, and most important a discussion forum.

A paper describing the Bullet's Continuous Collision Detection method is available online at http://continuousphysics.com/BulletContinuousCollisionDetection.pdf

For physics tools and COLLADA physics visit http://www.khronos.org/collada
You can find the latest plugin versions and other information at the COLLADA forum at https://collada.org/public_forum/

Links

COLLADA-DOM included in Bullet: http://colladamaya.sourceforge.net

ColladaMaya plugin http://www.feelingsoftware.com

Blender 3D modeler includes Bullet and COLLADA physics: http://www.blender.org

Ageia CreateDynamics tool http://www.amillionpixels.us/CreateDynamics.zip

This great tool can perform automatic convex decomposition and create ragdolls from graphics skeletons. It is also available from Ageia support forums at http://devsupport.ageia.com

Books

Realtime Collision Detection, Christer Ericson
http://www.realtimecollisiondetection.net/
Bullet uses the discussed voronoi simplex solver for GJK

Collision Detection in Interactive 3D Environments, Gino van den Bergen
http://www.dtecta.com also website for Solid collision detection library
Discusses GJK and other algorithms, very useful to understand Bullet

Physics Based Animation, Kenny Erleben
http://www.diku.dk/~kenny/
Very useful to understand Bullet Dynamics and constraints