PHYSICS

Introduction:-

Blender's physics system allows you to simulate a number of different real-world physical phenomena. You can use these systems to create a variety of static and dynamic effects such as:

- Hair, grass, and flocks
- Rain
- Smoke and dust
- Water
- Cloth
- Jello
- etc.

Sets up a basic simulation scene or effect including the selected objects. The tool will add essential objects like domains or particle systems both with predefined settings, so that there will be instant viewable result.

1. Rigid Body:-

Introduction:-

The rigid body simulation can be used to simulate the motion of solid objects. It affects the position and orientation of objects and does not deform them.

Unlike the other simulations in Blender, the rigid body simulation works closer with the animation system. This means that rigid bodies can be

used like regular objects and be part of parent-child relationships, animation constraints and drivers.

Creating a Rigid Body

Right now only mesh objects can participate in the rigid body simulation. To create rigid bodies, either click on Rigid Body button in the Physics tab of the Properties editor or use the Add Active/Add Passive buttons in the Physics tab of the Toolbar.

There are two types of rigid body: active and passive. Active bodies are dynamically simulated, while passive bodies remain static. Both types can be driven by the animation system when using the Animated option.

During the simulation, the rigid body system will override the position and orientation of dynamic rigid body objects. Note however, that the location and rotation of the objects are not changed, so the rigid body simulation acts similar to a constraint. To apply the rigid body transformations you can use the Apply Object Transform operator.

The scale of the rigid body object also influences the simulation, but is always controlled by the animation system.

2. Cloth Simulations

Introduction

Cloth simulation is one of the hardest aspects of computer graphics, it is a deceptively simple real-world item that is taken for granted, but it actually has very complex internal and environmental interactions. Cloth is commonly modeled as 2D mesh to simulate real world objects such as fabrics, flags, banners. And yet cloth can also be used to model 3D objects such as teddy bears, pillows, balloons, or balls.

Cloth interacts with and is affected by other moving objects, the wind and other forces, as well as a general aerodynamic model, all of which is under your control.

Once Cloth physics have been added to a mesh, a Cloth modifier will be added to the object's modifier stack. As a modifier then, it can interact with other modifiers, such as Armature and Smooth. In these cases, the ultimate shape of the mesh is computed in accordance with the order of the modifier stack. For example, you should smooth the cloth after the modifier computes the shape of the cloth.

You can Apply the Cloth Modifier to freeze, or lock in, the shape of the mesh at that frame, which removes the modifier. For example, you can

drape a flat cloth over a table, let the simulation run, and then apply the modifier. In this sense, you are using the simulator to save yourself a lot of modeling time.

Results of the simulation are saved in a cache, so that the shape of the mesh, once calculated for a frame in an animation, does not have to be recomputed again. If changes to the simulation are made, you have full control over clearing the cache and re-running the simulation. Running the simulation for the first time is fully automatic and no baking or separate step interrupts the workflow.

Computation of the shape of the cloth at every frame is automatic and done in the background; thus you can continue working while the simulation is computed. However, it is CPU-intensive and depending on the power of your PC and the complexity of the simulation, the amount of CPU needed to compute the mesh varies, as does the lag you might notice.

Workflow

A general process for working with cloth is to:

- Model the cloth object as a general starting shape.
- Designate the object as a "cloth" in the Physics tab of the Properties editor.
- Model other deflection objects that will interact with the cloth. Ensure the Deflection modifier is last on the modifier stack, after any other mesh deforming modifiers.
- Light the cloth and assign materials and textures, UV unwrapping if desired.
- If desired, give the object particles, such as steam coming off the surface.
- Run the simulation and adjust settings to obtain satisfactory results. The Timeline editors playback controls are great for this step.

Physical Properties:-

- Mass
  The mass of the cloth material.
- Air Viscosity
  Air has some thickness which slows falling things down.

  Bending Model
- Linear
  Cloth model with linear bending springs (old).
- Angular
  Cloth model with angular bending springs.

Stiffness

- Tension
  How much the material resists stretching.
- Compression
  How much the material resists compression.
- Structural
  Overall stiffness of the cloth (only in linear bending model).
- Shear
  How much the material resists shearing.
- Bending
  Wrinkle coefficient. Higher creates more large folds.

Pressure

Cloth pressure allows the simulation of soft-shelled objects such as balloons or balls that are filled with some sort of fluid. This fluid can be seen either as a gas or a liquid however, both are generalized as “fluids”. Cloth pressure can be enabled by toggling the checkbox in the Pressure panel header.

- Pressure
  The uniform pressure that is constantly applied to the mesh. This value can be negative to simulate implosions or any other case where an object has outside pressure pushing inwards.

- Custom Volume
  Use the Target Volume parameter as the initial volume for the cloth. This avoids having to use the Pressure to first inflate the object.

- Target Volume
  The mesh volume where the inner/outer pressure will be the same. If set to zero the volume will not contribute to the total pressure.

- Factor
  Scalar control over the overall pressure.

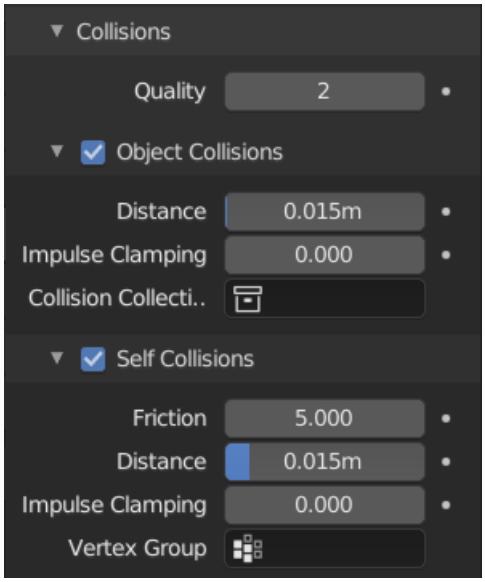
- Vertex Group
  Cloth pressure can be controlled via a Vertex Group to specify which the portions of the mesh to apply pressure. Zero weight means no pressure while a weight of one means full pressure.

Collisions:-

In most cases, a piece of cloth does not just hang there in 3D space, it collides with other objects in the environment. To ensure proper simulation, there are several items that have to be set up and working together:

- The Cloth object must be told to participate in collisions.
- Optionally (but recommended) tell the cloth to collide with itself.
- Other objects must be visible to the Cloth object via shared layers.
- The other objects must be mesh objects.

- The other objects may move or be themselves deformed by other objects (like an armature or shape key).
- The other mesh objects must be told to deflect the cloth object.
- The blend-file must be saved in a directory so that simulation results can be saved.
- You then Bake the simulation. The simulator computes the shape of the cloth for a frame range.
- You can then edit the simulation results, or make adjustments to the cloth mesh, at specific frames.
- You can make adjustments to the environment or deforming objects, and then re-run the cloth simulation from the current frame forward.



Now you must tell the Cloth object that you want it to participate in collisions. For the cloth object, locate the Cloth Collision panel.

Quality

A general setting for how fine and good a simulation you wish. Higher numbers take more time but ensure less tears and penetrations through the cloth.

Object Collisions:-

If the cloth object needs to be deflected by some other object. To deflect a cloth, the object must be enabled as an object that collides with the cloth object. To enable objects to collide with cloth objects enable collision physics for the collider object (not on the cloth object).

Distance:- The distance another object must get to the cloth for the simulation to repel the cloth out of the way. Smaller values might give errors but gives some speed-up while larger will give unrealistic results if too large and can be slow. It is best to find a good in between value.

Impulse Clamping:- Prevents explosions in tight and complicated collision situations by restricting the amount of movement after a collision.

Collision Collection:- Only objects that are a part of this Collection can collide with the cloth. Note that these objects must also have Collision physics enabled.

Self-Collisions:-

Real cloth cannot penetrate itself, so you normally want the cloth to self-collide. Enable this to tell the cloth object that it should not penetrate itself. This adds to the simulation's compute time, but provides more realistic results.

Friction:- A coefficient for how slippery the cloth is when it collides with itself. For example, silk has a lower coefficient of friction than cotton.

Distance:- As cloth at this distance begins to repel away from itself. Smaller values might give errors but gives some speed-up while larger

will give unrealistic results if too large and can be slow. It is best to find a good in between value.

Impulse Clamping:- Prevents explosions in tight and complicated collision situations by restricting the amount of movement after a collision.

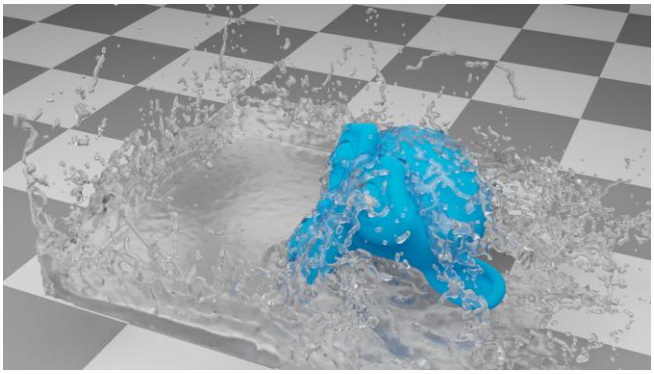
Vertex Group:- Only vertices that are a part of this Vertex Group can collide with each other.

3. Fluid

Introduction

Liquid Simulations:-

Fluid physics are used to simulate physical properties of liquids especially water. While creating a scene in Blender, certain objects can be marked to become a part of the fluid simulation. For a fluid simulation you have to have a domain to define the space that the simulation takes up. In the domain settings you will be able to define the global simulation parameters (such as viscosity and gravity).



Gas Simulations

Gas or smoke simulations are a subset of the fluids system, and can be used for simulating collections of airborne solids, liquid particulates and gases, such as those that make up smoke. It simulates the fluid movement of air and generates animated voxel textures representing the density, heat, and velocity of other fluids or suspended particles (e.g. smoke) which can be used for rendering.

Workflow

1) At least a Domain object and one Flow object are required to create a fluid simulation.
2) Create a Domain object that defines the bounds of the simulation volume.
3) Set up Flow objects which will emit fluid.
4) Set up Effector objects to make the fluid interact with objects in the scene.
5) Assign a material to the domain object.
6) Save the blend-file.
7) Bake the Cache for the simulation.

4. Forces

Gravity

Gravity is a global setting that is applied to all physics systems in a scene. It can be found in the scene tab. This value is generally fine left at its default, -9.810 on the Z axis, which is the force of gravity in the real world. Changing this value would simulate a lower or higher force of gravity. Gravity denoted g, measurement $m \times s\text{-}2$.

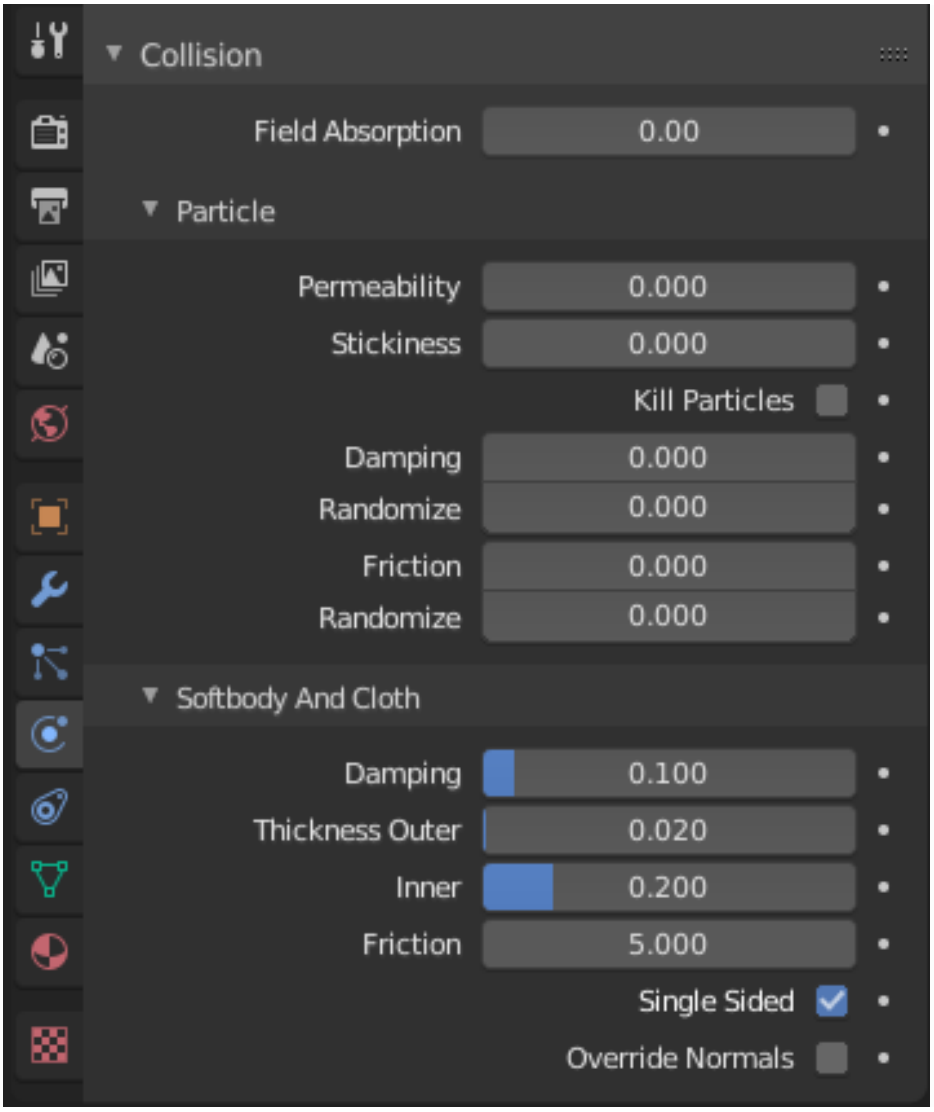
Gravity is applied in the same way to all physics systems.

5. Collisions

Particles, Soft Bodies and Cloth objects may collide with mesh objects. Boids try to avoid *Collision* objects.

- You may limit the effect on particles to a group of objects (in the Field Weights panel).
- *Deflection* for soft body objects is difficult, they often penetrate the colliding objects.
- Hair particles ignore deflecting objects (but you can animate them as soft bodies which take deflection into account).

If you change the deflection settings for an object you have to recalculate the particle, soft body or cloth system by *Delete Bake*, this is not done automatically.



Force Field

Field Absorption:- A deflector can also deflect effectors. You can specify some collision/deflector objects which deflect a specific portion of the effector force using the Field Absorption value. 100% absorption results in no force getting through the collision/deflector object at all.

Particle

Permeability:- Fraction of particles passing through the mesh.

Stickiness:- How much particles stick to the object.

Kill Particles:- Deletes Particles upon impact.

Damping:- Damping during a collision (independent of the velocity of the particles).

Randomize:- Random variation of damping.

Friction:- Friction during movements along the surface.

Randomize:- Random variation of friction.

Soft Body and Cloth:-

It is also important to note that this collision panel is used to tell all simulations that this object is to participate in colliding/deflecting other objects on a shared layer (particles, soft bodies, and cloth).

Damping:- Damping during a collision. The amount of bounce that the surfaces will have.

- No damping, soft bodies will have a maximum bounciness.
- Maximum damping, soft bodies will not bounce at all.

Thickness:-A padding distance is added to the inside and outside of each face, to help to prevent intersections. The soft body will come to rest at this distance away from the face of the colliding object. Outside and inside is defined by the face normal, depicted as blue arrow in Fig. A soft body vertex colliding with a plane..

Outer:- Size of the outer collision zone.

Inner:- Size of the inner collision zone (padding distance).

Friction:-A coefficient for how slippery the cloth is when it collides with itself. For example, silk has a lower coefficient of friction than cotton.

Single Sided:- When enabled, cloth collisions are only performed on the normal side of the collider plane.

Override Normals:- When enabled, cloth collision impulses act in the direction of the collider normals.