

## Collisions – Supporting Notes for slides

Lecture Date: 4/25/2006

### Introduction

There are two types of collision

- Rigid
- Elastic
  - Liquid – droplets, liquid to surface
  - Air
  - Cloths – avoid self intersection

Collisions are used to make realistic behavior, and to change object behavior.

### Rigid Collisions

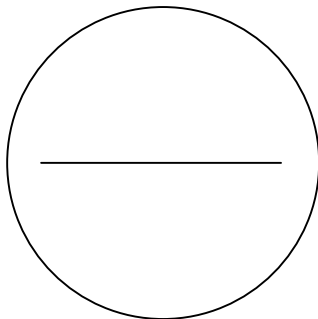
Rigid collisions involve objects such as:

- Planes
- Points
- Triangles
- Spheres

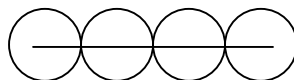
**Spheres** are often used as **bounding object** for collision detection. They have the advantage of:

- Being easy to test for collision
- Require no orientation tracking

If a bounded object is has an unusual shape such as being unusually long, a sphere would not be a suitable bounding object:



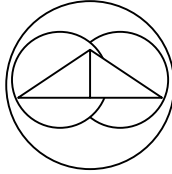
Wasted Space



Better Sphere Arrangement

**One technique for packing spheres:**

1. Create 1 sphere per triangle in a mesh.
2. Cluster spheres into larger spheres.

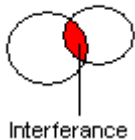


Smaller Spheres clusters into larger spheres

Packing techniques require **measures**. One measure would be to the ratio between the bounding spheres, and the object being bounded. One way to measure irregular volumes is to use the Monte Carlo method.

Reference: Paper by Hubbard on packing spheres.

**Interference** is defined as the areas involved in a collision after the collision.



**One interference problem** is to calculate the vector required to move two objects apart. Remember, there is no trajectory to use to help provide this vector.

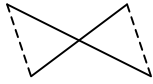
The solution involves calculating the normal to the closed loop created by the interference area.

**Reference to slide 5:** Detection can miss collisions. See figure in slide.

**Reference Frame:** With rigid collisions one object can be considered static, and the other moving.

One technique for sphere detection is to expand one sphere by the radius of the second sphere, and reduce the second sphere to a point. Then the problem becomes a sphere point intersection problem

**Testing Edge to Edge collisions** . When the tetrahedron constructed from the two edges has volume of 0, the edges have collided:



**Testing Vertex Face Collision:** This involves solving the equation  $PV(t).N = 0$ . See **slide 8** for details.

### **Screw Motion**

- The screw motion is instantaneous representation of motion.
- Rotation, and Translation are special cases of the screw motion.
- The Screw motion is the primitive on which all other motions are built.

See **slide 12** for equation on screw motion.

### **Elastic Collisions**

#### **Cloth**

There are some similarities to rigid collisions. The difference here is the reference frame has both objects moving.

One technique for cloth: If all faces in a t-mesh representing cloth are front facing there can be no self-intersection in the cloth.