Force

CS-116B: Computer Graphics Algorithms
Spring 2018

Types of forces

- Gravitational force
- Static and dynamic friction forces
- Fluid dynamics drag force
- Buoyancy force
- Spring and damper forces

Source: *Physics for Game Developers*, pp. 71-80

Gravitational force

Newton's law of gravitation:

$F_a = G \times m_1 \times m_2 / r^2$

G is the gravitational constant = 6.673×10^{-11} $N\text{-}m^2/kg^2$
F_a is gravitational force of attraction between the two bodies.
m_1 and **m_2** are the masses of the two bodies.
r is the distance between the center of mass of m_1 and m_2.

Source: *Physics for Game Developers*, p. 72

Static force

Static force:

$F_s = \mu_s \times N$

F_s is the static force exerted on a body
μ_s is the coefficient of static friction (a constant)
N is the normal force between a body and surface.

Source: *Physics for Game Developers*, p. 74

Dynamic force

Dynamic force:

$F_d = \mu_d \times N$

F_d is the dynamic force exerted on a body.
μ_d is the coefficient of dynamic friction (a constant)
N is the normal force between a body and surface.

Source: *Physics for Game Developers*, p. 74

Buoyancy force

“Buoyancy is a force that develops when an object is immersed in a fluid. It’s a function of the volume of the object and density of the fluid and results from the pressure differential between the fluid above the object and the fluid just below the object.”

For spheres, cubes, and cylinders calculating volume is easy. For other shapes, you may need to use techniques such as numerical integration.

Source: *Physics for Game Developers*, pp. 77-78

Spring forces

$F_s = K_s \times (L - r)$

F_s is the spring force.
K_s is a spring constant.
L is the length of a spring in tension or compression.
r is the length of the spring at rest (not in tension or compression).

Source: *Physics for Game Developers*, p. 79

Damper forces

Dampers act as a drag force.

$F_d = K_d \times (v_1 - v_2)$

F_d is the damping force.
K_d is a damping constant.
v_1 and **v_2** are the respective velocities of two connected objects.

In our simulations you should use dampers in your simulations to absorb energy. The drag induced by the damps will reduce oscillation effects in cloth and rope simulations.

Source: *Physics for Game Developers*, p. 79