GRADUATE SCHOOL OF SCIENCES AND ENGINEERING

MECH 534/ 434: Computer- Based Modeling and Simulation

Instructor: Prof. Dr. Çağatay Başdoğan
TA: Pouya Pourakbarian Niaz

Student: Gamze Keçibaş

Term Project 1: Rigid Body Simulation of a 3D Object

30/05/2022

Spring 2022

Project Definition

A rigid body motion which covers translation and rotation of a 1 kg rectangular box under the effect of gravitational forces and user-specified forces. The box is constrained a cubic space which has 100 units edges. The simulation environment is presented in Figure 1.

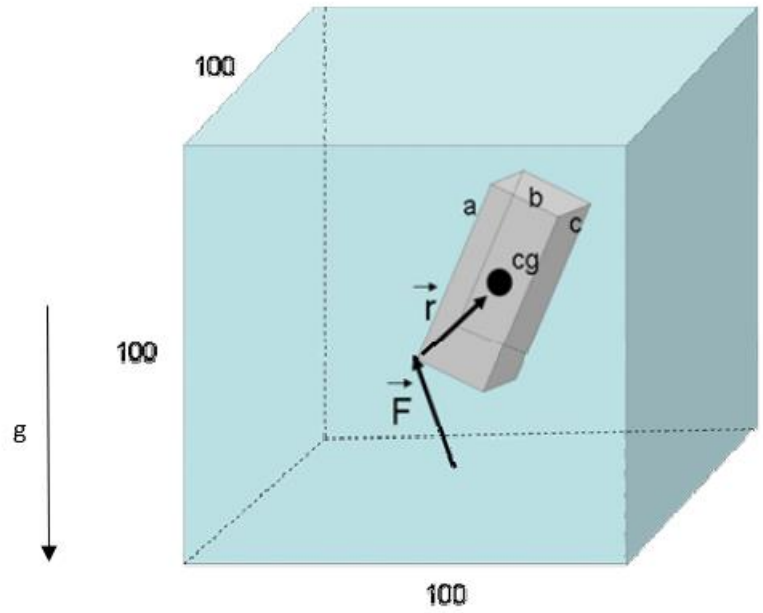

Figure 1: Simulation environment where g is gravitational acceleration, F is user-specified force

In the project, the simulation is built referring *Physically Based Modelling* notes by Andrew Witkin and David Baraff using Coin3D libraries of C++.

Deep Dive to Script

Firstly, required libraries are imported and given variables such as dimensions, mass, etc. are initialized. After that, derived variables are calculated using given variables and coefficients. For motion series, Euler method is implemented. Iterative variables which means update scene after each step are defined and they are calculated in for loops for each iteration. Transformation matrix is used to calculate position difference at three directions. A transformation matrix is used to calculate the coordinates of the rigid body's corners at each time step. In next step, to determine if the body collides with the room's walls, these coordinates are compared to the room's bounds at x-, y-, and z-directions. The component of the velocity vector parallel to the normal vector of the collision surface (of the wall) is negated when the body collides. A boolean flag is used to prevent multiple negations of the velocity vector (which is created by numerous corners impacting the surface at the same time). After the body's center of mass passes the room's center of mass, this flag is set to 1 (*True*). The flag is immediately set to 0 (*False*) after the velocity component is negated. The item loses 10% of its velocity after a collision.

Collision check can also be used to constrain the rigid body's position. If a corner turns out to be outside of the room after the position computation, we shift the rigid body slightly so that the corner is on the wall. When gravity is turned on without this functionality, the body exits the room. However, this strategy is faulty since it may remain locked on the surface.