Rigid Body Dynamics: A Graphical Simulation
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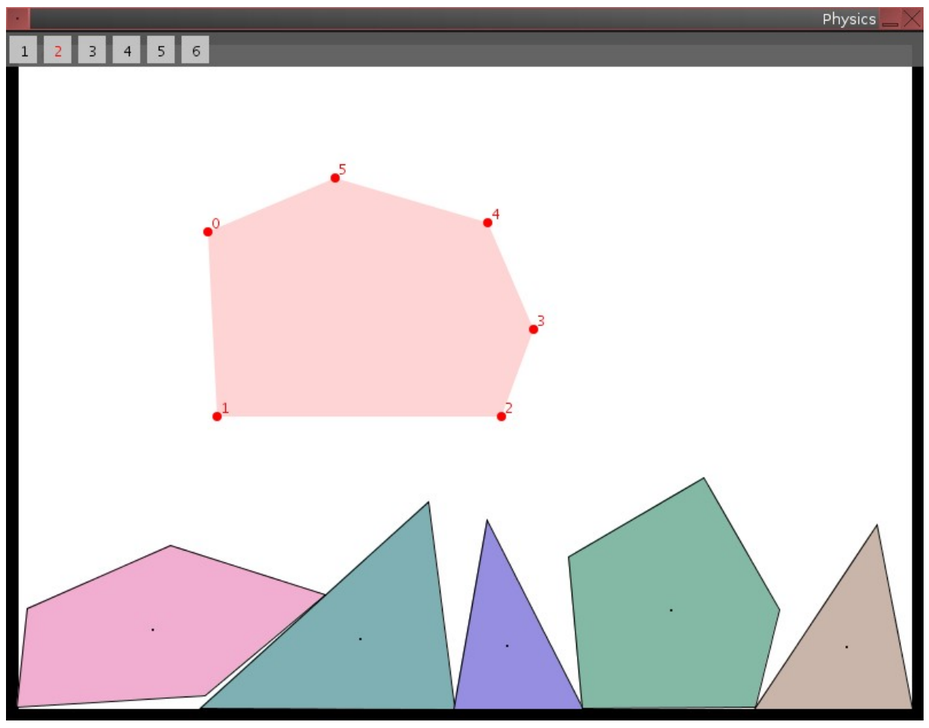

Abstract

Dynamics is defined as the study of the interaction between masses based on the laws of physics. The possible applications of a computer simulation in which dynamics are simulated are endless. A working dynamics simulation would be useful to engineers who are interested in designing a building, students trying to grasp the law of conservation of momentum, or even video game programmers who want their games to be as realistic as possible. The goal of this project is to design and program a fully functional, efficient, rigid-body dynamics simulation capable of supporting objects of variable shape and mass. Because of the consistencies between two-dimensional and three-dimensional dynamics, this project will focus on only the two-dimensional plane for the sake of simplicity.

Procedure

This project will be divided into two areas, the code behind making the dynamics work, and the graphics and interface of the simulation itself. The greatest difficulty in programming this simulation will probably be handling collision response. When two bodies collide, the resulting impulse acts on both the linear and angular aspects of the bodies. The graphics and interface should be very simple and intuitive, allowing the user to create, delete, and move bodies throughout the world.

Collision Detection

Collision detection in this simulation is done through application of the separating axis theorem. This theorem postulates that, if there exists a plane between two objects, then the two objects must not be colliding. While at first this seems like a very simple observation, it becomes infinitely useful once one realizes that there exist a limited number of axis to test for separation between two objects. These axis of separation are generated by finding the perpendicular normal vectors of every edge of a polygon. Then, using basic vector maths, its possible to determine whether the two polygons intersect over the axis.

Collision Response

Using an impulse-based system, the dynamics simulation generates impulse for every collision that occurs. In a simulation of a large number of bodies, this means that there are a great number of impulses generated every frame of the simulation. One problem with this is that impulses can be conflicting in some cases, resulting in bodies in the simulation that are misrepresented. To fix this problem, I implemented a correcting method that essentially forcibly separates each body before applying impulses, based on the separating axis theorem once again.