Graphical Display of a Physics Simulation
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Abstract

A physics simulation, in order to adequately demonstrate physical laws and predict an unlimited number of scenarios, must implement a broad range of mathematical equations and provide the user with the ability to set up any desired scenario.

This simulation allows the user to place any combination of objects, projectiles, ramps, and springs, and displays them graphically and displays information about those objects on a graphical user interface. The user may input values for these objects, such as constants, coefficients, and variables, and run a simulation that will track these values and display the interactions and positions of the objects in two-dimensions.

Background

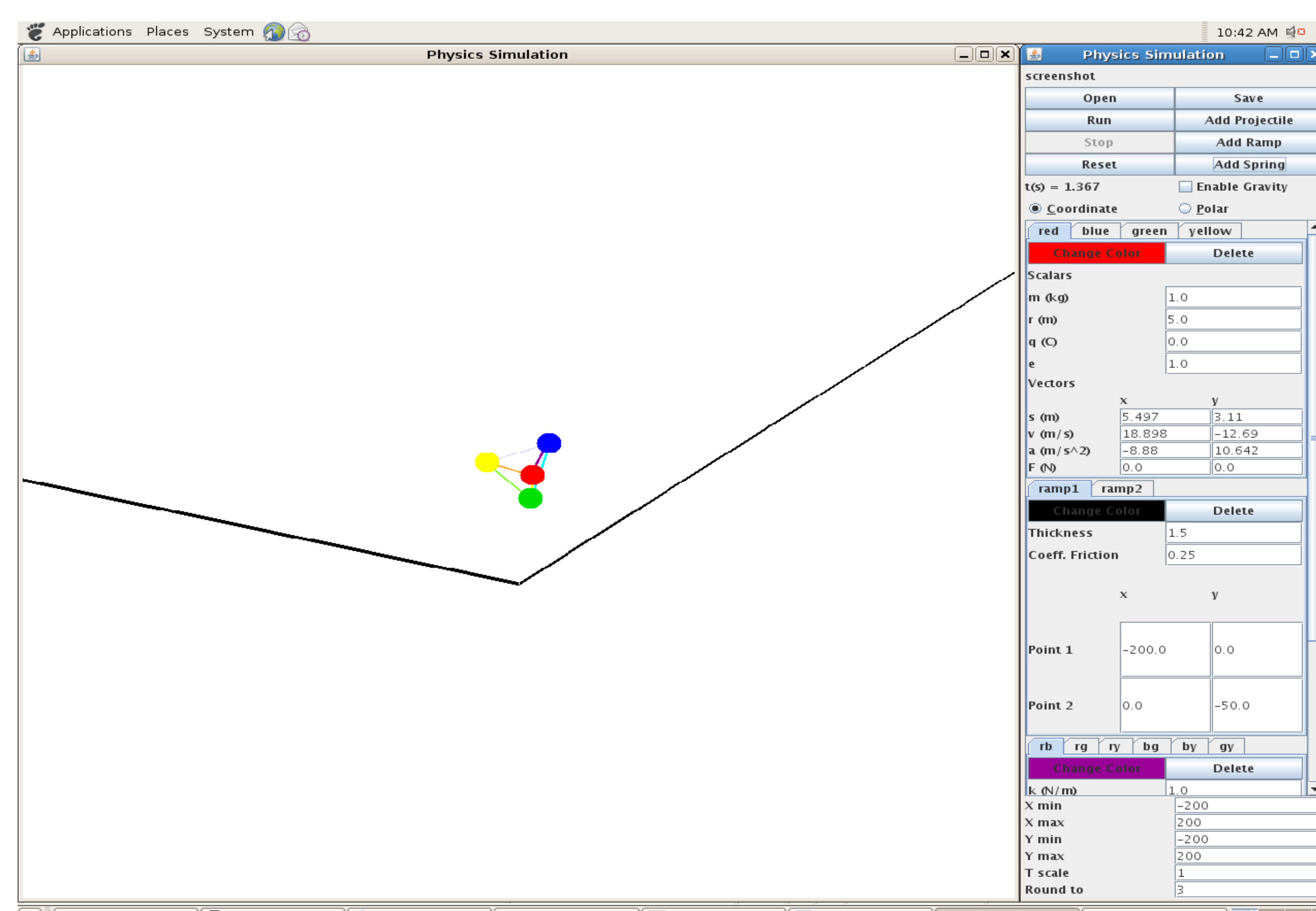
The concepts involved are kinematics, dynamics and Newton's laws, conservation of momentum and collisions, gravitational force, and electric charge and force. Relationships between related variables are given by equations.

The program may be used as an aid in a student's understanding of the physical world and how it behaves. The simulation can also be applied to making or confirming predictions on how certain situations will be resolved.

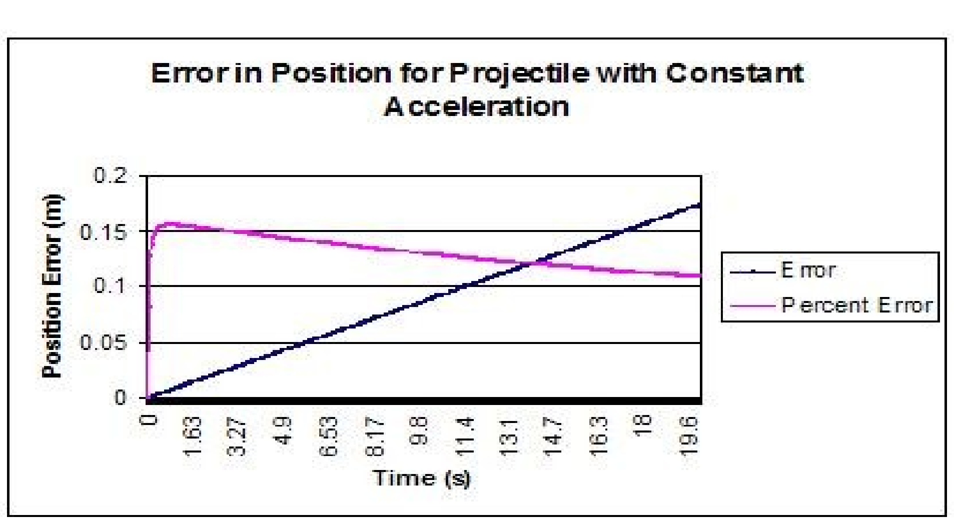
Procedure and Methodology

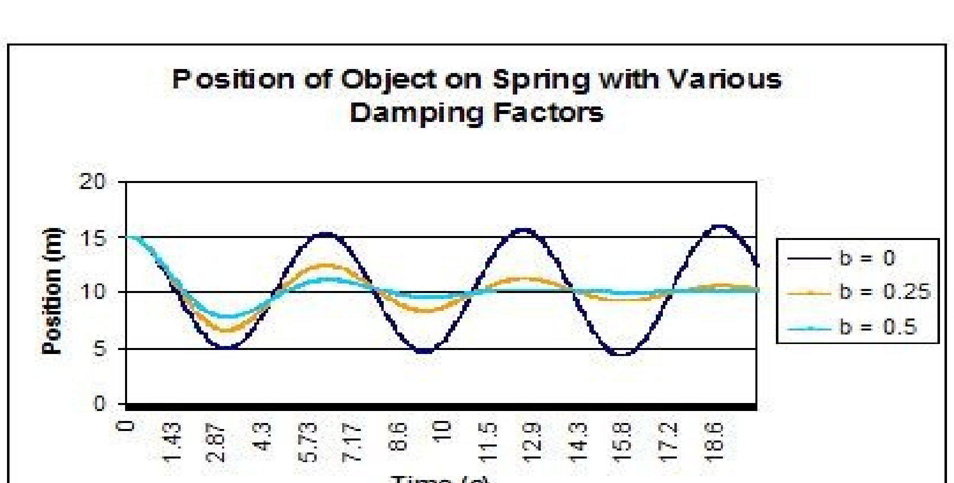
The project was divided into several sections. The implementation equations and principals of physics for kinematics, summation of forces, collision detection and response, and spring motion, was done in phases, as other sections of the project were completed.

Other sections were GUI structure and layout, graphical display, support of multiple objects and types of objects, scenario file storage, and an improved integration method. The method used is a modified Simpson's Rule, which uses a quadratic equation to approximate each three data points of an acceleration curve.



A screenshot of the simulation with a molecule, represented by four projectiles connected by springs, and two ramps below. Springs exert forces on attached projectiles, and projectiles can collide with each other and the ramps.





Results and Conclusions

The calculations for kinematics using a modified Simpson's Rule are accurate to within 0.16% with constant acceleration. With variable acceleration, such as with spring motion, however, error may propagate, resulting in an increase of amplitude over time.

Projectile-projectile and projectile-ramp collisions are detected and a velocity change occurs as a response, even accounting for the angles of non head-on collisions. Projectiles correctly apply gravitational and electrostatic forces to other projectiles, and ramps correctly apply frictional forces to sliding projectiles.