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Force and Motion Lab Report

# Introduction:

In many games we need to be able to simulate a realistic approach to stopping a character or object. Friction forces need to be simulated in these instances. In this lab we will simulate a box sliding and a rocket thrusting then free falling.

# Methods

For simulating friction with an initial force we don’t need to know the mass of the object only the friction between the surfaces and the initial speed. The acceleration is constant of the simulation described as:

Were is the coefficient of friction. Appling forward Euler with this will give you realistic results of friction being applied to an object moving.

For the second part of the lab we simulated a rocket under thrust for one second then simulate it under free fall. This simulation has so many uses in the future including rockets flying close to earth’s surface, or any projectile needing to be simulated.

To simulate the rocket, besides the mass and the wind coefficient everything else was defined as a vector. Following forward Euler we need to update the position vector with the velocity vector then update the velocity vector with the acceleration vector. The new parts of the simulation was applying wind to the rocket and calculating the net force that will become the acceleration.

I applied a wind vector by multiplying the velocity by the wind coefficient, making the net force just the thrust, weight, minus the wind vector. All these forces become the acceleration by dividing the net force by the mass. For the rocket thrust the first couple seconds of the simulation the thrust was applied to the rocket as a vector with a mag, head and pitch. After the thrust is no longer being applied the process is the same just without the thrust vector.

# Results:

Friction Simulation

For these results the initial Speed was set to 5 m/s and friction set to a coefficient of 0.1.

|  |  |
| --- | --- |
| Distance (m) | Acceleration (m/s^2) |
| 0.50 | 4.90 |
| 0.99 | 4.80 |
| 1.47 | 4.71 |
| … | … |
| 12.98 | 0.20 |
| 13.00 | 0.10 |
| 13.01 | 0.00 |

Rocket Simulation:

For these results thrust had a magnitude of 10 N, heading of 23 degrees, and a pitch of 62 degrees. Rocket was set to an initial position of (0, 0, 0.2), and the wind coefficient was set to 0.02.

|  |  |  |  |
| --- | --- | --- | --- |
| Under Thrust Samples | | | |
| Time (s) | X(m) | Y(m) | Z(m) |
| 0 | 0 | 0 | 0.2 |
| 0.1 | 0 | 0 | 0.2 |
| 0.2 | 0.58 | 0.25 | 1.29 |
| 0.3 | 1.73 | 0.73 | 3.45 |
| 0.4 | 3.43 | 1.46 | 6.63 |
| 0.5 | 5.67 | 2.41 | 10.83 |
| 0.6 | 8.43 | 3.58 | 16 |

|  |  |  |  |
| --- | --- | --- | --- |
| Under Free Fall Samples | | | |
| Time (s) | X(m) | Y(m) | Z(m) |
| 15.2 | 212.12 | 90.04 | 13.71 |
| 15.3 | 212.22 | 90.08 | 10.35 |
| 15.4 | 212.33 | 90.13 | 6.99 |
| 15.5 | 212.43 | 90.17 | 3.61 |
| 15.6 | 212.53 | 90.21 | 0.23 |
| 15.7 | 212.62 | 90.25 | -3.16 |

This chart shows what the rocket height looks like over time.

# Conclusion:

This lab shows the power of vectors and physics. All the forces applied are best described as vectors. This lab will lead the way for any simulated position close to earth using forward eular.

# Post Lab:

1. The problem of identifying a zero velocity in the program for Procedure one is important. Handling the problem correctly gives you a realistic behavior for the box. Describe how the model would proceed if a check for zero velocity is not done. Be careful here, the answer is not obvious.

It will start sliding backwards. Also the acceleration is constant we need to stop applying the acceleration when velocity is zero.

1. Surface friction and wind resistance are both forces that oppose motion and are in the −*v*^ direction. Explain how these two forces are different from each other.

Friction is pretty constant while wind resistance is proportional to the velocity.

1. In the model rocket program, no mention was made of the wind speed. Explain how one would incorporate the wind speed into the overall solution for the motion of the rocket. Keep in mind that the wind speed will have a velocity vector independent of the velocity vector of the rocket.

Create a wind vector and add it to the net force.