Marble Roller Coaster

“Thrill Ride”

New Mexico
Supercomputing Challenge
Final Report

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Executive Summary:

The goal of this project is to design a virtual marble roller coaster using the maximum design elements that combines speed with safety.

A real model roller coaster was built to help create, design, and test different factors that would act as aid to help make the computer program for the virtual marble roller coaster. There were three different sets of hills at different heights tested that were recreated in the design of the computer program. A marble that measured one centimeter in diameter was used to determine the velocity or acceleration of the each hill.

The results from the model roller coaster showed that the starting hill which was the highest starting point had an average speed of 0.0848. The second hill had an average speed of 0.1025 and the lowest hill had an average speed of 0.1411. When the marble goes downhill the highest hill it will gain speed. As it goes through the next uphill section it will slow down. The marble should be at its maximum speed at the end of the last hill.

Some experimental errors that might have affected the results is staring the marble at a slightly different sport or not using the same force releasing the marble each time. The shape of the roller coaster could have had slight changes due to moving or touching the model.

Recommendations for designing this model roller coaster would be to stabilize the track so that it does not move when the marble rolls down it. The energy to move the track comes from the marble. The energy that the marble loses to make the track move means less energy is available to make the marble move itself along the track. Also try making different lengths of roller coaster tracks and different weights of marbles.

Introduction:

The goal of this project is to design a virtual marble roller coaster using the maximum design elements that combines speed with safety.

Roller coasters must balance between thrills and safety. When designing the ride it should be made as safe as possible. Although the main reason that people ride roller coasters is for the death-defying thrill. The key to having a successful coaster is to give the rider the trill of speed and acceleration that is safe. This all can be achieved by speed control.

A roller coaster works because of gravity and the law of conservation of energy. It is called a coaster because once it starts it coasts through the entire track. No outside forces are required to make it work. Calculations will be determined by using velocity measurements.

Description:

A real model roller coaster was built to help create, design, and test different factors that would act as aid to help make the computer program for the virtual marble roller coaster. There were three different sets of hills at different heights tested that were recreated in the design of the computer program. A marble that measured one centimeter in diameter was used to determine the velocity or acceleration of the each hill. All the results of data can be seen on the appendix pages.

Speed, velocity, and acceleration are all important factors when building a roller coaster. Speed is distance divided by time or the rate at which the marble moves. The rate of change in velocity the speed of the marble in a certain direction is known as acceleration due to rapid changes in speed and direction of the roller coaster. If the marble is moving it will keep moving along the same direction of motion unless something causes it to speed up or slow down. On a downhill slope or curve the marble will accelerate or increase in speed, when moving uphill or a straight line it will decelerate or decrease in speed. The acceleration of the marble depends on its mass and how strong the force that is pushing or pulling it which is caused by gravity.

The two major types of energy that are major factor in designing this roller coaster is kinetic and potential energy. When the marble is in motion it is using kinetic energy the amount of energy depends upon the mass and speed of the marble. The kinetic energy of the marble is at its greatest when it is moving really fast and reaches a minimum height. Potential energy is the greatest at the start of the roller coaster. At the top of hill, the potential energy is at its maximum. When the marble starts down the other side, this potential energy is converted to kinetic energy.

When designing the different hills it was discovered that the height of hill number one had enough potential energy for the marble to make it over the hill. The steeper the slope the more the marble will have to accelerate in order to make it over the second hill. The force of gravity depends on the speed of the marble for it to make it over the hill or able to stay on the track.

Velocity calculations (distance traveled divided by time) were used to determine how fast the model roller coaster was. The measurements used for determining the height of the hills and length of the track was measured in centimeters and the time the marble took to roll down the hill was seconds.

Computer Program:

StarLogo was used to create this program by using terrain editor to make dips and color the terrain. Color was used on the terrain to make the marble turn. Black made the terrain separate from the roller coaster. The marble was created by using the turtle creator and an equation was used to make the marble go faster or slower according to the patch height. The equation to make the marble go faster or slower is all connected in a forever button. The equation is to determine if the patch height in front of the marble is lower than the patch where the marble is standing then the marble goes 1.5 steps forward. If the patch height is higher then the patch where the marble is standing then the marble goes .2 steps forward. The marble also goes 1 step forward on a flat surface. Tutorials were used to create this program.

Conclusion:

The results from the model roller coaster showed that the starting hill which was the highest starting point had an average speed of 0.0848. The second hill had an average speed of 0.1025 and the lowest hill had an average speed of 0.1411. When the marble goes downhill the highest hill it will gain speed. As it goes through the next uphill section it will slow down. The marble should be at its maximum speed at the end of the last hill.

Some experimental error that might have affected the results is starting the marble at a slightly different spot or not using the same force releasing the marble each time. The shape of the roller coaster could have had slight changes due to moving or touching the model.

Another factor to consider is friction. Friction always resists motion between the object that is moving along the track which would be the marble and the surface rubbing together it depends on the weight of the object. Heavy objects have more friction then lighter objects. The surface area of the track could have had tiny ridges or small bumps that might not have aloud the marble to roll smoothly along the track.

Recommendations:

Recommendations for designing this model roller coaster would be to stabilize the track so that it does not move when the marble rolls down it. The energy to move the track comes from the marble. The energy that the marble loses to make the track move means less energy is available to make the marble move itself along the track. Also try making different lengths of roller coaster tracks and different weights of marbles.

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Appendix Page:

Formulas Used:

Speed= distance / time

Height= Rise / Run

Measurements:

Marble= 1 centimeter in diameter

Gates placed at 1(30cm) & 2(40cm)

Distance= 10centimeters

Test Groups:

Different heights of hills tested to determine the types of hills that were used in the computer program:

1st Height= 20cm=28.7 & 50cm=19.6

2nd Height= 20cm=20.7 & 50cm=14.5

3rd Height= 20cm=12.7 & 50cm=9.4

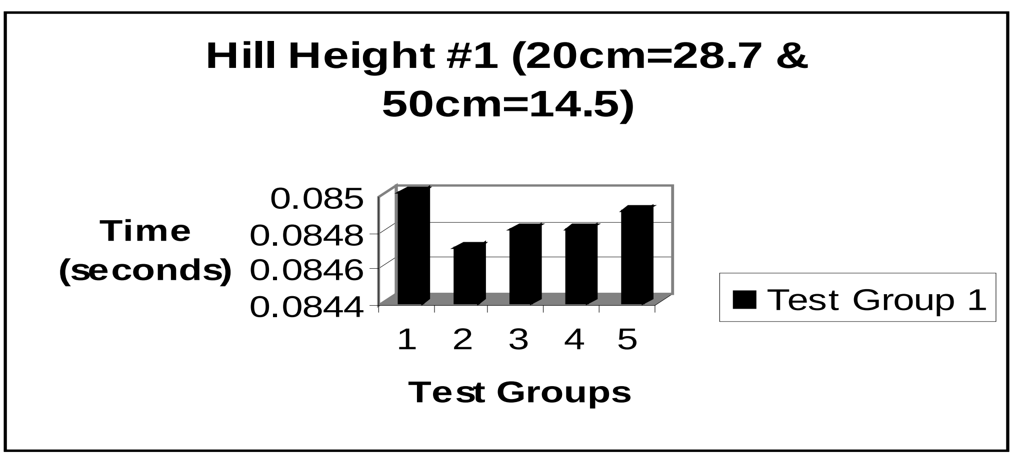
Data Table:

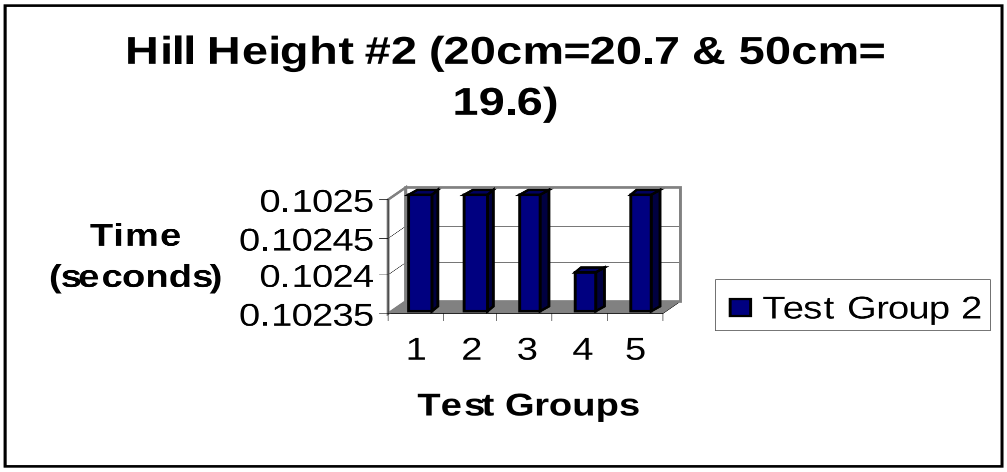
Test Group 1 Height: 20cm=28.7 50cm=19.6	Start:	End:	Time: Seconds
1	0.0171	0.0147	0.0850
2	0.0171	0.0147	0.0847
3	0.0170	0.0148	0.0848
4	0.0170	0.0148	0.0848
5	0.0171	0.0147	0.0849
Average			0.0848

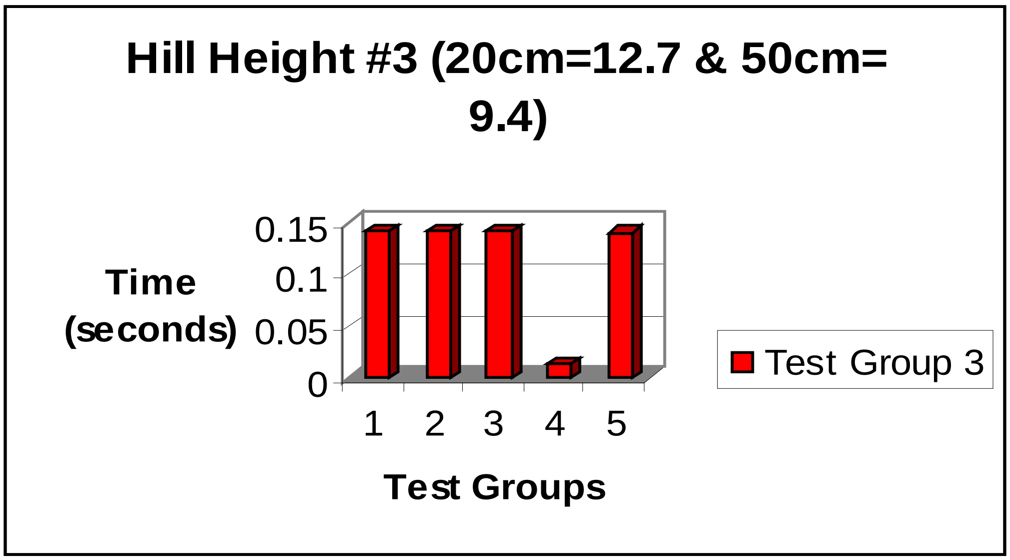
Test Group 2 Height: 20cm=20.7 50cm=14.5	Start:	End:	Time: Seconds
1	0.0206	0.0179	0.1025
2	0.0204	0.0179	0.1025
3	0.0207	0.0178	0.1025
4	0.0205	0.0178	0.1024
5	0.0205	0.0179	0.1025
Average			0.1025

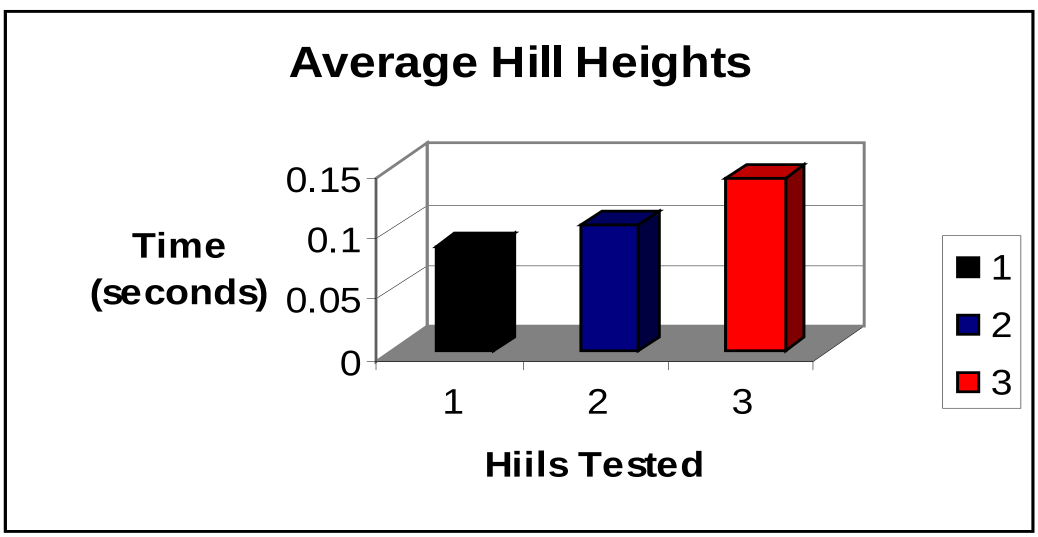
Test Group 3 Height: 20cm=12.7 50cm=9.4	Start:	End:	Time: Seconds
1	0.0282	0.0247	0.1414
2	0.0285	0.0245	0.1414
3	0.0282	0.0245	0.1414
4	0.0284	0.0246	0.01413
5	0.0282	0.0246	0.1411
Average			0.1411

Graphs:




Hill Height #2 (20cm=20.7 & 50cm= 19.6)
Time (seconds)
0.1025
0.10245
0.1024
0.10235
1
2
3
4
5
Test Groups
Test Group 2


Hill Height #3 (20cm=12.7 & 50cm= 9.4)
Time (seconds)
0.15
0.1
0.05
0
1
2
3
4
5
Test Groups
Test Group 3


Average Hill Heights
Time (seconds)
0.15
0.1
0.05
0
1
2
3
Hiils Tested
1
2
3