Using Applied Physics to create a 2-D Golf game

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Supercomputing Challenge
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Area of Science: Physics

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Executive Summary

The goal of this physics project was to use our knowledge of Physics and programming to create a game made from scratch. We wanted to create a model of the flight of a golf ball while adding some entertainment for the user. The program used to create the game was Java. We used a particle system to model the ball and its flight path. The “ball” is registered, as of now, as a 0-dimensional object rather than a 2-dimmensional or 3-dimensional object. The particle we created was designed to respond to stimulants as a 2-D object would. Stimulants acting on the particle included gravity, lift force, drag force, wind, and the force of the repulsion an object experiences while bouncing, rolling, or resting on the ground. As our project progresses, we hope to create a game where the user can play golf on different “planets” (i.e. change the gravity so the ball is affected in different ways). But as of now, we only have a demo of the simulation of multiples balls’ flight paths.

The results of the project suggest that making a game is quite tedious and the Physics of this project was difficult to master. The equations and algorithms used to create our model makes it evident that Physics is a rather challenging concept to understand. But, when done right, produces solid models and beneficial representations of certain phenomena.

The Problem & Solution

Physics is one of the most challenging subjects to retain. But, it's also one of the most beneficial to mankind. Physics acts as a guide to how things work and why. People are always using Physics even when they do not know it. The basis of this project was simple. Create a model that depicts a simple event or string of events in everyday life that clearly shows Physics is occurring. But, the model needed to tie in with something people can do or relate to, to better explain the Physics behind the model. Golf was a great candidate to use. It is quite a technical sport and acts as a clear representation of Physics.

Entertainment is also a great way to depict what the model is trying to represent. The model also needed a way to show what was happening with the golf ball to revise and move forward until the model is optimal. A simulation was the best option. Simulation is a great and effective tool to use when creating a model and a game. After the simulation is perfected, to provide entertainment, the project needs to be taken further i.e. a game.

Computational Model

The first iteration of our code used the very equations given in our physics textbook.

x(t) = (Vi * Cos(θ)) * time

y(t) = (vi * Sin(θ)) - (Gravity * time2)

These equations needed to be improved to make a more precise and specific model. Extensive research was done to find a way to better these equations to our liking..An article written on the physics of golf by Martin Paul Gardiner (article linked below), provided the equations needed to make the model work

$$\ddot{x}_n = -\frac{\rho \cdot S}{2 \cdot m}\left(\dot{x}_n^{\,2} + \dot{y}_n^{\,2}\right)\left(c_D \cdot \cos(\alpha) + c_L \cdot \sin(\alpha)\right)$$

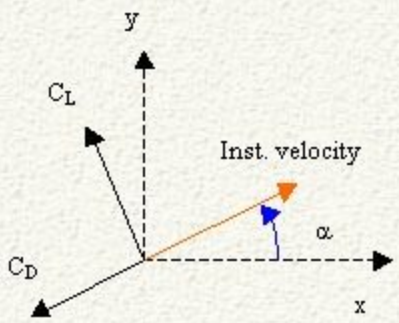
$$x_{n+1} = x_n + \dot{x}_n \cdot dt + \tfrac{1}{2}\ddot{x}_n \cdot dt^2$$

$$\dot{x}_{n+1} = \dot{x}_n + \ddot{x}_n \cdot dt$$

$$\ddot{y}_n = \frac{\rho \cdot S}{2 \cdot m}\left(\dot{x}_n^{\,2} + \dot{y}_n^{\,2}\right)\left(c_L \cdot \cos(\alpha) - c_D \cdot \sin(\alpha)\right) - g$$

$$y_{n+1} = y_n + \dot{y}_n \cdot dt + \tfrac{1}{2}\ddot{y}_n \cdot dt^2$$

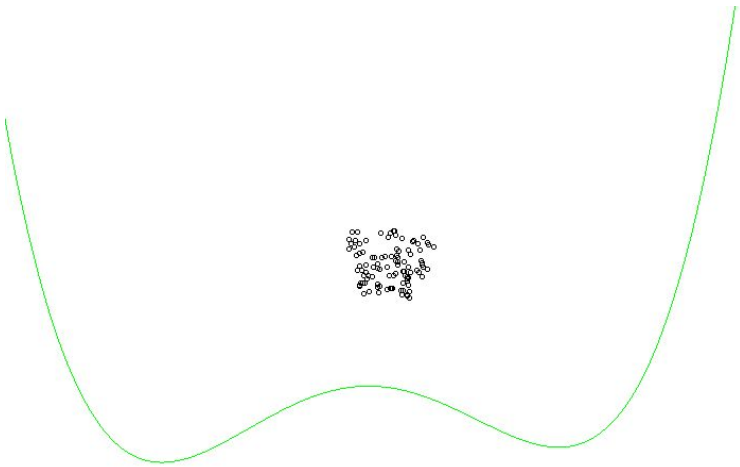
$$\dot{y}_{n+1} = \dot{y}_n + \ddot{y}_n \cdot dt$$



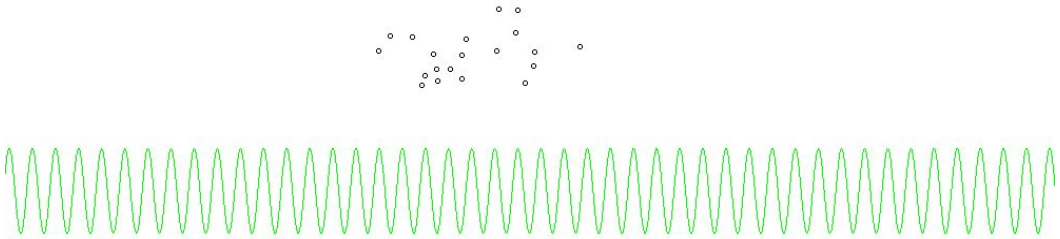
After working with these for awhile, the realization set in that more improvements could be made. That is when the shift went to primarily force vectors. Where the directional acceleration at any given moment is the sum of all the force vectors currently acting on the particle. From this idea we were able to create a demo simulating the balls activities on earth, and in a space-like environment. The figures below show show the balls being “swung” (exerting

a force) on a random plane.Each model depicts the physics being used such as the roll, bounce, lift, and gravitational pull.

(Figure 1)



(Figure 2)



(Figure 3)

(Figure 4)

Conclusion

Overall, this project proved to be a great starting point into an interesting sector of physics and applied physics. From this project, we made a solid model that will ultimately lead into a game. The model itself was tedious and went through many trial and error. Exploring areas such as particle physics makes way for a deeper appreciation of the universe and life. By learning and retaining such a difficult subject, society can push forward with more advancements in technology and knowledge just as we did with this project. The model can still be modified to be more optimal, but as of now, it is solid. Although we did not reach our ultimate goal of creating a game, we have a great start with our simulations and overall model.

Sources

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