**Physics Simulation – Supporting document**

Methods used

The methods used were said to be different to the Forward Euler method in physics simulation, I chose two methods when implementing physics; Backward Euler and Symplectic Euler. In brief, these methods can be explained by the calculations performed when using them.

Backwards Euler

The Backwards Euler (or Implicit Euler) is performed by calculating the derivative and then using that derivative in the next calculation. First, the velocity is calculated with:

Velocityn+1= Velocityn + (Accelerationn+1 \* *dt)*

Then, that velocity is used to calculate the position with:

Positionn+1 = Positionn + (Velocityn+1\* dt)

(jdickinson91, 2015)

Symplectic Euler

The Symplectic Euler (or Semi-Implicit Euler) is a middle ground or **mid-point** Euler between Forward and Backwards Eulers. To explain further; A Symplectic Euler calculates velocity and position at a specific time, unlike how the Forwards Euler calculates these things in a repeating cycle of times and the Backwards Euler calculates them way before they’re needed. To perform the method, you would calculate the velocity with a Forwards Euler calculation:

Velocityn+1= Velocityn + (Accelerationn \* dt)

Before performing the Backwards Euler calculation of:

Positionn+1 = Positionn + (Velocityn+1 \* dt)

(jdickinson91, 2015)

Why Backwards Euler?

Backwards Euler is being used due to its extremely stable nature despite the fact it will be a slower calculation for the program to perform. It is also incredibly accurate and works well when calculating friction and drag, meaning that it will be an important calculation to use for our grenade object that uses drag to make sure it doesn’t exit the screen when fired.

In comparison to the Forward Euler, it completely demolishes the occurrences of large amounts of errors as well as being incredibly accurate when compared with the Forward Euler. This accuracy and resistance to error is vital for the grenade object as the grenades are the main deciding factor of the winner and loser of the game. (jdickinson91, 2015)

Why Symplectic Euler?

Symplectic Euler is also very stable and also faster to implement than other techniques, meaning that – since two methods are required for the game – implementation will save time in favour of other tasks that need completing. Another advantage is that it is popular when implementing rigid body movement, covering the weakness that the Backwards Euler technique suffers from.

In comparison with the Forwards Euler technique, it has similar likelihood of error but overrides that weakness in its easy implementation and reliability when paired with Backwards Euler. (jdickinson91, 2015)

Sources

This document was assisted by the provided link to WordPress.com. Below is the citation to the specific page used.

jdickinson91 (2015) *Numerical integration in games development*, *Understanding Games Development*. Available at: https://jdickinsongames.wordpress.com/2015/01/22/numerical-integration-in-games-development-2/ (Accessed: May 3, 2023).