

Assignment 1 - Kian nightingale

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GAMES ARCHITECTURE AND MECHANICS - ASSIGNMENT 1



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Euler's Method

Euler is a numerical integration method that calculates velocity based on a time step or time interval and then predicts the new or updated velocity by summing the time step and the change of the time step ($t+\Delta t$). While Euler's Method is mathematically simple to implement into game engines it is also the least accurate, this is due to the fact that the further that you go from the known initial value the margin for error will increase and therefore become less accurate.

In relation to game engines Euler's Method can be used for very simple action where accuracy is not vital, this can be things such as platforming games. Euler's Method can be used in order to calculate the trajectory of a projectile thrown by an enemy, "Of course every weapon should have new trajectory lines and different ballistic features." [1]

Arguments can be made that the smaller the value of Δt the more accurate that the calculation will get, however there is a limit on how small you can make it before it becomes impractical to work with so there will need to be a balance of practicality and accuracy in which you will need to find the corresponding amount of accuracy and practicality that you will need when working with Euler's Method.

Runge-Kutta 2

As previously stated, Euler's Method is a simple form of numerical integration, there are other methods that are more complex and potentially more accurate in comparison to Euler's Method, such as Runge-Kutta 2 or "The Mid Point Method" this is calculated by taking two sets of coordinates (x_1, y_1, z_1) and (x_2, y_2, z_2) and performing a mathematical operation on them to find what is called the mid-point. While "The Mid Point Method" is slightly more mathematically challenging it is more accurate than Euler's Method as it has less margin for error.

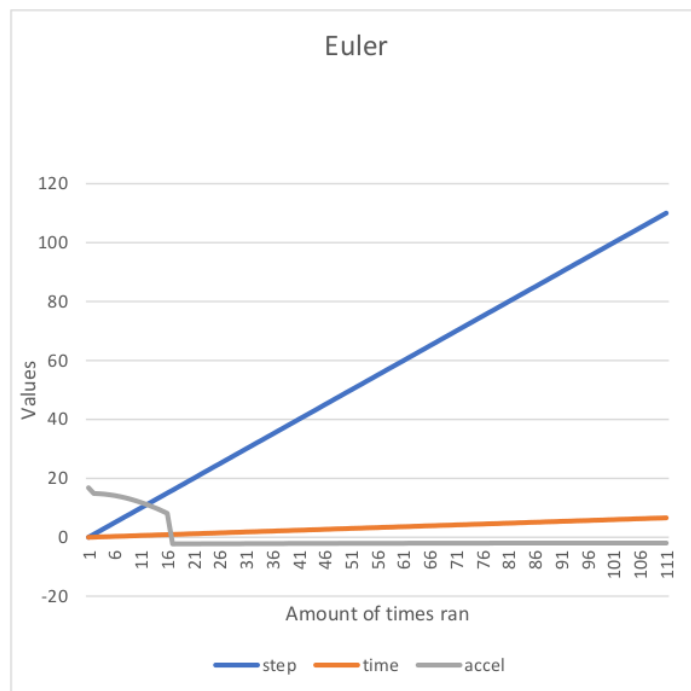
"The Mid Point Method" can be used to trace a line between two points and see if an object will intersect with the line, this can be used for collision detection.

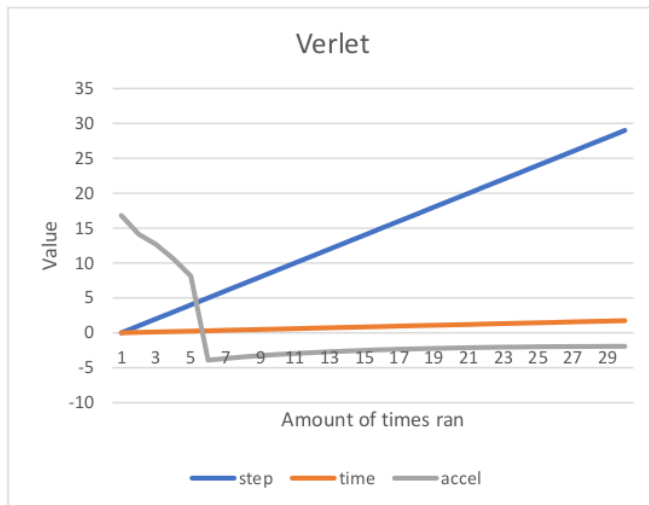
Verlet

"Verlet integration is a numerical method used to integrate Newton's equations of motion." [2]. By using the Kinematic Equation, I was able to calculate the Velocity and current position of the dragster in relation to my time step. While Runge-Kutta 2 is more accurate than Euler's Method, Verlet is an even more accurate expression for calculating velocities and potential energy conservation. However, due to the complexity of Verlet's expression this means that the calculation is more expensive in terms of memory. Verlet can be used for calculating ragdoll physics in videogames, it can also be used for fabrics that can be torn and particle simulations that will need to be accurate.

Comparison

In this section will be making a comparison between my two chosen method. These methods are Euler's Method and Verlet, I will be covering some of the major differences between the two methods and some of the similarities.





As shown above the two versions that I chose were Euler's method and Verlet. The Graphs display the amount of time the program was ran and also the values of each plotted attribute.

While both graphs look extremely similar you may see that Euler's Method took many more cycles to come to the same conclusion. Due to the scale of Verlet's Graph it also allows for more accurate readings as stated about when we discussed the advantages of Verlet, "Verlet is an even more accurate expression". Whereas as you may see above Euler's scale is much larger, this means that the readings are less accurate and will have a larger margin for error.

In conclusion, despite the fact that Verlet is more tasking on the system I prefer to use it due to its accuracy and versatility. However, that's not to say the Euler's Method doesn't have a place in the Games Development field as it is quick, efficient and it isn't as straining on the system meaning that it can be performed along side other more important operations.

References

- [1] Kungl, P. (*Trajectory calculation using modified euler method, presented in a ...*
Available at:
https://www.researchgate.net/publication/287205091_Trajectory_calculation_using_modified_Euler_method_presented_in_a_platform_game (Accessed: November 10, 2022).
- [2] L. Verlet, "Computer 'experiments' on classical fluids. I. Thermodynamical properties of Lennard-Jones molecules," *Physical Review*, vol. 159, no. 1, 1967.

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GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

63/100

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Comment 1

summing the velocity at the time step with the velocity at the next time step

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GRADING FORM: SMU GENERIC_GJ

KIAN NIGHTINGALE

63

RESEARCH-INFORMED LITERATURE



10 Verlet and Euler's covered but more please on Verlet- which kind was used.
Try to use more in line refs and expand your references section.

6

KNOWLEDGE AND UNDERSTANDING



20
Euler's approach explained - more could have been done for Verlet - several forms exist. Expand on these please. The interpretation of the code and implementation in C++ show a good understanding of the problem area as well as a good understanding of C/C++ and the VS IDE. However Verlet implementation needs reviewing..

13

ANALYSIS



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A good interpretation of the problem specification. The graphed results reflect the physics appropriately.
Please include a more detailed comparison of each method and explain the shape of the curves. Verlet method needs further consideration.

Include a discussion identifying and explaining the various advantages and disadvantages of the integration methods used.

12

PRACTICAL APPLICATION AND DEP.



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29

Some good SE practices shown here. Code well documented in general. Variables appropriately named. Separate program for Euler - ok. Results appropriate and reflect a good interpretation of the problem. Well done.

Graphs generated from results show appropriate behaviour.

SKILLS FOR PROFESSIONAL PRAC.



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3

Report structured. Good. Grpahs provided. Try to label axes clearly with units too. This can become confusing otherwise.

Refs used - try a few more and make more use of inline references.