3D Fluid Simulation

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Abstract

Team 73 used biological flow simulation data from Lattice Boltzmann method (LBM) to make an animation with cancer cells moving with a stream of red blood cells, visualized in Unity. The cells will move around pillars. The team also used of another numerical fluid mechanics method called Smooth Particle Hydrodynamics (SPH) from an open source code to create an interactive game within Unity. The user will be able to use a mouse to move a control sphere around to interact with fluid particles in Unity. The SPH simulation will use mouse controls to move an object to collide with SPH particles. The user can also move the SPH particles through applied forces by using the arrow keys. With the interactive simulation tools, the user can examine detailed flow physics such how fluid particle interact with each other.

Introduction

Fluid mechanics is a difficult for many students to understand. Many fields of engineering use this branch of physics and this very reason is why it is important to create a way to teach it so that students can understand this subject better. Virtual reality and creating a game maybe good ways to teach students on how fluids are created. Virtual reality helps with the visualization of how fluid particles interact with each other. Students can see the fluid mechanics equations come to life with the implementation of virtual reality. The use of a game can help students interact with the fluids and see how different parameters change a fluids characteristics. The game can also help keep students engage when learning the subject instead of just reading about it in a book.

Figure 1:HP-Windows Mixed Reality Headset

Methods and Materials

In Unity it was possible to create the 3-D fluid simulation using C# to code the interactivity inside of fluid simulation. Paraview was used to generate the models for the blood stream animation. The team used HP-Windows Mixed Reality Headset to view the blood stream animation. The method chosen to make the simulation run is Smooth Particle Hydrodynamics(SPH). The SPH relies on what is called a kernel function and there the function is “smoothed out” to make particles using the properties of any fluid. When the kernel function is smoothed out these new particles are made by adding a density and pressure to the particles. When two particles collide the density of both particles increase and then the pressure detects that change in density and increases as well.

Results/Discussion

The project outcomes included one interactive simulation utilizing smoothed particle hydrodynamics and one simulation with red blood cells traveling in a flow. The left figure shows the animation created in Unity with red blood cells. The right figure implements the SPH method and creates particles with user input. The user is able to move a gray ball to hit particles with a mouse as well as move a particular particle with the arrow keys in the direction of an axis.

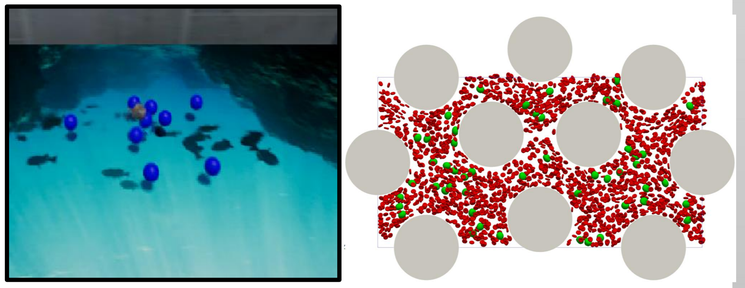

Figure 2:Blood stream animation(Left) Interactive simulation(right)

Conclusion

At the end of this project the team was able to make two fluid simulations which showed the capabilities of virtual reality technology and video game software. Unity proved to be a very versatile software to create fluid animations and simulations. The game engine helped with making the interactivity that was needed to make a more interesting way to learn about fluid particles, within the SPH simulation. Unity also opened the door to help visualize data via a virtual reality headset. The headset provides different perspectives on the data and for the case of this project, the visualization of blood flow. Our simulations hope to inspire others about education in this way and work towards a more interactive learning experience!

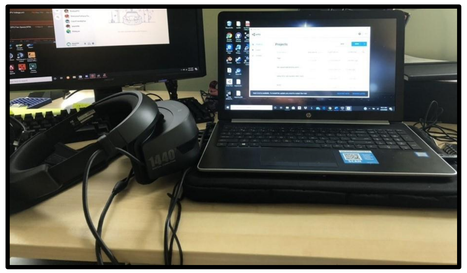

Figure 3: Headset and Laptop setup

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Unity-ECS-Job-System. Leonardo Montez. https://github.com/leonardo-montes/Unity-ECS-Job-System-SPH. (2019)