AE618 Group Project

Smooth Particle Hydrodynamics

Group 10

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Abstract

Smoothed Particle Hydrodynamics, or SPH, is a computer method for simulating fluids. We need SPH for problems that are hard for other methods like the Finite Element Method (FEM), especially when things deform a lot, like in explosions, or when there are complex surfaces, like splashing water. The main idea of SPH is to use a set of moving particles instead of a fixed grid to represent the fluid. Each particle carries properties like mass and velocity and moves with the flow. To calculate a property for any particle, the method looks at its neighbors and averages their properties using a special weighting function called a "smoothing kernel". To make this work in a simulation, the fluid equations are turned into particle equations using a process called kernel and particle approximation. The particles' positions are then updated over time using time integration methods, like the simple Leapfrog scheme. One of the biggest challenges is handling solid walls, which is often done using special boundary particles like "Repulsive Force Particles" that push fluid away or "Ghost Particles" that mirror the fluid to complete the calculations near a boundary.

References

1. Gingold, R.A. and Monaghan, J.J. (1977) Smoothed Particle Hydrodynamics: Theory and Application to Non-Spherical Stars.

2. Lucy, L.B. (1977) A Numerical Approach to the Testing of the Fission Hypothesis.

3. Monaghan, J.J. (1994) Simulating Free Surface Flows with SPH.

4. Liu, G.R. and Liu, M.B. (2003) Smoothed Particle Hydrodynamics: A Meshfree Particle Method.

5. Zhang, C., et al. (2022). Smoothed particle hydrodynamics: Methodology development and recent achievement. *Journal of Hydrodynamics*.