Exploring Fluid Simulation

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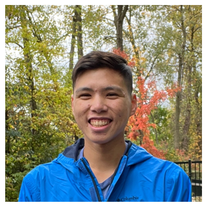

Introduction

- Basic 2D fluid simulation app
- Utilizes smoothed-particle hydrodynamics
- Powered by the Rust programming language and Bevy game engine

System Architecture

- Data-driven
- Entity component system (ECS)

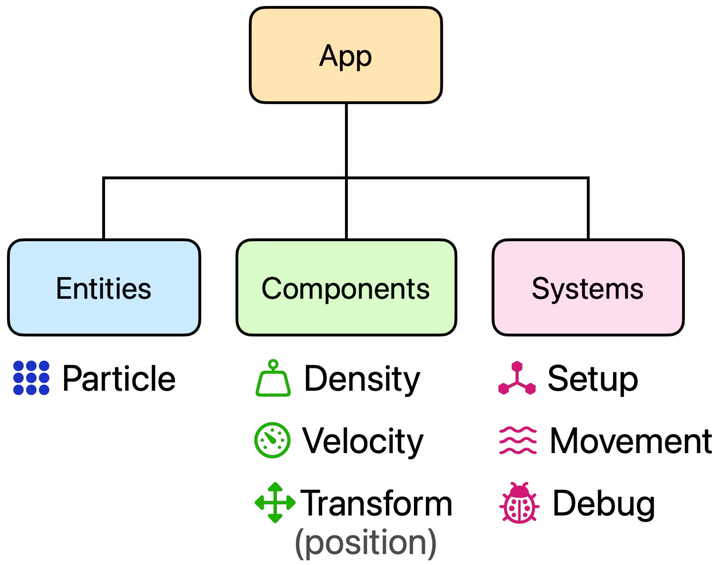

Figure 2: Diagram of ECS system architecture.

Game Loop

- $O(N^2)$ complexity

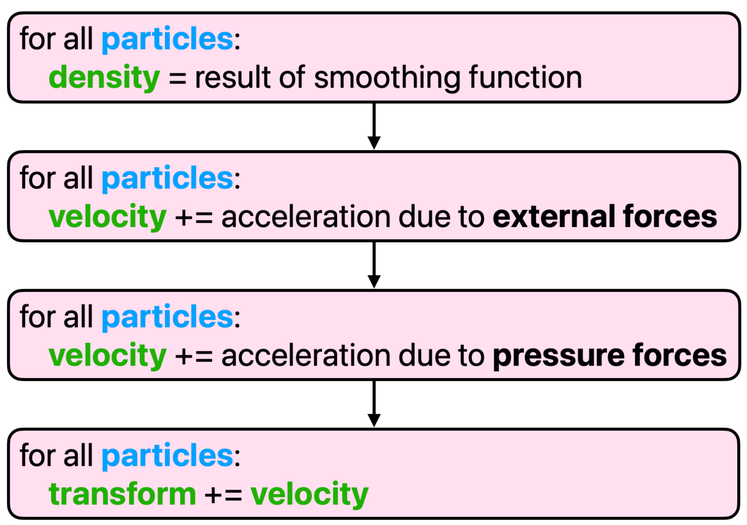

Figure 3: Flowchart of game loop.

Simulation

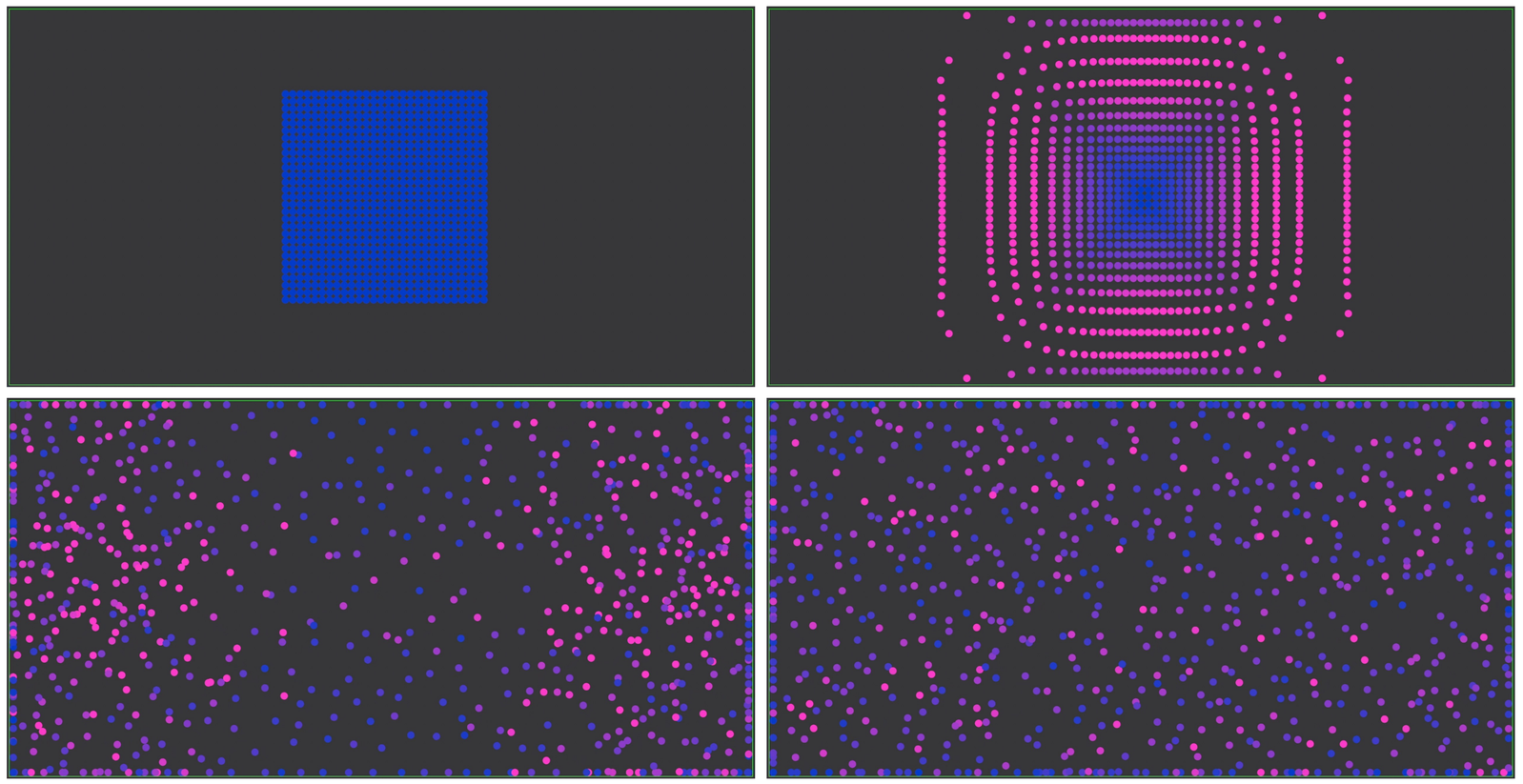

Figure 1: Snapshots of simulation over time; left to right, top to bottom.

Smoothed Particle Hydrodynamics (SPH)

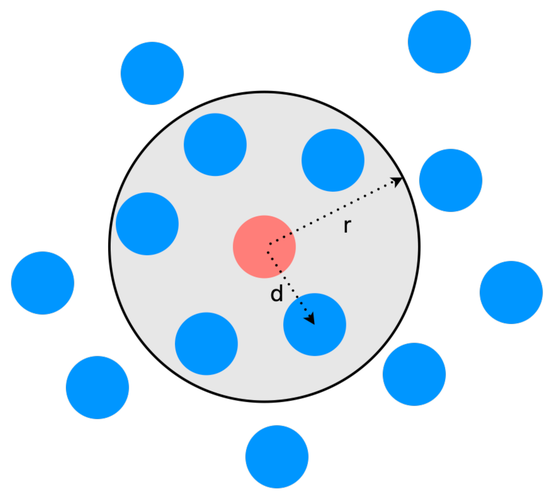

Figure 4: 2D visualization of SPH.

- Computational technique to simulate the behavior of fluids
- Collection of particles resemble fluid
- Pre-defined smoothing radius and function
- $f(d,r) = \frac{15}{\pi d^6} \begin{cases} (r-d)^3, & \text{if } 0 \le d \le r \\ 0, & \text{otherwise} \end{cases}$
- Calculates pressure force

Future Work

- Integrate solution for boundary issues
- Incorporate interactivity into simulation
  - geometric objects, mouse repels or attracts particles
- Implement UI to customize and toggle initial parameters

References

D. Koschier, J. Bender, B. Solenthaler, and M. Teschner, “Smoothed Particle Hydrodynamics Techniques for the Physics Based Simulation of Fluids and Solids,” Eurographics 2019 - Tutorials, 2019, doi: 10.2312/EGT.20191035.

M. Müller, D. Charypar, and M. Gross, “Particle-based fluid simulation for interactive applications,” in Proceedings of the 2003 ACM SIGGRAPH/Eurographics Symposium on Computer Animation, in SCA '03. San Diego, California: Eurographics Association, 2003, pp. 154–159. doi: 10.5555/846276.846298.