Predictive-Corrective Incompressible SPH

This project aims for a popular variant of particle-based liquid simulation method, Predictive-Corrective Incompressible SPH (PCISPH). This requires essential programming/software skills for generating computer animations and good understanding of numerical fluid simulations, which solve the Navier-Stokes equations that model a variety of fluid flows.

Objectives

The first step is to understand the fundamental knowledge of a particle-based liquid simulation approach, Predictive-Corrective Incompressible SPH (PCISPH) [1]. You can start with implementing a two-dimensional simulator and then extend to three-dimension (3D). You can reuse the codebase used for your previous classes such as IGR202. However, you have to implement yourselves the core of the PCISPH solver. The simulation outputs are a set of particles representing temporal and spatial changes of liquid volumes. For 3D, you need to have a way to construct surfaces (i.e., triangular meshes) from the particles via either your own implementation of known technique [2] or an open-source library such as OpenVDB[1]. For the final step, you visualize them using a rendering software such as Blender[2]. These three (simulation, mesh generation, and rendering) modules will be ideal outcomes of this topic. Once achieving, you are strongly encouraged to work further to improve the pipeline with own ideas, e.g., speeding up each module via multiprocessing, adding another variant of SPH, changing rendering setups, etc.

Topic difficulty: □ *easy* | ■ *intermediate* | □ *advanced*

Prerequisites

- Good programming skill in C/C++ both for implementing new codes and utilizing existing codes
- Knowledge of computer animation and physic-based modeling as well as numerical simulation
- Experience of computer graphics libraries/tools or interest in using them

References

[1] 2009, Solenthaler and Pajarola, Predictive-Corrective Incompressible SPH, ACM Trans. Graph.

[2] 2005, Zhu and Bridson, Animating Sand as a Fluid, ACM Trans. Graph.

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1 https://www.openvdb.org/

2 https://www.blender.org/