

Position-based DEM snow simulation

TE2502: Civilingenjör Thesis Topic for Game Programming Students

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Brief Description:

Snow animation in computer graphics is a challenging topic, especially in real-time. Recently computer games (ex, Red Dead Redemption) have used snow animation. However, due to the lack of a real-time simulator, most of these methods have used procedural or mesh deformation methods instead. Our group at BTH has proposed efficient and interactive real-time snow simulators to this end [2,1]. These simulators are GPU-based (using CUDA), and fastest existing so far in the world. Both of these were Civilingenjör student projects at BTH, and [2] was 8x-9x faster than [1]. Furthermore, [2] added a number of useful features to the [1].



In this project, we aim to further accelerate our particle-based snow simulator [2] on the GPU (image above) using position-based dynamics [4] or PBD. PBD has been a versatile and popular method to simulate various kinds of materials in CG. Most of them simulators using PBD are based on smoothed particle hydrodynamics (SPH) or its variant.

- 1) We envisage to use PBD for DEM-based snow simulation, which has not been tried before. It is expected that with the snow simulator could benefit from the large time steps provided by PBD.
- 2) Furthermore, the PBD simulator will be integrated in a spatial-temporal accelerator that is being developed by a group of students currently. The goal of this project is to further the acceleration, and to make the snow simulator more viable for real-time applications.

The student(s) will have a reasonable room to experiment and improve the project in the scientific and implementation areas.

Requirements:

- ✓ Student(s) should be advanced level programmers in C++.
- ✓ Knowledge in GPU programming required.
- ✓ Interest and motivation in the underlying physics, simulation and the overall project.

References:

- [1] Iterative discrete element solver for efficient snow simulation, Prashant Goswami, Adrian Nordin, Simon Nylen, Eurographics Parallel Graphics and Visualization (EGPGV), 2022 [\[Link\]](#)
- [2] Real-time particle-based snow simulation on the GPU, Prashant Goswami, Christian Markowicz*, Ali Hassan*, EGPGV 2019 [\[Link\]](#)
- [3] A material point method for snow simulation, Alexey Stomakhin et.al., SIGGRAPH 2013 [\[Link\]](#)
- [4] Position based fluids, Miles Macklin and Matthias Müller, 2013, ACM Trans. Graph. 32, 4, Article 104 (July 2013)