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Procedural generation and real-time rendering of a marine ecosystem

Key words: Procedural generation, Marine ecosystem, Biological feature, GPU acceleration

Corresponding author: Wen-ting Zheng
E-mail: wtzheng@cad.zju.edu.cn

Motivation

Marine ecosystem:

- extremely complex in diversity and complexity of underwater sealife
- special geometric biological features
- challenge in dynamic interaction with the environment
- billions of primitives

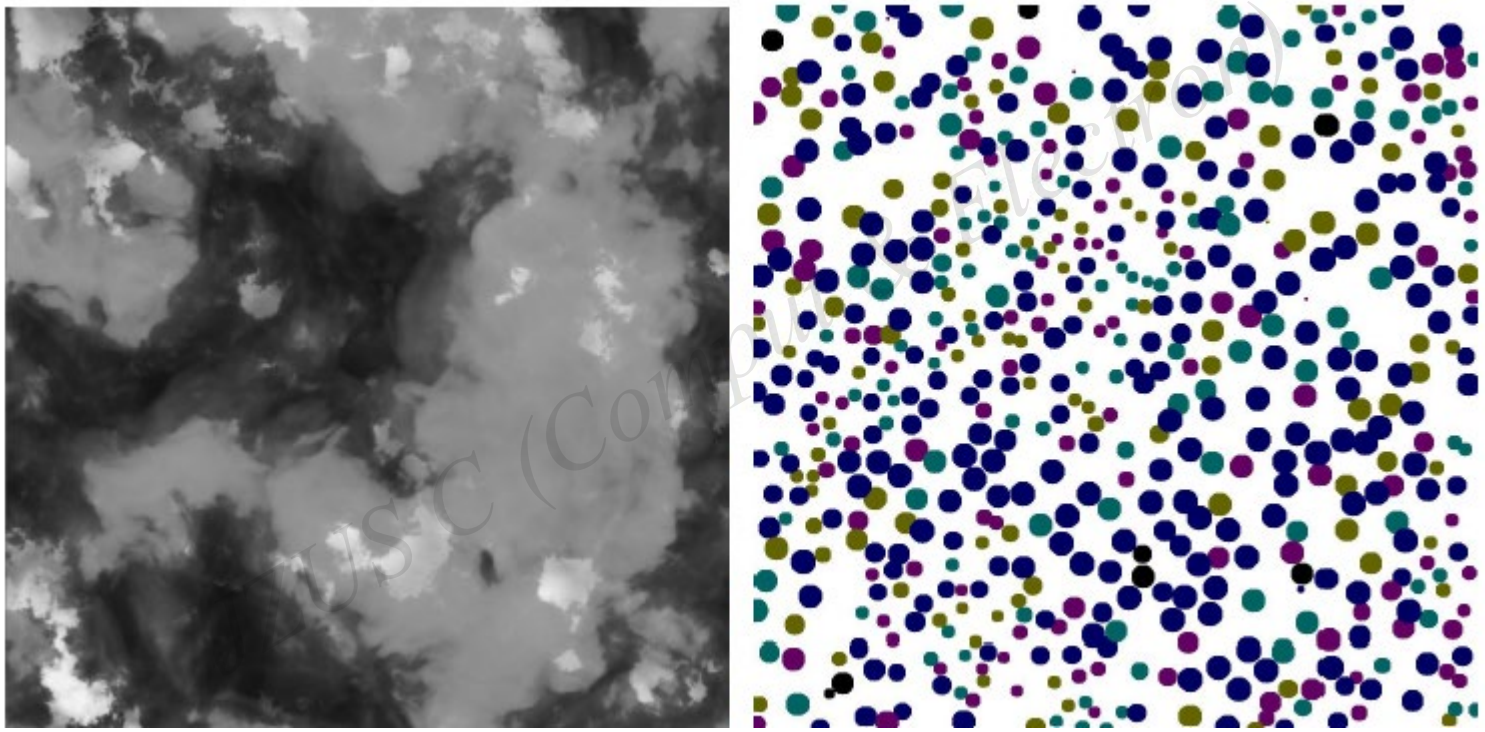
We design a real-time and high-performance visualization pipeline for large-scale complicated underwater environments.

Features of our method

- A marine ecosystem simulation model in our system to populate sealife in the ocean more naturally
- A CPU-GPU hybrid framework in our procedural model for rendering individual ocean sealife
  - Compact model representation on CPU
  - Fast generation of details on GPU
- Integration of dynamic interaction simulation with the underwater environment

Framework of our method (I)

Specification of sealife populations:

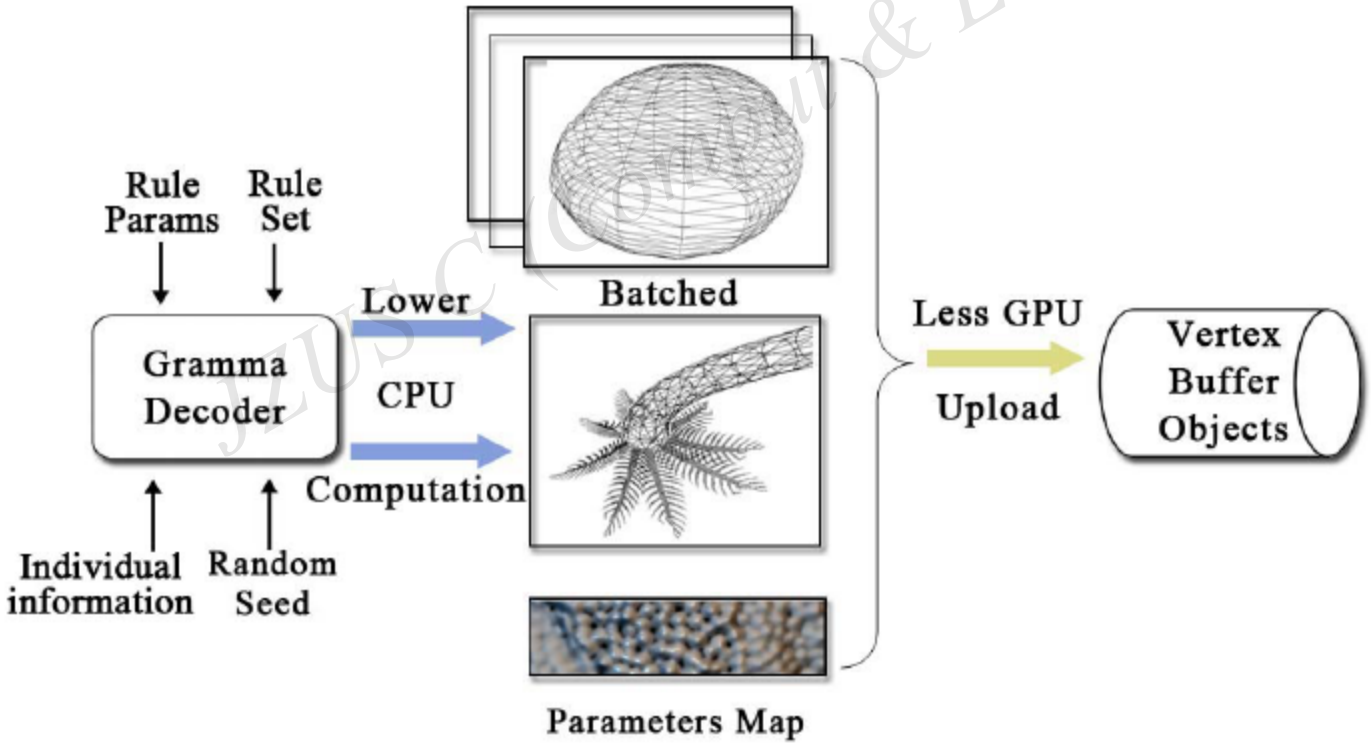


Different colors represent different species, while the size and density of the circles denote the growth situation

Framework of our method (II)

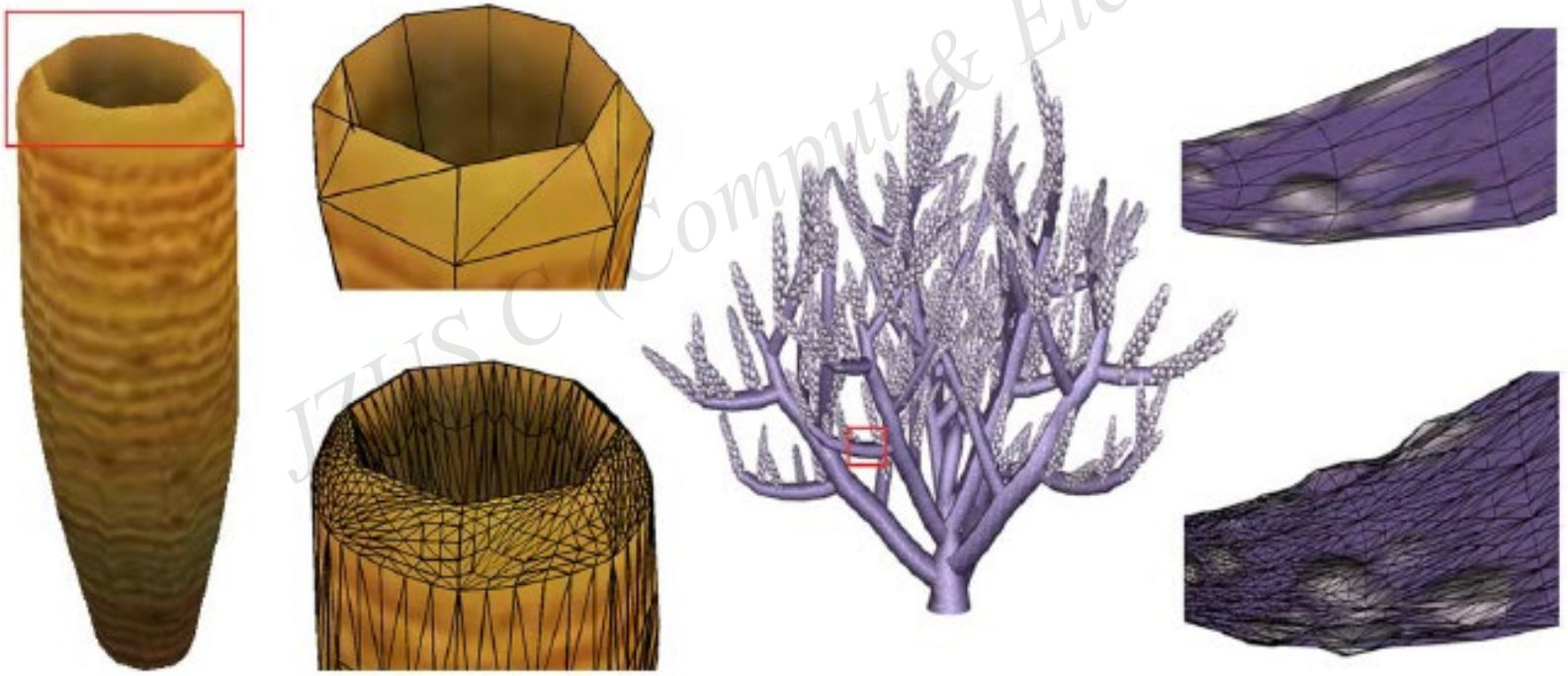
Two-level procedural generation of individual underwater sealife

CPU grammar decoder:



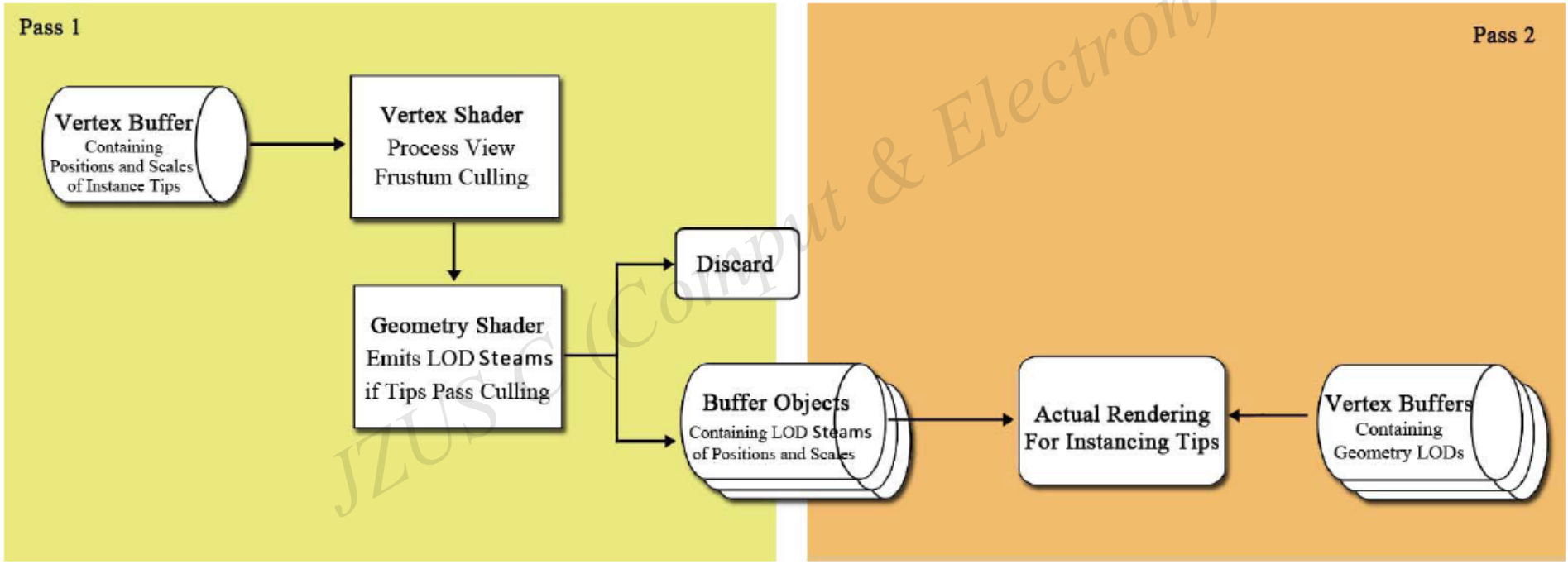
Framework of our method (III)

On-the-fly LOD Generation on GPU:



Framework of our method (IV)

Two-pass optimization of instancing:

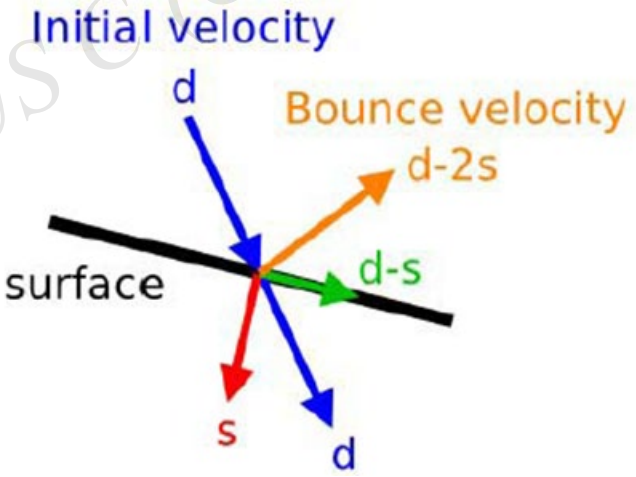


Two-pass based workflow to improve hardware instancing performance.

Framework of our method (V)

Dynamic interaction with the environment:

- spring force
- water flow
- friction force
- collision detection and bounce for control point



Major results

Different views and typical creatures are produced by our system: