GPU-based Raycasting of Volumetric Data

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Agenda

- Raycasting
- GPU-based Raycasting
- Raycasting In Layered Data
- Proposed Adaptive-Sampling Raycasting
- Accomplishment
- Conclusion
- Future work
Raycasting

- Raycasting in scientific visualization

Isosurface Extraction  Direct Volume Rendering

Volumetric Data for Simulation of Turbulence

GPU-based Raycasting of Volumetric Data
Raycasting

- Algorithm animations
GPU-based Raycasting

Rendering Pipeline on GPU

Vertex Data → Vertex Processing → Geometry Processing & Rasterization → Fragment Processing → Frame Buffer

Raycasting

Vertex Shader → Fragment Shader

GPU-based Raycasting of Volumetric Data
Raycasting In Layered Grid and Data

➢ Uniform Grid vs Layered Grid, Layered Data

GPU-based Raycasting of Volumetric Data
Raycasting In Layered Grid and Data

➢ Practical layered ocean data

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Raycasting In Layered Grid and Data

- Real-life illustrating example

Isosurface of salinity from data generated by a regional ocean model

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Proposed Adaptive-Sampling Raycasting

➢ Adaptive-Sampling

![Graph showing adaptive-sampling technique]
Proposed Adaptive-Sampling Raycasting

Algorithm brief description

1) Given the very first enter point corresponding to first cell
2) Calculate the corresponding exit point: calculating the ray’s possible intersecting points with three hitting-possible boundary planes, take the point closest to enter pointer as the exit point, set next cell to which the hit boundary plane belong, but not covered yet
3) turn the exit point into the enter point for next cell, goto step 2)
Proposed Adaptive-Sampling Raycasting

➢ Difficulties

☐ No Debugger
☐ No “printout” statement
☐ Numeric calculation inaccuracy
Proposed Adaptive-Sampling Raycasting

Solution

- Use each pixel’s color channel to for status checking
- Countless loops of analysing, assumption, test, proof/disproof
Accomplishment

➢ Test data

64^3 volumetric data with 5 non-zero valued layers, 4 condensed, the other apart
Accomplishment

➢ Running Result (1)

Proposed Algorithm

Original Algorithm

GPU-based Raycasting of Volumetric Data
Accomplishment

➢ Running Result (2)

Proposed Algorithm

Original Algorithm

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Accomplishment

➢ Running Result (3)

Proposed Algorithm

Original Algorithm

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Conclusion

- GPU Programming is a big challenge

- Implement a self-adaptive raycaster working well with ocean and atmosphere data

GPU-based Raycasting of Volumetric Data

SIMPARCS
Future Work

- Apply the proposed algorithm to curvilinear data for isosurface extraction
- Apply the proposed algorithm for direct volume rendering
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