THE UNIVERSITY OF ALABAMA IN HUNTSVILLE | COLLEGE OF SCIENCE

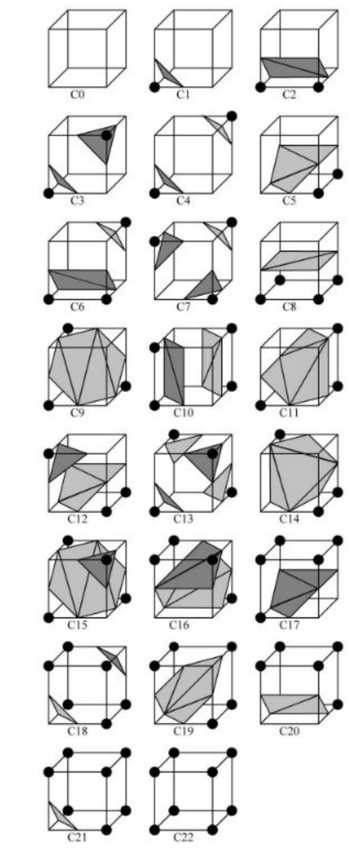
Research and Creative Experience for Undergraduates (RCEU) Program 2023

Achieving Voxel Rendering Effects using World-Class CPUs

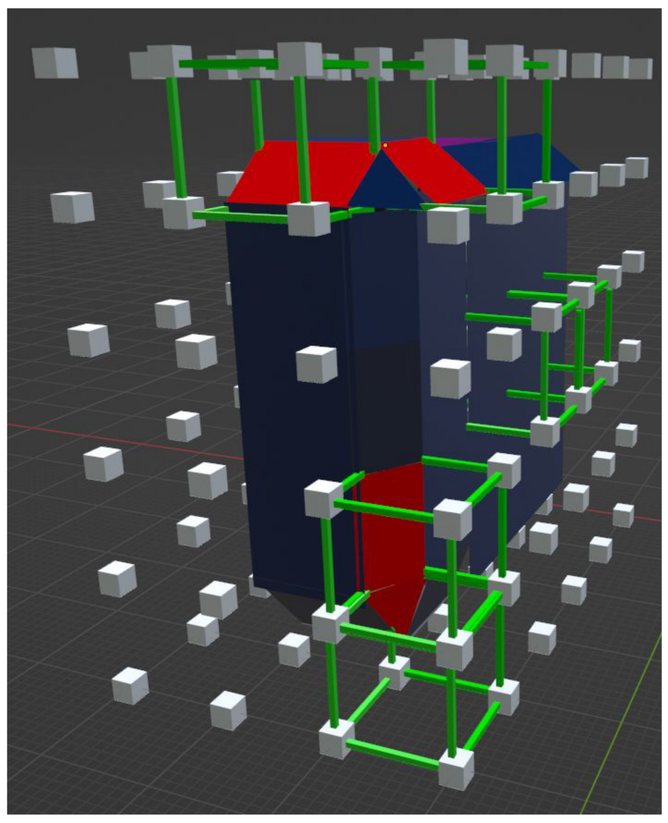
Ian Bohanan, mentor Dr. Timothy Newman
Department of Computer Science

Abstract

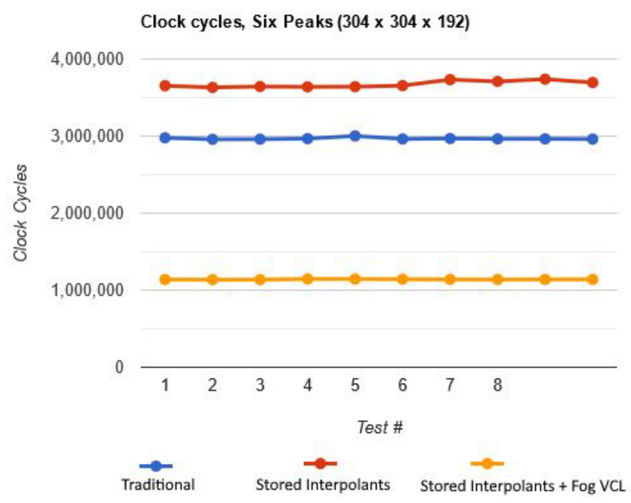
"Marching Cubes" is a technique to find the surface of a digital object. However, it is slow because it visits each point in the object one by one. We reduced the problem by combining the Marching Cubes technique with Agner Fog's Vector Class Library [1] to exploit advanced vector processing capabilities of the CPU to calculate the surface of multiple cubes at once.

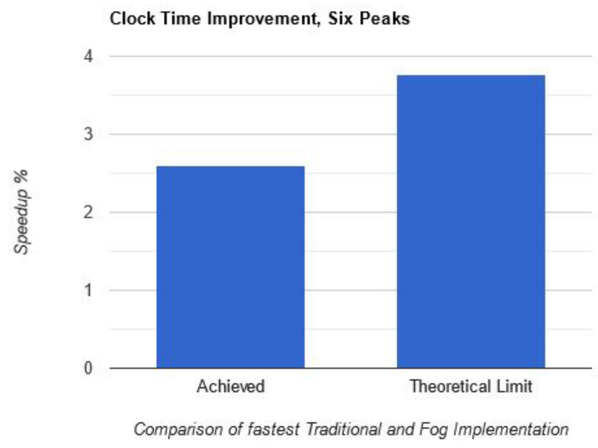


[2]



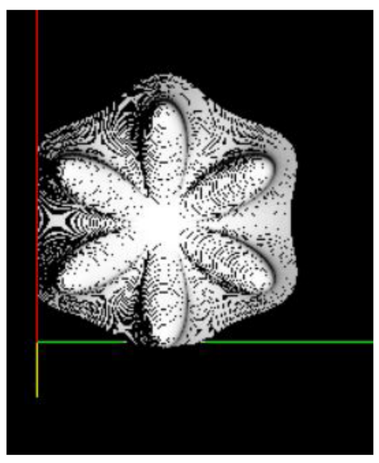
Key Findings/Results



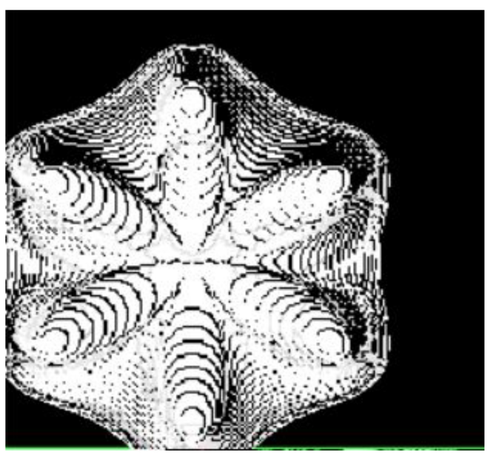


Comparison of fastest Traditional and Fog Implementation

The implementation of Agner Fog's library reduced the clock cycles needed to nearly a third of the same time (on i7-7700,16GB) required by the traditional Marching Cubes algorithm. Each render was similar in composition.



Traditional render of six peaks dataset



Render of six peaks dataset using VCL library

Impact/Conclusions

Voxel rendering is more accurate and revealing of physical properties than pixel rendering, but is also takes far more calculations. This taxes the CPU more. Streamlining those calculations makes Voxel representation more accessible to consumer hardware from physics research to medical imaging.

Explanation/Conceptual Framework

Surface rendering requires millions of points to accurately model an object. Applying physics calculations to each point takes hundreds of clock cycles to compute. By applying those calculations to multiple points at a time, we can speed up digital simulations and analyses of objects with high resolution and/or size.

References

[1] Agner Fog, "VCL C++ Vector Class Library Manual", Version 2, 2023.
[2] Gregory M. Nielson, "On Marching Cubes", *IEEE Trans. Vis. Comp. Graphics,* Vol. 9, pp. 283-297, 2003.

Acknowledgements

All RCEU projects were sponsored in part by the Alabama Space Grant Consortium, the UAH Office of the President, Office of the Provost, Office of the Vice President for Research and Economic Development, the Deans of the College of Science, the College of Engineering, the College of Arts, Humanities, and Social Sciences, the College of Education, and the College of Nursing.