Bilkent University

CS 478

Computational Geometry

Project Proposal

Implementing Two 3D Convex Hull Computation Algorithms and Comparing Their Performance

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Project Description

The goal of this project is to implement, visualize, and benchmark a program for calculating the three-dimensional (3D) Convex Hull of a set of 3D points. The convex hull is the smallest convex volume containing all given points [1]. We will create an interactive tool that utilizes two distinct methods to calculate these structures:

- Gift Wrapping Algorithm by Chand and Kapur [2]
- 3D Sweep Hull Algorithm (computing Convex Hulls and Delaunay Triangulation) by David A. Sinclair [3]

We will be designing a user-friendly interface where users can generate a set of random 3D points using different distributions. The graphical output will include camera controls, zoom in/out and translation. Users will be able to visualize the convex hull as a wireframe and with flat polygon shading and contour at the boundaries. Furthermore, the software will visually step through the execution of algorithms, which allows users to observe the states of the 3D convex hull as the algorithm proceeds.

Finally, we will empirically compare the two algorithmic approaches by testing them on arbitrary 3D point sets. Test cases will range from a size of 1,000 points up to 1,000,000 points. The performance results, analyzing both execution time and efficiency, will be reported.

Proposed Technologies

We will use C++ as our core programming language. The Graphical User Interface (GUI) and parameter controls will be built using the Qt framework. The 3D rendering, shading, and animation capabilities will be implemented using OpenGL. The C++ Standard Template Library (STL) will be utilized for efficient geometric data structures.

References

[1] Wikipedia. Convex Hull. https://en.wikipedia.org/wiki/Convex_hull

[2] Donald R. Chand and Sham S. Kapur. An Algorithm for Convex Polytopes. *Journal of the ACM (JACM)*, Vol. 17, No. 1 (Jan. 1970), 78–86.

[3] David A. Sinclair. A 3D Sweep Hull Algorithm for Computing Convex Hulls and Delaunay Triangulation. *Newton Apple Wrapper (NAW)*, 2016.