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Comparison of Delaunay ALGORITHM and CRUST ALGORITHM for the Optimization of Surface Reconstruction System

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ABSTRACT

In this paper we have studied the Delaunay algorithm and Crust algorithm. We compare these algorithm for the time taken for the surface reconstruction. The goal of surface reconstruction is to find a surface from a given finite set of geometric sample values.

Key words: Crust algorithm, Delaunay algorithm, Surface Reconstruction, Cloud Points.

INTRODUCTION

In many applications, the sample values are points. But other types of samples, like curves occurring e.g. in tactile sampling by an adapted milling machine, or volume densities occurring for instance in X-ray based computer tomography, are also possible. Reverse engineering of geometric shapes is the process of converting a large number of measured data points into a concise and consistent computer representation. In this sense, it is the inverse of the traditional CAD/CAM procedures, which create physical objects from CAD models. Triangulating scattered point-sets is a very important problem of reverse engineering. Given a set of unorganized points that lie approximately on the boundary surface of a three-dimensional object, and without a priori information on the topology, our goal is to reconstruct the surface by building a triangular mesh using the given points as vertices. The resulting polyhedron can be the input of further procedures like surface fitting, or can be visualized with various textures. (For example, in computer-animated films the characters are often created as clay models first, and then the 3D scanned and triangulated models are used for visualization. All algorithms aiming to solve this problem must overcome several difficulties. The first one is related to the size and quality of the input. Modern 3D scanners make it possible to acquire several (ten) millions of sample points on the object's surface. Algorithms for reconstructing surfaces from large data have been proposed in the past. These algorithms avoid three dimensional Delaunay triangulations and can do so by using special information such as surface normal’s that come with the input or by exploiting properties of the data like uniformity.

II. CRUST ALGORITHM

The Crust Algorithm is a new algorithm for the reconstruction of surfaces of arbitrary topology from unorganized sample points in 3d. The algorithm is the first one for this problem with provable guarantees. Given a "good sample" from a smooth surface, the output is guaranteed to be topologically correct and convergent to the original surface as the sampling density increases. The definition of a good sample is itself interesting: the required sampling density varies locally, rigorously capturing the intuitive notion that featureless areas can be reconstructed from fewer samples.

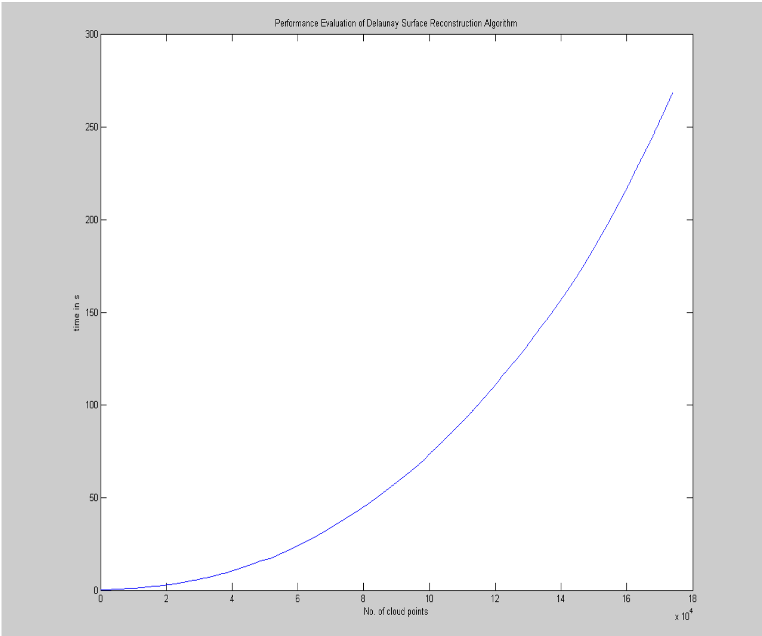

Fig1. Surface reconstruction v/s the number of cloud points

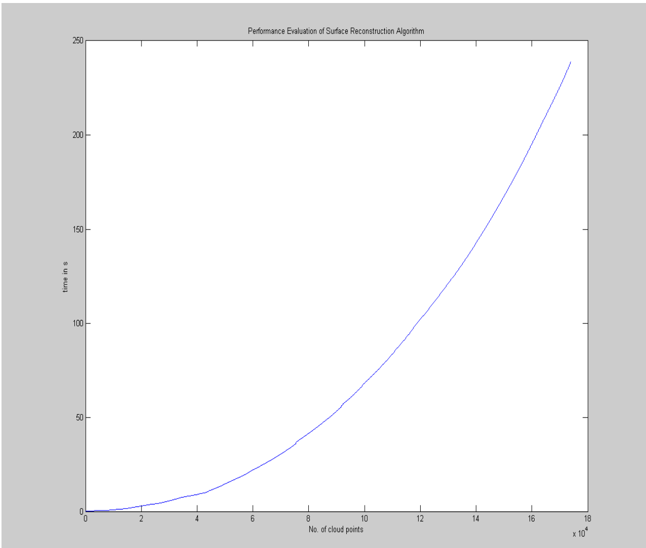

Fig2. Surface reconstruction v/s the number of cloud points for the crust algorithm.

III. Voronoi Diagram and Delaunay ALGORITHM

Voronoi diagrams and Delaunay triangulations are important geometric data structures that are built on the notion of "nearness." Many differential properties of curves and surfaces are defined on local neighborhoods. Voronoi diagrams and their duals, Delaunay triangulations, provide a tool to approximate these neighborhoods in the discrete domain. They are defined for a point set in any Euclidean space. We define them in two dimensions and mention the extensions to three dimensions since the curve and surface reconstruction algorithms as dealt in this book are concerned with these two Euclidean spaces. Before the definitions we state a non degeneracy condition for the point set P defining the Voronoi and Delaunay diagrams. This non degeneracy condition not only makes the definitions less complicated but also makes the algorithms avoid special cases. At a Voronoi vertex which is equidistant from four points in P. Three Voronoi cells meet at a Voronoi edge, and two Voronoi cells meet at a Voronoi facet. The vertices are dual to the Voronoi cells, the Delaunay edges are dual to the Voronoi facets, the Delaunay triangles are dual to the Voronoi edges.

IV. SIMULATION RESULTS

This section represents the optimization of surface reconstruction system from scattered cloud points. The graph below shows the trace for the Delaunay algorithm.

Added Shield: 0.0097 s, Triangulation Time: 3.3673 s, Connectivity Time: 1.5157 s, Circumcenters Tetraedroms Time: 0.1685 s, Intersection factor Time: 0.1191 s, Walking Time: 9.2955 s, Total Time using Delaunay: 14.5000 s.

Added Shield: 0.0086 s, Triangulation Time: 3.1603 s, Connectivity Time: 0.8623 s, Circumcenters Tetraedroms Time: 0.1568 s, Walking Time: 0.7339 s, Total Time using Crust: 4.9540 s. The output using Crust algorithm.

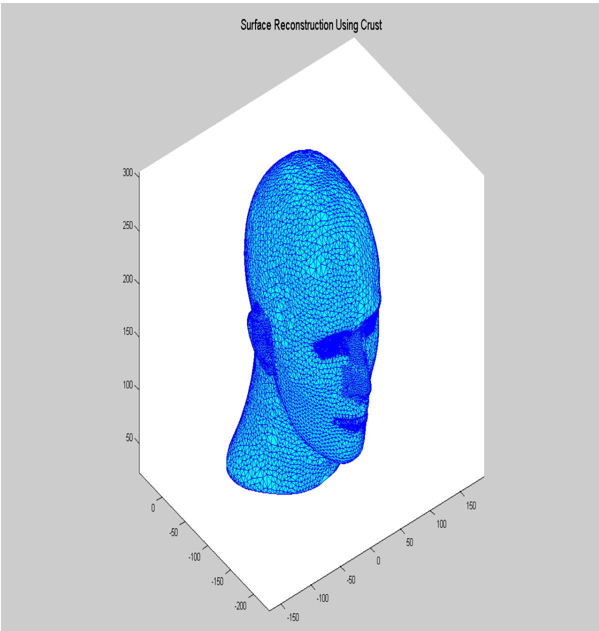

Fig3. Crust algorithm

The output using Delaunay algorithm

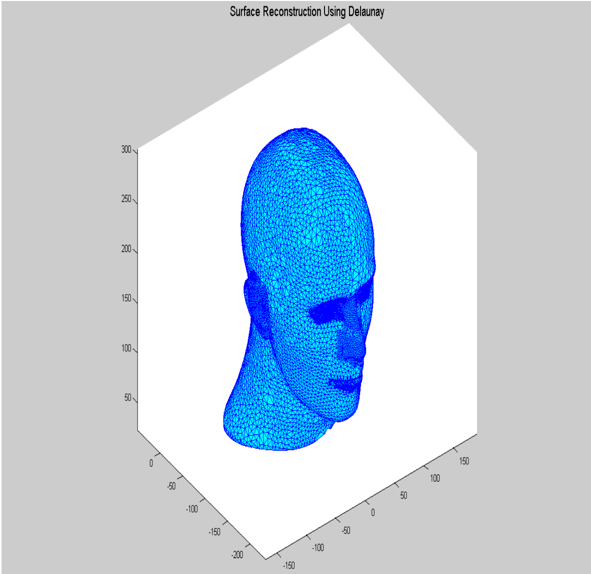

Fig4. Delaunay algorithm

CONCLUSION

This paper presents the optimization of surface reconstruction system from scattered cloud points. The results of the simulation are in the form of graphs of time taken to complete surface reconstruction v/s the number of cloud points.

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