Surface Reconstruction and Time Calculation using Crust Algorithm

Bharti Sood
Department of Electronics & Comm. Engg.
Baba Banda Singh Bahadur Engineering College
Fatehgarh Sahib, India
erbhartisood@gmail.com

Kamaldeep Kaur
Department of Electronics & Comm. Engg.
Baba Banda Singh Bahadur Engineering College
Fatehgarh Sahib,India
kamal_deep2k3@yahoo.com

Abstract— **The Crust Algorithm is an algorithm for the surface reconstruction from unorganized cloud points in 3D. This is the first algorithm which is developed for this problem. For a given point cloud from a smooth surface, the output guarantees to be topologically correct and as the sampling density increases it moves towards a common point to the original surface. According to the definition of a good sample the sampling density varies locally, strictly captures the intuitive notion so that the featureless areas can be reconstructed from fewer clouds. The algorithm is based on the three-dimensional Voronoi diagrams.**

Keywords- Point cloud; surface reconstruction; crust algorithm.

I. INTRODUCTION

All algorithms which are aiming to solve this problem must overcome several difficulties like the size and quality of the input. It is possible by modern 3D scanners to acquire several ten millions of sample points on the object's surface. A triangulation algorithm must be prepared for these applications to handle such huge data sets efficiently. Moreover due to curvature variations the point density is very uneven, some undesirable outlying elements may occur, and scanning techniques affect sampling distribution. The input also contains measurement errors.

Crust algorithm is recently proposed algorithm for surface reconstruction problem, some other algorithms have been designed with theoretical guaranty and empirical support. All the new algorithms are based on Voronoi diagrams and their dual Delaunay triangulations. If the input is having additional information such as the estimation of surface normal, or matrix adjacency among the cloud points from range scanners, efficient algorithms can exploit this information. However, in absence of any such extra information, Voronoi/Delaunay based methods seem to be very effective.

Crust algorithm computes the Delaunay triangulation D(P[Q]). To extract the candidate triangles of the surface that should be reconstructed from the computed Delaunay triangulation, the algorithm discards all triangles having not all vertices in P. The idea behind choosing the surface as a restriction of the Delaunay complex D(P[Q]) is that all triangles crossing the medial axis of the sampled surface S are removed. The candidate triangles contain a surface that is homeomorphic to S if the sampling P is dense enough. Therefore, a manifold extraction stage will be applied to find the final surface called the Crust.

II. CRUST ALGORITHM

The Crust algorithm for surface reconstruction, also called Voronoi filtering. This algorithm relies on the notion of the poles and medial axis. For the reconstruction, points are measured on a surface of an input shape. In 2D, if the sampling density of the shape goes to infinity, the vertices of the 2D Voronoi diagram approach the medial axis. However, a similar result does not hold in 3D. Some Voronoi vertices may lie very close to the surface and thus far from the medial axis.

A. Two Dimensions

We begin with a two-dimensional version of the algorithm. The crust connects the centers of the circum circles produces the Voronoi diagram. This technique has several strengths like: the construction of surface in 2D ensures the homotopy type, Efficient methods for computing voronoi diagrams are available for 2D,the method permit the use of both local and global salience measures to determine which surface constituents to retain and which to delete.

B. Three Dimensions

The first step is pre-processing where the data is input, organized, and partially analyzed to prepare for the remaining operations. Pre-processing includes data input, sorting, determination of a neighborhood for each point, and computation of an approximate normal vector to the surface at each point. The second step is extracting feature points from the data. This process is accomplished by detecting areas where there is an obvious edge based on the distribution of points in the neighborhood or areas where there is significant variation in approximate surface normals within the neighborhood. The final step of mesh generation consists of extraction of additional points as needed, generation of edges, generation of polygons from the edges, and triangulation of the polygons.

III. Results & Discussions

Results of the experiments are carried out by Crust Algorithm. This section presents the visual results of the experiments and parametric readings for the reconstructed meshes. The data object is the Mannequin. Fig. 1 is formed by the original point clouds. The result is shown in Fig. 2 which is formed by the Voronoi based Crust algorithm. To demonstrate the efficiency time monitoring is employed. As It is capable to generate the surface it also monitors the various parameters of mesh generation and evaluates the performance of Crust surface reconstruction algorithm. Time monitoring is a good approach for analyzing the triangulation efficiency. It describes the details of surface reconstruction and computes the execution times. As the results are depicted in Figure 2, corresponding settings and execution times are presented in Table 1.

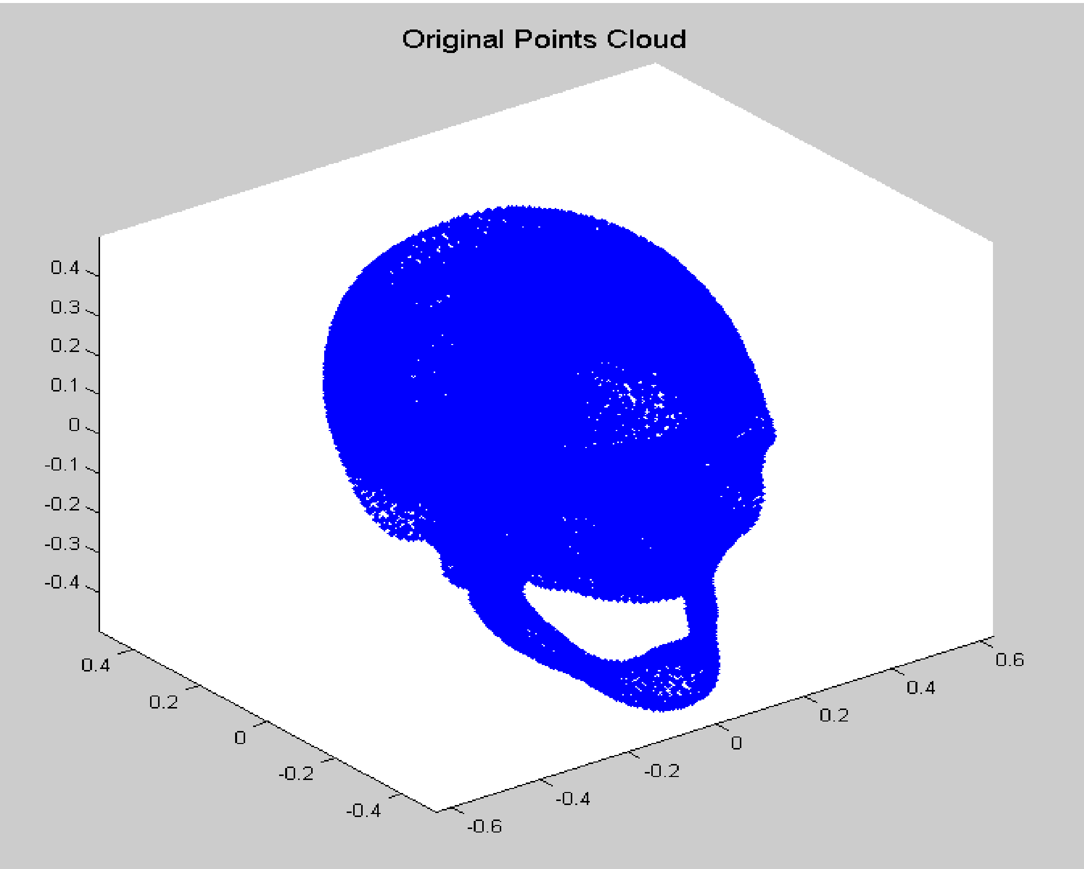

Figure1. Surface Reconstruction using Original point cloud.

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TABLE I. TIME CALCULATIONS USING CRUST ALGORITHM

S.No.	Parameters	Crust Algorithm
1	Scatter Added	0.0029 s
2	Triangulation	3.9681 s
3	Triangle Connectivity	1.1942 s
4	Circumcenters Tetraedroms	0.1520 s
5	Walking through whole scatter	4.1581 s
6	Total Time using Crust	9.4860 s

IV. CONCLUSION

In this paper Crust algorithm optimizes the mesh reconstruction system from 3D point cloud and it presents the execution times. Some applications medical imaging, geographic data processing, and drug designs, can take advantage of the technology to compute the digital model of a geometric shape with reconstruction algorithms. The output by Crust algorithm is guaranteed to be topologically correct and works more efficiently. It improves the Average shape of elements. In crust algorithm Image Formation is fast as compared to image formed by points.

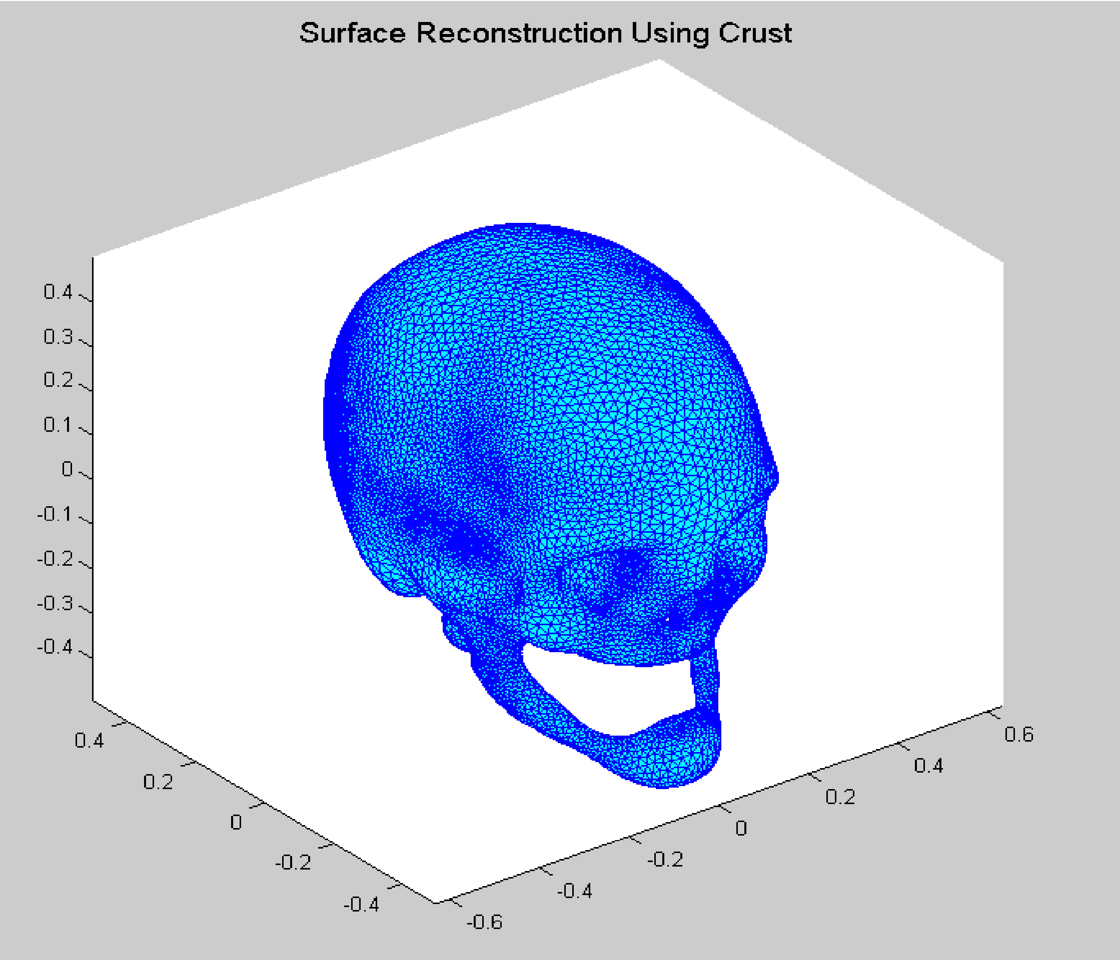

Figure2. SURFACE RECONSTRUCTION USING CRUST ALGORITHM.

REFERENCES

[1] S N Timothy, Y Hong, “A survey of the marching cubes algorithm, Computers & Graphics”,2006, 10(30), pp.854-879.

[2] S Peer, K Ullrich, M Hans. “Topologically Correct Image Segmentation Using Alpha Shapes”, Discrete Applied Mathematics, 17 July 2008.

[3] B Curless, M Levoy. “A Volumetric Method for Building Complex Models from Range Images” . ACM SIGGRAPH, 1996, pp.303-312.

[4] Nina Amenta and Marshall Bern, “Surface reconstruction by Voronoi filtering”. To appear in 14th ACM Symposium on Computation Geometry, June 1998.

[5] D. Attali, “r-Regular Shape Reconstruction from Unorganized Points”. In 13th ACM Symposium on Computational Geometry, pages 248.253, June 1997.

[6] C. Bajaj, F. Bernardini, and G. Xu, “Automatic Reconstruction of Surfaces and Scalar Fields from 3D Scans”. SIGGRAPH '95 Proceedings, pages 109.118, July 1995.

[7] N. Amenta, M.Bern, and M. Kamvysselis, “A new voronoi-based surface reconstruction algorithm”, in Siggraph Conference Proceedings,1998, pp. 415-422.

[8] F. Bernardini and C. Bajaj, “Sampling and reconstructing manifolds using alpha-shapes”, In 9th Canadian Conference on Computational Geometry, pages 193.198, August 1997.

[9] J-D. Boissonnat, “Geometric structures for three-dimensional shape reconstruction”, ACM Transactions on Graphics 3: 266.-286, 1984.

[10] K. Clarkson, K. Mehlhorn and R. Seidel, “Four results on randomized incremental constructions”, Computational Geometry: Theory and Applications, pages 185-121, 1993.

[11] B. Curless and M. Levoy, “A volumetric method for building complex models from range images”. In SIGGRAPH '96 Proceedings, pages 303-312, July 1996.

[12] H. Edelsbrunner, D.G. Kirkpatrick, and R. Seidel, “On the shape of a set of points in the plane”, IEEE Transactions on Information Theory 29:551-559, (1983).

[13] H. Edelsbrunner and E. P. Mucke, “Three-dimensional Alphan Shapes”. ACM Transactions on Graphics 13:43-72, 1994.

[14] L. H. de Figueiredo and J. de Miranda Gomes, “Computational morphology of curves”. Visual Computer 11:105.112, 1995.

[15] A.Witkin and P. Heckbert, “Using particles to sample and control implicit surfaces”, In SIGGRAPH '94 Proceedings, pages 269-277, July 1994.

[16] H. Hoppe, “Surface Reconstruction from Unorganized Point”, Ph.D. Thesis, Computer Science and Engineering, University of Washington, 1994.

[17] M. Melkemi, “A-shapes and their derivatives”, In 13th ACM Symposium on Computational Geometry, pages 367.369,June 1997

[18] G. Taubin and J. Rossignac, “Geometric compression through topological surgery”, Research Report RC20340, IBM, 1996.

[19] H. Hoppe, T. Derose, T. Duchamp, J. Mcdonald, and W. Stuetzle “Surface reconstruction from unorganized points”, Proceedings of Siggraph Conference, 1992, pp. 71-78.

[20] N. Amenta, S. Choi, and R. K. Kolluri, “The power crust”, Proceedings of the sixth ACM symposium on Solid modeling and applications, 2001, pp. 249-266.

[21] S. Fortune, “Voronoi diagrams and delaunay triangulations”, Computing in Euclidean Geometry, 1992, pp. 193-233.