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IMPLEMENTATION OF SURFACE RECONSTRUCTION USING SCATTERED POINT CLOUD WITH CRUST ALGORITHM

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ABSTRACT

Surface reconstruction means that retrieve the data by scanning an object using a device such as laser scanner and construct it using the computer to gain back the soft copy of data on that particular object. Surface reconstruction is a reverse method. It is very useful when in a particular object original data is missing without doing any backup. We develop a system for image reconstruction from scattered cloud points. Crust algorithm with umbrella Filtering will be implemented. Crust algorithm plays an important role due to its guaranteed quality of triangular mesh generation. Crust algorithm monitors the various parameters of mesh generation and evaluates the performance of the algorithm by calculating parameters. The main aim of the algorithm is to filter out left insignificant data while preserving an acceptable level of output quality.

KEYWORDS: Surface Reconstruction, Crust Algorithm, Umbrella Filtering, Point Clouds, 3D

INTRODUCTION

The past few decades have seen many applications of 3-D data acquisition technologies. For example, in computer graphics it is often required to capture complex 3D shapes on site by portable laser scanner for computer simulation and animation. In addition, X-rays, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) scanning are all typical data acquisition applications in medical field. In all these applications, data sources from various data acquisition devices consist of discrete sampling data, which could be further divided into different categories: unorganized data, contour data, volumetric data, range data, and so on. Converting the discrete sampling data representation of a physical object into a continuous surface of digital representation in computer is known as surface reconstruction.

If the discrete sampling data has enough resolution to represent the scanned model surface, the surface reconstruction would recover the topology and geometry of the model surface. The general pipeline of the 3D data acquisition and processing from the initial physical object in real-world to the final digital model in computer-world is shown in Figure 1. The first stage involves the acquisition of the discrete sample from a physical object through 3D data acquisition system. The second stage includes reconstructing basic geometric surface model from the acquired discrete sampling data. Once the geometric model is in place, various application-specific modeling and digital processing can be launched in the third stage. In all the stages of the data acquisition and processing, surface reconstruction undoubtedly stands out as the most significant and challenging task in obtaining the digital model from the physical object.

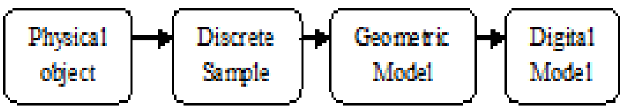

Figure 1: The General Pipeline of 3D Data Acquisition and Processing

The problem of surface reconstruction appeared in medical imaging. Recently digital documentation is very modern and expanding method in many scientific and engineering applications. The input is a finite set of points in the space, we know 3D coordinates. The input set is called point cloud in computer graphics. Real data can be obtained from 3D scanning of the real object and may contain as many as millions points. The output is a reconstructed surface so that the points of the input set lie on or close to surface. If it is possible we want to get the parametrical or implicit description and the final step is to create 3D model of reconstructed surface

The input set of points is mostly redundant, some points are useless, don't contain any new or important information. For that reason it is necessary to reduce the input set of points and remove the useless points.

Pole: A vertex of the Voronoi cell, V (pi,P), of a sample point pi belong to P is called a pole if

- Either it is the vertex vi of V(pi) that is the farthest from pi
- or it is the vertex wi of V(pi,P) that is the farthest from pi in the halfspace H−i , set of points x such that (vi−pi)· (x− pi) <0[3].

LITERATURE REVIEW

In recent years, the surface reconstruction problem in three dimensions found some attraction from researchers in computer graphics as well as from researchers in computational geometry. There is a wide range of applications for which surface construction from point cloud is important. We focus on the algorithm based on the spatial subdivision. The goal of these algorithms is to find the cells related to the surface described by the input set of points. We can select the cells in two ways – surface-oriented and volume-oriented.

Another region growing method [1],[2] by picking triangles from Delaunay triangles. The region growing approaches that the reconstructed surface mesh is highly dependent on the choice of the seed triangle and an appropriate hole-filling post processing method is needed for constructing a closed surface mesh.

Problems in Surface Reconstruction

- **Noisy Points:** The location of points may be perturbed by unknown levels of noise.
- **Missing Point Normal:** The points may not be equipped with point normal, which indicate the orientation of the local shape.
- **Irregular, Incomplete Sampling:** The surface may not be well-sampled. This often leads to holes, which are to be filled additional efforts.
- **Holes:** Holes, resulting from the insufficiently sampled regions, might need to be filled.
- **Boundaries:** The boundary of the surface might need to be preserved.
- **Non-Manifold Surface:** A non-manifold surface includes surface junctions or surface boundaries, which cannot be reconstructed correctly by traditional surface reconstruction algorithms.
- **Fair Mesh:** The triangles in the resulting mesh should be well-shaped. It is required by some follow-up operations on the mesh, such as Finite Element Analysis.
- **Sharp Features:** Sharp edges (creases) and corners should be preserved, even though they break the assumption of smoothness

ALGORITHM OVERVIEW

There are many algorithms for the surface reconstruction such as alpha shape, ball pivoting algorithm [10] but our approach is built on crust algorithm. In Crust algorithm, we first compute the Voronoi diagram of the sample and select the poles in the Voronoi vertices to estimate the medial axis, then we compute the Delaunay triangulation of the combined point set of the samples and poles, in the end we choose the triangles whose vertices are all samples.

CRUST ALGORITHM [7]

- Compute the Vornoi Diagram of the sample point S.
- For each sample point s do:
  - If s does not lie on the convex hull, let $p+$ be the farthest vornoi vertex of Vs from s. Let $n+$ be the vector of sp+.
  - If s lies on the convex hull, let $n+$ be the average of the outer normals of the adjacent triangles.
  - If $p-$be the vertex of Vs with negative projection on $n+$ that is farthest from s
- Let P be the set of poles $p+$ and$p-$, compute the Delaunay triangulation of S union P.
- Keep only those triangles for which all the three vertices are sample point in S.

Some triangles in three-dimensional crust aren't correct .It means it contains many bad poles so we apply filtering on this algorithm which is based on the number of edges, number of vertices and orientation. After that a power shape is formed of image which has a smooth surface

Flowchart for Surface Reconstruction

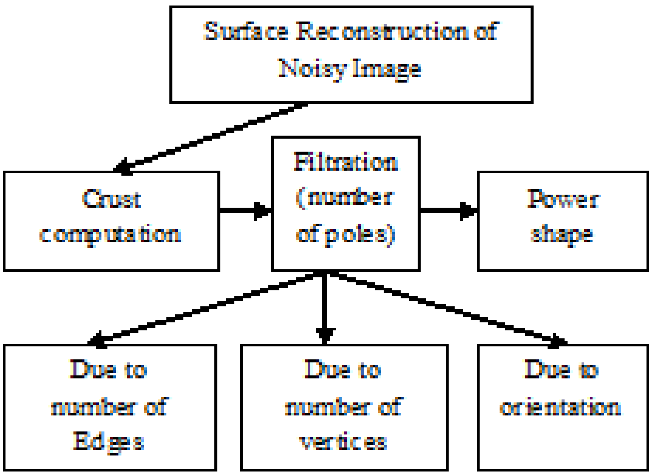

Figure 2

Table 1: Computation of Bad Poles Using Crust Algorithm of Image Knot

Noise Threshold	Number of Bad Poles	Total Poles
0.5	909	1528
0.55	131	2091
0.58	41	2168
0.6	14	2191
0.62	2	2201
0.65	0	2203

This table shows that on the different noise threshold value the number of bad poles changes. As the threshold value increases the number of bad poles decreases. As the number of bad poles reaches to zero which shows that the surface is smooth and filter out the insignificant data.

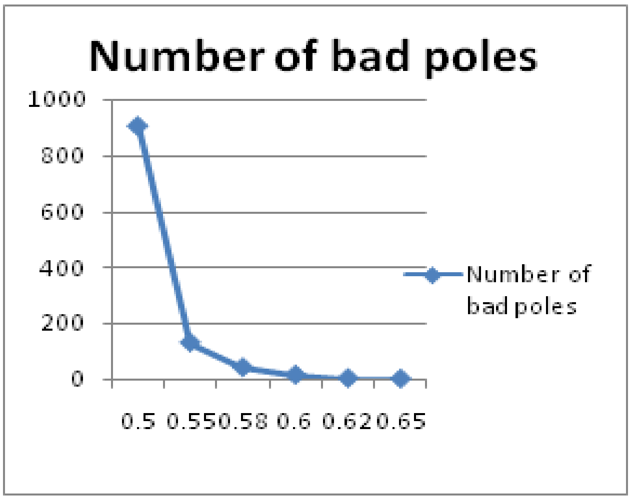

Figure 3: Performance Evaluation of Number of Bad Poles of Image Knot

This graph shows the number of bad poles compared with noise threshold value. Initially the image is noisy and number of bad poles is very large. As the value of threshold increases the number of bad poles decreases and reduces to zero which shows that surface is smooth on the threshold value 0.65

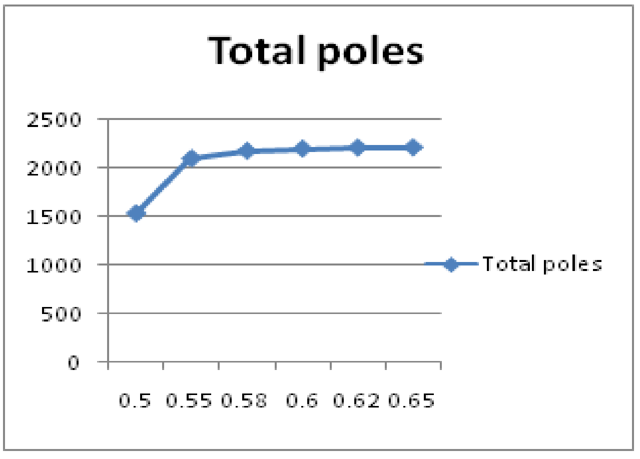

Figure 4: Performance Evaluation of Total Poles of Image Knot

This graph shows the total number of bad poles on different threshold values Noise threshold is a parameter which ranges from 0.5 to 1

CONCLUSIONS AND FUTURE SCOPE

In this paper we have given an algorithm for reconstructing an interpolating surface from sample points in three dimensions. The algorithm is simple to analyze, easy to implement. Crust algorithm compute the number of triangles but after crust algorithm some triangles are not good i.e left out some insignificant data so we can apply filtering based on the number of vertices, number of edges and orientation. After filtering number of bad poles are reduced and we obtain the smooth surface.

In this paper the image will be taken only of pts extension. This is the limitation with the algorithm so we can improve its efficiency by dealing with another image format.

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