

Diplomarbeitspräsentationen der Fakultät für Informatik

Normal Estimation Of Very Large Point Clouds



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1. Scope of the work

This diploma thesis shows a way to find the nearest neighborhood and furthermore the normals in very large point clouds. Point clouds with normals per point so called oriented point splats are useful in many applications. For example in object space point splatting, phong shading, visibility and many more.

6. Normal Estimation

An application of the k nearest neighborhood is the estimation of normals per point. The normal estimation operator has to solve a linear least squares problem. Which means it has to minimize the least squares errors orthogonal to a plane. Therefore an eigenvalue problem has to be solved which is done with a standard algorithm. The normal is the eigenvector with the smallest eigenvalue.

7. Hanghaus of Ephesos

2. Contribution

We improve on the point streaming framework by [PS04] in the following ways. The external sorting part takes advantage of the spatial relationship of the points. The k nearest neighborhood part finds nearest neighbors independent of the sampling density of the points.

3. Point Streaming sweep-direction

The point streaming approach is divided into two steps. First the point cloud is sorted along an axis. Then a plane is swept along this axis. Whenever a point lies on the plane so called local operators are applied to that point. Any local operator implements a specific task and operates on an active set of points. The active set are all points in main memory that are necessary to find the nearest neighborhood and furthermore the normals.



The image shows the false color coded normals of the Hanghaus

4. External Sorting

For the sorting step a distribution sort strategy was developed in this diploma thesis which allows to keep as many points as possible in main memory and furthermore to keep the I/O disc access as low as possible. In detail a balanced binary search tree was used to store the points and a least recently used cache was used to manage the memory.

5. K Nearest Neighborhood

The k nearest neighborhood operator finds the connectivity inside the point cloud. Which means it has to find the k nearest neighborhood for any point in the point cloud. Therefore an improved version of the existing operator in the work by Renato Pajarola was developed. A basic outline of the algorithm is shown here. Each point is storing a nearest neighbor list. For each point in the point cloud:

1. Search for the neighborhood in the active set. 2. Update the nearest neighbor lists of all found nearest neighbors with the new point.

of Ephesos point cloud. On the top left image the point cloud was processed with 10 nearest neighbors, on the top right with 20 nearest neighbors, on the bottom left with 30 nearest neighbors and on the bottom right with 40 nearest neighbors. The point cloud has 8.537.584 points. External sorting took 22 seconds. Point streaming in the order of the mentioned images took 3.5, 4.5, 7 and 9 minutes. The visual results together with the timings showed that 20 nearest neighbors are both accurate and fast enough.

8. Domitilla



3. Remove all points that are outside the searching range from the active set.

4. Insert the new point into the active set.

References

[PS04] Renato Pajarola and Miguel Sainz. Stream-processing point data. Technical report, Department of Computer Science, University of California, 3 2004.

took about 10 hours and point streaming about 24 hours.