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Implementation of Grid Point Cloud Data Processing and Dynamic Loading Technology

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Abstract. In recent decades, computer graphics have developed rapidly. With the development of computer graphics, some related technologies have also appeared one after another or have made great progress on the basis of the original. New terms such as virtual reality, digital city, digital museum, and reverse engineering emerged one after another and began to enter the application stage. These technologies are indispensable for 3D geometric modeling, but traditional modeling tools such as AutoCAD, 3D Max, and MAYA have gradually failed to meet the modeling needs of complex curved objects, resulting in the emergence of 3D laser scanning technology.

Keywords: Grid data, Point cloud data, Data processing, Dynamic model, Data loading technology, System implementation.

1. Introduction

The three-dimensional laser scanner adopts a non-contact measurement method to directly obtain the sampling point of the surface of the real object, namely the point cloud data, and any curved surface can be reconstructed by using the point cloud data. This method is not affected by the complexity of the surface. If the surface sampling density is sufficient, high reconstruction accuracy can be achieved. Therefore, the three-dimensional scanning and related data modeling technologies have developed rapidly in recent decades.

Because of the unique advantages of three-dimensional scanning technology, people have conducted a lot of research on it in the past two decades and in 1965, L. Robert in his dissertation. "Machine perception of two-dimensional objects" proposes the possibility of using computer vision technology to obtain three-dimensional information of objects, which marks the beginning of a new era of three-dimensional scanning technology. Later, people have proposed some methods of three-dimensional scanning, but because of computer vision technology Electronic devices, computer performance, image acquisition equipment and other requirements are very high. At that time, this condition was not met. Therefore, until the 1980s, with the development of related technologies, three-dimensional scanning technology gradually became industrialized.

Abroad, three-dimensional scanning equipment has been widely used in machinery processing, digital city modeling and other fields, according to the scanner usage and application areas are divided into handheld, desktop, ground and airborne scanners. The highest accuracy of desktop scanners in Europe and America can achieve a scan accuracy of a dozen micrometers. The density of point clouds even exceeds the resolution of human eyes when working, three-color laser scanning is used to obtain true color point cloud data. This kind of point cloud model does not need to be meshed, but the amount of model data is huge, which is more suitable for small and precious artifact modeling.

In terms of software platforms, various types of CAD software have introduced 3D functions one after another. The 3D GIS system is also a research hot spot. The most advanced digital city platform in the United States has successfully established digital Philadelphia and will launch products for different platforms such as general personal PCs, PDAs, car phones, and mobile phone wireless communications. The data collection is accomplished by the combination of an airborne 3D scanner and a terrestrial 3D scanner. The city model is highly realistic, and it is equipped with a rich database of urban comprehensive information and has a relatively complete function of a real-time interactive digital city. The point cloud data processing technology is the core algorithm in the above software implementation. Its research started roughly in the 1980s. The key technologies for processing point cloud data mainly include point cloud meshing, multi-view cloud stitching, point cloud model simplification, and multi-resolution representation.

Since the scanning of an object by a three-dimensional scanner needs to be performed several times in several positions, how to integrate point cloud data obtained by different viewpoints into a coordinate system, that is, the problem of splicing of multi-viewpoint clouds has become a hot spot of research. ICP algorithm is a basic algorithm to solve the problem of multi-view splicing.

2. The Proposed Methodology

2.1 Three-dimensional Information Acquisition Method.

Traditional coordinate measuring machines mostly use trigger probes such as mechanical probes, which can be used to perform point-position measurements by programming a scan path, and each time a coordinate value of a point on the measured surface is obtained. This measurement is slow. In the early 1990s, famous coordinate measuring machine manufacturers such as British Renishaw Company and Italian DEA Corporation successively developed a new generation of force-displacement sensor scanning measurement heads. The probe can perform sliding measurement on the workpiece to continuously obtain the coordinates of the surface information. The CMM is characterized by high measurement accuracy and no special requirements on the material and color of the measured object. For parts that do not have complicated internal cavities, feature geometry, and only a few characteristic surfaces, the CMM is also a very effective and reliable as the three-dimensional digitization method, but cannot accurately measure soft objects. The coordinate measuring instrument is expensive, has a high requirement for the use environment, has a slow measurement speed, and has a low measurement data density. The measurement process requires manual intervention. It is also necessary to perform probe damage and probe radius compensation on the measurement results. These deficiencies limit its application in the field of rapid reversal.

The laser line structure optical scanning measurement method is an active structure optical code measurement technology based on the triangulation principle, which is also called a light cut method. A laser line structure light is projected onto a three-dimensional object, and a CCD ingests a two-dimensional deformation line image on the object surface to calculate a corresponding three-dimensional coordinate. Compared with the laser spot scanning method and the projection grating method, the light cutting method is ideal both in terms of measurement accuracy and speed.

The layer-out image method can be used to measure the geometry of the cross-sectional profile of an object. The working process is: The part to be tested is completely encapsulated with a special resin material (filled graphite powder or pigment) until the resin is cured. It is clamped to a milling machine and micro-mechanical milling is carried out. The result is a section containing the parts and the resin material. The control table is then moved by the CNC milling machine to the CCD camera. The position sensor sends a signal to the computer. The computer receives the signal. After the signal, the image acquisition system is triggered to drive the CCD camera to sample and quantify the current section, thereby obtaining a three-dimensional discrete digital image. The boundary contour image can be obtained by extracting the boundary contour using digital image processing techniques such as filtering, edge extraction, texture analysis, and binarization. The coordinates of the position of each section profile. Layering can be used to measure objects with holes and cavities. The downside is that this measurement is a destructive and irreversible process.

2.2 Data Processing.

In the process of 3D modeling using point cloud data, data acquisition is a very important link, and it directly relates to the quality of the 3D model created last. To obtain accurate and low-redundancy data, human-induced errors must be reduced during the scan.

First of all, it is necessary to examine the scanned object and the surrounding environment to determine the position of each scanning position and the position where the reflector is placed. First, it must be ensured that the data of each scanning position will ultimately obtain the complete scanned object data. Second, try to select fewer scan positions to reduce the amount of original data and splicing errors. Third, ensure that there are at least four common reflectors that are not in a straight line at the two scanning locations.

Before using it for the first time, you must perform camera registration in accordance with the scanner's instructions for use. After the first registration, the relevant conversion matrix is generated and stored in the project file. The camera will be removed from the scanner after each use, and the position of the camera and the previous ratio will be slightly moved when it is used again. Therefore, the installation calibration is required before each use.

During the scanner's operation, the line scan in the vertical direction is first performed, and then horizontal rotation is performed according to the set horizontal angle resolution, and then the vertical direction line scan is performed. Although this kind of work process is very regular, the point cloud obtained is still rather scattered. It is necessary to smooth the point cloud before modeling.

Some scanners and software rely on the calibrators between the different points of the cloud during the scan. Generally, the reflectivity of the laser to the laser is relatively high, and it is relatively easy to acquire the spatial position of the laser during scanning. In this way, as long as there are four common calibration objects in the two point clouds, there are four common points, and the transformation matrix can be calculated.

A point is the simplest element in a geometry, but it is not easy to operate on its collection. Because it is not like a straight line or a face, it can perform various operations such as crossover and reduction. Since the overlapping area of multi-view clouds is generally not very large, it is feasible to take only a subset of the point clouds at the split point. Traversing all points of this subset is still acceptable for the current calculation speed and time. The most critical issue is the accuracy of the splicing. The error that causes accuracy comes from two aspects: The choice of the initial transformation matrix and the selection of the splicing algorithm when iterating.

The error of the transformation matrix is related not only to the selected mathematical model but also to the surface finish of the object. The main idea of the stitching algorithm is that it can be regarded as the composition of adjacent iteration points when any two planes whose normal angle is not greater than a certain critical angle are iterated in order. However, for a physical sample with a symmetric shape, the plane of any three points of the two symmetry sections is not only less than the critical angle, but may even be parallel to the normal angle, which will cause a huge deviation in the iteration, so that the selected The iterative point is far from the target point.

The advantage of the global method network construction method is that the established grid is relatively uniform, there is no overlap, and the number of grids is small; the disadvantage is that the amount of calculation and memory consumption are large, especially the complexity of the calculation time may be presented as the size of the point cloud increases. index increase. This is mainly due to the fact that each time a new point is introduced, the original grid structure will be destroyed and it needs to be re-divided, with the complexity of the points increasing in time.

The disadvantages of the large amount of computational cost and memory consumption of the global network construction method are unacceptable in many cases, especially as the depth of the application makes the model more and more complex. In order to increase the speed of network construction, researchers have started to pay attention to the method of network construction for local linear fitting in recent years.

The biggest advantage of local fitting is that it is fast. If you first preprocess the point cloud, calculate some local

Topological information, then it can be based on the local topology structure of the local segmentation line fitting. Although this process consumes sometime in the preprocessing, the local network construction process is much faster than the global network construction. As the point cloud size increases, the time complexity of the algorithm basically increases linearly.

2.3 Multi-resolution Representation of Data.

Generally speaking, when using 3D scanning, we hope that the higher the scanning accuracy, the better the sampling point is, so that the details of the scanned object can be captured more accurately. However, the point cloud size becomes larger during modeling and storage transmission.

The progressive mesh model generation algorithm is based on the vertex deletion algorithm and the top point deletion simplification method is used to simplify the original model. To avoid complicated triangulation, the algorithm selects a vertex associated with the deleted vertex as a starting point to locally triangulate the remaining holes. According to different vertex classifications, the algorithm calculates the importance degree of the corresponding vertices, deletes the vertices from the smallest to the largest, and records the simplified process of the model with a certain structure, and obtains a new representation of the progressive mesh model. The representation method of the progressive mesh model can generate an appropriate simplified model of the current viewpoint in real time based on the current viewpoint parameters.

Neighbor classification is an extreme case of piecewise linear discriminant functions. It takes all samples in each class as “representative points”, and the approximate degree of two samples is defined as the distance between representative points. Until now, the nearest neighbor classification is still one of the most important methods of pattern recognition nonparametric methods. The most basic neighborhood classification is the nearest neighbor method. For an unknown sample, we only need to compare its Euclidean distance with all samples in a known class.

In point cloud data processing, point cloud simplification and local network construction methods need to set neighbor information. Since home nearest neighbors are an important local topological relationship of scattered point clouds, they are often searched for near neighbors before surface reconstruction.

In computer vision, multi-view generally uses image information. Considering some constraints of multi-view geometry, related research is currently very hot. Projective geometry and multi-view geometry are the basis of visual methods. Similar co-linear equations exist in photogrammetry, beam adjustment method, etc. Here, the multi-view matching of point clouds is also put here. For example, the three-dimensional reconstruction of the human body, multi-view reconstruction of point clouds is no longer a simple frame-by-frame matching, but also needs to consider the accumulation of errors from different angle observations, so there is a The model is optimized or the Fusion fusion process is inside. Usually SLAM is achieved by observing the formation of a closed-loop overall adjustment, giving priority to ensuring the accuracy of the pose. Multi-view reconstruction achieves the overall optimization of the model through the Fusion process, ensuring the optimal model. Multi-view 3D reconstruction can use only images, or point clouds, or a combination of both (depth images). The result of the reconstruction is usually a mesh mesh. The most typical examples are KinectFusion, Kinfu and so on.

3. Conclusion

If you want to describe a three-dimensional point cloud, the position of the light cloud is not enough, and often you need to calculate some additional parameters, such as the normal direction, curvature, and cultural characteristics. Like the features of the image, we need to use a similar approach to describe the characteristics of the 3D point cloud. On the two-dimensional image, there are key point extraction algorithms such as Harris, SIFT, SURF, and KAZE. The idea of this feature point can be extended to three-dimensional space. Technically, the number of key points is much smaller than that of the original point cloud or image.

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