# Research on Rapid Reconstruction of Three-dimensional Model in Medical Image Processing Based on VTK Library

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**Abstract:** Medical image three-dimensional model reconstruction technology, which uses two-dimensional medical image sequence to reconstruct three-dimensional model, provides doctors with intuitive, comprehensive and accurate information of lesions and normal tissues, is one of the hotspots in the field of medical imaging. According to different reconstruction models, virtual arbitrary cutting is realized, and surface cutting and volume cutting, and the interactive method of virtual cutting is discussed. The minimum error in merging is calculated to determine the location of the new vertex. Using the toolkit and library to develop a medical image 3D model reconstruction and visualization system, can read medical image data in a specific format, perform 3D model reconstruction, and finally real-time interaction. The experimental results show that the proposed method can effectively preserve the graphical features of the original model and provide convenient use for real-time rendering. The VTK toolkit and library developed a medical image 3D model reconstruction and visualization system that can read medical image data in a specific format, perform 3D model reconstruction, and ultimately real-time interaction.

## 1. Introduction

In recent years, the computer three-dimensional model graphics and image technology has developed rapidly, and the latest achievements have been rapidly applied to various fields. In clinical medicine, the computer three-dimensional model image technology is used to reconstruct the two-dimensional image sequence into three-dimensional model virtual entity, which provides an intuitive and accurate model for doctors [1]. The three-dimensional model image is reconstructed from the three-dimensional model space. A series of two-dimensional slice images are used to reconstruct the three-dimensional model image model and carry out qualitative and quantitative analysis. Various operations such as rotation, zooming, moving and section display are performed on the image   The image can visually display the complex structure of human tissues, help doctors to make a clear diagnosis and guide the operation. This assistant means can make up for the lack of imaging equipment [2]. The obtained closed polygon and the direction of the line of sight form an infinitely long cylinder as the defined cutting area. Therefore, the "three-dimensional model medical image visualization system" was developed. It is the use of computer graphics and visualization technology to construct a human body model from a two-dimensional human body slice image sequence obtained from medical imaging equipment, which has become the focus of attention in recent years. The doctor can determine the condition through the auxiliary medical treatment system, so that the patient's pain can be alleviated. It enables doctors to quickly and accurately determine the patient's condition and improve the treatment level of all medical systems, playing an irreplaceable role in China's medical career [3].

In 2013, the viewpoint of medical image processing was put forward by relevant scholars [4]. Since then, the performance evaluation of simple linear iterative clustering algorithm in medical image processing has been studied by relevant scholars [5]. Since 2017, Memory Pulse Coupled Neural Network and its application in medical image processing have been proposed [6]. Medical image three-dimensional model reconstruction is a hot research topic at present. It is an interdisciplinary research field and an important application of computer graphics and image processing in biomedical engineering. It involves digital image processing, mathematics, graphics and related knowledge in the field of medicine [7]. In the simulation calculation, the geometric

information of the simulation model is also obtained by extracting the geometric information in the drawing elements. Moreover, it is difficult to fully satisfy the discretization requirements of the calculation area in the simulation calculation. Therefore, proper simplification and adjustment of the reconstructed model is an indispensable step in the simulation calculation [8]. Topological reconstruction obtains the topological representation of the entity, which classifies the contour lines on each fault layer in the 3D model fault dataset, and determines the correspondence between the entities belonging to each contour line and the contour lines on different faults of the same entity. Geometric reconstruction is the geometric representation of an object based on topology reconstruction. Commonly used in surface-oriented reconstruction is the reconstruction of the surface of the triangular surface. The reconstruction of the volume has tetrahedral reconstruction and hexahedral space mesh reconstruction [9]. By calculating the effect of all voxels on light, and human-computer interaction adjusts parameters such as opacity and illumination effects, and then synthesizes images with three-dimensional model effects [10].

## 2. Materials and Methods

In the acquisition process of medical image data, random disturbance of electronic devices in image equipment inevitably brings noise. The purpose of pretreatment is to filter or smooth the image in order to suppress noise, enhance image features and improve signal-to-noise ratio. VTK provides a variety of advanced and mature visualization algorithms and full interactive functions, thus avoiding the redevelopment of basic image algorithms and facilitating the rapid and flexible construction of application systems. Combining this tool with the widely used Windows operating system, the Windows-based modeling system developed can adapt to a wide range of application environments and provide a friendly user interface, making the interaction between users and systems more convenient and effective. . Because the original data does not generally include the normal direction where the data points are located, and this is needed in the subsequent steps, it needs to be calculated in advance. The medical image 3D model reconstruction and visualization coefficients are shown in Table 1.

Table 1 Reconstruction and Visualization Coefficient of Three-Dimensional Model of Medical Image

|  | Calculation | Combination |
|---|---|---|
| Medical Image Data Reading | 5.13 | 2.92 |
| Visualization of three-dimensional model reconstruction | 4.85 | 1.64 |
| Interacting with Users | 4.76 | 2.04 |

VTK is a general development tool kit for data visualization, not specifically for the field of medical imaging [11]. The main functions of VTK are image processing, computer graphics and visualization of scientific computing, especially three-dimensional model reconstruction (such as surface rendering and volume rendering and its powerful image processing ability). The core of VTK develops source code in C++. Due to the presence of noise and debris (the patient's head pillow, ring frame in cT imaging), there is a lot of noise and useless data in the DlcoM image, and the raw data needs to be preprocessed. Our approach is to first extract the outline of the head and classify all pixel values outside the outline to the lowest value. This method is simple and practical, and is easy to program. The light is sampled and integrated along the line segment to calculate the brightness and transparency, and the image is synthesized in the sampling order to obtain the resulting image. Medical image data is shown in Figure 1.
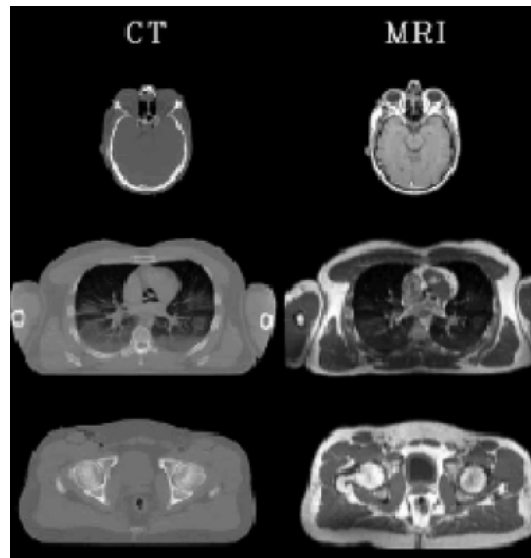
Fig.1. Medical image data

In VTK, data stream technology divides the whole volume data into several data blocks, and then processes each data block one by one. In this way, only a small part of the whole data is processed in memory. The memory occupancy of the program decreases dramatically and the speed is obviously accelerated. In addition, dividing the whole volume data into blocks provides a basis for parallel processing of multiprocessors. It is more convenient to display the reconstructed three-dimensional model image in front of users. Through the screen, users can move, rotate or cut images to observe the internal structure of human body from different vision. The positional relationship between the voxel and the cutting area is detected, and the voxel value in the cutting area is set to the set threshold, so that the partial data is discarded in the volume data, so that the cutting effect is not visible in the final image. Due to the large amount of volume data in the 3D model, the cutting speed will be slower than the face cutting. When calculating the curvature of the model vertex, first determine each edge and use the dihedral angle to determine whether the edge is a feature line. Compare all the vertices with the principal curvature of its neighborhood vertices to determine whether the vertices are feature points, and use the piecewise function to distinguish their role in the simplification of the graph from ordinary vertices.

## 3. Result Analysis and Discussion

Surface rendering first constructs intermediate geometric primitives (such as surfaces, planes, etc.) from the spatial data field of three-dimensional models, and then realizes the rendering of images by traditional computer graphics techniques such as reasonable illumination model, texture mapping method, etc. Generally, rendering itself includes three basic steps: projection, blanking and rendering. These steps are necessary for generating stereo sense of three-dimensional models, while other techniques such as stereo display, motion parallax caused by rotating objects, shadow and texture mapping can be used to enhance stereo sense. In addition, in the cutting process by the above method, the data after cutting and being cut can be separately stored, so that repeated cutting can be realized. Undo cutting and display and manipulate the data being cut. It can not only perform three-dimensional model entity interaction rotation on the 3D model reconstruction object, but also measure the distance between any two points in the space of the 3D model reconstructed object model. This laid a good foundation for the development of an accurate treatment evaluation plan. Medical image data measurement is shown in Figure 2.
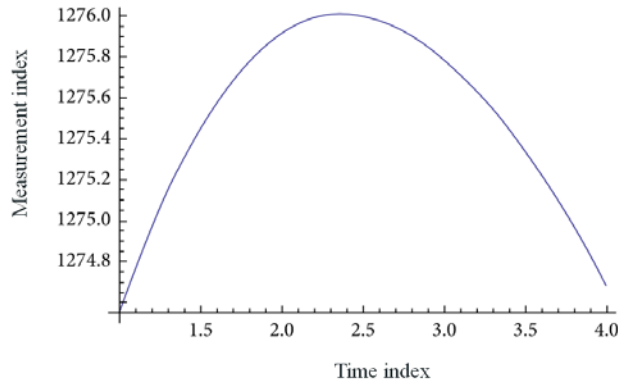
Fig.2. Schematic Map of Medical Image Data Measurement

In VTK, we can realize the dynamic display of the reconstructed three-dimensional model, such as translation, zooming, rotation and so on. The worker responds to a predefined set of actions. It allows you to control cameras and roles, and provides two interactive styles, position-sensitive and action-sensitive. Style conversion can be done by position sensitive keys and action sensitive keys on the keyboard. Surface rendering algorithm is used for surface reconstruction. According to the geometric and topological information of the reconstructed model, the points, edges and surfaces that have little influence on the geometric characteristics of the model are adjusted or deleted while maintaining certain geometric errors, and the resulting model is simplified. The result of the optimized surface model can be directly output to obtain the CAD or RP RM file, and the optimized result (surface mesh) can be meshed as the supporting surface required for meshing to obtain the final desired. The finite element body mesh. Reduce the number of meshes of the original model, including the number of patches, the number of edges, and the number of vertices, by maintaining appropriate geometrical appearance and tolerances within the model. Meet the simplification speed and quality users need. Therefore, various grid model simplification algorithms have emerged. The proposed algorithm makes the rendering and network transmission of large models possible, which has important significance and application value.

The key of picking up in the three-dimensional model environment is to get the coordinate value of input point in the direction of input device. However, it is very difficult to get the information of the third dimension model of the two-dimensional input point directly, so this idea only applies to the case where the coordinates of the input point are known. The difficulty of the problem is how to find the corresponding points in the object coordinate system from the input points of unknown coordinate information in the screen coordinate system, but the corresponding points should have the coordinate information of the three-dimensional model. Pay attention to the following facts to observe the actual situation of opaque objects, always see the nearest point to the observer on the object. In addition, the shared boundary between adjacent slices is kept unchanged because of direct resampling in the three-dimensional model space. Although this method is more sparse in the initial mesh and more complex in topology, the number of points generated by resampling may be more than the initial number of points, but for the simplified model. The degree of mesh density can fully meet the requirements of resampling, and this method can get better results at one time. From the quality of the resulting image, volume rendering is superior to surface rendering. However, in terms of interaction performance and algorithm efficiency, surface rendering is superior to volume rendering on the current platform. This is because the surface rendering method uses the traditional graphics drawing method, and the existing interactive algorithm, graphics hardware and graphics acceleration board can fully play its role.

## 4. Conclusion

In this paper, fast reconstruction of three-dimensional model in medical image processing based on VTK library is studied. With the rapid development of medical image visualization technology

and the emergence of related algorithms and optimization algorithms, the research starting point in this field has been greatly improved. Therefore, it is a shortcut to redevelop with some international open source toolkits. Based on the requirement of medical development, from the two aspects of building method and module management of three-dimensional model visualization system, satisfactory experimental results are finally obtained. It can make up for the defects caused by inaccuracy or uncertainty of providing data information by utilizing the information of multiple imaging or multiple imaging devices. Face drawing is worse than body drawing in terms of display effect. The advantage is that after the model is built, the data set can be ignored. Directly perform some processing on the model like triangle mesh simplification to improve rendering performance, and also improve the performance of the interaction. At the same time, the real operation of reconstructing the model and the basic operations of illumination display, interactive translation, rotation, and scaling are realized. These functions have been tested in a large number of modes, and have good versatility, which has deduced a good foundation for the in-depth study of 3D model reconstruction and visualization of medical images.

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