Shear Skew Warp Volume Sketch on Cloud Collaboration

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Abstract. An Active Content Collaboration Platform (ACCP) is to perform content centric collaboration with computation intensive application on cloud environment. Volume rendering for visualizing 3D data from CT or MRI of human body is one of the collaborative application in medical case. But volume rendering is limited in terms of speed, if the size of volume data becomes large. So we need a new high-performance volume rendering algorithm running on ACCP because the computational power of each machine on cloud environment is low. We proposed a Shear Skew Warp algorithm which resolves some defects of existing shear warp algorithm. In this paper, we present an improved Shear Skew Warp algorithm combined with non photorealistic rendering techniques to render the huge size of volume data in real time.

Keywords: shear warp volume rendering, cloud computing

1 Introduction

With the increase in the number of information exchange through network, collaboration environment becomes more necessary. An Active Content Collaboration Platform (ACCP) [1] is to perform content centric collaboration with computation intensive application on cloud environment. There are several cases which can be efficiently applied in ACCP, and medical case is the one of them. In medical case, a 3D data from CT or MRI is essential for analyzing interior part of patients' body. Volume rendering [2, 3] is a technique for visualizing 3D volume data from CT or MRI on the screen. One of the most widely used volume rendering techniques is direct volume rendering, which calculates the color of screen pixels by processing voxels directly. Such techniques as ray-casting [2], and splatting [4] are based on this method. Direct volume rendering results in slow speed, as it requires traversing the entire volume data whenever the viewing direction changes. Therefore, direct volume rendering is limited in terms of speed, if the size of volume data becomes large. So, we need a new high-performance volume rendering algorithm running on ACCP because the computational power of each machine on cloud environment is low.

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In previous work [6], we optimized the shear warp algorithm [5] which is one of the fastest algorithm among direct volume rendering. Further, in this paper, we present a improved Sear Skew Warp algorithm combined with non photorealistic rendering (NPR) techniques to render the huge size of volume data in real time. It is called the Shear Skew Warp Volume Sketch.

2 Shear Skew Warp

The existing shear warp algorithm has some defects such as the increases in memory consumption and in preprocessing time as well as the deterioration in image quality

In order to resolve such problems, we provide a Shear Skew Warp algorithm that does not involve the creation and use of compressed-opaque-voxel. The Shear Skew Warp algorithm skips transparent voxel region by using optimized run-length-encoding, and directly accesses to the volume memory where the initially loaded volume data is stored to get voxels needed for bilinear-interpolation. As a Shear Skew Warp algorithm makes direct access to original volume data, neither is the decompression process needed nor do resampling errors occur, which reduces the memory consumption and preprocessing time.

3 Shear Skew Warp Volume Sketch

The Shear Skew Warp Volume Sketch algorithm creates only one run-length-encoded volume by traversing volume data in the order of voxel storage, it efficiently reduces preprocessing time and memory consumption. Also, it uses mapping to the nearest screen pixel by projecting one voxel (or one pixel) to its nearest corresponding pixel without bilinear-interpolation. This can accelerate rendering speed but cause sawlike aliasing in resultant image degrading quality. Therefore it does not suit for photorealistic rendering that depicts objects in volume data realistically.

To solve these problems, we give up depicting the exact and accurate shape of objects in volume. Instead, we choose non photorealistic rendering technique that approximately visualize the silhouette lines of volume objects quickly. To render non photorealistic resultant image depicting rough silhouette lines in a fast time, the original volume data is down-sampled by the factor of 2 along each axis, and then rendered to intermediate image by applying silhouette extraction method.

Then the intermediate image is warped and up-scaled for resultant image by using warp-matrix combined with the up-scaling factor of 2. During this process, we do not carry the warp-calculations out for all the pixels. We perform the warp-process only for the pixels belong to Poisson-Disk distribution to reduce redundant time consuming and put space aside for drawing silhouette lines later.

After rendering resultant image composed of Poisson-Disk distribution points, we complete the final sketch image by simply drawing tangent lines at all the points. Tangent lines can be easily calculated and drawn by using the normal vector of most opaque voxel which is stored in each pixel memory while rendering the intermediate image.

4 Performance Evaluation

We tested three kinds of volume data on single core CPU. In piggy bank (361x512x512) case, it was running in 16ms (62.5fps). Other data were running in 17ms (58.8fps) on average. When using Shear Skew Warp algorithm for photorealistic image, Piggy bank was running in 46ms (21.7fps). Shear Skew Warp Volume Sketch algorithm shows about two times faster performance than Shear Skew Warp algorithm on average in every cases.

5 Conclusions

In this paper, we proposed and implemented an improved Shear Skew Warp Volume Sketch algorithm combined with non photorealistic rendering techniques for cloud collaboration as a medical application.

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