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A Novel Realization of Three-D Rounding Photography System

Huang Jun-Sheng, Hou Zhen-Jie, Zhang Jian-Hua
School of Information Science & Engineering Changzhou University Changzhou, China
College of Computer Science & Engineering Inner Mongolia Agricultural University Hohhot, China
*Corresponding author, e-mail: hhhuuuhu@126.com

Abstract

Three-D rounding photography system is an application of Desktop Virtual Reality. It takes the pictures around the objects with the computer, and then deasl with them for the 360 degree display in the local computer or a web page. The Three-D visual sense and image real-time amplification of this system are the key technical problems. This paper researches on this system and proposes a new solution based on the Silverlight technology togher withan improved triangle internal interpolation method based on the barycentric coordinates properties for the image real-time amplification.The experimental results show that the solution meets the visual sense and interaction Requirements of the Three-D Rounding Photography system. And the improved algorithm reduces the operation time efficiently, thus it has some practical value.

Keywords: *Three-D rounding photography; Desktop Virtual Reality; Three-D visual sense; Silverlight*

1. Introduction

The desktop virtual reality technology displays the virtual world by a conventional computer monitor, it can also be called the windows of the world. Compared with the "immersion type" virtual reality technology, desktop virtual reality system has advantage of low cost and easy promoted [1]. Based on the desktop virtual reality, panoramic technology has been developing rapidly as a new vision technology. It sutures the pictures or does some other image process, realizes the scenery display of the freedom angle and shows the object in a Three-D manner. Rounding photography is a form of the panorama photography and observation by the object node [2]. Through the rounding photography, it can get the object image,deal with the 360 degree display, and realize the viewpoint zooming. This image system would be called the Three-D rounding photography system.

In the early time of rounding photography manufacture, the accuracy, production efficiency and application manners are referred to be the obstacles of large-scale promotion. But along with the development of rich internet applications, the Three-D rounding system is adopted as a kind of low cost, high efficiency, simple release way for Three-D image process. Rich internet applications make full use of the client computer to improve the usability of the internet applications. It strengthens the interactivity and logical control, and improves the user experience, thus to fill up the gap between the local application and the internet application [3]. It is the trend of the development of the web, and would be the carrier for the Three-D rounding system at present and future. The Three-D rounding photography system is mainly realized by flash application development. There are some other realization ways, such as gif dynamic image, QuickTime VR documents, etc. In recent years, the Silverlight technology is developing very fast as Microsoft's main product for the rich internet application. It is useful for the Three-D rounding photography system development. Compared to other realization, in addition to keep the small image document volume, the Three-D rounding photography system which based on Silverlight technology is well done in program control and convenient for search found .

The actual application development and system testing prove that the Three-D rounding photography system which is based on Silverlight technology is good running and easy to be developed, it is of practical value.

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2. The System Analysis and Design of the Three-D Rounding Photography

2.1. System Requirement Analysis

Three-D rounding photography system is an image processing and display system, including image processing, image storage, and web presentation. The display platform is the internet browser, so the internet connection speed is the external factor that the Three-D photography system must consider with. Seeking a small size file format is the whole system's first priority. Secondly, the pictures which captured through professional equipment need post processing for real-time storage which needs a local image processing application, and image database. The images which stored in the server disk or in professional database would be retrieved. The internet display is the part of realization for nice user experience which including Three-D visual sense and interactive scanning, it needs clear play control logic. The analysis above has discussed what the system requires, and we find that there are many ways for us to choose. Take the Windows operating system for example,the local image processing application can be developed by any kind of computer languages only need that the Windows system can compile them. And if we decide to store the image files in a database, we can choose some database software which supports keeping the binary file, such as ORACLE, SQL SERVER. Otherwise, we can put the image files in the computer and store the image path in the database, and we could adopt some lightweight database software. The last presentation is developed mainly by rich internet application. At present, more and more rich internet application develop software for choose. Java FX, JavaScript/Ajax, Microsoft ActiveX, Silverlight, Flash, etc. Each technology possesses its advantages and has shown the excellent ability in developing the internet application. We can find that the developing of Three-D photography system has a large degree of freedom.

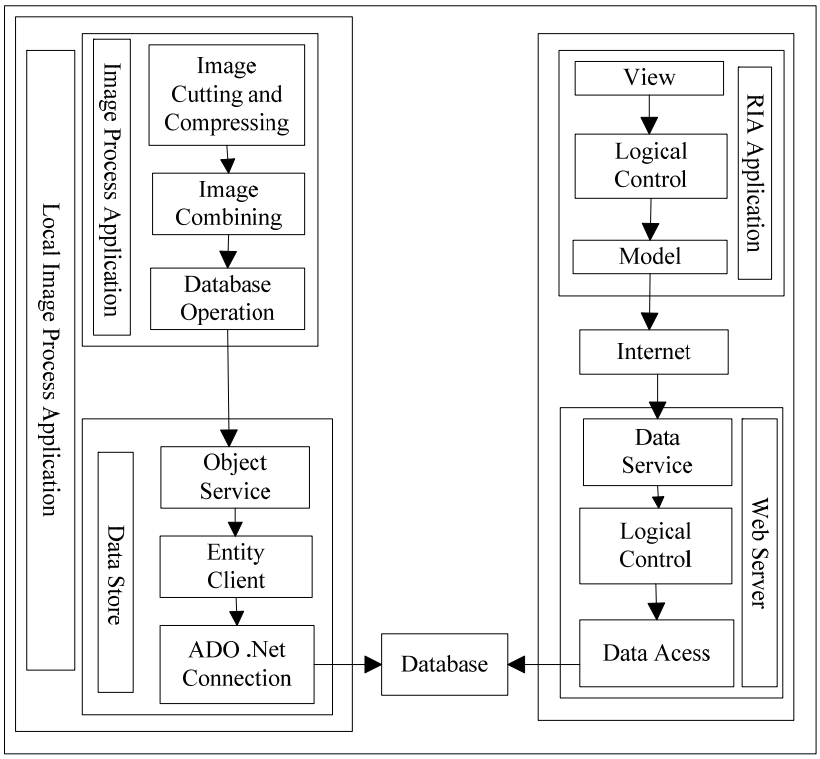

Figure 1. The system function modules

In this paper, we will propose a novel realization of Three-D photography system which is based on Silverlight technology. According to the paper above, we know that it is the kind of system which employs the Silverlight technology for developing the internet presentation application. Silverlight technology is a new software of rich internet application. It is

Microsoft.NET framework implementation for cross-browsers and cross-platform. It has the extremely superior over vector graphics, animation, and rich network communication function. Silverlight technology possesses more lightweight running environment, and has excellent develop language support. Therefore, based on Siliverlight technology, it is a novel realization of Three-D photography system, and has great practical value.

2.2. System Function Module Design

The Three-D rounding photography system which based on Silverlight technology also developed a local image processing client, and established a SQL server database to store data and communications. The file format employed is SWF which is small in the file size and widespread used in the internet. The detail module design figure is shown in Figure 1. The system is based on SQL Server database for image data operation and transmission. It adopts the LINQ database access solutions, so the local database develop is convenient. The local image processing procedures and the internet application are programmed by C sharp senior language, so the system has excellent program control ability and expansion potential. At the same time, Silverlight technology is based on the text format of XAML, so the Three-D rounding system is friendly for internet application search.

2.3. Interactive Function Analysis

The interact function of Three-D rounding photography system refers to the Three-D visional sense and the real-time interactivity. How to realize the function that the object can be viewed but left but right, but near but far, and optional zooming, it is the key problems to be solved.

For the Three-D rounding system proposed in this paper, The interactive function is realized in the internet client. Different from embedding the logical control file in the image file, it will greatly reduce the network data transmitting. The experimental data show that a nearly 900 k swf file which embedded logical data in it can be reduced below to 500 k. And it directly proves this system is superior in reducing the network burden. And how to fulfill the function demand is shown in Figure 2.

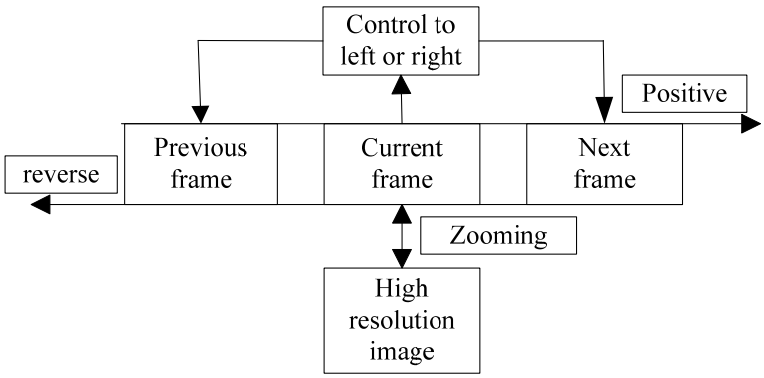

Figure 2. The basic control logic

Figure 2 is the basic interactive function schematic diagram. It shows the basic function that the single frame must have to realize the Three-D version sense and real-time interaction. First of all, the system requires sequence played and reverse played function. Second, the current frame can be controlled to left or right, and the play speed is able to be controlled too. The last is the zoom function of the current frame image. It is a key program in the Three-D rounding photography system, and we will employ an improved image interpolation for the image zooming which would be discussed in the next section. The Three-D rounding photography system proposed in this paper has achieved the interactive function perfectly through the Time FUNC and the variety of mouse input FUNC.

2.4. Real-Time Zooming Function Realization

The real-time image zooming is a key program for the Three-D rounding photography system. The image interpolation technology has to be used in the system. Image interpolation technology is varied. In this paper, we do a lot of work in the image interpolation and propose a fast triangle internal linear interpolation algorithm which based on the image quadrilateral mesh. The experiments show that the new algorithm has the less complexity about the computation. So the image interpolation algorithm which proposed in this paper is practical [4].

Most of the triangle internal linear interpolation algorithms employ the Gouraud interpolation which interpolate along the triangular edge and the horizontal scan line separately and get the final pixel value within the triangle [5,6].Though Gouraud interpolation is commonly used for triangle internal interpolation.But the image triangle mesh is projected as the right-angle isosceles triangles on the x-y plane, and the computational speed and complexity could be improved by employing the triangle barycentric coordinates interpolation. Any one point internal the triangle can be determined by weighted average of three vertexes, and the weight is called triangle barycentric coordinates. As shown in Figure 4, set b1, b2, b3 are the components of the point P, and these three values are corresponding to the ratio of child triangle area($S_{\Delta pbc}$, $S_{\Delta pac}$, $S_{\Delta pab}$) to the entire triangle area $S_{\Delta abc}$ respectively. I_1 , I_2 and I_3 are the values of the three of triangle vertexes, I_p is the value of point P .Then we get b1 + b2 + b3 = 1 and $I_p = \begin{bmatrix} b_2 & b_3 & b_1 \end{bmatrix} \begin{bmatrix} I_2; & I_3; & I_1 \end{bmatrix} \frac{n!}{r!(n-r)!}$. As shown in Figure 3, choose a point P internal the triangle ABC which is in three-dimensional space, we could get the value of point p from the formula $Z_p = \begin{bmatrix} b_2 & b_3 & b_1 \end{bmatrix} \begin{bmatrix} Z_2; & Z_3; & Z_1 \end{bmatrix}$. Z_i is the Z coordinate value of the point in three-dimensional space, and stand for the pixel value in gray image processing. According toplane projection properties, the projected area ratio is $COS\theta$, θ is the angle between the triangle ABC and the projection plane. Then the follow three formulas can be obtained.

$$b_2 = \frac{S_{\Delta PAC}}{S_{\Delta ABC}} = \frac{S_{\Delta pac} / \cos\theta}{S_{\Delta abc} / \cos\theta} = X_p - X_1 = x \tag{4}$$

$$b_3 = \frac{S_{\Delta PAB}}{S_{\Delta ABC}} = \frac{S_{\Delta pab} / \cos\theta}{S_{\Delta abc} / \cos\theta} = Y_p - Y_1 = y \tag{5}$$

$$b_1 = \frac{S_{\Delta PBC}}{S_{\Delta ABC}} = \frac{S_{\Delta pbc} / \cos\theta}{S_{\Delta abc} / \cos\theta} = 1 - x - y \tag{6}$$

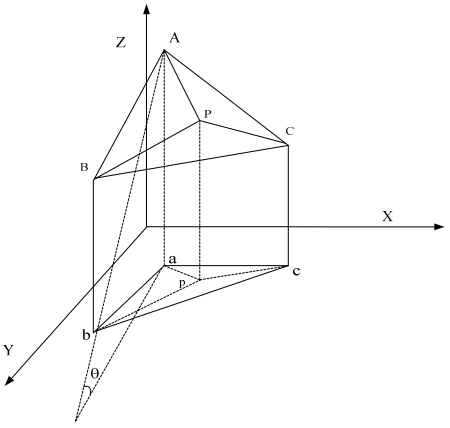

Figure 3. Triangle Projected in three-dimensional space

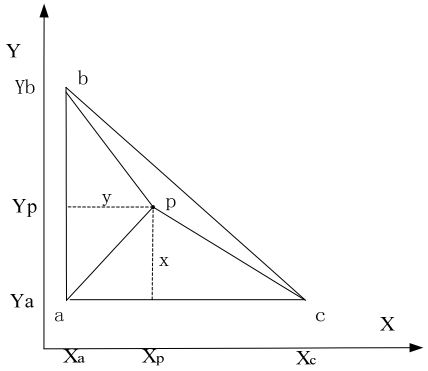

Figure 4. The projection plane

Table 1. The Comparison of the operation time

Image size	Bilinear	Method in paper 6	Improved method
100*100	0.24932	0.37411	0.36062
150*150	0.56339	0.83687	0.78669

Finally, we could achieve the Results derived. $Z_P = [x \quad y \quad (1-x-y)] \quad [Z_2; \quad Z_3; \quad Z_1]$. As shown in Figure 4, x is defined as the horizontal offset that the point P projected on the x-y plane, and y is the vertical offset. Obviously, the shape of the projection triangle on the x-y plane is a right-angle isosceles triangle. The value of the components of point p could be calculated fast. So the interpolation method would be better than the Gouraud interpolation in operation speed. As shown in table 1, our proposed algorithm has advantage in speed than the original one. It is feasible for us to employ this interpolation method for image real-time zooming.

3. System Operation Interface and Result Analysis

The Three-D rounding photography system operation interface is shown in figure 5. The test computer hardware configuration is follow, CPU of Intel dual-core E4500, and 2 G memory. The operating system is Microsoft Windows XP Professional SP3.

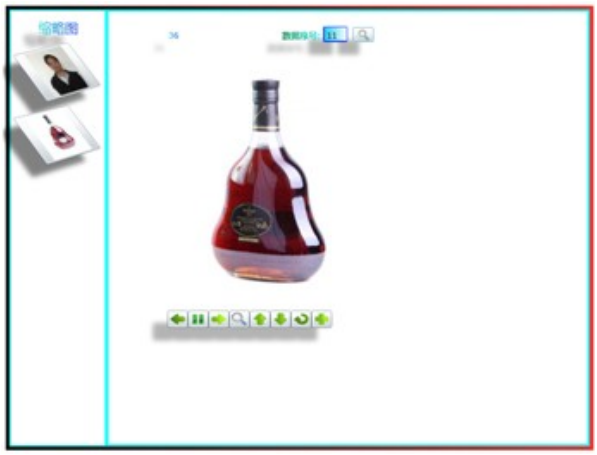

Figure 5. The system operation interface

4. Conclusion

As a kind of efficient Three-D imaging way, Three-D rounding photography is wide putted into use in the electronic commerce, virtual tour, virtual museum, and so on.. This paper proposes a novel Three-D rounding photography system which base on Silverlight technology, it possess excellent program control ability and expansion potential. At the same time, the fast triangle internal interpolation algorithm is workable in image real-time zooming, and has some practical value. Three-D rounding photography system is associated with the image processing, program design, computer communication and other related science and technology. It is a gradual development photography system. And we will do much more work in the program control optimization and functional expand.

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