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Light Illumination Information Extraction Method of High Dynamic Range Image

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***Abstract*—In this paper we investigated access technology of the light illumination information in real scene. By analyzing the conventional method, we proposed a method to access light illumination information of high dynamic range image. In the method, the image information obtained by camera was converted to the panoramic image by using image mosaic technology and then converted to the high dynamic range image by the software HDR.**

Keywords-Augmented reality; High dynamic range image;Image processing; illumination

I. INTRODUCTION

Receive real scene illumination information is augmented reality system an important means of illumination consistency, in the light of the real scene is quite complex, direct light from a variety of light sources, such as a point source, surface light source and direct sunlight inobjects between reflection arising from the indirect lighting, lighting information is difficult to describe with traditional virtual light source. references [1] proposed a way to use multiple photos of different exposure levels to obtain radiometric Figure method, this method is easy to use, but because of the camera we used is a nonlinear optical system, the brightness of the pixels in the photo is not realreflect the environmental light conditions. references [2] use of graphics hardware technology, the light enhancement of the video image, but can only be used for the viewpoint unchanged. references [3]using high dynamic range of the camera to get the environment map. Good that the method can achieve virtual, interactive light enhancement of the real scene, but not conducive to short-range illumination. references [4] using two high dynamic range camera to record the ambient light, although this method is applied to close the light but metering equipment is more expensive, is not conducive to the ordinary user. In response to these problems, this paper presents a high dynamic range image-based lighting information acquisition method. Namely the use of image stitching technology, the splicing of the ordinary camera captures multiple images into panoramic images, panoramic image generation high dynamic range image HDR software. High dynamic range image two features: one for each direction in the real environment, the image has a corresponding pixel corresponding; brightness values of each pixel in the image of high dynamic rangebrightness proportional to the real environment. As can be seen from the above features, high dynamic range image can record the spatial light distribution of the real situation. This method compared to traditional methods, saving costs, and more conducive to the ordinary user, at the same time be able to expand the use of the scene.

II. METHOD

A. Get panoramic images

Panoramic image acquisition can take different means, using professional panoramic camera panoramic images can be obtained directly, but this camera price is relatively expensive, not suitable for ordinary users to use; shoot camera with a fish-eye lens, can be obtained through image stitchingpanoramic image, captured image distortion but this method is more serious. The article will use ordinary camera to obtain images, and the image obtained is subjected to a splicing and generating a panoramic image. The hardware required for this method is simple, a wide range of applications.

1) Image acquisition

The camera fixed on a tripod, shooting position by rotating the camera with a layer of the photo, and then adjust the angle of the shaft tripod shooting multi-angle photos, as long as the overlapping area between the adjacent two or more images to pre-setthe standards can be obtained that contains a set of photos of the entire scene.

2) Projection transformation

Multiple images as captured by a camera taken under different angles, directly spliced in the overlapping area will produce localized deformation distorted image therefore needs to be unified projection onto the sphere, complete spherical orthographic then splicing can be obtained without distortion panorama image[5]. In this paper, a spherical projection model as shown below.

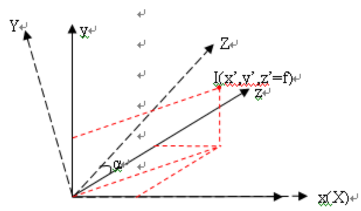

Figure 1. Spherical projection model

Set the world coordinate system of the XYZ camera coordinate system xyz, the camera's shooting angle of elevation α (For the sake of simplicity, we selected the world coordinate system and camera coordinate system x (X) axis coaxial). Arbitrary a TOUR pixel point I coordinates in the camera coordinate system as (x ', y', f), and its coordinates in the world coordinate system XYZ (XW, Yw, Zw), the link between the two can be is expressed as:

$$\begin{pmatrix} X_w \\ Y_w \\ Z_w \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\alpha & \sin\alpha \\ 0 & -\sin\alpha & \cos\alpha \end{pmatrix} \begin{pmatrix} x' \\ y' \\ f \end{pmatrix} \quad (1)$$

Spherical panorama coordinates can be represented by (θ, φ, r) , and wherein θ is the horizontal angle of rotation, φ is the pitch angle, r is the spherical radius, real pixel coordinates of the point I in the spherical panorama can be expressed as:

$$\theta = tg^{-1} \frac{X_w}{Z_w} \quad (2)$$

$$\varphi = tg^{-1} \frac{Y_w}{\sqrt{X_w^2 + Z_w^2}} \quad (3)$$

So that you can determine the location of each image point through the spherical coordinates.

Spherical projection model that reflects the scene of space in all directions, and independent spherical coordinates with pitch angle to represent the image at any point. The following figure shall we captured images and spherical projection map.

Figure2. Original image

Figure3 . Spherical projection map

3) Image Stitching

Image mosaic is the most important step to generate a panorama, its methods are many, the most widely used mosaic method based on feature points[6] , the specific splicing flow chart is as follows:

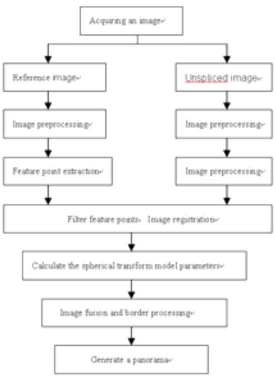

Figure4. Spherical panorama stitching flowchart based on feature points

As can be seen from the graph, image registration and image fusion is a critical step in the process of image stitching. Image registration refers to the extraction of the characteristics of the image of the reference image and to be spliced, to find the best match in the extracted features, and completion of the alignment between the images.The typical method for image registration using the Harris operator sub-image corner detection[7][8], image corner matching. Principle: to determine a point in either direction is a little offset will cause changes in the gray scale, if the point is corner. The specific algorithm is to determine by analyzing the pixel area around the autocorrelation function of autocorrelation matrix eigenvalue one point is a corner point. Define the autocorrelation function

$$E(u,v) = \sum_{x,y} w(x,y)[I(x+u, y+v) - I(x,y)]^2 \quad (4)$$

u, v is the Small offset of x, y direction, $I(x,y)$ is the Gray value of x, y Pixels, $[I(x+u, y+v) - I(x,y)]^2$ is an image gray value of the gradient, $w(x,y)$ is Gaussian filter, the practical application is used to calculate the response function of the angle point written:

$$R = \lambda_1 \lambda_2 - k(\lambda_1 + \lambda_2)^2 \quad (5)$$

Where k is 0.04-0.06.

Actual calculation, in order to reduce the impact of noise on the corner of extraction, image Gaussian smoothing, and then set a reasonable threshold, the actual calculation of the value is greater than the threshold value is the angle point, otherwise not. The following figure is the corner points detected with this method.

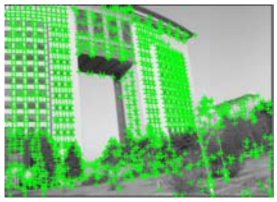

Figure5. Corner figure

From the above two figures, the number of feature points matching computationally intensive, direct impact on the speed of image stitching.In this paper, Using corner pixels, select grayscale window, In the range of (2N + 1) × (2N + 1),and then use of cross-correlation for computing the image of the reference image to be matched.

$$R = \frac{[\sum_{i=-N}^{N}\sum_{j=-N}^{N}(I(x-i,y-j)-\bar{I})(I'(x'-i,y'-j)-\bar{I}')]}{\sqrt{\sum_{i=-N}^{N}\sum_{j=-N}^{N}(I(x-i,y-j)-\bar{I})^2 \sum_{i=-N}^{N}\sum_{j=-N}^{N}(I'(x'-i,y'-j)-\bar{I}')^2}} \quad (6)$$

$\bar{I}$ and $\bar{I}'$ are The average values of the luminance of all pixels in the gray scale window. By the above formula to draw a correlation value R, Its threshold processing for 0.8, For all R> 0.8 corner as candidate points. The experimental results are as follows:

Figure6. Reference image

Image Fusion means that after the completion of the image matching, the image to be stitched, and the boundary of suture smoothing process, so that the stitching natural transition. Image fusion technology can be divided into three levels[9]: pixel level fusion, feature level fusion and decision-level fusion Pixel-level image fusion retains the original image information, the large amount of information. The commonly used method of pixel-level image fusion weighted average method[10]. Its basic theory weighting process is to treat the corresponding pixel values of the fused image, $A(x, y)$ is a one pixel in the image A, $B(x, y)$ is a pixel point in image B corresponding point, The fused image F with the corresponding pixel is 0. The mathematical model is:

$$F(x, y) = \omega_1 A(x, y) + \omega_2 B(x, y) \tag{7}$$

$$\omega_1 = \frac{A(x, y)}{A(x, y) + B(x, y)} \tag{8}$$

$$\omega_2 = 1 - \omega_1 \tag{9}$$

ω_1, ω_2 are The weighting coefficients of the pixels of the overlapping area. Reasonable choice of the weighting coefficients can be the ideal fusion effects, seamless splicing. The following diagram is our experimental results using the above method.

Figure7. After fusion splicing images

After the above process to afford the desired panoramic image.

B. Get high dynamic range images

The high dynamic range image is one kind of a very wide range of brightness in the image, it has a greater brightness than other format image data storage, and it records the brightness of a different way as with the traditional picture, is not used in a nonlinear manner to the luminance information8bit or 16bit color space is compressed to a corresponding manner but with a direct recorded luminance information can say lighting information recorded picture environment.

By HDRshop software, you can get panoramic image is converted into a high dynamic range image.This high dynamic range image which recorded the light of the need to obtain environmental information, so we can get the light distribution of the different environments, namely the use of this image to "illuminate" the scene. The following figure shall be obtained through the software high dynamic range view

Figure8. Image of high dynamic range

III. CONCLUSION

The real scene lighting information access is a bottleneck in the field of augmented reality, accurate, stable, and realistic lighting information is conducive to enhancing the virtual objects realistic. Get information of scene illumination many ways, but the common method there is limited conditions of use, poor stability, expensive problem. This paper presents a high dynamic range image-based lighting information acquisition, image stitching technology and HDR software combination experiment scene high dynamic range image recorded in the real environment lighting, due to the high dynamic range image , so you can be as a light source to illuminate the virtual scene. So as to achieve the purpose of obtaining realistic lighting information. In this paper, the method does not require special hardware and real scene geometry model information, easy to implement, a small amount of calculation, cost savings at the same time to expand the scope of use.

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