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SYNTHESIS ALGORITHM OF MULTI-EXPOSURE IMAGES

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Annotation. An effective way of synthesizing high dynamic range images is to shoot the same scene under a set of different exposure time conditions to obtain a set of multi-exposure images, and then extract, organize, and analysis to synthesize a luminance image that represents the original scene light distribution.

Keywords. High dynamic range image synthesis, Multiple exposure images.

The images taken by ordinary digital cameras are very different from the real scene, but it is difficult to generate images with high dynamic range by using ordinary digital cameras. Properly use the camera's exposure time to take multiple shots of the same scene, and each shot has a different exposure. By adjusting the ISO setting, a group of images with different exposures can be captured at different exposure times, and high dynamic range images can be effectively synthesized by using the full details of each image.

The details of the synthesized high dynamic range image are fully preserved, and the details of the high-exposure image and the low-exposure image can be well blended in one image. The visual effect of the synthesized image is enhanced, the recognition of the image is improved, and the details of the image can be better observed with the naked eye. This method of image synthesis can be widely used in digital video surveillance, remote sensing technology, real-time railway surveillance, medical imaging equipment, etc.

In a specific scene, the exposure area of a digital image is different, divided into three areas: overexposure, underexposure and normal exposure. Different exposure times will affect the shooting effect of the image. For an image with a long exposure time, the image shooting effect of the low-exposure area is better. Conversely, for an image with a short exposure time, the image shooting effect of the over-exposed image area is better. Taking advantage of this phenomenon, a series of exposure images can be obtained by changing the exposure time by shooting the same scene. Based on such a group of exposure images, the image information of different brightness regions can be extracted for each image, and finally a high dynamic range image is synthesized by using the detail information of this group of images [1].

To synthesize an HDR image, we divide the LDR image into the same region according to the exposure time, and then sum the normalized image pixels in the relevant range, however this is not straightforward to do because most cameras pass the sensor The process of collecting incident light by the circuit is nonlinear [2]. Such a nonlinear process of the camera is called the camera response function. By inverting it, the response function of the synthetic high dynamic range image can be obtained.

If the response function of the camera is known, then the nonlinear response function of the camera can be negated, and the response function of the camera is usually kept secret, and the camera manufacturer will not publish it [3]. Then in recent years, some algorithms have been developed to restore the response function of the camera. These algorithms use multiple images of the same scene with different exposure times to create the response function. Once the response function is restored and reconstructed through an image sequence, it can be Used to linearize other images taken with the same camera.

After calculating the camera's response function f and weight function w, the final irradiance I_p of the pixel p is obtained by calculating the weighted average of the pixel values in the relevant area of N consecutive frames [4]. As shown in Formula 1:

$$I_p = \sum_{a=1}^{N} \frac{f^{-1}(p_a) w(p_a)}{t_a} / \sum_{a=1}^{N} w(p_a) \quad (1),$$

In the formula, f^{-1} represents the inverse of the camera's response function, p_a is the pixel value in image a, and t_a is the exposure time of image a. If the HDR synthesis process based on the exposure value is accompanied by noise, then the synthesis process of the high dynamic range image may produce a noisy image. In fact, the weight function is applied to the HDR synthesis process. In many cases, this is not unsatisfactory. And the resulting image will be rendered unusable. Therefore, in order to improve the quality of HDR, it is necessary to remove the noise in the synthesis process, further play the role of the weight function, and analyze the noise influence mode and principle of the high dynamic range image synthesis process, which is very important for the following work.

For the noise problem of HDR images, there are two types of methods to solve it: the first type of method is to perform noise processing after HDR image synthesis, treat HDR images as ordinary images, and use classic image denoising algorithms, such as mean filtering, etc. . The disadvantage of this type of method is that the details of the image are sacrificed, making the image blurred, and even this cannot completely remove the noise. Since the noise processing occurs after image synthesis, a large amount of image information has been lost, and the real information of the original image cannot be restored, and denoising will cause the image to further lose information. The second type of method is to perform noise reduction processing on the image group before HDR synthesis, and then obtain the noise-filtered image and then synthesize the HDR image. This method can greatly improve the quality of the image.

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