Study on High-Quality Wide Dynamic Image Synthesis Algorithm in Multiple Image Processing

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Abstract. The key to adopting DSP technology to deal with multiple images into a high quality wide dynamic image is to adopt a suitable synthesis algorithm. In order to solve the puzzle of synthetic effects in image by image synthesis method and weighted average method based on relative illumination, the paper presented a new method for synthesizing a wide dynamic range image by image weighted fusion and later mapping. In the paper, we firstly explored the synthetic principle, by means of adjusting the fusion ratio of multiple images, obtained the fused image. Then, the image data of fused image was mapped to the interval of [0, 1] by using the mapping method of wide dynamic image. Finally, the corresponding data was mapped to the interval range of [0, 255]. The actual test demonstrated that we could obtain a better synthetic wide dynamic image effect by using the presented method regardless of the length of the exposure light time being a big difference or not. The study results show that the presented new algorithm is simple and has strong real-time performance.

Introduction

In the real world, due to a variety of factors light, environment, forming a large dynamic range of natural scenes. This large dynamic range of the scene, the human eye can easily adapt to it, the human eye can perceive the maximum dynamic range can reach 200dB. This shading for larger environments and has been widely used CCD / CMOS image sensors such, it is difficult to get a good image. The area is too bright, the camera is saturated output, dark areas, due to random noise and other reasons, from the image can not distinguish the subject. Proposes wide dynamic image acquisition technology [1-3], that is, in order to solve the strong chiaroscuro scene, how to keep details of the image. To get comparable to the human eye observed effects, the need for three main factors: a high-resolution lens, high-dynamic sensor and image synthesis algorithm.

Common synthetic method of wide dynamic image

Based on contrast of image synthesis In general, the more the number of synthetic source image, the composite image smoother. Synthesized by the two figures a wide dynamic image quality is more difficult, mainly due to exposure in both figures the vast difference between the situation can easily lead to the synthesis of the image is not continuous at some point, so that the composite image is poor. The synthesis of a wide dynamic image contrast based on [4] is a popular WDR image synthesis method, principle of this method is to find the contrast of each pixel of the image by the camera response curve, obtained degrees contrast, will be able to the scene different exposure times linearized image. Wherein the response curve of the camera may be known, if the response curve is unknown, it needs to be calibrated. Calibration method [5-7] There are Debevec and Malik algorithm, Nayar algorithm. In theory, the synthesis of a wide dynamic images are the most accurate. But because of its synthesis requires multiple images, and the calibration algorithm response curve fitting more complex, larger than the calculation algorithms, so the relatively poor real-time aspect. Secondly, the process must be required for the synthesis of multiple images of the same scene, different image pixel deviation will cause the composite image quality.

Weighted average image synthesis method The weighted average method is a relatively simple multiple images fusion method, that is, for the corresponding pixel source images were weighted. In both images, for example, set A (i, j) the image of a pixel A, B (i, j) of image B corresponding pixels, the pixels in the image fusion point by next formula to get that

$$C(i,j) = \omega_A(i,j)A(i,j) + \omega_B(i,j)B(i,j) \qquad (1)$$

$$\omega_A(i,j) + \omega_B(i,j) = 1 \qquad (2)$$

The method is simple, fast calculation, suitable for real-time computing. But the difficulty is that the option value, and the effect is not ideal synthesis.

WDR image synthesis method of improving

Image segmentation weighted synthesis Taken gray value g_1 (x, y) from the same point where the two images[2] , g_2 (x, y), the weighted linear [8-10] A synthetic method of a composite image after image.

$$g_f(x,y) = \alpha_1 g_1(x,y) + \alpha_2 g_2(x,y) \qquad (3)$$

Wherein α1, α2, respectively g1 (x, y), g2 (x, y) of the weight. According to the human eye's ability to distinguish the gray model that sensitive areas of the human eye is an area between 32 to 192. In this range, the human eye can distinguish at least two gray scale gradation. Therefore, the selected two boundary values: Tmin = 32, Tmax = 192, mean gray two images divided into three regions, with different weights synthesized, as shown in Table 1.

Table1 The selected weights for piecewise weighted method

Analyzing conditions	Choose the right size
$[g_1(x,y) + g_2(x,y)]/2 < T_{min}$	$\alpha_1 = 0.5\{[g_1(x,y) + g_2(x,y)]/2\}/T_{min}$ $\alpha_2 = 1 - \alpha_1$
$T_{min} \leq [g_1(x,y) + g_2(x,y)]$	$\alpha_1 = \alpha_2 = 0.5$
$[g_1(x,y) + g_2(x,y)]/2 < T_{max}$	$\alpha_1 = 1 - \alpha_2$ $\alpha_2 = 0.5\{256 - [[g_1(x,y) + g_2(x,y)]/2\}/(256-$

After testing, the length of the process in the case of exposure or less can achieve good results, but in the long exposure image overexposed area is relatively large, it can not achieve a good synthesis results. But the algorithm is relatively simple, its time complexity is O (n).

Weighted image fusion, post-mapping Compared with the weighted average method, which assumes that the pixel is a linear relationship between the exposure time by adjusting the ratio of the fusion of two images to obtain a fused image. And the image is assumed to be a wide dynamic image mapping method utilizing a wide dynamic image fusion image data mapped to [0, 1] range, and then [0,1] corresponding data is mapped to [0,255] (If the image is 12, compared with [0,4095]).The first step:

Fusion formula used in the experiment are as follows:

$$g_f(x,y) = \alpha_1 g_1(x,y) +(100 - \alpha_1)g_2(x,y) \qquad (4)$$

For g_f (x, y) with double type, α1 is an integer of 1 to 100, due late there will be many floating-point operations, and therefore did not introduce fusion calculate decimal, decimal precision to avoid being lost in the post-amplification and increased noise the impact of the image synthesis results. Here In order to maintain continuity of the composite image, all the pixels of the image taken of the same weight.

Step Two: Find the natural logarithm of the average brightness

g_f (x, y) in the first step of the synthesis, we assume that it is a wide dynamic image, which ranges (0,25500), (4) Natural averaged brightness of the composite image according to the formula,

$$L_{avg} = \exp(\frac{1}{N}\sum \log\left(\delta + L_w\right)) \qquad (5)$$

In the formulaδ= 0.0001， N is the total number of image pixels,Lw is the pixel gray value

The third step: the image data is mapped to [0,1] ,The (-∞, + ∞) Interval number maps to (0,1) have a function S,

$$(6) \quad S = \frac{1.0}{1.0 + e^{-x}}$$

The S-function is shown in Figure 1

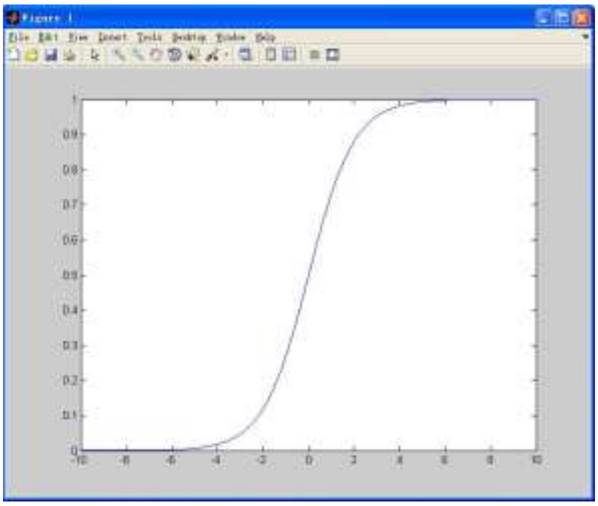

Figure 1 S-function graph

According to the characteristics of the S-curve pattern can be seen in the x value is a function of the value (-4,4) when the greatest change. Therefore, in order to obtain smoother results, the first x value using a logarithmic transformation loga (x) maps to (-4,4), a base value of the dynamic range and the final visual effect sought. According to the formula (4) can be obtained fused image data in the range (0, 2n × 100), due to the actual calculation of the pixel gray scale value of 0 basically non-existent, the minimum pixel is generally 2, the image data fusion theoretical range approximately (202, (2n-1) ×100), where n is the number of bit image data. However, if the data is taken directly to the fusion number, the result obtained is always greater than zero, the corresponding function value S curve is always greater than 0.5, the pixel value of the processed image obtained values> 2n-1/2, the whole image bright. Do logarithmic transformation, the range will be greater if the image data range (202, (2n-1) × 100) to deal with (0, k) inside. Figure 2 is a logarithmic function curve comparison function curve represented by $f(x) = \log_2(x)$ 1, 2 function curve is represented $f(x) = \log_5(x)$, according to the comparison of the two curves function, the lower the conversion rate of the base taken the greater function, function the results of a range of smaller intervals were calculated.

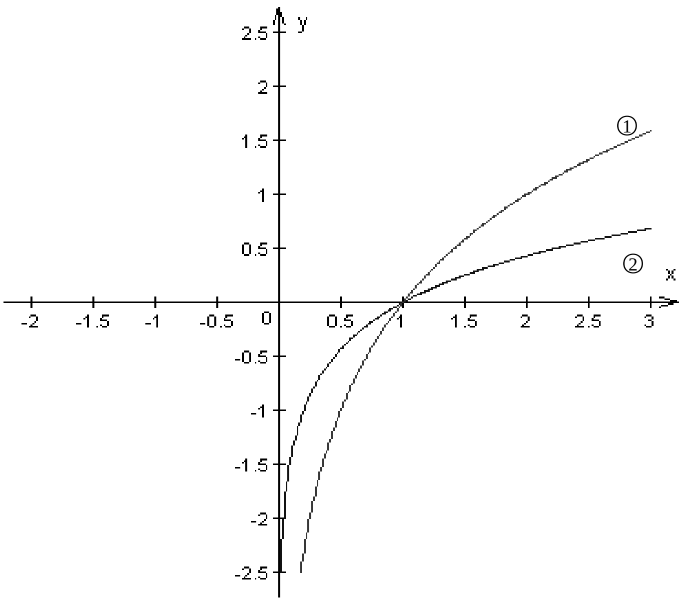

Figure 2 Comparison of the logarithmic function graphing

Therefore, in the experiment, The（202，(2n-1) ×100）divided by the interval L_{avg}, S curve formula is transformed

$$L_d = \frac{\log_5(L_w / L_{avg} + 1.0)}{1.0 + \exp(-\log_4(L_w / L_{avg}))} \qquad (7)$$

Such gray s normal distribution curve of -4 to +4 and, low stretch, high-end inhibition, the entire image is full of gray maximize space, overexposed and underexposed region area can get better image.

After testing, the method and length of exposure time or less the difference in a lot of circumstances can get better results, and the algorithm is simple, real strong.

Conclusion

WDR image synthesis algorithm is wide dynamic image acquisition technology a key part in the synthesis of the two images, the selection of the optimal synthesis algorithm and transplanted to the DSP in order to achieve a composite image clearly shows the different lighting scenes. In this paper, several common synthetic methods wide dynamic images were studied and compared with the actual proposed a new improved method and experimental verification by using the synthesis method can achieve the desired results.

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