Image Fusion with Guided Filtering

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Abstract- **Image Fusion is the process in which core information from a set of component images is merged to form a single image, which is more informative and complete than the component input images in quality and appearance. The proposed method is based on a two-scale decomposition of an image into a base layer containing large scale variations in intensity, and a detail layer capturing small scale details. A novel guided filtering-based weighted average technique is proposed to make full use of spatial consistency for fusion of the base and detail layers. Experimental results demonstrate that the proposed method can obtain state-of-the-art performance for fusion of different kinds of images.**

Index Terms –Image fusion, Guided filter

I. INTRODUCTION

In this section we propose a new type of explicit image filter, called guided filter. The filtering output is locally a linear transform of the guidance image. This filter has the edge-preserving smoothing property like the bilateral filter, but does not suffer from the gradient reversal artifacts. Image fusion is an important technique for various image processing and computer vision applications such as feature extraction and target recognition. Through image fusion, different images of the same scene can be combined into a single fused image. The fused image can provide more comprehensive information about the scene which is more useful for human and machine perception. For instance, the performance of feature extraction algorithms can be improved by fusing multi-spectral remote sensing images. The fusion of multi-exposure images can be used for digital photography.

In these applications, a good image fusion method has the following properties. First, it can preserve most of the useful information of different images. Second, it does not produce artifacts. Third, it is robust to imperfect conditions such as miss-registration and noise. Several advantages of the proposed image fusion approach are highlighted in the following.1. Traditional multi-scale image fusion methods require more than two scales to obtain satisfactory fusion results. The key contribution of this paper is to present a fast two-scale fusion method which does not rely heavily on a specific image decomposition method. A simple average filter is qualified for the proposed fusion framework.2. A novel weight construction method is proposed to combine pixel saliency and spatial context for image fusion. Instead of using optimization based methods, guided filtering is adopted as a local filtering method for image fusion.3. An important observation of this paper is that the roles of two measures, i.e., pixel saliency and spatial consistency are quite different when fusing different layers. In this paper, the roles of pixel saliency and spatial consistency are controlled through adjusting the parameters of the guided filter.

II. IMAGE FUSION WITH GUIDED FILTERING

Recently, edge-preserving filters have been an active research topic in image processing. Edge-preserving smoothing filters such as guided filter , weighted least squares, and bilateral filter can avoid ringing artifacts since they will not blur strong edges in the decomposition process.

Edge-preserving guided image filtering: The basic idea of the guided filtering is to solve a linear model, and obtain the corresponding linear coefficients. Actually, it is a generalized expression of bilateral filtering;.

Most of previous image fusion methods aim at obtaining as many as information from the different modality of the images. The fusion criterion is to minimize different error between the fused image and the input images that we are taken. With respect to the medical diagnosis, the edges and outlines of the interested objects is more important than other information. Therefore, how to preserve the edge like features is worthy of investigating for medical image fusion. As we know, the image with higher contrast contains more edge-like features. In term of this view, introduce a new image fusion scheme based on guided filtering

The visual experiments and quantitative assessments demonstrate the effectiveness of this method compared to present image fusion schemes, especially for medical diagnosis, climatic change application, and environmental change in day to day infrastructure. The guided filter computes the filter output at a pixel as a weighted average of neighboring pixels. It smoothed the image while preserving edges. Due to this nice property. It is generalized to the joint guided filter in which the weights are computed from another guidance image rather than the filter input. The joint guided filter is particularly favored when the filter input is not reliable to provide edge information, e.g., when it is very noisy or is an intermediate result.

The guided filter is based on a local linear model, making it qualified for other applications such as image matting, up-sampling and colorization. Furthermore, when the input is a color image, the filtering output can be obtained by conducting the guided filtering. On the red, green, and blue channels of the input image, respectively.

Concerning image fusion, People have proposed many schemes. A most direct way is preset weighted fusion, which requires sufficient prior knowledge to obtain appropriate weight coefficients. However, false weight can lead to disastrous result to fused image. Moreover, Multi-resolution decomposition based fusion methods are also commonly used in many fusion problems such as Discrete Wavelet Transform (DWT) (Piella, 2003; Hamza *et al*., 2005), complex wavelet (Wan *et al*., 2009), curvelet (Li and Yang, 2008), contour let (Zhang and Guo, 2009), pyramid transform (Toet, 1990) etc. The key technique of multi-scale transforms lies in how to select appropriate decomposition levels and fusion rules, which also determines the final fusion quality and contains the greater subjectivity. Even so, the DWT-based fusion schemes are still attractive when massive volumes of image data are to be merged quickly (Rahman *et al*., 2010). In this instance, sparse representation based fusion method achieve Considerable development (Yang and Li, 2010). It is an approximate computation but, can effectively solve the problem of large amount of data by dictionary learning.

Weighted fusion of source image: Defining the original input images are I_1 and I_2, preliminary weighted fusion result as the input image p of the next step. This process can be expressed as follows:

$$\alpha = \frac{I_1(i,j)}{(I_1(i,j)+I_2(i,j))}, \beta = \frac{I_2(i,j)}{(I_1(i,j)+I_2(i,j))} \quad (1)$$

$$p_{ij} = \alpha \times I_1 + \beta \times I_2 \approx \frac{I_1^2 + I_2^2}{I_1 + I_2 + \epsilon} \quad (2)$$

Where, i and j are pixel indexes, p is the preliminary fusion result, ε is a regularization parameter to avoid denominator is zero.

The guided filter is first applied for image fusion. The main processes of the proposed guided filtering based fusion method (GFF) are described. First, an average filter is utilized to get the two-scale representations. Then, the base and detail layers are fused through using a guided filtering based weighted average each source image into a base layer containing the large-scale variations in intensity and a detail layer containing the small scale details. Then two-scale image reconstruction is done. Two-scale image reconstruction consists of the following two steps: (i) First, the base and detail layers of different source images are fused together by weighted averaging. (ii)The fused image is obtained by combining the fused base layer and the fused detail layer. (iii)Finally, experiments are performed on three image databases, i.e., the Petro Vic database which contains pairs of images including aerial images, outdoor images and indoor images (with different focus points and exposure settings), the multi-focus image database and the multi-exposure and multi-modal image database.

III. CONCLUSION

This paper presenting a novel filter which is widely applicable in computer vision and graphics, Different from the recent trend towards accelerating the bilateral filter .we define a new type of filter that shares the nice property of edge-preserving smoothing. The guided filter is used in a novel way to make full use of the strong correlations between neighborhood pixels for weight optimization. The SIFT algorithm performs better for images with scale and rotational variance. Take several overlapping pictures of a scene and then let the computer determine the best way to combine them into a single image. Encouragingly, the method is very robust to image registration process. At last, how to improve the performance of the method by adaptively choosing the parameters of the guided filter with different algorithms. Experiments show that the fusion methods can well preserve the original and complementary information of multiple input images. GFF and stitching methods well preserve the color, detail information of different exposures. We analyze that the two methods outperforms, and also which enable to produce very good results in a fully-automated process. Real-world results are presented to demonstrate the method's performance.

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