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Advanced Approach for Image Fusion Using Filtering Methods

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Abstract: ***Image fusion technique combines details from multiple images of a scene into a single image. The output image is of good quality and suitable for different kinds of applications. The proposed method divides an image into two layers a base layer and a detail layer. Base layer shows high intensity variations and Detail layer shows low intensity variations. This method utilizes a guided filtering technique which helps to perform base and detail layer fusion. The proposed method works well for different kinds of images.***

Keywords: Image fusion, Image decomposition, Weight map construction, Image reconstruction

1. Introduction

Image Fusion technique aims in combining two images of a scene together. The fused image produced will be high in quality. It represents every object from both images very accurately. The fused image produced can provide more detailed information about the scene. It is very useful for human and machine perception. The accuracy of feature extraction algorithms can be enhanced by fusing multi-spectral remote sensing images. The multi-exposure image fusion can be used for digital photography. A perfect image fusion method must have some properties. It must protect useful information of different images. Second, it must not produce noise. Third, it must perform well under imperfect conditions like mis-registration and noise. So many image fusion methods are available. Most of these methods protects the needed information of different images. These methods cause colour distortions and noise because spatial consistency is not very well considered in these methods. Fusion approaches based on optimization methods can solve this problem. These methods will estimate spatially smooth and edge aligned weights by using energy function and then perform fusion of source images by using constructing weight maps of pixel values. But optimization methods may cause in efficiency because they will over smooth the fused image.

To solve the problem mentioned above a new fusion method based on guided filtering is introduced in this paper. It can solve all the problems mentioned above. This method uses a fast decomposition method. It is done with the help of an average filter. Pixel saliency and spatial consistency are joined together by using a weight construction method. Proposed system does not depend on optimization methods. It uses a guided filtering technique. Guide filter is a type of edge preserving filter which won't produce ringing artefacts. Also the computing time of guided filter is very less.

2. Methodology

The Proposed system consists of 3 stages. Those are Two scale image decomposition, Weight map construction and Two scale image reconstruction. During the first stage source image is divided in to base and detail layers. Weight maps of source images are constructed in the second stage. Guides filtering are also applied in this stage. The output of this stage is processed during reconstruction of images in the final stage.

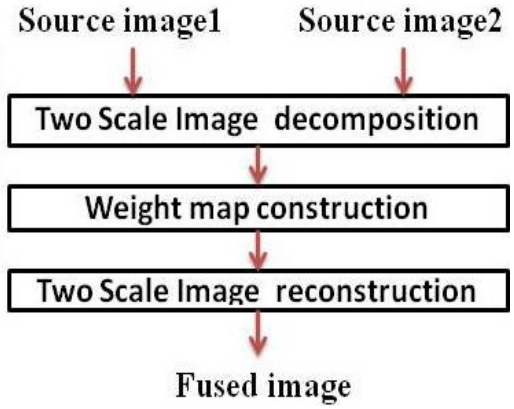

Figure 1: Image Fusion process

The above diagram shows Different stages of the image fusion process. Among these stages second stage is the most important. Because the guided filtering process is happened during this stage. So it consumes much time than any other module. However we can reduce this delay by modifying the filtering parameters. Window size is one such parameter which have a good effect on processing speed. If the window size taken is so big then processing delay will be high. So an appropriate window size is necessary.

3. Image Fusion Process

The Above figure shows different stages of image processing. An average filter is used there to average the number of pixels in the source images. Then Fusion of Base and Detail layers are performed using guided filtering technique.

3.1 Decomposition of Image

Decomposition of source images are done at this stage. An average filter can be used for this job. The input image is divided in to base and detail layers.

$Base_m = L_m * F$ (1)
$Detail_m = I_m - Base_m$ (2)

$Base_m$ represents the base layer and $Detail_m$ Represents the Detail layer. F is used to represent the average filter. Base layer holds high intensity pixels and Detail layer holds low intensity pixels.

3.2 Creating weight maps

This is one of the important steps in Image Fusion process. Here a weight map is constructed for both base and detail layers. Laplacian filters are used for this job. The weight map is created in the following way.

$\mathbf{Highpass_n} = Input_n * L_n$ (3)

$Sn = \mathbf{Highpass_n} * gf_{ig,\mu g}$ (4)

$BW_n = K_{s1,\epsilon 1}(P_m, Input_n)$ (5)

$DW_n = K_{s2,\epsilon 2}(P_m, Input_n)$ (6)

L represents a 3*3 Laplacian filter. The output of laplacian filter is a high pass image H_n. Saliency maps are constructed using the average values of the high pass image. A Gaussian filter G is used to process the high pass image. The weight maps produced are usually noisy and their alignment may not met with object Boundaries. It will produce noise to the fused image. Applying Spatial consistency is the best way to solve this problem. Spatial consistency indicates that if two neighbour pixels have equal brightness, they may have equal weights. Fusion approach based on spatial consistency will generate an energy function. Weight maps are produced from this energy function. Fusion of base layer employs large filter size and large blur degree. In order to perform detail layer fusion small filter size is suitable.

$BW_n = K_{s1,\epsilon 1}(P_m, Input_n)$ (8)

$DW_n = K_{s2,\epsilon 2}(P_m, Input_n)$ (9)

Here BW_n represents weight map of base layer and DW_n represents weight map of detail layer. $Input_n$ represents the source image.

3.3 Guided Image Filtering

Guided filtering method is also known as edge preserving filtering. While using other kinds of filters the edges of output image looks blurred which will affect the quality. Guided filters are known for their edge preserving qualities. Guided filter takes less time to process an image. In most of the filters selection of filter size directly affects the processing time. So more the filter size more will be the time to produce fusion. Guided filtering can be used for both color and colorless images. In color images there will be red, green, and blue channels. In order to create fusion of color images these three channels must be filtered separately.

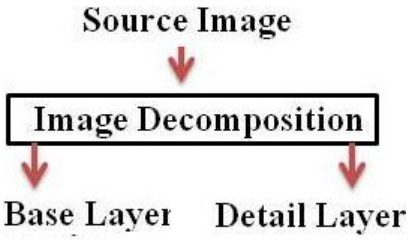

Figure 2: Image Decomposition process

Guided filter imagine that the filtering output *Q* is a linear transformation of the guidance image *I* . Guided filtering is done on each color layer of this image to get the filtered image. The guided filter will blur the image details while preserving the strong edges of the image. After filtering, noisy pixels are avoided and the edges in the image are corrected with object boundaries. The pixels with same colors in the image may have equal values in the filtering process.

3.4 Image Reconstruction

A Two step image reconstruction process is happening here. Base layer and detail layers of input images are fused in the first step. Weighted averaging method is used for that.

$Base' = BW_1 Base_1 + BW_2 Base_{2+} \ldots\ldots..BW_n Base_n$ (9)

$Detai' = DW_1 Detail_1 + DW_2 Detail_{2+} \ldots BW_n Detail_n$ (10)

Fused Image = Base' + Detail' (11)

Then fusion of fused base layer and fused detail layer is performed. Thus we will get the final image which contains needed information's from both source images. The fused image can be used for various image processing applications such as satellite mapping, medical image processing etc. The whole fusion process is divided in to three different stages, image decomposition, weight map generation and finally image reconstruction. Guided filtering is the new technique used in this paper which can be improved again by changing the filtering parameters.

4. Results and Analysis

Experiments were performed on different kinds of images such as satellite images, multifocal images, medical images etc. These images were subjected to different filtering techniques including our guided filtering technique. Then the results were compared. Guided filtering performs well on every image. It preserves most of the useful information in source images. Other filters failed to preserve the edges of the input images. But guided filtering method protects the edges and produced a fused image of fine quality.

5. Conclusion and Future Work

An advanced approach for image fusion is presented in this paper. Experimental results show that the proposed method for image fusion works well for different kinds of images. To improve the Performance and capability of current method further research is needed.

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