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An Optimal Image Fusion Using Local Variation and Gradient Reversal Suppression

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ABSTRACT: The goal of image fusion(IF) is to integrate complementary multi-sensor, multi-temporal and/or multi-view information into one new image containing information the quality of which cannot be achieved otherwise. In this paper presents an optimal Image fusion scheme is novel for capturing a scene by using a standard dynamic range device and synthesizing an image suitable for SDR (Standard Dynamic Range) displays. The captured image series, first calculate the image global luminance levels, which maximize the observable contrasts, and then the scene gradients embedded in these images. The fusion algorithm techniques of diffusion and contrast are implemented. This is done in a multi-resolution of brightness variation in the sequence.

KEYWORDS: Image Fusion; gradient; SDR; Luminance;

I. INTRODUCTION

Image fusion is the process of combining information from two or more images of the same scene so that the resulting image will be more suitable for human and machine perception or further image processing tasks such as segmentation, feature extraction, and target recognition [1]–[4]. It is widely applied into many fields such as computer vision, medical imaging, and remote sensing. For example, in the computer vision field, the technique can be used for overcoming the limited depth-of-focus of optical lenses in charge-coupled devices.

Image fusion methods can be broadly classified into two categories, namely, spatial domain and transform domain. The former, including averaging and principal component analysis (PCA) [2], can directly fuse the source images into the intensity values, whereas the latter, which include the Laplacian pyramid (LAP)-based method [1], discrete wavelet transform (DWT)-based approach [3], and discrete cosine transform (DCT)-based algorithm [4], merge the transform coefficients using the classical weighted average strategy or the choose-max strategy and then obtain the fused result through the inverse transformation of the combined coefficients.

Digital Imaging System has been used in various image processing domains such as satellite and commercial domain like Voter ID. The proposed system uses JPEG images and it supports two-dimensional (2-D) images. The quality of the image is measured using Peak-Signal- Noise Ratio (PSNR) which is measured by decibel (dB). It mainly concentrates on Depth of Field (DOF) of an image. In the proposed work the input images are in the form of sequence of four images which is taken at various situations such as with flash, without flash, with light and without light. Depth of Field is nothing but the distance between the nearest and farthest objects in a scene which appears acceptably sharp in an image. The various steps are carried out and thus the result obtained is a fusion of the images which is clear and the quality of image is good. It shows best result when compared with the existing system.

The fusion algorithm techniques are used for fusion of images based on contrast and gradient level. This is done in a multi-resolution of brightness variation in the sequence. Gaussian filter method and Laplacian methods are used so that up-scaling and down-scaling is done successfully.

The rest of the paper is organized as follows: Related is detailed in Sect. 2. In Sect. 3, Proposed Methodology and the conclusion are in Sect. 5.

II. RELATED WORK

In [2] authors discussed to increase the spatial resolution, a SPOT panchromatic image was combined with the extracted spectral image; merging methods, classic IHS transforms and linear combinations were tested. For these two steps of image processing, the best results were obtained by respectively using PCA and a selective linear combination. The merging of the SPOT data was done selectively in order to avoid the disturbance of the spectral content of the

Landsat TM image. For this reason, only the PC corresponding to the visible part of the spectral domain was combined with the SPOT. In [3] authors proposed the goal of image fusion is to integrate complementary information from multisensor data such that the new images are more suitable for the purpose of human visual perception and computer-processing tasks such as segmentation, feature extraction, and object recognition. This paper presents an image fusion scheme which is based on the wavelet transform. The wavelet transforms of the input images are appropriately combined, and the new image is obtained by taking the inverse wavelet transform of the fused wavelet coefficients. An area-based maximum selection rule and a consistency verification step are used for feature selection. In [4] authors studied the image fusion techniques in the discrete cosine transform (DCT) domain. A new image fusion technique based on a contrast measure defined in the DCT domain is presented. The performance of our contrast measure based technique is analyzed and compared with other image fusion techniques. In [5] authors presented a tensor modeling and algorithms for computing various tensor decompositions (the Tucker/HOSVD and CP decompositions, as discussed here, most notably) constitute a very active research area in mathematics. Most of this research has been driven by applications. There is also much software available, including MATLAB toolboxes. The objective of this lecture has been to provide an accessible introduction to state of the art in the field, written for a signal processing audience. They believe that there is good potential to find further applications of tensor modeling techniques in the signal processing field. In [6] authors illustrated Two particular tensor decompositions can be considered to be higher-order extensions of the matrix singular value decomposition: CANDECOMP/PARAFAC (CP) decomposes a tensor as a sum of rank-one tensors, and the Tucker decomposition is a higher-order form of principal component analysis.

III. PROPOSED ALGORITHM

The proposed method accepts the Image fusion parameters as input which contains the MATLAB simulation where the novel image fusion based on scene gradient and luminance extraction algorithm is applied to the real-world image databases. This overall proposed architecture in figure 1 follows a from the beginning to end state.

A. *Image separation*

The exposure level of a photo is the total radiant energy integrated by the camera when the shutter is opened. The exposure level can influence significantly the quality of a captured photo because when there are no saturation or thermal noise, a pixel's signal-to-noise ratio (SNR) always increases with higher exposure levels. For this reason, most modern cameras can automate the task of choosing an exposure level that provides high SNR for most pixels and causes little or no saturation.

The exposure level is not affected by the sensor gain, but affects noise properties and saturation are affected by sensor gain. Lens-based camera systems provide only two ways to control exposure level—the diameter of their aperture and the exposure time. All light passing through the aperture will reach the sensor plane, and that the average irradiance is measured over the aperture which is independent of the aperture's diameter. . In this case, the exposure level L satisfies

$$L \propto \tau D^2 \text{ eqn. (1)}$$

Where τ is the exposure time and D is the aperture diameter.

For a specified aperture and focus setting, the depth of field is the interval of distances in the scene [*d1*, *d2*], whose blur diameter is below a maximum acceptable size.

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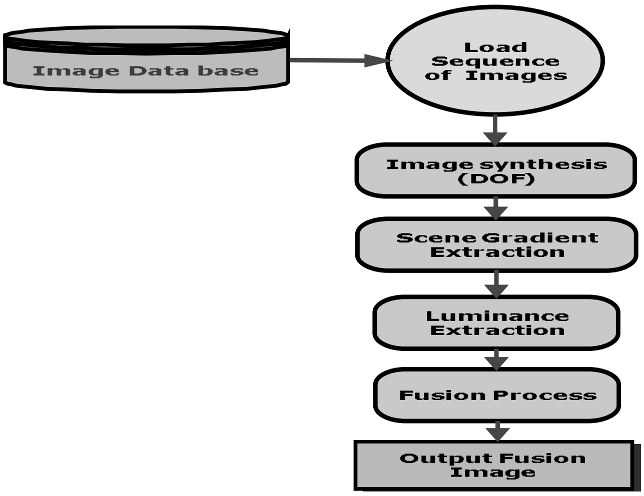

Fig.1. Proposed Framework flow diagram

B. *Scene Gradient Extraction*

A good solution to suppress halos is to apply the scene gradients to adjust the gradient of the synthesized SDR image. The scene gradient information is adaptively captured by setting the different exposure levels, i.e., the scene gradients are captured through the local adaptation to the scene luminance for an window $M \times M$ centered at (x, y). Technically, the scene gradient of a point is reflected by the gradient that is perceivable by human eyes, called visible gradient, and that can be measured by counting the number of visible differences of luminance's between neighboring pixels in the window.

To compute the quantity of the visible gradient ψ(x, y) by

$$\psi(x,y) = \sum_{i=x-\frac{M}{2}}^{x+\frac{M}{2}} \sum_{j=y-\frac{M}{2}}^{y+\frac{M}{2}} T(|c(I_H(x,y).VMAX(\nabla I_H(x,y))|) \;\; eqn.(2)$$

These exposure levels lead to different gradient magnitudes because the gradient magnitude depends on the image luminance's and the image luminance depends on the exposure level. The scene gradient extraction is a process to find gradient *G(x, y)* which maximizes the quantity of the visible gradient,

$$G(x,y) = \arg max_{\nabla I_H(x,y)} \psi(x,y) \qquad eqn.(3)$$

In this gradient extraction, the pixels positions are estimated along with x-coordinate and y-coordinate. In vector calculus, the gradient of a scalar field is a vector field that points in the direction of the greatest increase rate in the scalar , and in the magnitude. The variation in space of any quantity can be represented (e.g. graphically) by a slope in general. The gradient represents the steepness and direction of the slope.

C. *Luminance Extraction*

The image dimensions (width, height and number of channels) are calculated using the image luminance (color variance) which maximizes the visible contrasts over different captured images. The visible contrast of the window between the point and its surrounding points is observed. The image luminance is calculated for each point(x, y) which maximizes the visible contrasts over different captured SDR images. The point (x, y) and its surrounding points form an M × M local window in a scene. The visible contrast v(x, y) is calculated using,

$$v(x,y) = T(\Delta \mathrm{I_H}(x,y))\Delta \mathrm{I_H}(x,y) \qquad eqn. (4)$$

Where $T(\gamma) = 1$ which is larger than or equal to a predefined threshold.

D. *Fusion*

The fusion of N images and computation of average weight can be estimated with the help of quality measures which are already computed. To obtain a consistent result, the values are normalized for the N weight maps. The resulting image R can then be obtained by a weighted blending of the input images:

$$\sum_{k=1}^{N} W_{ij,k} I_{ij,k} \qquad eqn. (5)$$

where I_k is the k-th input image in the sequence and 'W' is the weight which varies very quickly, corresponding to the layer that appear. This occurs due to fusion of images which contains different absolute intensities due to their different exposure different exposure times. The sharp weight map transitions can be avoided by smoothing the weight map with a Gaussian filter, but this result in undesirable halos around edges, and spills the information across object boundaries. An edge-aware smoothing operation using the cross-bilateral filter seems a better alternative. However, it is unclear how to define the control image, which gives the information where the smoothing should be stopped. Using the original grey scale image as control image does not work well. Also, it is hard to find good parameters for the cross-bilateral filter (i.e., for controlling the spatial and intensity influence).

IV. CONCLUSION AND FUTURE WORK

In this paper presents a new fusion scheme is achieved in the proposed system by considering local variation and gradient reversal suppression. The visible scene contrasts and the scene gradient can be captured adaptively by utilizing the different exposures. A gradient model is proposed to carry out the scene reproduction by preserving both the visible contrasts and the gradient consistency. The proposed system maintains visible contrasts and the gradient consistency effectively. Fusion based on Gradient Exposure technique blends images in a multi-exposure sequence, showed by simple quality measures like saturation and contrast.

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