Image Fusion and Decomposition using Non Sub-sampled Contourlet Transform (NSCT)

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Abstract - *The limited depth-of-focus of optical lens in digital devices, it is often impossible to acquire an image that contains all relevant focused objects. Therefore, in the scene, some objects are in focus, but other objects at different distances from the imaging equipment will be out of focus and, thus, blurred. To solve the problem of multiple images focusing in digital cameras, in this paper Non-Sub sampled Contourlet Transform (NSCT) based image fusion technique is proposed. The initial fused image is subsequently re-constructed based on the inverse NSCT with the fused coefficients. Secondly, the similarity between the fused image and the source images are analysed to obtain the focus area detection map. Experimental results demonstrate that the proposed method is better than various existing transform-based fusion methods.*

Key Words: Digital image, Multi-focus image fusion, Non-Subsampled Contourlet Transform, Focus area detection, Fusion methods.

1.INTRODUCTION

The importance of image fusion in current image processing systems is increasing, primarily because of the increased number and variety of image acquisition techniques [1]. The image fusion is the process of combining different images from several sensors or the same sensor at different times to create a new image that will be more accurate and comprehensive and, thus, more suitable for a human operator or other image processing tasks [2]. Currently, image fusion technology has been widely used in digital imaging, remote sensing, bio-medical imaging, computer vision, and so on [3].

In applications of digital cameras, optical microscopes or other equipment, because of the limited depth-of-focus of optical lens, it is often impossible to acquire an image that contains all relevant focused objects. Therefore, in the scene, some objects are in focus, but other objects at different distances from the imaging equipment will be out of focus and, thus, blurred . However, in reality, people tend to obtain a clear image of all targets. A possible way to overcome this problem is to utilize multi-focus image fusion techniques, in which one can obtain one image with all of the objects in focus by way of it containing the best information from multiple original images [4]. The simplest spatial-based method is to take the average of the input images pixel by pixel. This method leads to several side effects, such as reduced contrast. The quality of the fused image is improved by fusing input images by dividing them into uniform-sized blocks and having those blocks to take the place of single pixels. This paper proposes contourlet transform based multi resolution approach to combine (or fuse) the two source images for vision clarity.

2. LITERATURE SURVEY

A possible way to overcome this problem is to utilize multi-focus image fusion techniques, in which one can obtain one image with all of the objects in focus by way of it containing the best information from multiple original images. Image fusion methods are usually divided into spatial do-main and transform domain fusion techniques [5]. In the spatial domain fusion methods, the fusion is directly on pixel gray level or color space from the source images for fusion operation, so the spatial domain fusion methods are also known as single-scale fusion method. For transform domain-based methods, each source image is first decomposed into a sequence of images through a particular mathematical transformation. Then, the fused coefficients are obtained through some fusion rules for combination. Finally, the fusion image is obtained by means of a mathematical inverse transform. Thus, the transform domain fusion methods are also known as Multi-scale fusion methods.

The simplest spatial-based method is to take the average of the input images pixel by pixel. However, along with its simplicity, this method leads to several side effects, such as reduced contrast. To improve the quality of the fused image, some researchers have proposed to fuse input images by dividing them into uniform-sized blocks and having those blocks to take the place of single pixels [6].

3. PROPOSED DESIGN

CT can be divided into two stages, including the Laplacian Pyramid (LP) and Directional Filter Bank (DFB), and offers an efficient directional multi-resolution image representation [7]. Among them, the point singularities are captured using LP. Then the singular point are linked into linear structures by DFB. LP is employed to decompose the original images into low frequency and high frequency sub-images, and then the DFB divides the high frequency subbands into directional subbands. A contourlet decomposed schematic diagrams are shown in Fig. 1 and 2.

During the realization of the CT, the decomposition and construction filters of LP are separable bi-orthogonal filters with bandwidth greater than /2 [8]. According to the sampling theorem, the pseudo-Gibbs phenomena would appear in low- and high-frequency sub-images in LP domain. Directional subbands which come from the high frequency sub-images by DFB filtering would also appear the pseudo-Gibbs phenomena. These phenomena would weaken the directional selectivity of the CT based method to some extent.

Today, most composite image approaches employ pixel fusion methods. The major advantage of pixel fusion is that the images used contain the original information. This algorithms is rather easy to implement and time efficient. As the present author observed before in one of the findings [9-10], an important pre-processing step in pixel based fusion methods is image registration, which ensures that the data at each source is referring to the same physical structures. In the remainder part of the paper, it will be assumed that all source images have been registered. Figure 3 shows a detailed block diagram of the proposed scheme in flow layout. The framework contains eight modules and the description of each of the building blocks is given below in each process block.

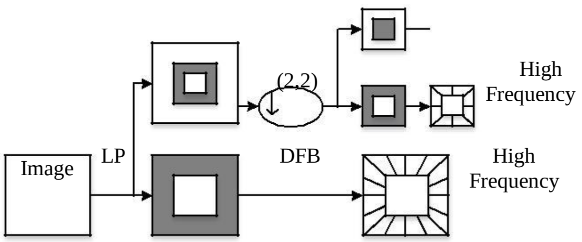

Fig. 1. Contourlet decomposed schematic diagram.

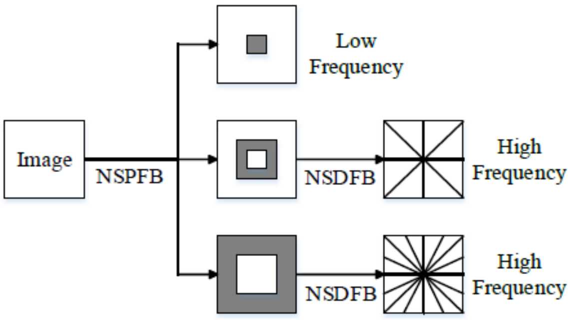

Fig. 2. Non-Subsampled contourlet decomposed schematic diagram

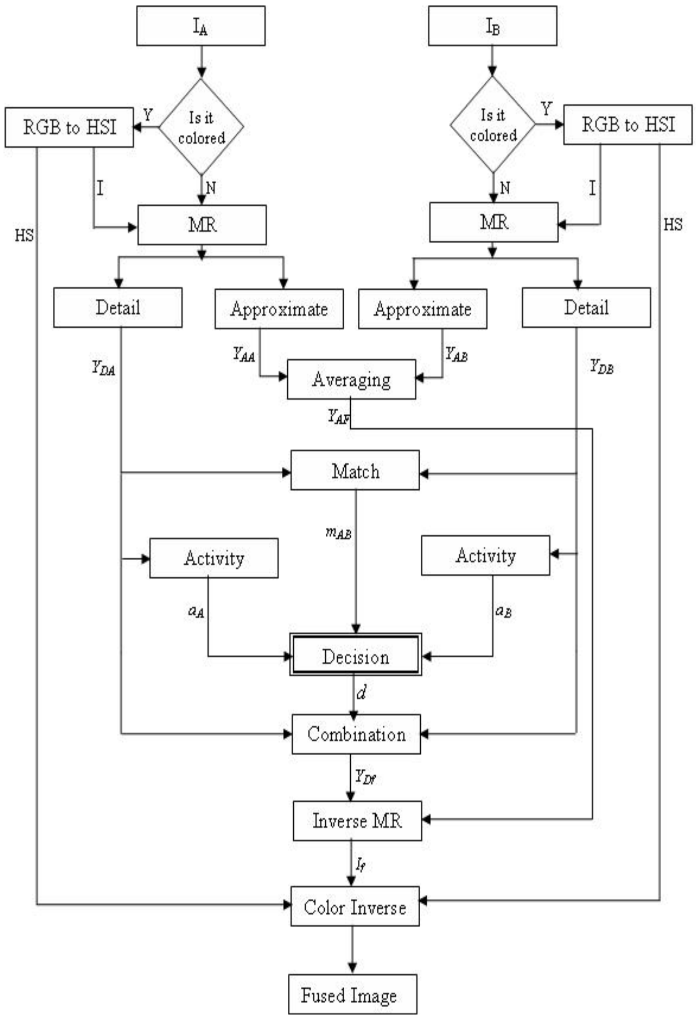

Fig. 3. General Composite image enhancement Frame work

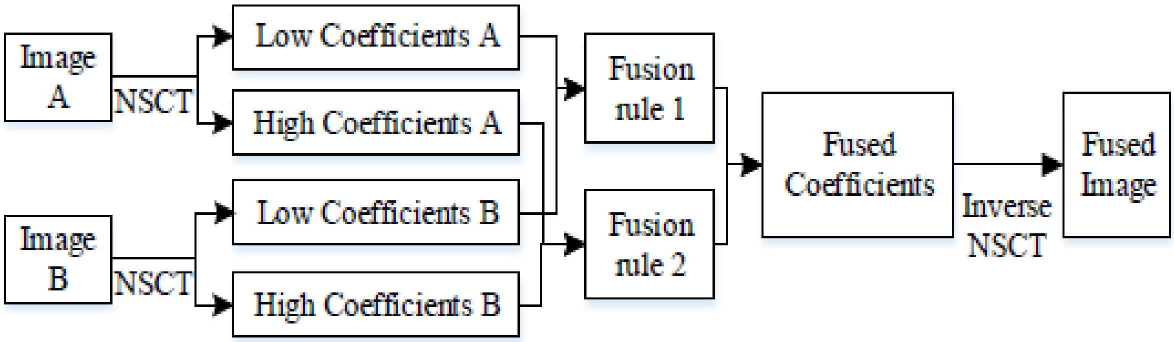

Fig. 4. Schematic diagram of NSCT-based fusion algorithm

In Fig.4, the image fusion for image enhancement, the visual quality of an image, with minimal image distortion is needed to be improved. Some limitations are presented in Wavelet Bases, because the detection of highly anisotropic elements such as alignments in an image are not well adapted [11-12]. Do and Vetterli proposed an efficient directional multi resolution image representation recently, called the contourlet transform. Contourlet transform provides good performance in representing the image features such as edges, curves, lines and contours than wavelet transform because of its anisotropy and directionality. Therefore it is well-suited for multi- scale edge based color image enhancement. The contourlet transform consists of two steps which is the sub band decomposition and the directional transform. A Laplacian pyramid is first used to capture point discontinuities, then followed by directional filter banks to link point discontinuity into linear structure.

Fig.5. Barbara Image

4. SIMULATION RESULTS

The simulation performed for four different images are shown in Figs.5 and 6. The comparison table clearly proves that the proposed technique has achieved the expected output. The Table 1 presents the PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error) values. By using basic elements like contour segments, it results in image expansion, thus the term contourlet transform being coined.

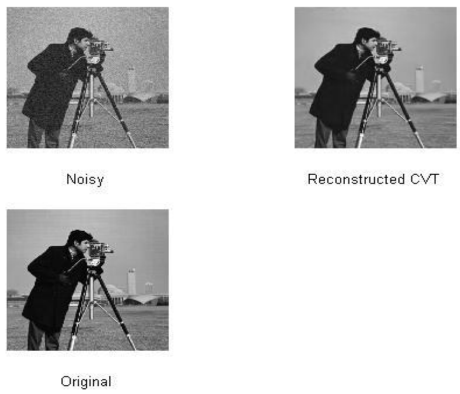

Fig.6. Cameraman Image

Table 1 : Comparison Table

Image Type	PSNR	MSE
Barbara Image	16.2568	0.7568
Pepper Image	17.4568	0.6548
Saturn image	18.8965	0.5684
Cameraman Image	20.6795	0.5188

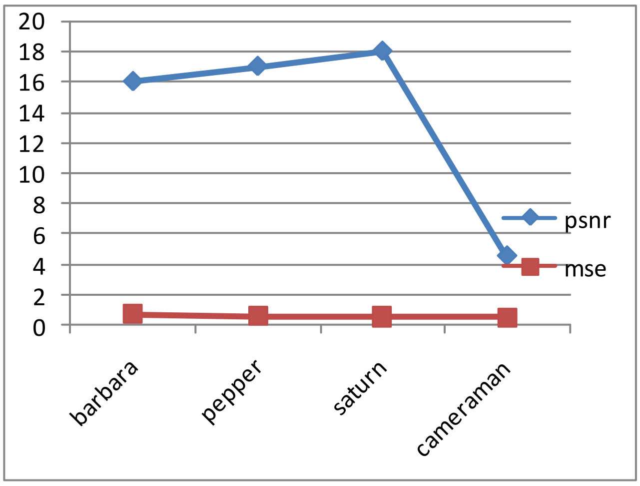

Fig.7. Comparison chart of different images

5. CONCLUSIONS

In many applications human perception of the fused images is of a most importance and as a result the enhancement results are mostly evaluated by subjective criteria. The experimental results prove that, obtained results are achieved the expected output. It shows that the contourlet transformation gives encouraging results for all the images, since the image salient features such as edges lines and contours are well represented using the contourlet transform.

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