



Quality assessment of image fusion methods in transform domain

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Abstract — *The technique of mixing the multiple images into one is called image fusion. The resultant image is more significant as well as it gives the better quality. Image fusion provide a greater importance in defense and civilian sector eg:-medical imaging. This paper presents the comparison of image fusion techniques using FFT,DCT,DWT.The comparison is based on parameters like entropy,standard deviation.*

Keywords-Image fusion;FFT;DCT;DWT;Transform domain.

I. INTRODUCTION

Image Fusion is a mechanism to provide more significant image as well as to improve the quality of information from a set of images. By the process of image fusion the good information from each of the given images is fused together to form a resultant image which is superior to any of the input images. This is achieved by applying different operators on the images that would make the good information in each of the image prominent.

Image Fusion finds its application in different areas. It is used for medical diagnostics and treatment. Images in different data formats can be fused. Different formats can include magnetic resonance image (MRI), computed tomography (CT), and positron emission tomography (PET) [1]. Image fusion is also used in the field of remote sensing wherein multivariate images like thermal images, IR Images, UV Images, ordinary optical image etc can be fused together to get a better image taken from a satellite. The fast development of the technique of sensors, micro-electronics, and communications requires more attention on information fusion. Several situations in image processing require high spatial and high spectral resolution in a single image. For example, the traffic monitoring system, satellite image system, and long range sensor fusion system all use image processing. However, the majority of available equipment is not capable of providing this type of data convincingly. The sensor in the surveillance system can only provide the scenery view in a narrow depth for a particular focus, yet the demanding application of this system requires a clear view with a high depth of the field. Image fusion provides the possibility of combining different sources of information. In this paper, we state two commonly used image fusion algorithms with manually defined parameters. The process of image fusion can be performed at three different levels of information representation, namely pixel-, region- or decision-level [5]. In following we briefly introduce each one of them.

1.1.Pixel-level image fusion

Image fusion at pixel-level represents the combination of information at the lowest level of information representation, since each pixel in the fused image is determined by a set of pixels in the source images. Usually, this set consists of a single pixel or comprises of all pixels within a small window, typically of size 3×3 or 5×5 . The advantage of pixel-level fusion, apart from its easy and time-efficient implementation, is that the resulting image contains the original information from the sources. However, since pixel-level fusion methods are very sensitive to misregistration, co-registered images at subpixel accuracy are required. Today, most image fusion applications employ pixel-level fusion methods.

B.Region-level image fusion

Region-level fusion approaches typically start by extracting all salient features from the various input images. This is done by applying an appropriate segmentation algorithm which identifies all salient features within the input images with respect to certain properties such as size, shape, contrast, texture or gray-level. Based on this segmentation, a region map is created which links each pixel to a corresponding feature. Consequently, the fusion process is performed on the extracted regions (as opposed to pixel-level image fusion where the fusion result is determined by an arbitrary set of pixels). Region-level image fusion usually yields advantages compared to pixel-based techniques since some drawbacks, such as blurring effects, high sensitivity to noise and misregistration can be avoided. However, the final fusion performance of region-level image fusion methods highly depends on the quality of the segmentation process. In other words, segmentation errors such as under- or over-segmentation may lead to the absence or degradation of certain features in the fused image [8].

C.Decision-level image fusion

Fusion at decision-level allows the information from multiple sensors to be effectively combined at the highest level of abstraction. In this context, first a decision map is built for each source image by performing a decision (labeling)

procedure on all input pixels. Finally, a fused decision map is constructed based on the individual decision maps. For this purpose decision rules are used which reinforce common interpretation and are able to resolve differences between the individual decision maps. The choice of the appropriate level depends on many different criteria such as the underlying application, the characteristics of the physical sources as well as on other factors such as execution time and the available tools. However, there exists a strong inter-linkage between the different levels of image fusion. Many fusion rules which are used to determine the individual pixels in the composite image at pixel-level can, for instance, also be used at region-level to fuse the extracted features. Furthermore, decision-level fusion often resorts to the segmentation map created at region-level to aid with decision-making.

II. METHODS OF IMAGE FUSION

A.DWT based image fusion based image fusion

The Fig1 shows the top level block diagram of image fusion using wavelet transform. The two input images image1 and image 2 that are captured from visible and infrared camera respectively are taken as inputs. The wavelet transform decomposes the image into low-low, low-high, high-low, high-high frequency bands [1]. The wavelet coefficients are generated by applying the wavelet transform on input images. Wavelet coefficients of the input images are fused by taking the average of input images. The resultant fused image is obtained by applying the inverse wavelet transform

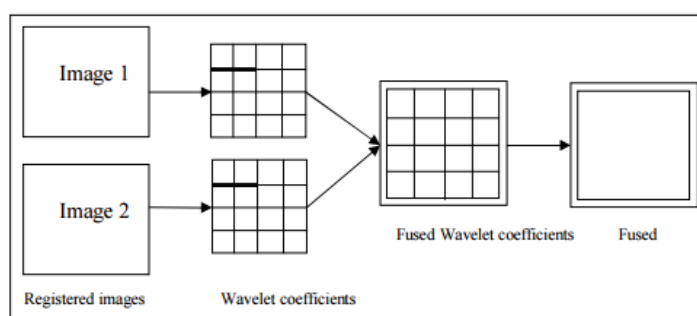


Fig1:DWT based image fusion

B.Discrete Cosine Transform (DCT) based image fusion

For simplicity, Discrete Cosine Transformation (DCT) can convert the spatial domain image to frequency domain image

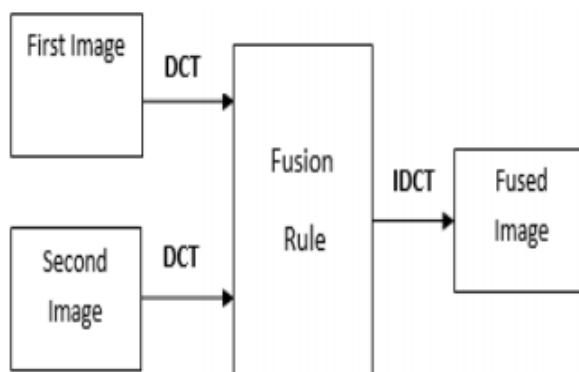


Fig2:DCT based image fusion

Image to be fused are divided into non-overlapping blocks of size $N \times N$ as shown in Fig2. DCT coefficients are computed for each block and fusion rules are applied to get fused DCT coefficients [2]. IDCT is then applied on the fused coefficients to produce the fused image/block. The procedure is repeated for each block.

C.Fast Fourier transform based image fusion

Read images and Binaries them. Identify the highest frequency from input image. Find FFT of Each Element. Take Inverse FFT to assemble the merged Image [5].

III. PERFORMANCE EVALUATION

Performance evaluation is an essential part of Image fusion processing so one can further adjust the algorithm parameter through analyzing, testing and evaluating the effects of the fusion algorithm and performance so the whole fusion process can be optimized. Performance parameters are of two types: with reference image and without reference image. When the reference image is not available then the performance of the image fusion algorithms can be evaluated using following metrics

A.Information Entropy

Entropy is used to evaluate the information quantity contained in an image. If entropy of fused image is high, it indicates that the fused image contains more information. Entropy is defined as

$$E = - \sum_{i=0}^{L-1} p_i \log_2 p_i \quad \dots(1)$$

Where, L is the number of pixel levels in the fused image. P_i is probability of occurrence of a particular gray level. Entropy can directly reflect the average information content of an image.

B.Standard Deviation

Degree of dispersion between the value Of each Pixel and the average value of image. Standard Deviation can be find using following formula:

$$\sigma = \sqrt{\sum_{i=0}^L (i - \bar{i})^2 h_{if}(i)}, \quad \bar{i} = \sum_{i=0}^L i h_{if} \quad \dots(2)$$

Maximum the standard deviation gives better resultant image

Example of image fusion using DCT,FFT,DWT for SET 1 is shown below



Fig3:Input images



Fig4: DCT based image fusion



Fig5: FFT based image fusion

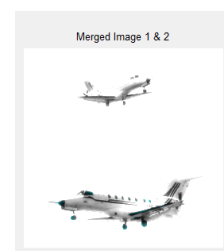


Fig6: DWT based image fusion

SET 1					
Parameters	Input image 1	Input image 2	DCT	FFT	DWT
Entropy	4.013	3.904	0.991	1.13	1.00
Standard deviation	47.624	45.207	27.75	45.57	30.90
SET 2					
Parameters	Input image 3	Input image 4	DCT	FFT	DWT
Entropy	6.07	66.07	1.95	3.37	2.08
Standard deviation	88.06	88.06	109.5	112.1	109.5
SET 3					
Parameters	Input image 3	Input image 4	DCT	FFT	DWT
Entropy	7.42	7.41	4.91	4.92	4.48
Standard deviation	87.28	87.30	90.78	91.59	76.74

Table 1: Comparison of DCT,FFT,DWT based image fusion for images of SET1,SET2,SET3.

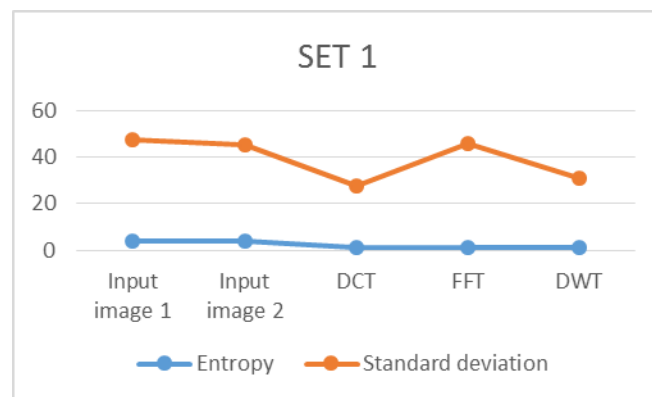


Fig7: :Comparison based on entropy and standard deviation for SET1

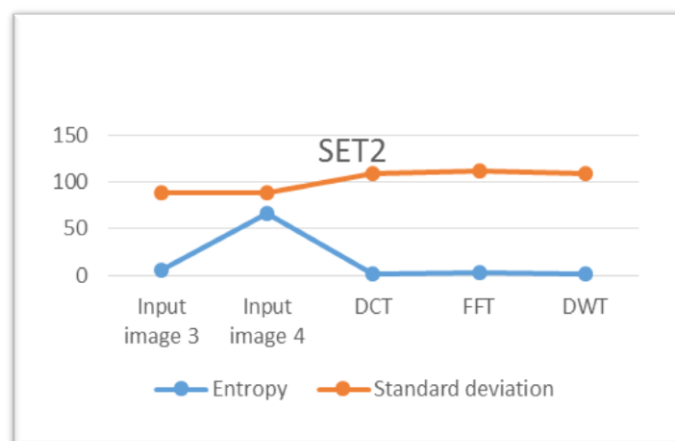


Fig8: :Comparison based on entropy and standard deviation for SET2

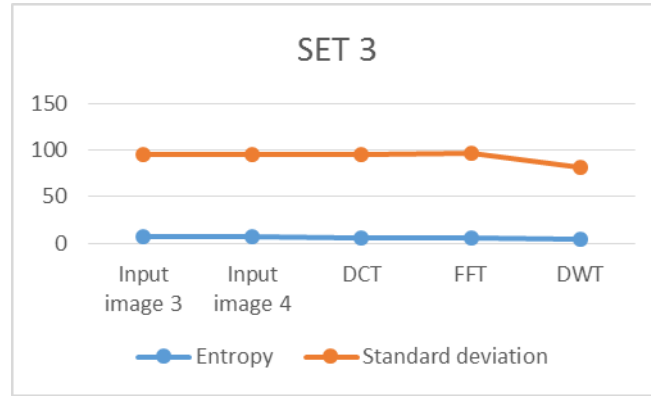


Fig9: :Comparison based on entropy and standard deviation for SET3

IV. CONCLUSION

This paper presents the comparison of image fusion techniques. In this paper, we performed experiments to compare and analyze the fusion results of three different fusion methods in transform domain. We evaluated and analyzed our experimental results using different performance quality metrics to ensure a correct comparison. Based on quality matrices and qualitative (visual) results DWT gives better results.

V. REFERENCES

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