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A Combined Approach using DWT & PCA on Image Fusion

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Abstract: Image fusion is the process that fuses the information from multiple images of the same size. The image fusion results generate new images that contain the contents and most desirable information and characteristics of each input image. The main application of image fusion is merging the gray-level high-resolution panchromatic image and the colored low-resolution multispectral image. The image fusion methods perform well spatially but usually introduce spectral distortion. . Which means that the variation of hue before and after the fusion process has appeared? There is color distortion when the fusion is appeared in the color images. There is human visualization and objective evaluation criteria related problems when the fusion of two images occurred. The Hue, Saturation and the Intensity of the color images effected due to fusion. To overcome the problem of color distortion image fusion is implemented. The image fusion is to generating a new image that enjoys the high-spatial resolution of images and the color information of the Multispectral images. To reduce the color distortion of the images without destroying any factor of the images like Hue, Saturation and Intensity and implement the DWT technique of Image Fusion. To implement the image fusion Multilevel DWT technique is implemented. In this research work DWT is combined with PCA and different parameters like PSNR,MSE,AD,AME etc.

Keywords: PSNR, DWT, MSE, PCA, image fusion etc.

I. INTRODUCTION

Image fusion can be defined as the process of extracting the appropriate information from a set of images and then combining them intelligently to form a single composite image with extended information content in order to overcome the limitation of the type and resolution of the hardware sensors capturing images [2]. Image fusion technology can be applied to many areas dealing with images such as medical image analysis, remote sensing, military surveillance, etc. The following figures show how image fusion can be applied to several areas.

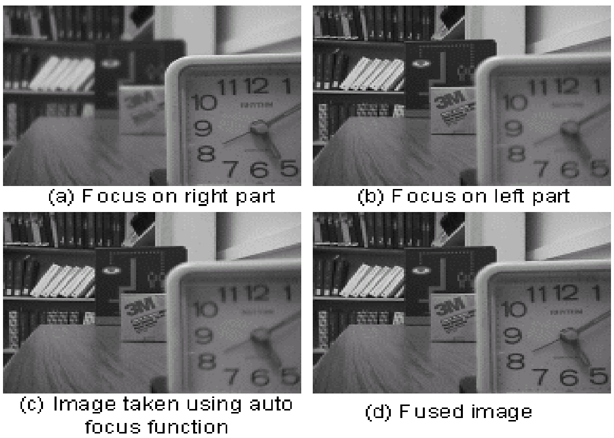

Figure 1.1 Example of Fused Image [3]

In Figure 1.1, each image (a) (b) and (c) has some blurred part due to bad focus. Image (d) is the result of combining the three other images using image fusion technology. This example could be used in a commercial advertisement photo shot. In the next example it is shown that this technology is also applicable to medical analysis.

1.2. IMAGE FUSION

The resulting image will be more informative than any of the input images. In remote sensing applications, the increasing availability of space borne sensors gives a motivation for different image fusion algorithms. Several situations in image processing require high spatial and high spectral resolution in a single image. Most of the available equipment is not capable of providing such data convincingly. The image fusion techniques allow the integration of different information sources. The fused image can have complementary spatial and spectral resolution characteristics. However, the standard image fusion techniques can distort the spectral information of the multispectral data while merging. In satellite imaging, two types of images are available. The panchromatic image acquired by satellites is transmitted with the maximum resolution available and the multispectral data are transmitted with coarser resolution. This will usually be two or four times lower. At the receiver station, the panchromatic image is merged with the multispectral data to convey more information.

1.2.1. Evolution of Image Fusion Research

The evolution of the research work into the field of image fusion can be broadly put into the following three stages:

Simple attempts for image fusion

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Pyramid based image fusion

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Discrete Wavelet transform based image fusion

Figure 1.2 Evolution of Image Fusion Research

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Wavelet based image fusion

The standard image fusion techniques, such as IHS based method, PCA based method and Brovey transform method operate under spatial domain. However, the spatial domain fusions may produce spectral degradation. This is particularly crucial in optical remote sensing if the images to fuse were not acquired at the same time[6]. Therefore, compared with the ideal output of the fusion, these methods often produce poor result. Over the past decade, new approaches or improvements on the existing approaches are regularly being proposed to overcome the problems in the standard techniques. As multi resolution analysis has become one of the most promising methods in image processing, the wavelet transform has become a very useful tool for image fusion. It has been found that wavelet-based fusion techniques outperform the standard fusion techniques in spatial and spectral quality, especially in minimizing color distortion [7, 10, and 11]. Schemes that combine the standard methods (HIS or PCA) with wavelet transforms produce superior results than either standard methods or simple wavelet-based methods alone. However, the tradeoff is higher complexity and cost.

Introduction to Wavelet Transform

Wavelet transform consists of a set of basis functions that can be used to analyze signals in both time and frequency domains simultaneously. This analysis is accomplished by the use of a scalable window to cover the time-frequency plane, providing a convenient means for the analyzing of non-stationary signal that is often found in most application [8].

Wavelet analysis adopts a wavelet prototype function known as the mother wavelet given as:

$$\psi(\tau, s) = \frac{1}{\sqrt{s}}\,\psi\left(\frac{t-\tau}{s}\right) \qquad (1.1)$$

This mother wavelet in turns generates a set of basis functions known as child wavelets through recursive scaling and translation.

Where, s reflects the scale or width of a basis function,
τ is the translation that specifies its translated position on the time axis,
$\psi\left(\frac{t-\tau}{s}\right)$ is the mother wavelet,
$\frac{1}{\sqrt{s}}$ is the normalized factor used to ensure energy across different scale remains the same[10].

Discrete Wavelet Transform

Discrete Wavelet Transform (DWT) is introduced to overcome the redundancy problem of CWT. The approach is to scale and translate the wavelets in discrete steps as given in equation (1.6).

$$DWT(\tau_0, s_0) = \frac{1}{\sqrt{s_0^f}} \int_{-\infty}^{\infty} f(t)\,\psi\left(\frac{t-k\tau_0 s_0^f}{s_0^f}\right) dt \qquad (1.2)$$

Wheres_0^f is the scaling factor,$\tau_0$is the translating factor, k and j are just integers.

Subsequently, we can represent the mother wavelet in term of scaling and translation of a dyadic transform as

$$\psi_{j,k}(t) = 2^{-f/2}\psi(2^{-f}t - k) \qquad (1.3)$$

Replacing equation, the coefficients of DWT can be represented as [10]:

$$C_{f,k} = 2^{-f/2}\int_{-\infty}^{\infty} f(t)\psi(2^{-f}t - k)\,dx \qquad (1.4)$$

The Discrete Wavelet Transform is identical to a hierarchical sub band system where the sub bands are logarithmically spaced in frequency and represent octave-band decomposition [8].

By applying DWT, the image is actually divided i.e., decomposed into four sub-bands and critically sub sampled .

II.RESULT & DISCUSSION

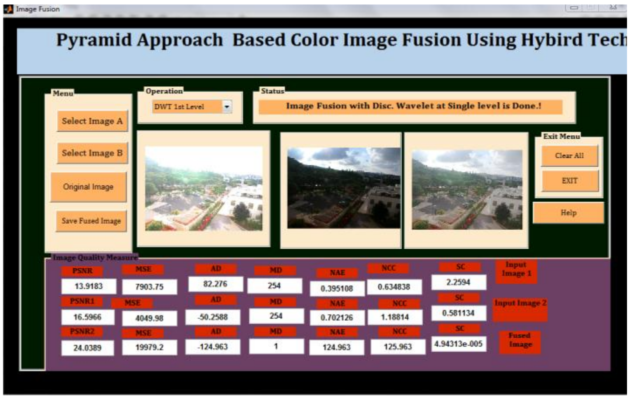

Figure 5.3 DWT 1- Level Ouput for image fusion

Figure 5.4 DWT-2-Level Output for image fusion

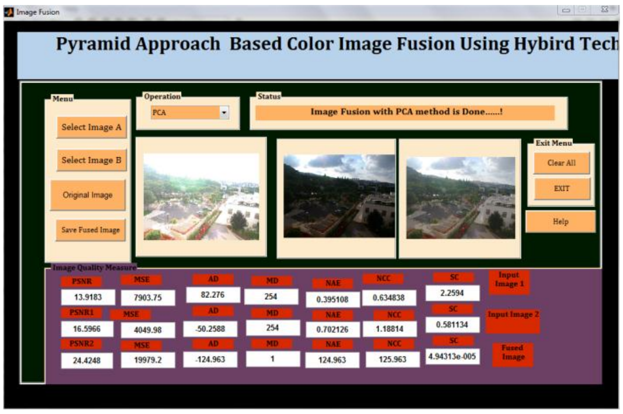

Figure 5.5 PCA Ouput for image fusion

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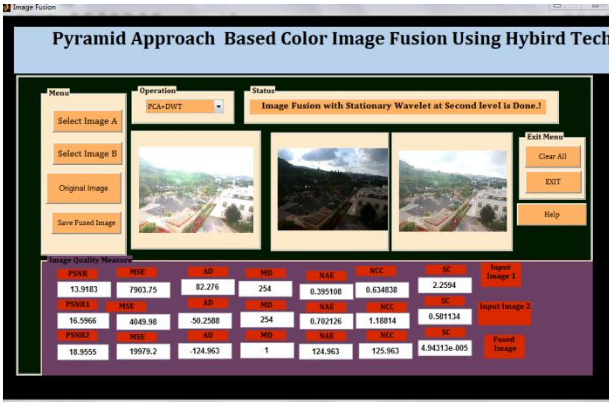

Figure 5.6 PCA+DWT Ouput for image fusion

III.CONCLUSION & FUTURE WORK

CONCLUSION

Image fusion is the process that fuses the information from multiple images of the same size. The image fusion results generate new images that contain the contents and most desirable information and characteristics of each input image. The main application of image fusion is merging the gray-level high-resolution panchromatic image and the colored low-resolution multispectral image. There is color distortion when the fusion is appeared in the color images. There is human visualization and objective evaluation criteria related problems when the fusion of two images occurred. The Hue, Saturation and the Intensity of the color images effected due to fusion. To overcome the problem of color distortion image fusion is implemented.In this study, multilevel DWT for image fusion and Principle component Analysis and DWT with PCA is combined, So that the best results of the image fusion is founded. The DWT coefficient can improve classification accuracy without adding new information because wavelet method can use both spectral and spatial information simultaneously. The image fusion is to generating a new image that enjoys the high-spatial resolution of images and the color information of the Multispectral images. To reduce the color distortion of the images without destroying any factor of the images like Hue, Saturation and Intensity the DWT fist level and second level technique of Image Fusion is implemented. To implement the image fusion Multilevel DWT technique PCA is combined with DWT -1st level and median filter is added to get the better results. In this research work DWT is combined with PCA based on their PSNR and different parameters like PSNR, MSE, AD, AME etc.

FUTURE WORK

In future the image fusion is implemented with different types of wavelets with their hard and soft threshold values and gets the better results. Further image fusion is implemented on the real time videos and real time images with high resolution capture devices and gets efficiency results.

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