A Survey On Image Fusion Techniques

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Abstract- *This paper presents the different image fusion techniques. Image fusion is a mechanism to join multiple images into an image. This mechanism is used to fetch informative data and represent large amount of data into single form. These fusion techniques enhance the quality of the input images. Image fusion techniques are of two types, Spatial Domain fusion method and Temporal Based fusion method. This paper explores the spatial domain fusion method. Spatial domain fusion method further divides into different fusion methods. Comparisons among all these fusion methods have explained at last of the paper.*

Keywords- Fusion, Minimum, Maximum, PCA, IHS, Brovey, Average.

I. INTRODUCTION

Image fusion is a mechanism that collects data form multiple images and produces single image with better visual perception. Fusion helps to generate high quality image. Produced images are more beneficial for computerized tasks. There are various advantages of fusion as these techniques improve the reliability and capability of the images; due to these advantages fusion techniques are more using in every field day by day. Fusion techniques have the great scope in medical imaging field, multimodality is widely using here. Often adjoined images provide additional clinical data that not available in disjoint images. Many fusion techniques are available in digital image processing but these mainly categorized into two methods, spatial domain fusion method and temporal domain fusion method. Transformation is required in transform domain fusion method that means it firstly transfer image into frequency domain and then process input image. Whereas, Spatial domain fusion method directly processes the pixel of input image. These techniques further categorized into number of transform methods. Spatial domain has brovey method, principal component analysis and intensity hue saturation. These all have different merits and demerits respectively. Spatial domain fusion method is based on high pass filtering and spatial distortion is the main demerit of this method. Transform domain method also distributed into various transformations. Image fusion techniques are widely used in remote sensing application. There are three (pixel level, decision level and feature level) different levels of image fusion techniques.

II. IMAGE FUSION TECHNIQUES

Minimum method: This method is use to pick up the pixels from input images with least intensity value and derive the final fused image with minimum intensity. It is very simple.

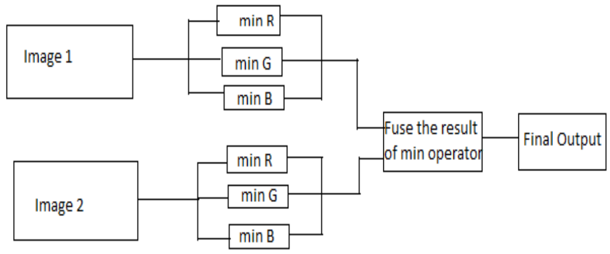


Figure 1: Working model of Minimum Fusion Method.

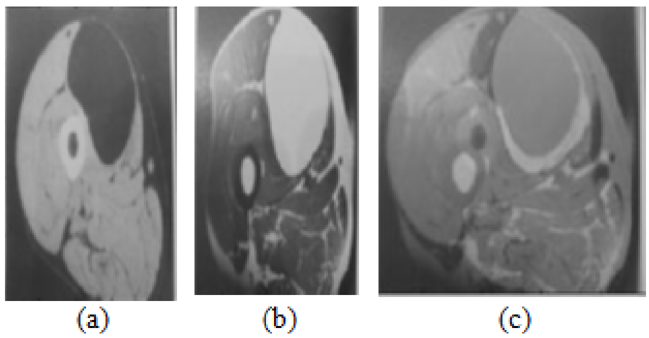


Figure 2: Example for Minimum Method[4]
(a) Input image1 (b) Input image2 (c) Fused Image

Maximum method: This is similar to minimum method. But here, pixels with highest intensity value have been picked up to produce final fused image [3].

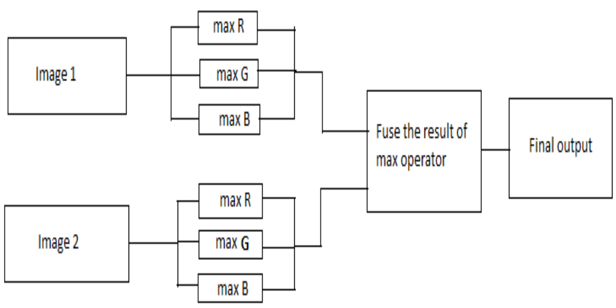
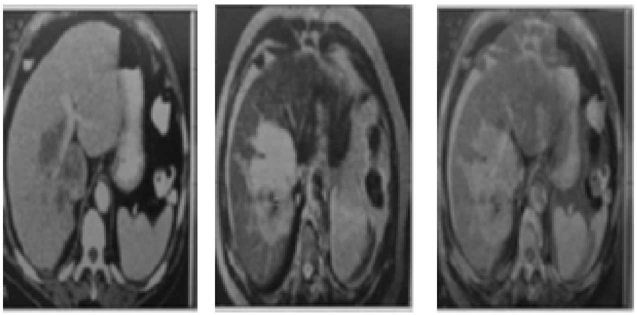


Figure 3: Working model for Maximum Fusion Method



(a) (b) (c)

Figure 4: Example for Maximum Method[4]
(a) Input Image1 (b) Input Image2 (c) Fused Image

Average method: Unlike minimum and maximum method here, we get average value of pixels by adding all the pixel values of the input images divided by number of images [10]. In this both good quality and bad quality pixel values have been merged. That’s why the final output image doesn’t provide the accurate result.

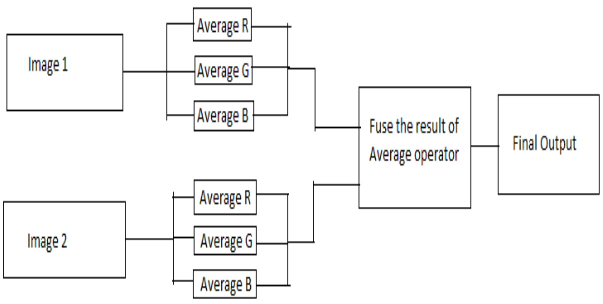
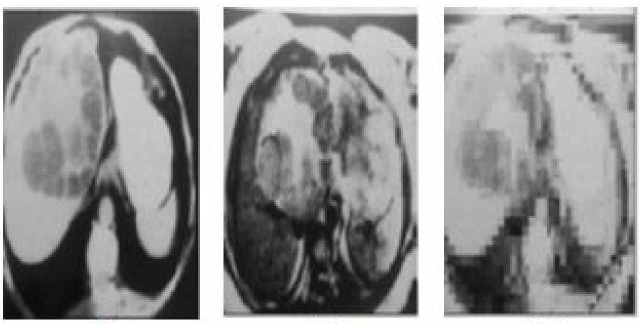


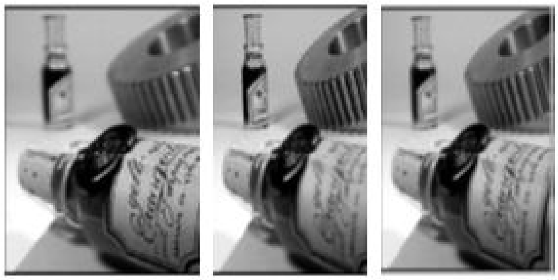
Figure 5: Working model for Average Fusion



(a) (b) (c)

Figure 6: Example for Average Method[4]
(a) Input Image1 (b) Input Image2 (c) Fused Image

Principal Component Analysis: Principal component analysis is a transform of spatial domain method. It is used to multidimensional data sets to lower dimension for the analysis purpose. Uncorrelated variables transformed by correlated variables are called principal components [1,2,6]. PCA is used to compute compact and optimal description of datasets. Image compression and classification techniques performed by principal component analysis. Principal component analysis applies linear algebra to fuse input images. Input images arrange into column vectors and calculate empirical mean for each column. Final fusion has done by calculate Eigen vector and Eigen values.



(a) (b) (c)

Figure 7: Example for Principal Component Analysis [7]
(a) Input Image1 (b) Input Image 2 (c) Fused Image

Intensity Hue Saturation: Intensity hue saturation, basically converts R, G, B bands into I, H, S components and applied inverse transformation to get final fused image [5]. This transform has the three properties of a color that give controlled visual representation of an image. In the IHS space, hue and saturation need to be meticulously controlled because it contains almost all of the spectral data. In the process of fusion of high resolution panchromatic (PAN) image and multispectral images, the actual aspect data associated with high spatial resolution is added to the spectral information. IHS technique is based on a principle of replacing one of the three ingredients (I, H or S) of one data set with another image. Mostly the actual high intensity route is actually replaced. IHS transform is done on the low spatial resolution images and then the intensity ingredient is replaced by the high spatial resolution image. Reverse IHS transform is applied on new set of ingredients to form the fused image. The IHS technique is one of the most frequently used fusion method for sharpening.

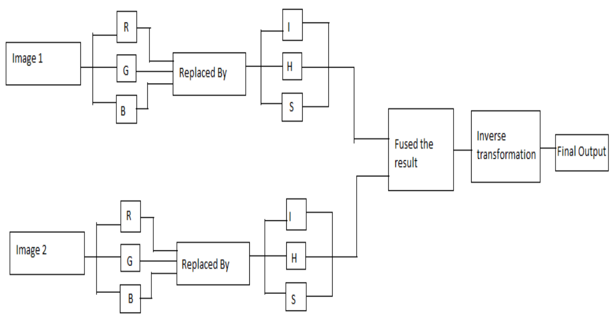


Figure 8: Working model for Intensity Hue Saturation

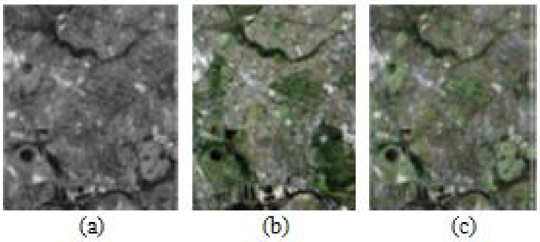


Figure 9: Example for Intensity Hue Saturation [9]
(a) Input Image1 (b) Input Image2 (c) Fused Image

Brovey method: Brovey performs mathematical notations to combine both panchromatic and multi spectral bands. It is based on the chromaticity transform. It's able to fuse images captured by different sensors. The ratio of high spectral resolution co-registered image multiplies with the three spectral components. It produces the fused image with low quality pixels.

III. ANALYSIS AND DISCUSSION

Table1: Comparison of Different Fusion Techniques

Techniques	Advantages	Disadvantages
Minimum	• It finds the noise from darker pixels of the image.	• It produces the blurred image that degrades the quality of an output image.
Maximum	• It provides good information of the data.	• It doesn't provide accurate result for dark pixels.
Principal Component Analysis	• It based on principal components. • It able to calculate accurate Eigen vector and values. • It contains spatial quality at high rate	• It degrades the spectral quality of an image.
Brovey	• It helps to fuse images taken by different sensors. • It doesn't effect on the spectral features of the pixels.	• It degrades the spectral quality of an image.
Intensity Hue Saturation	• It is based on replacing principals. • It helps to sharp the edges of the input image.	• It reduces the color contrast of the pixels.
Average	• It runs fast	• It produces blurred image.

As the above table, described the advantages and disadvantages of each and every fusion technique. As IHS performs some replacing components and provide better visibility of image. Even each technique is better but among all PCA and IHS are the best.

IV. CONCLUSION

In this paper various spatial domain fusion techniques have been studied. Fusion techniques help to enhance the quality of the input images. Image fusion techniques have their own merits and demerits. These techniques can apply on various methods to produce final good quality image. These directly effect on the spectral quality of the input images. Furthermore most of the input images have artifacts problem. Artefacts problem can be improved by applying gradient optimization algorithms. Fusion techniques provide the concluded data of different types of images. Image fusion has wide scope in the computer vision applications. The above comparison has shown that PCA and IHS fusion techniques are better than others. But still the neglected problems in existing techniques can be improved in near future.

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