"IDENTIFICATION OF WATER BODIES BY FUSION OF REMOTE SENSING IMAGES" - A REVIEW

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Abstract- *Remote sensing is the collection of the information from the image capture by the sensor. The resultant image of the input image will be more informative and consummated rather than any of the input images, which makes it easy to categorize, compare, and evaluate the existing quality matrices of image fusion methods. Remote sensing of water body detection is fundamentally rooted of electromagnetic radiation from the object. The fused image is inter compare with the other method on the basis of quality matrices and from the fused image detected water area of small as well as large water body. MS image is the composite of Red (R), Green (G), Blue (B) bands and PAN image is the gray scale image. Therefore, few of the image fusion techniques for image fusion like Averaging image fusion method, Maximum image fusion method, Minimum image fusion method, Discrete Wavelet transform based fusion, Principal component analysis (PCA) based fusion, Low pass filter (HPF), Intensity hue saturation (IHS) etc. To check the quality of the fused image few quality matrices are like Peak signal to noise ratio (PSNR), Mean square error (MSE), Average gradient (AG), Mutual information (MI) etc.*

Key – Words : Remote sensing, fused image, MS image, PAN image, Discrete Wavelet transform based fusion, PCA, Low pass filter (LPF), Intensity hue saturation (IHS), Peak signal to noise ratio (PSNR), Mean square error (MSE), Average gradient (AG).

1. INTRODUCTION

At present time, water resources are decreasing day by day from the world, in many places, water shortage is a major issue to sustain development and poverty dispense and the cause of serious pique between some countries. Many image fusion and analysis techniques have been developed to aid the interpretation of satellite images and to collect as much information as possible from the images. Depending on the availability of the requirement many techniques of digital image processing and modelling are required for the better output of information. So, surface water can be surveyed in image processing by detection process. From this it is easy to highlight the water body by segmentation and morphology techniques in the image. Detecting of the surface water bodies using remote sensing techniques help in the areas like rainfall, irrigation management, flood forecasting, drought monitoring, water harvesting and watershed planning and management.

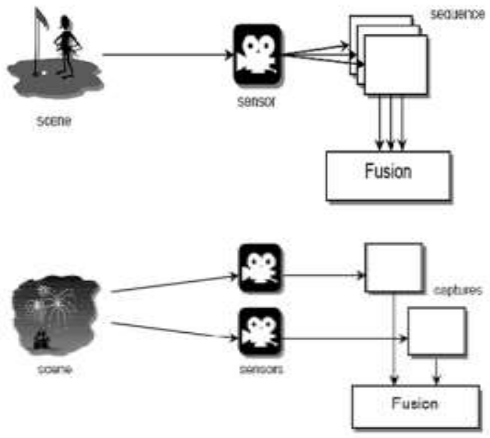

Fig-1 (a): Single Sensor Image Fusion System, **(b):** Multi- Sensor Image Fusion System (Rane et al., 2014)

1.1 Image Fusion

Image fusion is a technique of fusing multiple images so to get a single output. The image fusion is to remove the problem from one of the image and another. This is only possible by applying some of the certain algorithms to obtain better and informative about an object of the area.

1.2 Multispectral image (MS)

Multispectral image generally refers to 3 to 10 bands, with each band acquired using a radiometer. MS images are costly. MS image have low spatial resolution and higher pixel size.

1.3 Panchromatic image (PAN)

Panchromatic image have high spatial resolution and low spectral resolution. Whereas PAN image is less costly. The PAN image comprises of the spatial details of an area. It is 2 to 4 times better in terms of spatial resolution than MS image.

1.4 Domains of Image Fusion methods can be broadly classified into two Techniques

1.4.1 Spatial domain fusion method:

In it individual pixel value of an image are taken directly. It include point process, mask process and global process. The techniques deal with grayscale manipulation, histogram equalization, image smoothing, image sharpening etc.

$$F(x, y) = T\,(F(x, y))$$

Where,

F = an image.

T (F) = transform image.

x, y = size of the image.

1.4.2 Transform domain fusion method:

It directly work with the pixel value of an image. It is not possible because this method based on orthogonal transform manipulation of the image rather than the image itself in which we deal with amplitude and phase of the image.

1.5 LEVELS OF IMAGE FUSION

Mainly image fusion depends on three levels which are given below:-

a. Signal levels
b. Pixel levels
c. Feature levels
d. Decision levels

2. LITERATURE REVIEW

Hasanlou et al. (2016).

Quality assessment of pan-sharpening methods in high-resolution satellite images using radiometric and geometric index' used multispectral and panchromatic image as input image. In it a new quality index has been proposed which work on both geometric and radiometric measurement based on morphological algorithms and work on the assumption of the separate and direct effect of spectral and spatial component. The method studied are Intensity hue saturation (IHS), PCA, Gram Schmidt (GS), Brovey transform, Ehlers and High pass filter (HPF). The quality matrix used are Spectral Angle Mapper, Structural Similarity, correlation coefficients and universal quality index. In quality matrix the fused image generally is an RGB image which is compared to original image. In proposed one the main work done on two component of edge having high frequency and background information of the image. On comparing SSIM, CC, UQI and SAM RG index with the proposed method have same required quality fused image or more accurate in terms of image segmentation and classification.

Singh et al. (2016).

Multi focus image fusion based on Spatial Frequency and Contrast Based Analysis under Stationary Wavelet Transform Domain study multi focus image and proposed a new method in which firstly focus right and left of the images and apply SWT to get four sub-band in which one is approximation sub band and other three are detail sub band after that on the high frequency coefficient contrast calculated from which they get three images from both input images among them our interest is on high value of LL, HL, LH and HH and on lower frequency apply spatial frequency then apply inverse SWT on the components to get the final fused image. Finally for the result DCT and NSCT are compared with the proposed method and found almost similar result.

Salem et al. (2016).

For fusion three basic approaches are used they are JDL (Data fusion lexicon) model, Intelligence cycle model and DFD (Data feature decision) these are nothing but decision level, feature level etc. Now based on these level of fusion image fusion methods are described. The average of all the pixel value of the input images forming a resultant fused image. In Maximum image fusion method, the resultant image is produce by the maximum pixel value of the input images while in Minimum image fusion resulting image is the minimum pixel value of the input images. To transform inter-correlated data in uncorrelated data known as Principal component and produces high quality fused image. In HIS

techniques the input images are transformed from the RGB to HIS. The weighted least square filter decomposes into two components based on average filter i.e. base layer and detail layer, obtained by subtracting base layer from input image.

Zhao et al. (2016, July).

A new Pan-sharpen method based on Guided Image Filtering: A case study over gaofen2 imagery had studies some methods deeply i.e. DWT, CT, Non-subsampled shearlet transform (NSST) which has much better feature capturing ability as well as lower computational complexities. In it the input images decomposes into sub band images for reconstructing fused image in which detail information is not satisfactory and Deep Boltzmann machine (DBM) which work on the coefficients selection in the sub band images for visible and infrared images. In proposed method the detailed of the leave outlines, houses, and fences having better consistency. Finally for result quality matrix (SD,MI,IE,AG) are used from result it seems that quality matrix value of SD and MI have higher value than the studied method from which we found that the proposed method has high contrast as compare to studied method and loss of information from the images is also less.

Kaur et al. (2016).

An approach for image fusion using PCA and Genetic Algorithm, based on two image fusion methods they are PCA and Genetic Algorithms and the new approach is also based on these two methods. In the proposed method two input images are taken and apply principal component analysis for fused image. Now applying genetic algorithm to obtain the optimized value after initialization of the parameters. After it fitness function is generated, to obtain more optimized fitness value cross over and mutation is performed and compare the both fitness value. If the fitness value is less than the 7 then again repeat the process from the assuming value. Finally calculate the parameters and obtained resultant image. The implemented methods gives reliable fused image for calculating quality of the fused image Mean square error, Entropy, mean, peak signal to noise ratio are used.

Zeng et al. (2010, June).

The input images are PAN image of 15m resolution and MS image of 30m resolution from Landsat-7 and PAN image of 0.61m resolution and MS image of 2.5m resolution of the Quick bird satellite and some image fusion methods are applied in both satellite image. The SVR (Synthetic variable ratio) produces better spectral fused image. The GS show better fused image as compared to SFIM and SVR. The quality matrices means value changes with the change in fusion method, highest SFIM value, middle SVR value and lower GS value, lower value show better result of fused image.

3. METHODS

3.1 Image fusion methods

3.1.1 Discrete wavelet transform

The DWT has been introduced as a highly efficient and flexible method for sub band decomposition of the image. It is multi-resolution analysis and it decomposes image into wavelet coefficient scaling function. It convert the image into series of wavelet that stored more efficiently than pixel blocks. It work in a straight forward manner by inserting array transposition between the two DWT. The rows of the array are processed first with only one level of array are processed first with only one level of decomposition. It divides the array into two vertical halves, in which the first half storing the average coefficients, while the second vertical half stores the detail coefficients of the image. This process is repeated again with the columns which result in four sub-bands within the array defined by the filter output.

3.1.2 Low pass filter

It blocks the high frequency component that means it keep only low frequency component. It is used to smoothen the image and remove noises from the image. Whereas high frequency components correspond to boundaries of the object. Generally the noise is always a high frequency component so to remove we use often low pass filter. Sine low pass filter make the frequency variation more even that is removing the high variation. In this method we assume a virtual image that is nothing but around the image matrix so that the image just expanded and good to impose the mask on the bigger image. So, that all the pixels have been processed more accurately. Now, simply multiple each element with the superimposed mask. The approach for low pass filter is simple take the average of all the multiplication superimposed

mask value and divide it by scaling factor. The scaling factor is nothing but multiplication of size of the actual input image. This whole iteration is done for all the pixel value.

3.1.3 Gaussian filter

It is a filter whose impulse response is a Gaussian function. It have the properties of having no overshoot to a step function input while minimize the rise and fall time. It is considered the ideal time domain filter, this property is important in the area of digital image fusion. If the input have linear combination then the fused image will be smooth and some of the edges have a little bit more detail. Its attribute weight gives weight to the pixel at the center and less value to that are way from center.

3.1.4 Alpha factor image fusion

This algorithm combines images in such a way that if alpha factor equal to 0.5 it means that both input images are merge equally, if alpha factor < 0.5 means the contribution of first image is more than second image and if alpha factor > 0.5 means the contribution of second image is more than first image.

3. Quantitative analysis

The ground requirement of the fused image is to preserve all information from the input images. To measure the quality of the fused image many different metrics have been presented. So, for measuring quality of fused image Wald's consistency characteristics measure which is almost close to input MS image.

Table-1: Quantitative analysis method for image quality matrices

Grade	Absolute measure	Relative measure
1	Excellent	The best from all
2	Good	Better than the average from all
3	Fair	Average from all
4	Poor	Lower than the average from all
5	Very poor	The lowest from all

3.2.1 Average difference (AD)

The higher value, show the better fused image. It provide the sensitive and clarity to the details of the two images.

$$\mathrm{AD} = \frac{1}{ij}\sum_{i=o}^{i}\sum_{j=0}^{j}(Im(m,n) - If(m,n))$$

Where,

I_m is the input image.

I_f is the fused image.

i, j is the size of the input image up to m, n.

3.2.2 Normalized cross-correlation (NCC)

The higher value, show the better fused image. It calculate the spectral similarity performance of the fused image.

$$NCC = \frac{\sum_{i=o}^{m}\sum_{j=0}^{n}(Im(i,j) * If(i,j))}{\sum_{i=o}^{m}\sum_{j=0}^{n}(Im(i,j))^2}$$

Where,

I_m is the input image.

I_f is the fused image.

i, j is the size of the input image up to m, n.

3.2.3 Maximum difference (MD)

The higher value, show the poor quality of the fused image.

$$MD = \max(Im(i,j) - If(i,j))$$

Where,

I_m is the input image.

I_f is the fused image.

i, j is the size of the input image up to m, n.

3.2.4 Object detection

The main purpose of this is to examine and representing the surface water body and make the most common object detection method for fused image.

3.3 Software used

MATLAB is the high performance language for technical computation developed by Mathworks. It basic data elementary is the matrix and strong mathematical and numerical support for the implementation purpose.

4. CONCLUSION

There exists many image fusion methods on the basis of quality matrices and detection portion should focus on techniques, categories and specific algorithms. It would be impossible to cover all methods used in this field. This review focus on the most common methods of fusion and quality matrices. While dealing with detection section several challenges from the popular image fusion method are observed and the complex processing steps of fusion.

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