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Filter Based Fusion of Panchromatic and Multispectral Image to Improve Spectral Quality

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Abstract— Image fusion intends is to improve color information in a final image as well as adding edge (spatial) information to it. Along with the existing fusion algorithms, filter based fusion method are the most frequently discuss cases in fresh publications due to their skill to get better edge and color information of multispectral (MS) and panchromatic (PAN) images. Filter based fusion approach extract edge information from the PAN image and injects it into MS images. Visual and numerical assessment show that the proposed algorithm plainly improves the fusion quality in terms of correlation coefficient (CC), relative dimensionless global error (ERGAS) in synthesis, spectral angle mapper(SAM), universal image quality index(UIQI), and quality without reference(QNR), as compared with fusion methods, including better intensity-hue-dispersion(IHD), Bayesian, and sparse fusion of image.

Index Terms — Directional filter, Image fusion, Pansharpening,Color information.

1 INTRODUCTION

Image fusion is a technique that concatenates information from multiple images of the same scene. Different Images can be captured from different sensors, and acquired at different times, or having different edge and color characteristics. Image fusion is a useful process for merging single sensor and multisensor images to retrieve more information. The aim of image fusion is to concatenates information from more images in order to produce an image that deliver only the useful information. To collect more energy and maintain signal to noise ratio simultaneously, panchromatic (PAN) image with a higher spatial resolution and a wider spectral bandwidth compare to multispectral (MS) image. Where MS image as poor spatial quality compared to PAN image. By means of image fusion, it is possible to synthesize images with the high edge resolution and the appropriate color content.

The filter based image fusion provide more color and edge information, and as a consequence, the fused products have a good quality. Highpass filtering is the primary GLP, Non Subsampled Contourlet Transform(NSCT) and Atrous Wavelet Transform(ATWT)[1][2] are the present filter based fusion methods. The wavelet method has the good ability in representation of the details with 1D transforms. Hence, it is incapable of resenting directive objects.

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The NSCT is flexible, such that it allows more number of directions in each scene and captures edge structure of images along the smooth contours, and is there by more efficient in representation of 2D objects.

A new adaptation is proposed to the filter based fusion method that varies the manner in which the lowpass filter and the extracted edge information are calculated based on the initial MS and PAN images[3]. The proposed filter preserves the color quality of the expanded MS images, as well as improves the edges quality by minimizing a trade off objective function.

2 FILTER BASED FUSION METHOD

PAN image and MS image are fused and edge detail is inject into entity MS bands, then, the fused image now and then appears like a fusion result through a highpass filtering technique, e.g., the combination between color and edge factor is not smooth. Some band effects may be appearing in the image, and small objects may not be obtaining color information. It is attractive for the procedure for integration high-resolution PAN data with low resolution MS data preserves the unique color characteristics of the afterward as much as possible. The procedure should be best in the sense that only the extra edge information available in higher resolution data is imported into the MS bands.

$$Fi = MSi + Gi\,(PAN - h * PAN)$$

Where Fi is the ith fused band, MSi is the ith MS band resembled to the scale of the PAN image and h denotes a low pass filter,

$$h = \{ \ldots h(n+1)/2, (n+1)/2 \ldots$$

Lowpass filtered report of the PAN image, i.e., PANL, has to be created to dig out the high-frequency component of the PAN image. Later, by a subtraction procedure, the highfrequency component is extracted and added to the MS images via addition.

If Gi is a stable for the ith band, then it is usually calculated from global information on the whole image. GLP is a exacting folder in which Gi is obtained from the regression coefficient linking each MS band and PANL. Otherwise, Gi depends on the present pixel and can be obtained from local data on a sliding window in context adaptive (CA) models.

For straightforwardness, it is assumed that Gi is stable, its formula is the regression coefficient between MSi and

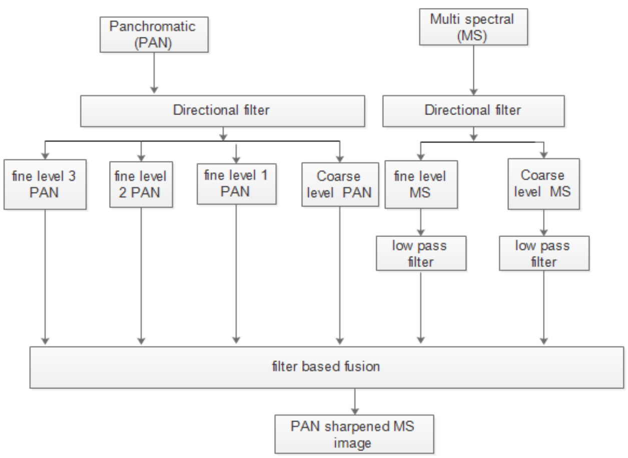
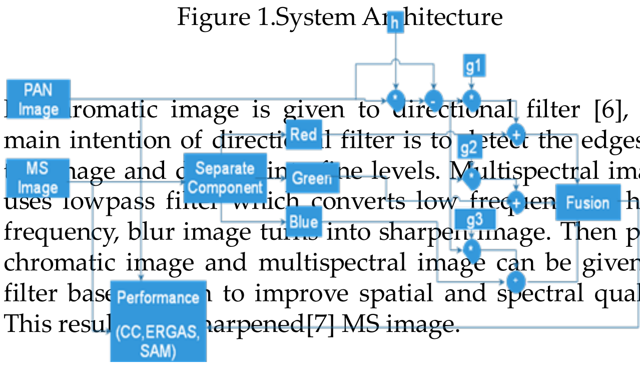


Figure 1.System Architecture



Panchromatic image is given to directional filter [6], the main intention of directional filter is to detect the edges of image and divide into the levels. Multispectral image uses lowpass filter which converts low frequency to high frequency, blur image turns into sharpen image. Then panchromatic image and multispectral image can be given to filter based fusion to improve spatial and spectral quality. This result in pan sharpened[7] MS image.

Figure 2.working of proposed system

1. Read PAN and MS images
2. Find Lambda
3. Find Filter Coefficient
4. Find convolution and filter method

PAN image and MS image taken from the IKONOS dataset, h denotes lowpass filter added to pan image and the multiply with G where G is the constant randomly generated for every pan image. MS image contains three color components red, blue, green are injected to pan image. Filter based fusion method contains various method like lambda, filter coefficient and convolution theses the various method to form fusion algorithm.

Lambda plays important role in term of calculating filter coefficient by using orthogonal matrix.

$$\lambda = 2\,(1 - (\sum_{i=1}^{N} \frac{G_i^2 C_{P,PAN}^T + G_i C_{P,MSi}^T + G_i PAN - PAN_i}{m_{MSi}^2}) \times (2\sum_{i=1}^{N} \frac{G_i^2 C_p}{m_{MSi}^2})^{-1} \times O) \times (O^T \times (2\sum_{i=1}^{N} \frac{G_i^2 C_p}{m_{MSi}^2})^{-1} \times O)^{-1}$$

Where Cp is the correlation matrix of vector P, $C_{p,MS}$ is the cross correlation between vector P and MSi +Gi*PAN-PANi and $C_{p,PAN}$ denotes the cross correlation between vector P and PAN.
The filter coefficient helps to find intensity of the image and helps to shift the rows and columns of the image based on the input

$$H = (2\sum_{i=1}^{N} \frac{G_i^2 C_p}{m_{MSi}^2})^{-1} * (\sum_{i=1}^{N} \frac{G_i^2 C_{P,PAN}^T + G_i C_{P,MSi}^T + G_i PAN - PAN_i}{m_{MSi}^2} + 0.5 * \lambda * O)$$

Filter coefficient can be finding by using lambda value and then injected to PAN image. Filter coefficient helps to improve edge detection of PAN image and then adds to multispectral image to produce filter based fusion image with better spatial quality.

Convolution uses a straightforward formal implementation of the two-dimensional convolution equation in spatial form. Convolution operator is used to multiply H with pan image. Convolution operator can be identified as "*".

Filtering method can be given as

$$F_i = MS_i + G_i * (PAN - h * PAN)$$

Where Fi is the ith fused band, MSi is the ith MS bands resemble to the level of the PAN image, and h denotes a low pass filter. If Gi is a stable for the ith band, then it is typically planned from global statistics on the whole image. GLP is a particular case in which Gi is obtained from the drop coefficient relating each MS band and PANL. Otherwise, Gi depends on the present pixel and can be obtain from limited statistics on a sliding window in context adaptive (CA) models.

4 EXPERIMENTAL RESULTS

a) Panchromatic image b) Multispectral image

C) Filter Based Fused Image

Figure3. a) Panchromatic image b) Multispectral image taken
from the IKONOS dataset these are satellite images.
c) Filter based fused image forms as a result by fusion of Pan Image and MS image with good spatial and spectral quality.

The performance of filter based fusion method can be compare
with previous method can be done by using these parameters are Correlation coefficient,Quality with No Reference,Spectral Angle Mapper and so on.

Correlation Coefficient (Cc)

The correlation coefficient is the measure of the nearness or likeness in small size structures between the inventive and the fused images. It can vary between +1 and -l Values closer to + 1 indicates that the situation and fused images are highly similar while the values closer to -1 indicate that the images are highly dissimilar.

Quality with No Reference (QNR)

Quality with No Reference is the product of the one's complements of the edge and color deformation indices, each raised to a real valued exponent that attributes the relevance of color and edge distortions to the overall excellence. The two exponents jointly determine the non linearity of reply in the interval [0,1],same as a gamma correction, to achieve a better favoritism of the fusion results compared

$$QNR \triangleq (1 - D_\lambda)^{\alpha} . (1 - D_s)^{\beta}$$

Thus, the maximum value of QNR is one and is obtained when the color and edge distortion are both zero.

ERGAS

Ranchin and Wald (2000) planned an error index that offers a worldwide picture of the excellence of a fused product. This error is called ERGAS, the French acronym for relative dimensionless global error in synthesis, and is given by:

$$ERGAS \triangleq 100 \frac{dh}{dl} \sqrt{\frac{1}{L} \sum_{l=1}^{L} \left(\frac{RMSE(l)}{\mu(l)} \right)^2}$$

Where dh/dl is the ratio between pixel sizes of PAN and MS $\mu(i)$ is the mean (average) of the ith band, and L is the number of band. This index measures a distortion, and thus must be as small as possible.

Spectral Angle Mapper

Spectral Angle Mapper (SAM) denotes the total value of the spectral angle between two vectors, v and $\hat{v}$

$$SAM = \arccos \left(\frac{\langle v, \hat{v} \rangle}{\| v \|_2 \| \hat{v} \|_2} \right)$$

A resultant value of Equation equal to zero denotes nonattendance of spectral distortion, but possible radiometric distortion (the two pixel vectors are similar but have different length). SAM is measured in either degree or radians and is usually averaged over the whole image to yield a global dimension of spectral distortion.

Universal Image Quality Index (UIQI)

New universal objective image quality index, it is easy to compute and appropriate to various image processing application. Instead of using established error abstract methods, the proposed index is designed by model any image distortion as a permutation of three factors, loss of relationship, luminance distortion, and similarity distortion. Although the new index is scientifically defined and no human visual system model is implicitly em-

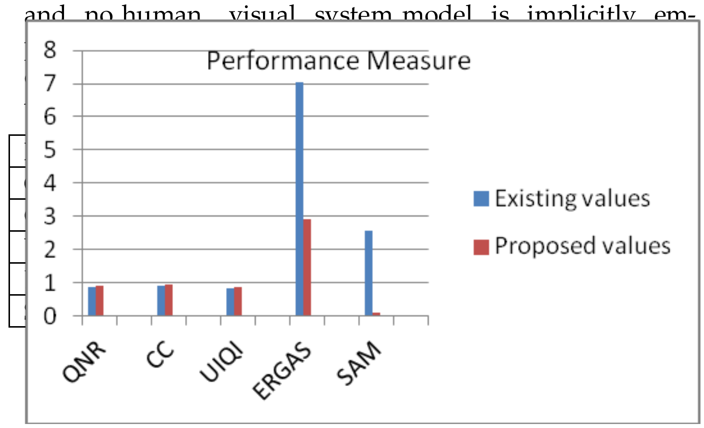


Figure4. The performance measure shows better result for filter based fusion method compared to other fusion technique. The quality of image as increased, error rate is totally decreased in ERGAS and SAM compared to existing.

5 CONCLUSIONS

A new pansharpening method based on the directional filter idea has been proposed in this note. The Edge ERGAS index is been adopted to review the bend between the fused images and the original image. Edge ERGAS review the dissimilarity between the fused images and the PAN image. To preserve the color quality of the MS image, as well as improve the edge quality, the aim was to create from both the edge and color indicator. The directional filter coefficients were planned by setting the imitative of the cost purpose is equal to zero. The numerical analyzing tools such as CC, ERGAS, QNR, SAM, and UIQI established that the proposed algorithm can improves the edge information details and reduces the color bend compared with the

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equivalent fusion methods.

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