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Implementation of Robust Satellite Image Enhancement for Fusion of Multispectral and Panachromatic Images

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ABSTRACT

This paper shows execution and assessment of the picture combination methods connected on the panchromatic and multispectral satellite pictures. The review territory is secured diverse landscape morphologies. A decent combination plan ought to safeguard the phantom qualities of the source multi-ghostly picture and also the high spatial determination attributes of the source panchromatic picture. So as to discover the combination calculation which is most appropriate for the panchromatic and multispectral pictures, combination calculations, for example, PCA and wavelet calculations have been utilized and broke down. In this paper, execution assessment criteria are likewise utilized for quantitative appraisal of the combination execution. The otherworldly nature of combined pictures is assessed by the Deviation Angle, Spectral Angle, Correlation Index, ERGAS, Q4, and RMSE. The examination shows that the DWT combination plot has the best definition and also phantom constancy, and has better execution with respect to the high textural data retention. Accordingly, as the review region is concerned, it is most suited for the panchromatic and multispectral picture combination.

Keyword: Image fusion, Panchromatic images, Multispectral images, PCA, Wavelet, HIS, ERGAS, Q4.

1. INTRODUCTION

Data Fusion is an actually happening marvel in most natural frameworks. Information from different sources is converged with a specific end goal to settle on ideal choices. Global society of data combination appropriately characterizes it as – "Data combination incorporates the hypothesis, systems and instruments imagined and utilized for misusing the cooperative energy in the data obtained from numerous sources to such an extent that the subsequent choice or activity is in some sense superior to would be conceivable if any of these sources were utilized independently without such collaboration exploitation"[1] Image Fusion is a comparably motivated push to blend important visual informational indexes which are reliant but have dissimilarity to certain degree keeping in mind the end goal to think of a littler informational collection adept for a superior semantic elucidation of information for a given application.[3] In the field of remote detecting, satellite pictures are caught in different recurrence groups with various spatial, transient and ghastly resolutions.[12] The information procured from every one of these sources have a uniqueness in nature and pictures of same areas have a spatial dependency.[6] This circumstance is abused by picture combination calculations to concoct consolidated pictures which are more itemized and data rich than any of the individual pictures. Because of physical limitation, there is a tradeoff between spatial determination and unearthly determination of a high determination satellite sensor, i.e., the panchromatic picture has a high spatial determination at the cost of low phantom determination, and the multispectral picture has high otherworldly determination with a low spatial determination (IRS-P5: panchromatic picture, 1m, IRS –P6 multispectral picture 4m).[9] To determine this issue, the combination of multispectral and panchromatic pictures, with corresponding ghostly and spatial attributes, is turning into a promising method to acquire pictures with high spatial and ghastly determination all the while. Picture combination is generally used to coordinate these sorts of information for a full abuse of this information, on the grounds that intertwined pictures may give expanded translation capacities and more dependable outcomes since information with various qualities are combined.[7] The pictures differing in unearthly, spatial and fleeting determination may give a more exhaustive perspective of the watched objects.

Picture combination has been widely utilized as a part of the past on remote detecting information for different applications. Some of them are Sharpening of pictures, enhancing geometric corrections,[6] giving stereo review abilities to stereo photograph Grammarly, Enhancing highlights not completely noticeable in both of the single information alone, Detect changes utilizing multi-transient information.

Despite the fact that advances in sensor innovation have possessed the capacity to give superb symbolism, certain normal conditions, for example, overcast cover and climate and reflectance properties of various items confine the last nature of data accumulated from the pictures. Picture combination along these lines assumes an imperative part in acknowledging for all intents and purposes helpful applications from the remote detecting information.

2. IMAGE FUSION ALGORITHMS

Many methods have been developed in the last few years producing good quality merged images. The existing image fusion techniques can be grouped into four classes:

1. Color related techniques such as intensity–hue–saturation (IHS)
2. statistical/numerical methods such as principal components analysis (PCA)
3. Pyramid based Methods such as Laplacian Pyramid
4. Wavelet Methods using powerful haar wavelets.

This review dissects current picture combination systems to survey their execution. The picture combination techniques utilized incorporate Standard IHS, PCA and wavelet calculations. IHS (Intensity-Hue-Saturation) is the most widely recognized picture combination method for remote detecting applications and is utilized as a part of business skillet honing programming. This method changes a shading picture from RGB space to the IHS shading space. Here I (force) band is supplanted by the panchromatic picture. Before melding the pictures, the multispectral and the panchromatic picture are histograms coordinated. In a perfect world, the intertwined picture would have a higher determination and more honed edges than the first shading picture without extra changes to the phantom information. In any case, on the grounds that the panchromatic picture was not made from indistinguishable wavelengths of light from the RGB picture, this procedure creates an intertwined picture with some shading mutilation from the first multispectral. There have been different adjustments to the IHS technique trying to fix this issue (Choi et al., 2008; Strait et al., 2008; Tu et al., 2004; Siddiqui, 2003). In this examination is utilized change strategy recommended by Siddiqui (2003).

The Principal Component Analysis (PCA) is a factual method that changes a multivariate dataset of corresponded factors into a dataset of new uncorrelated direct mixes of the first factors (Pohl and Genderen, 1998). It is accepted that the primary PC picture with the most noteworthy fluctuation contains the most measure of data from the first picture and will be the perfect decision to supplant the high spatial determination panchromatic picture. The various multispectral groups are unaltered. A converse PCA change is performed on the altered panchromatic and multispectral pictures to acquire a high-determination container honed picture.

In wavelet combination technique First, three new panchromatic pictures are delivered by the histogram of R, G, and B groups of multispectral picture separately. At that point, each of the new high determination panchromatic pictures is deteriorated into a low determination estimate picture and three wavelet coefficients additionally called detail pictures, which contain data of neighborhood spatial subtle elements. The deteriorated low-determination panchromatic pictures are then supplanted by the genuine low-determination multispectral picture groups (B, G, R), separately.

In the last stride, a turnaround wavelet change is connected to each of the sets containing the neighborhood spatial points of interest and one of the multispectral groups (B, G, R). [12] After three times of turn around wavelet changes, the high-determination spatial points of interest from the panchromatic picture are infused into the low-determination multispectral groups bringing about intertwined high determination multispectral groups (Zhang, 2005).

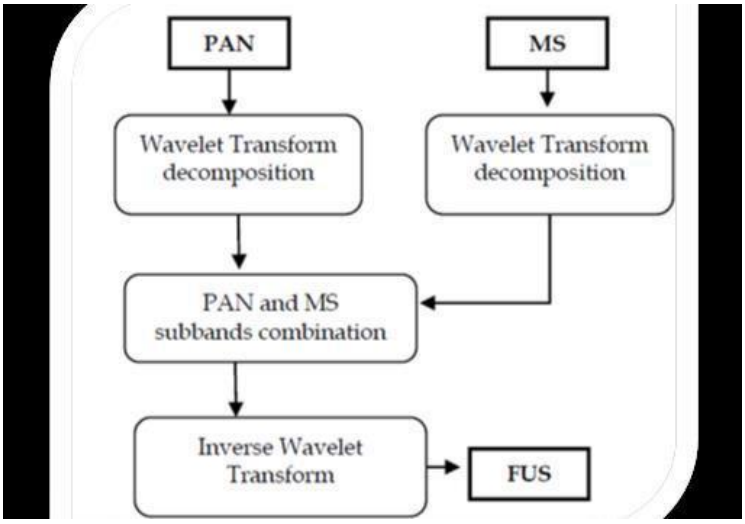

Fig -1: Block diagram of Wavelet fusion

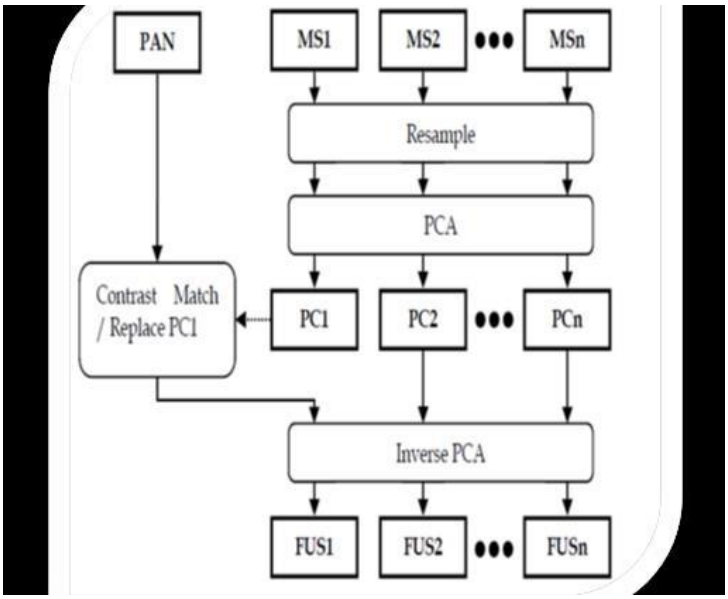

Fig -2: Block Diagram of PCA Fusion

3. QUALITY ASSESSMENT CRITERIA

Quality alludes to both the spatial and phantom nature of pictures (Wald, 1997). Picture combination strategies go for expanding the spatial determination of the MS pictures while safeguarding their unique unearthly substance. The assessment of the combination results depends on the quantitative criteria including phantom and spatial properties and meaning of pictures (Xu, 2004). In this paper, condition of-workmanship assessment criteria are utilized for 9.5

3.1 Root Mean Squared Error (RMSE)

The root means squared error (RMSE) displays spectral distortion of the fused band when compared with the original low spatial resolution data. It is computed by the difference of the standard deviation and the mean of the fused and the original image. The best possible value is again 0.

$$RMSE = \sqrt{\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(I_r(i,j) - I_f(i,j))^2}$$

In the above equation, M and N are matrix sizes for the reference and fused images, respectively.

3.2 Relative Global Dimensional Synthesis Error (ERGAS)

The formula for Relative Global Dimensional Synthesis

$$ERGAS = 100\frac{h}{\ell}\sqrt{\frac{1}{n}\sum_{i=1}^{n}\frac{RMSE_i^2}{MR_i^2}}$$

Where MRI is the mean radiance of the ith MS band, h is the spatial resolution of the high-resolution image, l is the spatial resolution of the low-resolution image. ERGAS offers a global depiction of the quality of radiometric distortion of the fused product. The lower the value of the RMSE index and the ERGAS index, the higher the spectral quality of the fused images.

3.3 Universal Image Quality Index (Q-average)

Quality Index (QI) is a metric that is used in order to evaluate the quality of monochrome images. Q4 is a generalization of QI by extending it to be calculated for hyper complex numbers, or quaternions, representing the spectral pixel vectors. Q4 is defined as

$$\begin{aligned} Q4 &= \frac{4|\sigma_{rf}| \cdot |\bar{r}| \cdot |\bar{f}|}{(\sigma_r^2 + \sigma_f^2)(|\bar{r}|^2 + |\bar{f}|^2)} \\ &= \frac{|\sigma_{rf}|}{\sigma_r \sigma_f} \frac{2|\bar{r}| \cdot |\bar{f}|}{|\bar{r}|^2 + |\bar{f}|^2} \frac{2\sigma_r \sigma_f}{\sigma_r^2 + \sigma_f^2} \end{aligned}$$

The first term measures the alignment of the spectral vectors and as such detects where radiometric distortion is accompanied by spectral distortions in a single factor. The second term measures the luminance distortion and the third measures the contrast distortion. The q4 factor is calculated over a window of M-by-M which is normally selected as M=16 or M=32. Q4 is averaged over the whole image to lead a global quality metric. Q4 is in the range [0; 1] where one represents the ideal fusion that is when the fused image and the reference image are identical.

4. EXPERIMENT DATA AND ANALYSIS OF FUSION RESULTS

The picture combination systems connected on the IRS-P5 (panchromatic) and IRS-P6 (Multispectral) satellite pictures. The irs-p6 multispectral picture has three 5.8-m determination ghastly groups (Green, Red, NIR) and determination of IRS-P5 panchromatic picture is 2.5-m. The review range is secured diverse territory morphologies. Underneath figures demonstrates a case of the melded IRS-P6 MS and IRS-P5 container pictures utilizing five combination calculations, for example, Standard IHS, Modified IHS, PCA, Brovey and wavelet calculations. Starting subjective visual investigations uncover that all the combined pictures have preferable capabilities over unique non-melded pictures. The sharpness of the intertwined pictures has been fundamentally upgraded. The further quantitative assessment should be possible with above criteria.

Fig -3: Multispectral Image of IRS-P6

Fig -4: Panchromatic Image of IRS-P5

Fig -5: Panchromatic Image of IRS-P5

Fig -6: PCA Based Image Fusion Result

Table -1: PARAMETERS

Parameter	PCA Based Fusion		WT Based Fusion	
ERGAS	129.2809		111.6863	
Q 4	8 by 8	0.43337	8 by 8	0.44466
	16 by 16	0.52693	16 by 16	0.54496
	32 by 32	0.56941	32 by 32	0.59173

5. CONCLUSIONS

From the above examination and correlation, we can infer that PCA calculation can safeguard the ghastly qualities of the source multispectral picture and in addition the high spatial determination attributes of the source panchromatic picture and suited for the combination of Panchromatic and Multispectral pictures. In PCA and Standard IHS picture combination, prevailing spatial data and feeble shading data is a regular issue, Therefore are suited for visual elucidation, picture mapping, and photogrammetric purposes wavelet Transform in view of haar wavelet is the best technique in holding unearthly property of the first picture among the five utilized strategies at the cost of low spatial data, Therefore are suited for advanced arrangement purposes.

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