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Enhanced Multi-Resolution Satellite Image Registration and Fusion using Average Principal Component Analysis

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ABSTRACT: In this paper, we propose an algorithm for image registration and fusion with a higher resolution panchromatic image and a lower resolution multispectral image at the same geographical place. It addresses the principles, implementation and evaluation of average PCA algorithm for both image registration and fusion. The input images may have the noises like salt and pepper noise also images may have low contrast and brightness. The low quality of given images may lead to improper image fusion. To avoid this problem, we should apply proper pre-processing technique like image de-noising using adaptive median filter (AMF) and adaptive mean adjustment (AMA) algorithms. Pixel level image fusion using average principal component analysis (PCA) has been implemented and demonstrated. The method improves a standard PCA algorithm for merging the lower resolution components of a multi-spectral image and its high resolution image by means of local deviation rules with averaging of PCA technique. This paper presents the two more different image fusion techniques than average PCA and their comparative analysis, as the existing fusion algorithm wavelet and PCA has some drawbacks. The comparative study concludes that average PCA is better approach for image registration and fusion.

KEYWORDS: Image registration, Image fusion, PCA, AMF, PAN Image, Multispectral Image, image noise.

I. INTRODUCTION

Image Fusion is a method of joining the related information from a set of images of the same scene into a single image and the final fused image will be highly useful and absolute than any of the source images. Input images could be satellite images, medical images, multi sensor, multimodal, multi-focus or multi temporal. The image fusion is that the more than one image which obtains from a sensor or many sensors synthesize an image, in which the statistics from the couple of primitive pictures may be pondered in order to investigate and choose the goal more precisely and comprehensively. Due to the fact both the images benefit from multi-sensors have the redundancy and the supplement, the multi-sensor image fusion generation may beautify the reliability of the system and additionally decorate the use performance of the pictorial information [1]. It is far a mathematical tool from applied linear algebra. It is miles an easy non-parametric technique of extracting applicable facts from confusing facts sets. PCA is a useful statistical technique that has found application in fields along with image fusion, face recognition and image compression [3]. The origins of PCA lie in multivariate informative analysis, it has a wide range of other packages PCA has been called one of the maximum critical consequences from implemented linear algebra and maybe its most usual use is as the first step in trying to analyses large information units. In general phrases, PCA makes use of a vector space transform to reduce the dimensionality of higher information.

In satellite imaging applications, satellites provide the information of the higher volume of the earth. To fulfil the requirements of few satellite imaging applications such as weather, and environmental, the remote sensing system offers spectral, spatial and radiometric resolutions. Usually satellites captures different pictures from different frequency range in the visual and non-visual ranges called as monochrome images. Each monochromic image is considered as a band and a group of these bands of the same prospect captured by a sensor is called multispectral image (MS). In general, an MS image contains three bands (Red, Green and Blue). The mixture of these three bands makes a color image. Satellites usually provide a panchromatic (PAN) image along with MS image [11]. A PAN image denotes to a gray scale image that have the data with a wide choice of wavelengths from the noticeable to the thermal infrared.

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The main motive for the increased significance of image fusion in satellite imaging is that satellite imaging is presently passing towards much significant public and scientific submission. An image may be characterized in spatial domain and in spectral domain. Satellite Image Fusion (SIF) is the function of merging properly registered input images, which may denote both spatial and spectral information. It keeps significant information and makes an image. Since time domain is simple, frequency domain fusion methods are also simple. Spectral representation can clearly define the edge features of the image. Various types of image fusion are multitier fusion, multimodal fusion, multi focus fusion, multi sensor fusion and single sensor fusion [3]. The Multi view Fusion method is used to fuse the images obtained from different sensors. The captured images will be taken from various views of the same content. Multimodal image fusion method is used to fuse the images taken from various angle of the same content. The technique is called multi sensor fusion, in this method the input images will be taken from various sensors. This method is broadly used in satellite imaging purpose where the sensors loose quality. There is an ease of use of images with various individuality, elasticity of time, less revisiting time of satellite technologies. A increasing requires appear to continuous process different information from the satellite imaging for data removal and data fusion. In the satellite imaging all the sensors work either in panchromatic mode or multispectral mode. Either of these images alone will not give entire information of the thing. The objective of image fusion in satellite imaging is mixing the grey-level higher resolution panchromatic image and the colored lower resolution multispectral image. The input images are captured from various satellite objects, fusing of images can be named multi-sensor image fusion otherwise it is said to be single-sensor image fusion. A multi-sensor image fusion rectifies the problems of a single-sensor image fusion by adding the several sensor images to form a composite image. The multi-sensor image fusion includes different advantages like system performance, increased reliability, compact illustration of data, extended range of process and low uncertainty. Feature level fusion operates on image features calculated from the input images and decision level fusion operates at high level and adds the interpretations of various images estimated after image understanding. Depends on domain of working, pixel level image fusion techniques are separated into two types [10]. They are spatial domain fusion and frequency transform domain fusion methods. In the image fusion, at the starting level, we have to apply the proper pre-processing techniques. The pre-processing techniques are image filtering and image enhancement techniques to de-noise the source image and to enhance the quality of the source images. After pre-processing we have to apply the image registration technique. Image Registration is requirement to align the corresponding pixels in the source images. The previous may use MS images and secondary Pan Images. The latter can use multi-resolution Pan Images, secondary map data, and particular road models such as snakes. In this paper, we will expand a mixture approach to mainly use the spectral data from the Multi-spectral images and the geometric data from the Pan images using the proposed algorithm.

II. Related Work

The fusion can be divided into two distinct parts.

- Up-sizing or down-sizing of the Multispectral images, it leads to the upsized or downsized multispectral images have the equal size as the PAN image.
- The operation of fusion, which may be reached either by the merging of the high frequency content of the PAN image to the high frequency content of multispectral image or by replacement of the intensity image by the PAN image in case of the image fusion algorithm. Entire geographic data is an input feature in decision making operation during refugee relief operations. The approaching marketable high resolution sensors will be able to acquire multispectral images at resolutions of 1m panchromatic and 4m multispectral of refugee camps and their environment. This process shows refugee camp setting area and population may be estimated using a satellite sensor image from the Russian KVR-1000 sensor. The MS image was originated to be fitting for mapping the refugee camp environment and area. A statistically significant linear association between camp area and population was determined. The size of the structuring element was distinct by the morphological top-hat by reconstruction transform.

To eliminate unrelated locations, vegetation areas were covered by the normalized difference vegetation index, and the distinguish area were confirmed by the proximity of darkness. The recognition of thing with the transform, depends on the opportunity of important pattern that communicate to the configurations of things. The several sizes of structure would engage the definition of high numbers of pattern.

Mr.Rahul Shivaji Shinde, A.O.Mulani had presented biomedical image fusion plays an important role in analysis towards clinical application which support more accurate information for physician to diagnose different diseases .CT and MRI image used for this purpose or use here as input. Then the wavelet transform is computed, and the fused

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image is reconstructed. There are different types of rules used for image fusion here we used Maximum selection fusion rule they are Input image, Image Resize, Wavelet Transform, Fusion Rule (Maximum frequency), Inverse Wavelet Transform, Fused Image. There are two types of analysis they are visual analysis and mathematical analysis. By using wavelet transform we can observe the fused image edges which are very useful for correct diagnosis. In this analysis we take the four parameters entropy, correlation, PSNR for comparison point of view for fused image and original image. Here in this work we take the reference of normal patient images with abnormal images. Out of these four parameters entropy gives us the correct analyses which gather more information from input images to fused image.

Ambily P.k, Shine P.James, Remya R.Mohan in IJERGS MARCH-APRIL 2015 has put forward an brain tumor is a mass of abnormally rising cell in the brain. The objective of the algorithm is to denote the significance of wavelet based image fusion in the proposed method. With the introduction of pyramid transform in 80's some approaches began to emerge.

Major advantages of pyramid transform are:

- Extract image features at multiple scales such as edges etc.
- Image modeling and Redundancy reduction.
- It provide both frequency domain localization and spatial.

Several types of pyramid decompositions are Laplacian pyramid, ratio-of-low-pass pyramid and gradient pyramid. After obtaining the resultant fused image the performance evaluation of the images was carried out with the help of peak signal to noise ratio and mean square error. Final fused image is used to extract tumor region after segmentation using artificial neural network. Skull stripping is performed on the segmented image. Boundary and area of the tumor region is calculated and plotted in fused image. The system utilizes wavelet based image fusion to discover a high excellence fused image with spatial and spectral information. Method also detect brain tumor automatically using Artificial Neural Network (ANN) and also determined the position and the area of the tumor. Thus the results from the image fusion using different wavelets are compared on the basis of the PSNR and MSE in detection of the tumor as compared to the original MR image and CT scan image.

III. Literature Survey

Z. Li and H. Leung (2009) presented fusion of multispectral and panchromatic images using a restoration-based method. The technique allows reconstruction of multispectral images with resolution higher than resolution of the panchromatic image, new technique for multispectral image fusion with resolution higher than resolution of the panchromatic image and with minimization of color composite distortion. Two responsibilities are to be solving in order to reach the better resolution panchromatic image and multispectral image fusion.

Hamid Reza Shahdoosti and Hassan Ghassemian (2010) presented fusion of Multispectral and Panchromatic Images Preserving Spectral Quality. The project discussed with enhancing multi spectral image quality enhancement using weighted average merging method under multi level Non-sub sampled Contour let transform domain. In remote sensing system, the multispectral sensors with high spectral resolution and have a poor spatial quality compared with panchromatic sensor with a higher spatial resolution and a wider spectral bandwidth.

S. Li and B. Yang (2011) addressed the remote sensing image pan-sharpening problem. Pan-sharpening is converted into signal restoration problem with sparsity regularization. The basis pursuit (BP) algorithm is used to resolve the restoration problem, which can recover the high-resolution MS image effectively.

N.Indhumani et al. (2011) presents work on different modals or techniques of image fusion and applying 2D-DWT algorithm on input images. Both SF and Wavelet- DWT are used for efficient output in fused image. Coefficients at lower approximations are used in laplacian algorithm. Where SF and Wavelet combined together they are working for high approximation. Finally DWT algorithm gives the desired results with desired new fused coefficients. In this paper performance parameters are MSE, PSNR gives better results than this techniques.

V.P.S Naidu et al. (2008) works on pixel level image fusion algorithms used wavelet and PCA techniques fused image can be avoided using wavelets with shift invariant property. M.Choi et al. (2006) discussed the concept of IHS fusion technique useful in applications of remote sensing in panchromatic and multispectral images. By this technique it distorts the color in the same way as it is applied in this image fusion. The author uses the tradeoffs parameters with its new approach with fast and easy implementation.

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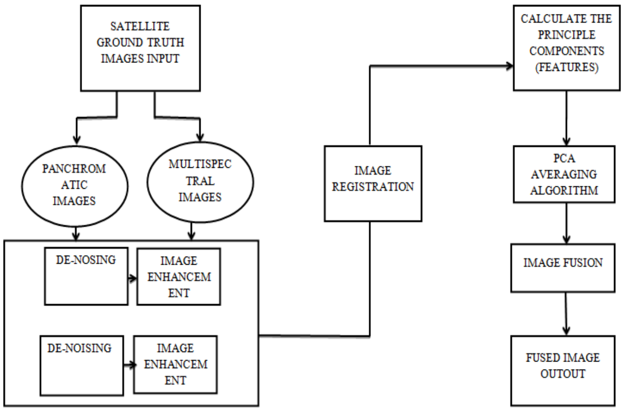
IV. BLOCK DIAGRAM



V. IMAGE PROCESSING

The image preprocessing is classified into three fields.

1. Image de-noising using Adaptive Median Filter (AMF)
2. Image Enhancement using Adaptive Mean Adjustment (AMA)
3. Image registration

A. *Image denoising using Adaptive Mean Filter:*

The input image is affect by impulse noise, the typical poverty model at point (i, j) in a 2D matrix can be written as

$$y(i, j) = x(i, j) + n(i, j), \qquad (1)$$

Where x, y, and n represent an input image, the noisy image, and the impulse noise, respectively. For successful filtering, it is popular to get a reliable degradation estimation function that can find the degree of the noise as well as the noise's pixels [4]. The adaptive median filter reflects on all pixels in the image in roll and seems at its close by adjacent pixels to choose whether or not it is representative of its background [4]. Instead of restore the pixel value with the mean of neighbor's pixel values, it is restored with the median of those values. The proposed AMF filter differs from the existing median filter. The AMF performs spatial functioning to find which pixels in an image have been degraded by noise [4]. The AMF organize pixels as noise by evaluating each pixel in the image to its neighbor pixels.

The size of the surrounding is adaptable and the threshold for the evaluation. A pixel that is different from a majority of its surroundings and being not properly managed with those mentioned pixels, to which it is comparable, is tagged as a noise. These noise pixels are restored by the median rate of the pixels in the surrounding that have moved the noise test. Thus, the AMF resolve the double purpose of extracting the noise from the image and dropping deformation in the image [5].

Image Acquisition

Step2: Apply Adaptive Median Filter for both Gray and Colour space Images

Step3: Subtract the Filtered Image from Input Image

Step4: Calculate the Noisy Pixels.

Let X (.,.) and Y (.,.) be the input and output respectively, of the adaptive median filter. The

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$$Y\ (i,\ j) = \text{median}\{X\ (i\text{-}s,\ j\text{-}t)|(s,\ t)\ W\} \text{ ---------} \qquad (3.1)$$

Here W is the window that is defined in terms of image co-ordinate the neighborhood of the origin.

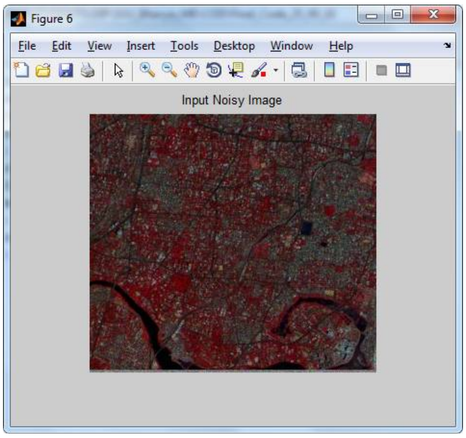

Figure 1: Input Noisy Image

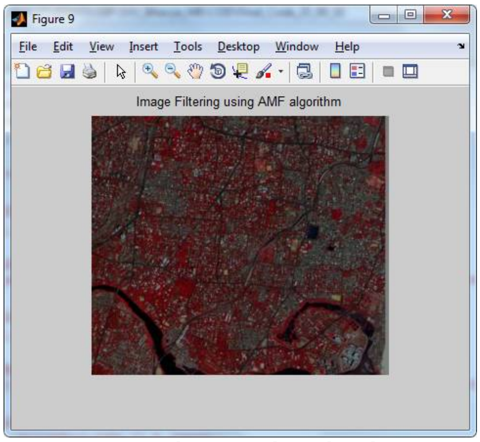

Figure 2: Adaptive Median Filtered image

Figure 1 shows that the source image 1 before filtering. It contains impulse noise and it is also distorted. It has to be restored and enhanced using proper filtering technique like AMF and enhanced using AMA algorithms.

Figure 2 shows that Adaptive Median Filtered image which has noisy pixels are properly eliminated due to the proper application of the proposed filtering technique.

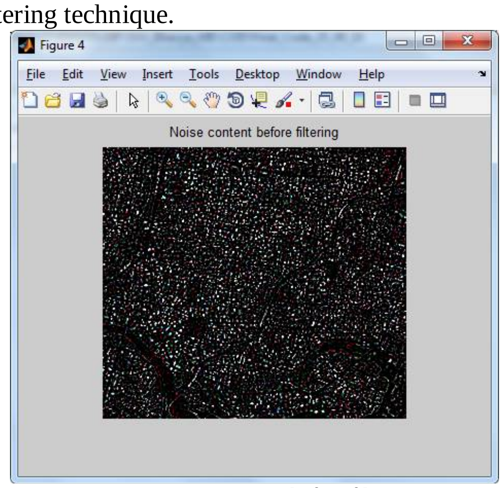

Figure 3: Noise content before filtering

Figure 3 show that the different between input noisy image and AMF filtered image. The impulse noise content is extracted and shown on the above image.

VI. Image Enhancement

The main aim of the image enhancement is to improve the contrast and brightness of the image in order to improve the quality of the image [6].

The image is considered as a function z=f(x,y), it is an 2D matrix.

Where z is the gray level of the image.

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f(x,y) = a1*x +a2*y + a3 +e(x,y), -- (2)

Calculate the values a1, a2, a3, i.e. $\hat{a}1$, $\hat{a}2$, $\hat{a}3$,

We have to reduce the sum of square of residuals at each pixel,

$$S^2 = \sum_x \sum_y [\hat{a}1 * x + \hat{a}2 * y + \hat{a}3 - f(x,y)]^2, \quad (3)$$

It gives
$\hat{a}1$, $\hat{a}2$, $\hat{a}3$ by

$$\hat{a}1 = \frac{\sum_x \sum_y x * f(x,y)}{\sum_x \sum_y x^2},$$

$$\hat{a}2 = \frac{\sum_x \sum_y y * f(x,y)}{\sum_x \sum_y y^2},$$

$$\hat{a}3 = \frac{\sum_x \sum_y f(x,y)}{\sum_x \sum_y 1}. \quad (4)$$

Thus,

$$F = \frac{[(\hat{a}1 - a1)^2 \sum_x \sum_y x^2 + (\hat{a}2 - a2)^2 \sum_x \sum_y y^2]/2}{S^2/(n-3)} \quad (5)$$

F has an F distribution with 2,n-3 degree of freedom.
When considering 3*3 window, n-3= 6.
Now we derive the following. Change f(x,y) by equation (2) ,

Ie).,

a1*x +a2*y + a3 + e(x,y) ,

$$\hat{a}1 = a1 + \frac{\sum_x \sum_y x * e(x,y)}{\sum_x \sum_y x^2},$$

$$\hat{a}2 = a2 + \frac{\sum_x \sum_y y * e(x,y)}{\sum_x \sum_y y^2},$$

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$$\hat{a}3 = a3 + \frac{\sum_x \sum_y e(x,y)}{\sum_x \sum_y 1}. \quad (6)$$

From above equation and noise equation, it drives variances of $\hat{a}1$, $\hat{a}2$, $\hat{a}3$

$$\sigma^2_{\hat{a}1} = \frac{\sigma^2}{\sum_x \sum_y x^2}, \quad \sigma^2_{\hat{a}2} = \frac{\sigma^2}{\sum_x \sum_y x^2}, \quad \sigma^2_{\hat{a}3} = \frac{\sigma^2}{\sum_x \sum_y x^2}, \quad (7)$$

the covariance is 0, nN
Now noises are un-correlated for pixels [6].
From equations (2) (4) (6):

$$S^2 = \sum_x \sum_y e^2(x,y) - (\hat{a}1 - a1)^2 \sum_x \sum_y x^2 - (\hat{a}2 - a2)^2 \sum_x \sum_y y^2 - (\hat{a}3 - a3)^2 \sum_x \sum_y 1. \quad (8)$$

Now e(x,y) ~ N(0),

$$\frac{\sum_x \sum_y e^2(x,y)}{\sigma^2} \sim \chi^2_{\mathrm{n}}, \quad (9)$$

The χ^2_{n} → for the chi-squared distribution with n degrees of freedom, n can be calculated as,

$$\mathrm{n} = \sum_x \sum_y 1. \quad (10)$$

Because e(x,y) is a normal distribution function, based on the equation (6), $\hat{a}1$, $\hat{a}2$, $\hat{a}3$ gives the normal distribution :

$$\hat{a}1 \sim \mathrm{N}(\mathrm{a1}, \sigma^2_{\hat{a}1}), \hat{a}2 \sim \mathrm{N}(\mathrm{a2}, \sigma^2_{\hat{a}2}), \hat{a}3 \sim \mathrm{N}(\mathrm{a3}, \sigma^2_{\hat{a}3}), \quad (11)$$

with the variance given in equation (23), so

$$\frac{(\hat{a}1 - a1)^2}{\sigma^2_{\hat{a}1}} = \frac{(\hat{a}1 - a1)^2 \sum_x \sum_y x^2}{\sigma^2} \sim \chi^2_1,$$

$$\frac{(\hat{a}2 - a2)^2}{\sigma^2_{\hat{a}2}} = \frac{(\hat{a}2 - a2)^2 \sum_x \sum_y y^2}{\sigma^2} \sim \chi^2_1,$$

$$\frac{(\hat{a}3 - a3)^2}{\sigma^2_{\hat{a}1}} = \frac{(\hat{a}3 - a3)^2 \sum_x \sum_y 1}{\sigma^2} \sim \chi^2_1. \quad (12)$$

Following the equations (9), (10), (12) ,

$$\frac{S^2}{\sigma^2} \sim \chi^2_{(\mathrm{n}-3)}, \quad (13)$$

U~ χ^2_{j} , V ~ χ^2_{k}, then

$$\frac{U/j}{V/k} \sim \mathrm{F}_{\mathrm{j,k}}.$$

$$\frac{[(\hat{a}1-a1)^2\sum_x\sum_y x^2+(\hat{a}2-a2)^2\sum_x\sum_y y^2]/2}{S^2/(n-3)} \sim F_{2,n-3.} \quad (14)$$

DN (Digital number)

Estimate the Digital Number (DN) as

DN = WF * RV + (1-WF) * DN(old), (15)

RV - > Reference value for the pixels

WF - > Weight vector

WF = max (WF1, WF2) (16)

The contrast of the image is calculated as follows [5,6],

(Image contrast enhancement)

$$WCON = \frac{DN\max(window) - DN\min(window)}{DN\max(image) - DN\min(image)} \quad (17)$$

VII. ALGORITHM

Step1: Input the Filtered Image

Step2: Case 1: PAN Scale Image

Step3: Set the thresholding values (Median)

Step4: Set Lower and Upper thresholding values to calculate the Minima and Maxima.

Step5: Apply the double Precision to the Image

Step6: Apply Normalization

Step7: Calculate the Mean of the Gray Scale Value

Step8: Adjust the Mean Value

Step9: Case 2: Multispectral Image

Step10: Set lower and Upper thresholding values to calculate the Minima and Maxima

Step11: Color Image Thresholding (Image Bandwidth)

Step12: Convert from Multispectral RGB Image to NTSC Color format (to Improve Luminance, the intensity of light emitted from a surface per unit area in a given direction)

Step13: Calculate the Mean adjust value for Green layer using Color Image Upper Thresholding

Step14: Calculate the Mean adjust value for Blue layer using Color Image Lower Thresholding

Step15: For Case 1 and Case 2: Mean Adjustment for First Layer Calculate Minima and Maxima

Step16: Apply formula (Image-Minima/Maxima-Minima) Calculate the Mean adjust value for Blue layer using Color Image Lower Thresholding

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Step17: Enhanced Image Output.

VIII. IMAGE REGISTRATION

Satellite Image registration is the function of converting various sets of information into one form. Information may be different images, information from various sensors, from various situations, or from size of images. Estimation instance becomes more decisive with the current raise in information. Finally higher performance image registration is needed [8]. In satellite imaging applications, physical registration used which is not good for higher number of images want to be registered because of physical collection of managing the images. Therefore, there is a need of automatic image registration processing. Automatic image registration is to do the image registration process without the direction and intrusion of others.

IX. IMAGE FUSION USING AVERAGE PCA ALGORITHM

Average PCA is an arithmetical tool it converts an amount of correlated variables into an amount of uncorrelated variables based on the average of the correlated image pixels. It is called as Average PCA algorithm. It estimates a higher description of the information of the source images. The first principal component calculates for as much of the dissent in the information as possible and each following factor estimates for as much of the remaining variance as potential. First principal component is considered to be beside the track with the most variance. The second principal component is forced to recline in the subspace vertical of the primary. Within this Subspace, this component points the way of highest variance. The third principal component is considered in the most variance direction in the subspace vertical to the first two and the process continuous till fusion process completes [9].

Thus, X is the 2-dimensional random vector and supposes it is having zero empirical factorial mean. Ortho-normal projection array V could be estimated that Y V X = T with the following limitations. The covariance of Y, i.e., cov( ) Y is considered as a diagonal matrix and inverse matrix of V is equivalent matrix to its transpose vector (V V -1 = T) [10].

$$\begin{aligned}\mathrm{cov}(Y) &= E\left\{YY^T\right\} \\ &= E\left\{\left(V^T X\right)\left(V^T X\right)^T\right\} \\ &= E\left\{\left(V^T X\right)\left(X^T V\right)\right\} \\ &= V^T E\left\{XX^T\right\} V \\ &= V^T \mathrm{cov}(X) V\end{aligned} \quad \text{--} \qquad (18)$$

V cov(Y)=VV^Tcov(X)V=cov(X)V -- (19)

We can write V as V=[V1,V2,…,Vd] and

$$\mathrm{cov}(Y) \text{ as } \begin{bmatrix} \lambda_1 & 0 & \cdots & 0 & 0 \\ 0 & \lambda_2 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & \lambda_{d-1} & 0 \\ 0 & 0 & \cdots & 0 & \lambda_d \end{bmatrix} \quad \text{--} \qquad (20)$$

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$$[\lambda_1 V_1, \lambda_2 V_2, \ldots, \lambda_d V_d] = [\mathrm{cov}(X)V_1, \mathrm{cov}(X)V_2, \ldots, \mathrm{cov}(X)V_d] \quad (21)$$

$$\lambda_i V_i = \mathrm{cov}(X)V_i \quad (22)$$

where i d =1,2,..., and Vi is an eigenvector of cov( ) X .

The source images I x y 1(,) and I x y 2 (,) are formed in two column vectors with its empirical means are deducted [11]. The secondary vector have a dimension of n x 2, in this, n is length of the vector of the image. Estimate the eigen-vector and eigen-values for the resultant vector are estimated and the eigen-vectors related to the higher eigen-value estimated [12]. The factor of normalized components P1 and P2 (i.e., P1 + P2 = 1) using equation (21) are calculated from the estimated eigen-vector. The resultant fusion image is written as,

$$I_f(x,y) = P_1 I_1(x,y) + P_2 I_2(x,y) \quad (23)$$

A. ***ALGORITHM:***

Step 1: Read the PAN image and hyper spectral image of R, G and B.

Step 2: Convert the matrix into column vectors of read images.

Step 3: Performs the covariance of column vectors. Covarience matrix will be a 2*2 matrix.

Step 4: Compute Eigen values and Eigen vectors of covariance matrix.

Step 5: Find the largest Eigen value and normalize Eigen vector of corresponding Eigen values. This is the first output of average PCA1.

Step 6: The average PCA1 values are multiply with first band (Red) of MS image and PAN image.

Step 7: Repeat the step 6 for Green and Blue bands.

Step 8: Concatenate allthe bands and apply adaptive histogram equalization to form the fused output using PCA.

X. RESULTS AND DISCUSSION

In this section, simulation results are presented to demonstrate the performance of contrast enhancement in the low contrast satellite ground truth images and fusion of Panchromatic and Multispectral images has been tested on several different satellite images shown in table 4.1 and 4.2

Table 4.1 shows the PSNR and RMSE comparison between without image enhancement and with image enhancement for different satellite images. Implementation using three set of images and their results are tabulated.

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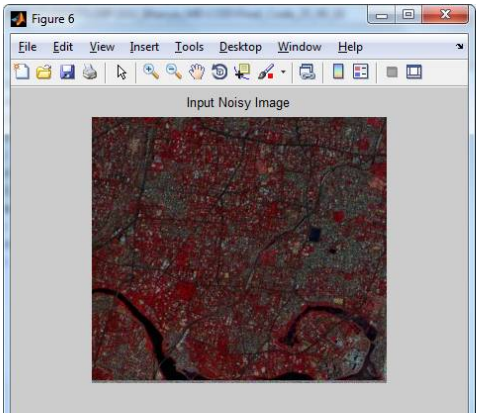

Figure 4: Multispectral Source Image

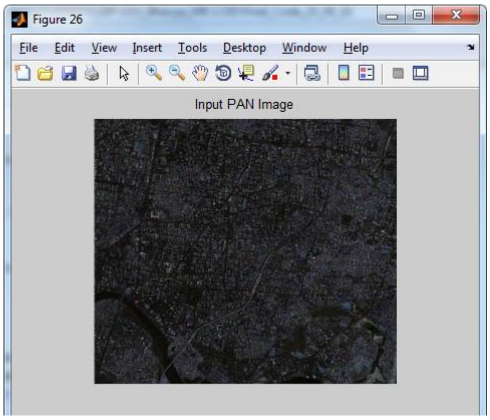

Figure 5: PAN Source Image

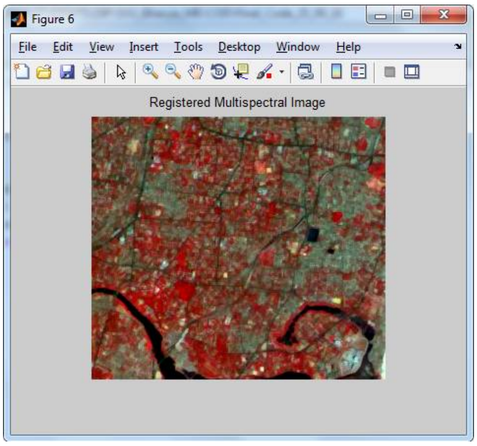

Figure 6:Filtered, Enhanced and registered Multi spectral Image

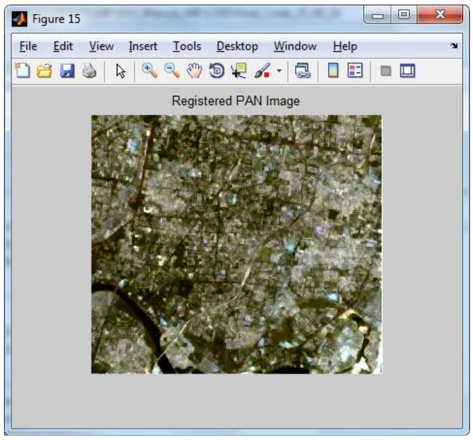

Figure 7: Filtered, Enhanced and registered PAN Image

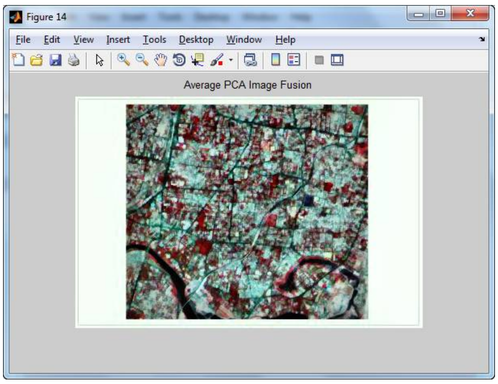

Figure 8: Average PCA fusion image

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IMAGE NAME	WITHOUT IMAGE ENHANCEMENT		WITH IMAGE ENHANCEMENT	
	PSNR(Db)	RMSE	PSNR(Db)	RMSE
Image 1-Multispectral	24.9277	0.2091	49.6668	0.1978
Image 1-Panchromatic	23.2572	0.3072	43.3438	0.2847
Image 2- Multispectral	26.3045	0.1523	41.6451	0.3139
Image 2-Panchromatic	26.5703	0.1432	43.4380	0.2831
Image 3- Multispectral	24.3599	0.2383	48.5755	0.2106
Image 3-Panchromatic	26.0218	0.1625	40.4380	0.2867

Table 4.1: PSNR Comparision

PERFORMANCE ANALYSIS

Figure 4.1 (a) and (b) shows the experimental results between the image enhancement and without image enhancement with the help of parameters like PSNR and RMSE.PSNR and RMSE are tested with very high resolution Quick-Bird satellite data of Chennai city.

Table 4.2 Fused result for different Satellite images using Average PCA algorithm are tabulated.

IMAGE NAME	FUSED IMAGE BY PCA	
	PSNR(Db)	RMSE
Image 1-Fused Image	65.0455	0.1018
Image 2-Fused Image	64.9067	0.1022
Image 3-Fused Image	67.4238	0.0957
Average Fused result	**65.792**	**0.0999**

Table 4.2 RMSE COMPARISION

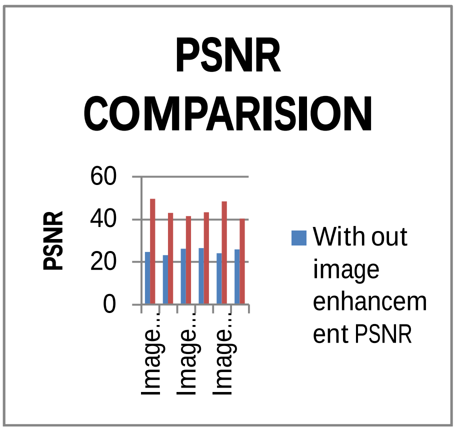

Figure 4.1 (a): Without Image Enhancement PSNR

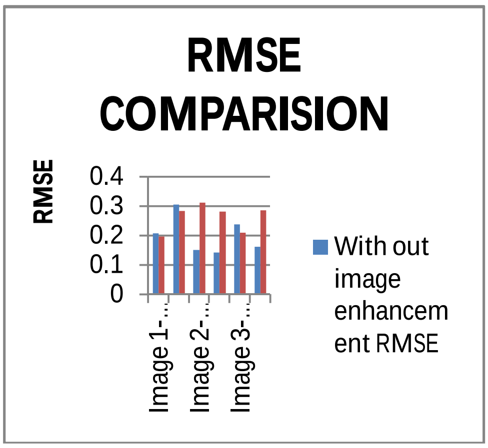

Figure 4.1(b): Without Image Enhancement RMSE

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XI. Conclusion and Future Work

The created new image from Pan-sharpening will benefit the high-spatial resolution of panchromatic image and the color information of the Multispectral images. In this research work, PCA based Image Fusion has been implemented for analysis and this method is tested with very high resolution Quick-Bird satellite data of Chennai city. The obtained Peak Signal to Noise Ratio (PSNR) and Root Mean Square Error (RMSE) of this test data after image fusion 65.792 and 0.0999. From these results, the spatial resolution of output image is improved with limited distortion.

In future the image fusion is implemented for different satellite data with different fusion methods. Further image fusion is implemented on the real time videos and real time images. It is planned to fuse more than two images and produce a de-blurred fused image and to concentrate on increasing the PSNR value of the fused image as compared to the current PSNR value.

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