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Improvement in Image Quality using PCA based Image Fusion

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Abstract: Image fusion is combining different features of different modality into a single composite image. Fused image is generated using two images. We can get better output image that is validated by parameters like PSNR, MSE etc. We can get even better output image if we fused three images instead of two. In this paper we discuss the system which take three blur images as input and generate single fused image as output. The method used for fusion is principal component analysis(PCA).For performance analysis parameters that is PSNR and MSE are used.

Keywords: Principal component analysis, PSNR, MSE

I. Introduction

The object of image fusion is to retain the most desirable characteristics of each image. Result of fusion is a new image which is more suitable for human and machine perception. In most of cases of fusion number of images used are two, so here we are using three images for better result. In first step fusion of two images takes place using PCA method, then output image of first step get fused with third image using same technique. Following section explains the block diagram, working of PCA method of fusion, results and conclusion.

II. PCA based image fusion system

Block diagram of Principal component analysis based image fusion system is shown in fig. 1 First of all image 1 and image 2 are fused using PCA method to generate fused image A, which is get fused with the third input image i.e. image 3. Output image generated after second fusion will be final fused image

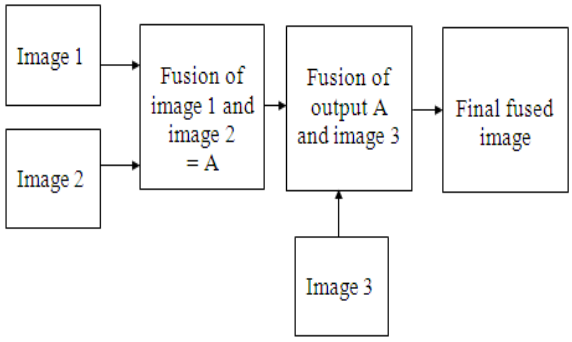

Fig1 : PCA based image fusion system.

III. Principal component analysis(PCA)

Principal component analysis (PCA) is a data analysis technique that can be traced back to Pearson. It is a mathematical tool from applied linear algebra. Principal component analysis (PCA) is a vector space transform often used to reduce multidimensional data sets to lower dimensions for analysis. PCA is the simplest and most useful of the true eigenvector-based multivariate analyses, because its operation is to reveal the internal structure of data in an unbiased way. Normalize column vector corresponding to larger Eigen value by dividing each element with mean of Eigen vector. Those normalized Eigen vector values act as the weight values and are multiplied with each pixel of input image. Sum of the two scaled matrices are calculated and it will be the fused image matrix.

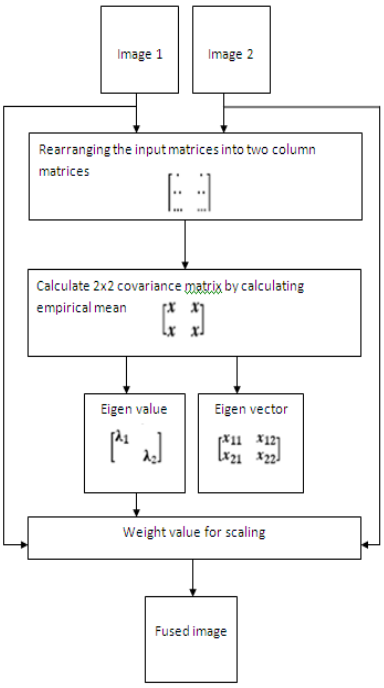

Fig. 2 : PCA algorithm

Principal Component Analysis Algorithm

1. Generate the column vectors, respectively, from the input image matrices.
2. Calculate the covariance matrix of the two column vectors formed in 1
3. The diagonal elements of the 2x2 covariance vector would contain the variance of each column vector with itself, respectively.
4. Calculate the Eigen values and the Eigen vectors of the covariance matrix
5. Normalize the column vector corresponding to the larger Eigen value by dividing each element with mean of the Eigen vector.
6. The values of the normalized Eigen vector act as the weight values which are respectively multiplied with each pixel of the input images.
7. Sum of the two scaled matrices calculated in 6 will be the fused image matrix.

The PCA based fusion system is used for fusion using two images[7]. Corresponding tables and graphs are given as below

PSNR	case1	case2	case3	case4
Image 1	78.47	80.38	80.73	78.93
Image 2	80.15	78.66	80.23	83.48
Fused Image	84.87	85.21	85.52	83.9

Table 1 PSNR values for fused image using two images

MSE	case1	case2	case3	case4
Image 1	43.6	34.92	33.58	41.31
Image 2	35.91	42.64	33.62	24.47
Fused Image	20.85	20.05	19.35	23.33

Table 2 MSE values for fused image using two images

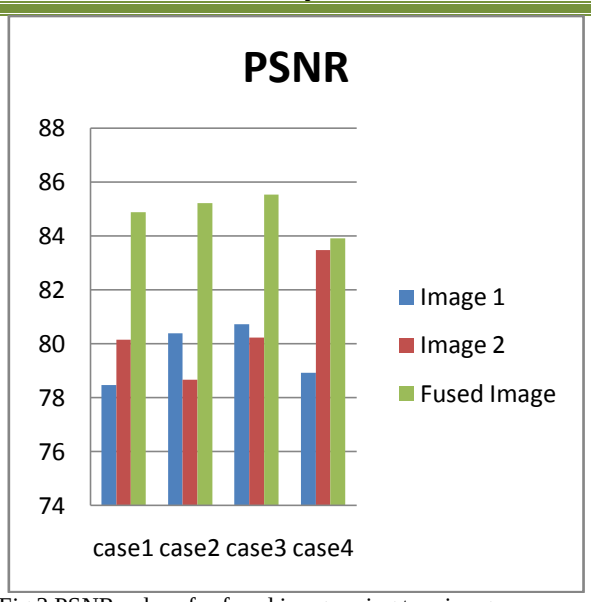

Fig.3 PSNR values for fused image using two images

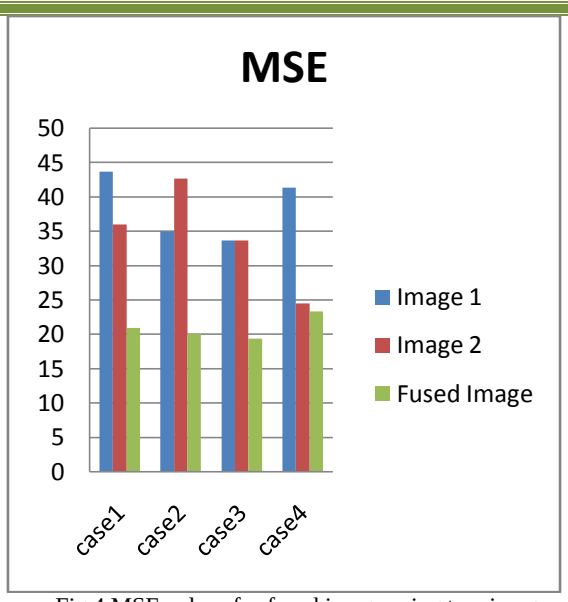

Fig.4 MSE values for fused image using two images

IV. Analysis of fusion system

For analysis of above mentioned technique different cases were considered where input images have blur portions at different parts of images. The values of PSNR and MSE are collected in tables 3 through 6 and corresponding graphs are also shown.

(a) image1 (b) image2 (c) image3 fused image

Fig.5 : case 1 for image fusion using three images

	Image 1	Image 2	Image 3	Fused Image
PSNR	78.47	80.15	80.38	86.07
MSE	43.6	35.91	34.99	18.17

Table 3 PSNR and MSE values for fused image using three images(case1)

(a) image1 (b) image2 (c) image3 (d) fused image

Fig.6 : case 2 for image fusion using three images

	Image 1	Image 2	Image 3	Fused Image
PSNR	78.66	80.73	80.23	86.34
MSE	43.6	35.91	34.99	18.17

Table 4 PSNR and MSE values for fused image using three images(case2)

(a) image1 (b) image2 (c) image3 fused image

Fig. 7 : case 3 for image fusion using three images

	Image 1	Image 2	Image 3	Fused Image
PSNR	78.93	83.48	81.88	84.75
MSE	41.31	24.47	29.43	21.15

Table 5 PSNR and MSE values for fused image using three images(case3)

(a) image1 (b) image2 (c) image3 fused image

Fig.8 : case 4 for image fusion using three images

	Image 1	Image 2	Image 3	Fused Image
PSNR	77.75	80.59	85.09	84.91
MSE	47.36	34.2	20.34	20.75

Table 6 PSNR and MSE values for fused image using three images(case4)

The variations in PSNR and MSE values for all four cases are shown commonly in fig.9 and fig.10.

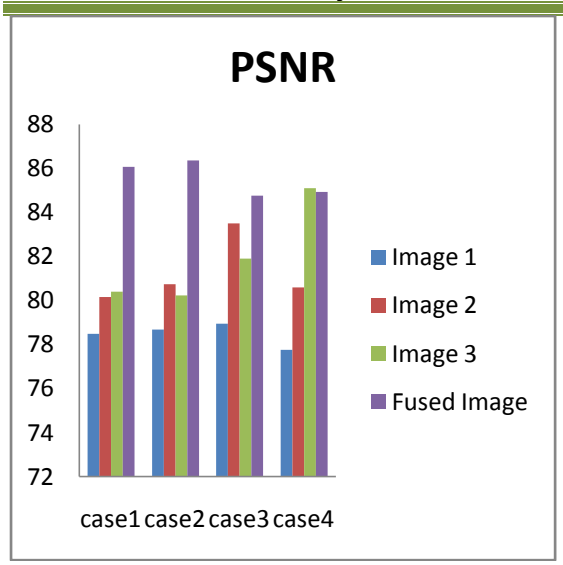

Fig.9 case-wise PSNR values

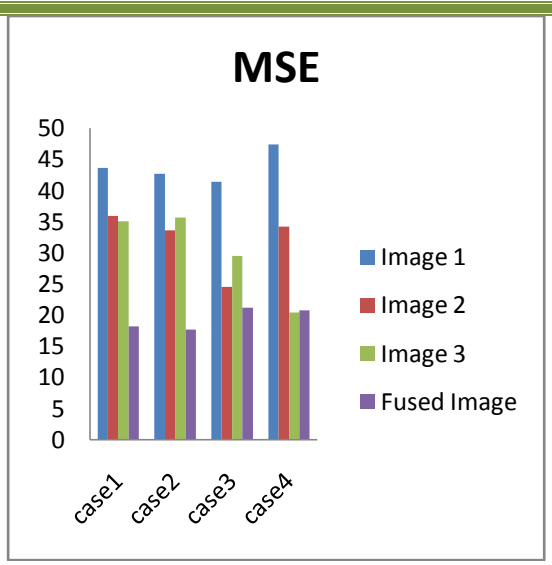

Fig.10 case-wise PSNR values

In addition to this we can use the same technique on different combinations of same three input images which are created by simply changing their input sequence. Let us say we have three input images image1, image2, image3 so different combinations we will get are

C1 : image1-image2-image3
C2 : image1-image3-image2
C3 : image2-image1-image3
C4 : image2-image3-image1
C5 : image3-image1-image2
C6 : image3-image2-image1

The variations in values of PSNR and MSE for different combinations is shown in graphs given below

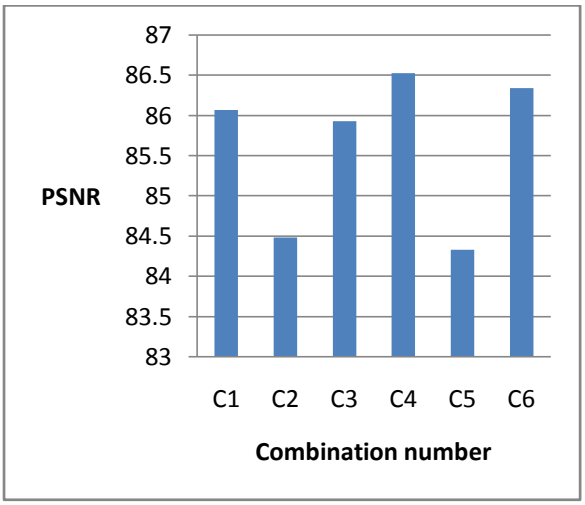

Fig.11 case-wise variations in PSNR values

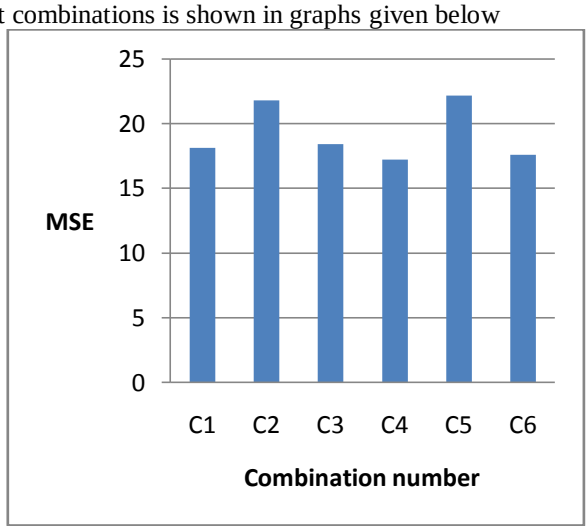

Fig.12 case-wise variations in PSNR values

V. Conclusion

In this paper the PCA based fusion technique is used to get better image from three blur images. The parameters PSNR and MSE are used to check the performance of system. From tables it is seen that the PSNR values of fused images using three images are greater than PSNR values of fused image using two images, and MSE values of fused image using three images are smaller than that of MSE values of fused image using two images. This indicate that the quality of output fused image is better using three input images than that of two images .the blurred input images. Fig 11 and fig 12 clearly shows that there will be variation in values of PSNR and MSE values if change the input sequence of images, it will not be same even though input images are same.

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