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An Enhanced Version of Combination of Multifocus Image Using Alpha Factor

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Abstract—Right and high quality image makes a huge difference, whether it can be any field of digital image processing. It is often not possible to get an image that contains every object in focus. To obtain an image that contains every object in focus a Multifocus image fusion process is required. In the process of image fusion good information from each of the given image is fused together to form a resultant image whose quality is far better than the any of the Multifocus input image. In this paper we proposed an algorithm which is the enhanced version of the existing algorithm. We utilize the concept of alpha factor and we vary the values of alpha factor according to our requirement. The proposed method is also compared with different methods. It is observed that proposed method preserves more information compared to earlier methods. It evaluates the performance of each algorithm with Matlab 2012a .We evaluate the algorithm by using performance parameter peak signal to noise ratio and the mean square error value.

Keywords— Image fusion; PCA; Pixel level transform; alpha factor.

I. INTRODUCTION

Image fusion produces a single image by combining information from a set of source images together, using various techniques. In the process of image fusion good information from each of the image is fused together to form an image whose quality is far better than the existing input image. Image fusion is essential for robotics vision and artificial systems in which fusion results can be used to help further processing steps for a given task.
Image fusion algorithm are desired to achieve benefits like high accuracy and reliability this can be achieved by reducing the redundant information , also high features and dimensionality this can be achieved by adding complementary information , by using simultaneous data acquisition it can be made cost effective.

The fused image contains higher information content of the scene of any of the individual image sources alone. Image fusion requires that images are registered first before fusing. Data fusion techniques combine data from different sources together. The main reason for using fusion is to produce a result which provides the more detailed and reliable information possible. Fusing multiple sources of information together also produces a more efficient representation of the data.

Image fusion is performed at a different level: pixel, feature and decision level. Pixel level [1,2,3,4,5,6,] image fusion is performed on pixels of an image. In feature level main requirement is the extraction of features like pixel intensities, edges, and textures. Decision level image fusion combined image description to the fused image. This is a description of fusion by decision, such as when the classification results are obtained from single image.

Our paper mainly deals with the pixel level fusion techniques because of its linear operations and simplicity. The main advantage of pixel level fusion is use to detect the undesirable noise, low complexity and it fuses raw images directly pixel by pixel to enhance the features and dimensionality [2,7,8,9]. This paper is organized as follows. A brief description of image fusion techniques is given under the next heading we have covered mainly three techniques PCA techniques, existing techniques and the proposed method. Existing method is given after that Proposed modified technique for obtaining high PSNR and MSE fused image is discussed after that, and at last we presents results of the proposed method in comparison with existing methods follows with the conclusion.

II. IMAGE FUSION TECHNIQUES

In this section, we review and analyze image fusion methods that can be used general image fusion. Three categories of image fusion methods are addressed, on the basis of which further comparison is done: a) PCA based image fusion-

principal component analysis is a complex fusion approach. b) Existing algorithm- combination of image using alpha factor c) Proposed algorithm – a new way or approach to deal with image fusion. Assessment of the fused images based on these methods is given in the next section.

A. Principal Component Analysis

The main purposes of a principal component analysis (PCA) are the analysis of data to identify patterns and finding patterns to reduce the dimensions of the dataset with minimal loss of information. It is a subspace method, which reduces the multidimensional data sets into lower dimensions for analysis [1,2,10,11,12,13,14]. The Principal Component Analysis (PCA) involves a mathematical tool that transforms a number of correlated variables into a number of uncorrelated variables called principal components. A compact and optimal description of the data set is calculated. The first principal (main) component accounts for measuring the variation in the data as possible, and every subsequent component accounts for as much of the remaining variance possible. First principal component is taken to be along the direction with the maximum variance. The second or next main principal component is forced to lie in the subspace perpendicular of the first. Within this subspace, this part points the direction of maximum variance.[5,15,16] The third principal component or the main one is taken in the maximum variance direction in the Subspace perpendicular to the first two and so on [2,17,18]. The PCA is also defined as the Karhunen-Loève transform or the Hotelling transform. It does not have a fixed set of basis vectors like FFT, DCT etc and basis vectors of PCA depend on the type of data set.

B. Existing algorithm

This program combines or fuses two images. In this algorithm of fusion using alpha factor it supports both Gray and Color Images. In the program, Alpha Factor can be varied to vary the proportion of mixing of each image. With Alpha Factor = 0.5, the two images are mixed equally. With Alpha Factor < 0.5, the contribution of background image will be more. With Alpha Factor > 0.5, the contribution of foreground image will be more.

C. Proposed Algorithm

Although several fusion algorithms have been developed, then to image fusion algorithm still not reached its maturity level. In this approach we try to find out an enhanced version of image fusion using alpha factor techniques in exchange of better fusion result, there are various steps involved in the process.

Step1: We will take two images (one pair of Multifocus images), although more than two images are taken into account, but for simplicity we restrict ourselves to two images one is foreground image and the other is background image.

Step2: Now both the images are combined using alpha factor, with alpha = 0.1, taking value of alpha <0.5 means contribution of background image will be more.

Step3: Similarly we combine both the images using alpha factor, with alpha = 0.9, taking value of alpha >0.5 means contribution of foreground image will be more.

Step4: Now we mix or combine output from step 2 and step 3 to get the final fused image using alpha = 0.5, Taking value of alpha as 0.5 means contribution of both the images will be equal.

Step 5: Finally display the fused image contains all the high intensity value of the pixel.

Step 6: We calculate the peak signal to noise ratio or the MSE (mean square error value of the signal

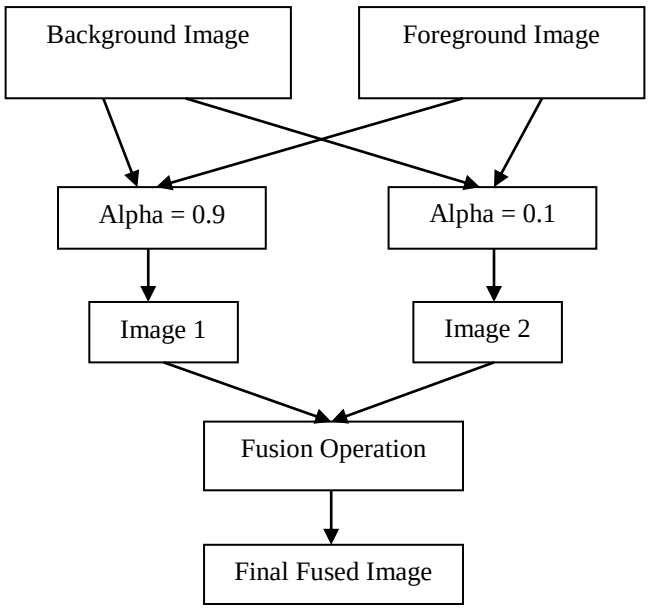


Figure 1. Flowchart of the Proposed Algorithm

III. EVALUATION CRITERIA

A. Peak Signal to Noise Ratio (PSNR)

PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation, the higher the PSNR, the better the quality of the fused or reconstructed image. PSNR value is computed by following equation:

$$PSNR = 10 \log_{10} \left(\frac{\text{Peak}^2}{\text{MSE}} \right) \quad (1)$$

B. Mean square error (MSE)

Mean square error is a measure of image quality index. The large value of mean square means that image is a poor

quality. Mean square error between the reference image and the fused image is:

$$MSE = \frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(A_{ij} - B_{ij}\right)^2 \quad (2)$$

Assumptions made in the following equations are:
A - the perfect image
B - the fused image to be assessed
i – pixel row index
j – pixel column index

IV. RESULT AND DISCUSSION

The proposed algorithm and the existing algorithm is implemented on Matlab R2012a using pair of images. We perform the test on a pair of nonreference based multifocus images. Proposed algorithm results are compared with the existing pixel based algorithm. Two well known image performance parameters for digital image have been selected to prove that performance of the proposed algorithm is quite better than the other existing fusion methods.

A. Evaluation of Peak Signal to Noise Ratio (PSNR)

Table 1 is showing the comparative analysis of peak signal to noise ratio (PSNR). As PSNR needs to be maximized, so the main goal is to increase the PSNR as much as possible. Table 1 has clearly shown that the PSNR is high in case of proposed algorithm in comparison to existing techniques therefore it is providing the best result.

TABLE 1

Algorithm	PSNR of fused image w.r.t to input image1 (in decibel)	PSNR of fused image w.r.t to input image2 (in decibel)
Source01_1.tif and Source01_2.tif		
PCA	28.7868	28.8996
Alpha	28.8385	28.8353
Proposed	32.9010	32.8949
Source02_1.tif and Source02_2.tif		
PCA	30.8305	30.9954
Alpha	30.9266	30.8829
Proposed	34.5030	34.5483
Source03_1.tif and Source03_2.tif		
PCA	31.0039	30.9498
Alpha	30.9855	30.9485
Proposed	36.3264	36.2746
Source04_1.tif and Source04_2.tif		
PCA	33.4734	33.2922
Alpha	33.3631	33.3655
Proposed	38.6830	38.6853
Source05_1.tif and Source05_2.tif		
PCA	30.5990	30.1744
Alpha	30.2918	30.4598
Proposed	33.9321	34.0995

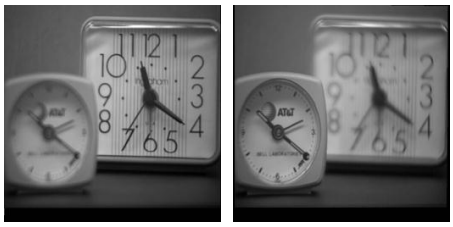
B. Evaluation of Mean Square Error (MSE)

Table 2 is showing the comparative analysis of Mean square error (MSE). As MSE needs to be minimized, so the main goal is to decrease the MSE as much as possible. Table 2 has clearly shown that the MSE is low in case of proposed algorithm in comparison to existing techniques therefore it is providing the best result.

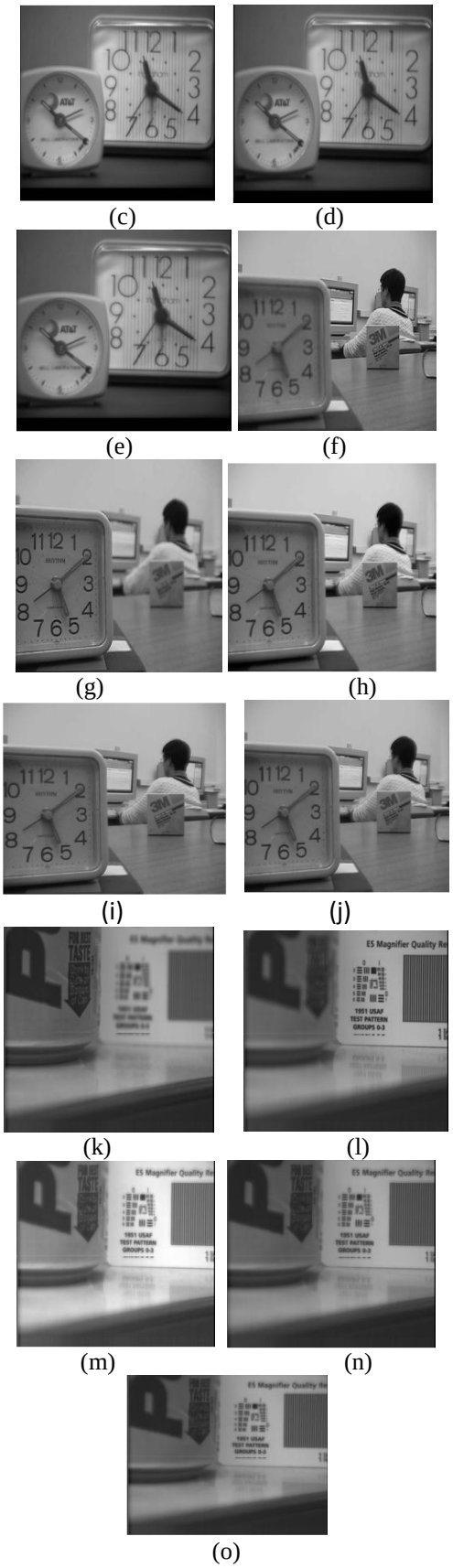
TABLE 2

Algorithm	MSE of fused image w.r.t to input image1 (in decibel)	MSE of fused image w.r.t to input image2 (in decibel)
Source01_1.tif and Source01_2.tif		
PCA	83.7765	85.9815
Alpha	84.9639	85.0260
Proposed	33.3409	33.3880
Source02_1.tif and Source02_2.tif		
PCA	53.7070	51.7065
Alpha	53.0632	52.5318
Proposed	23.0560	22.8166
Source03_1.tif and Source03_2.tif		
PCA	51.6050	52.2514
Alpha	52.2668	51.8235
Proposed	15.1509	15.3326
Source04_1.tif and Source04_2.tif		
PCA	29.2237	30.4694
Alpha	29.9758	29.9595
Proposed	8.8014	8.8061
Source05_1.tif and Source05_2.tif		
PCA	56.6478	62.4660
Alpha	60.7995	58.9928
Proposed	25.3007	26.2951

C. Input Images and Fused Images are shown in figure



(a) (b)



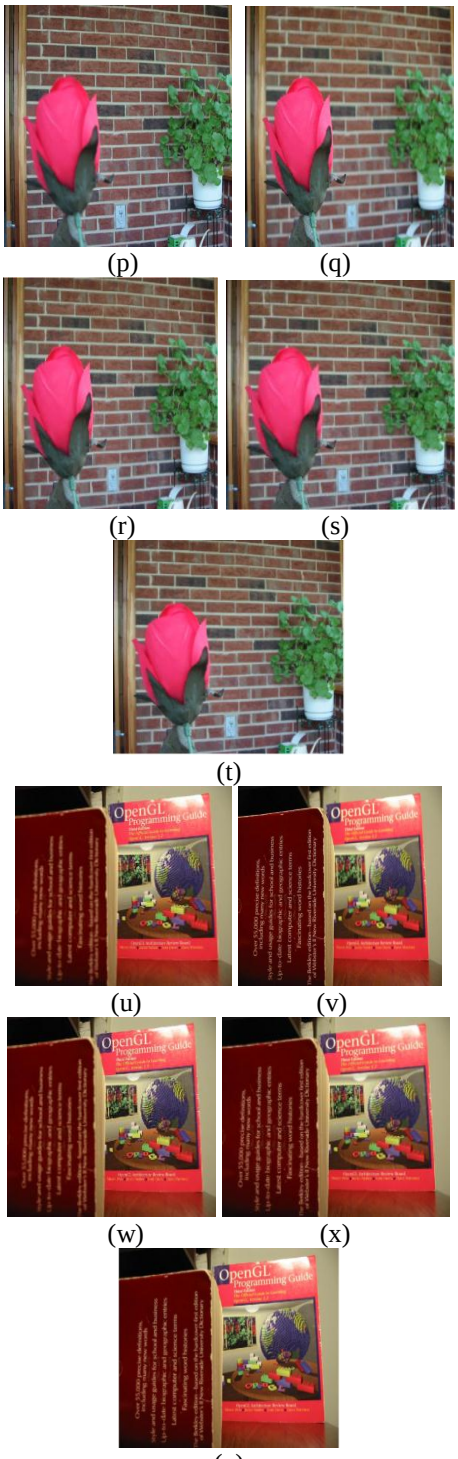


Figure 2. (a, f, k ,p ,u) Input Image with Focus on Foreground (b, g, l, q, v) Input Image with Focus on Background (c, h, m, r, w) Simple Average Fused Image (d, i, n, h, x) PCA Fused Image (e, j , o , t, y) Proposed Algorithm Fused Image.

V. CONCLUSION

In this paper we have studied and evaluate a new approach to image fusion techniques which is the enhanced version of the

existing technique. Being given an image, there exist several possible image fusion methods. Therefore, a good method will be that which provide the best interpretation of the result without loosing the important details. Proposed enhanced version of the image fusion provides the better result as compare to other but still some improvement is required.

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Authors Profile

Ms. Namrata completed B.Tech in Electroics and Communication Engineering and pursuing M.Tech in Electronics and Communication Engineering from Dr. A.P.J. Abdul Kalam Technical University Lucknow, Uttar Pradesh. Area of interest: circuit designing, networking, image processing.

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