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Image fusion using Teaching Learning Based Optimization

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ABSTRACT

Image fusion is one of the techniques in Image processing. In this paper, we are g to propose a Image fusion method based on Teaching Learning Based Optimiza Taking two multifocused images, we are going to divide them into blocks ther contrast visibility of the two image blocks then is calculated. TLBO algorith performed to obtain optimal coefficients and fused image is acquired finally using Optimal Coefficients. For different set of multi focus images, different quantit measured are calculated. Then the results of proposed method are compared existing Particle Swarm Optimization.

Introduction

Image fusion can be described as the process of combining two or more multifocused images to acquire an output image with more clarity and information content.

There are different types of Image Fusion techniques: Multi view Fusion, Multimodal Fusion, Multi temporal Fusion and Multi focus Fusion. Multi focus image Fusion can be obtained by combining the images of same scene which creates a resultant image with all the objects in the image to be in focus. Image Fusion process takes place in two domains: Spatial Domain and Transformed Domain. If the pixel values are directly integrated on the fusion process then it is spatial domain. But in transformed Domain, input images are transformed to exploit information at different resolutions using Pyramid decomposition or Wavelet decomposition.

In an image, at different resolutions some physically relevant features are observed. A means to exploit this fact is provided by Multi-Scale or Multi-resolution [1-2]. The resultant transformed image is again fused using any fusion operation. Then by taking inverse form fused image can be obtained.

Image Fusion can be performed in three different levels of information which includes Pixel level, Decision Level and Feature Level [3-4]. Pixel Level image fusion is the simplest fusion where fusion operation is directly performed on pixel intensities. In Pixel Level image Fusion, the mean or max of the pixel values of registered images is calculated. But these techniques have some undesired effects like smoothening of Sharp edges or blurring effect on the image. For feature level image fusion, input images should be segmented first into different regions, then the features of each region is calculated. The detection and classification of different objects in input images is done by Decision level image fusion and then fused image is obtained using any of the fusion algorithms. To perform Image Fusion, different techniques like PCA based image fusion [5], laplacian pyramid image fusion [6], DWT based image fusion and wavelet transform based image fusion. But each technique has certain disadvantages like not providing information about sudden intensity changes, edges are smoothed out, reducing contrast of the images. So, there is a need to overcome disadvantages.

Particle Swarm Optimization:

Particle Swarm Optimization is one of the optimization techniques used for continuous problems. It is developed by J. Kennedy et al.,[7]

PSO in inspired by the societal behaviour of bird flocking, fish schooling nature/ PSO these days have been used in different areas such as image processing, sensor networks, neural networks etc. PSO is used in image processing for finding an optimal block size of fused image [8].

As PSO is inspired by birds, each bird is called a particle. Every particle has its own solution. At first, the velocity and position of the particle is determined randomly in the search space. Each bird has its own fitness value which is evaluated using fitness function. Every particle alters its position by moving forward on the basis of path followed by it and by neighborhood. Velocity and Position of the each particle is updated every time using the equations.

$$v_b^a(t+1) = w * v_b^a(t) + c1 * r1 * (p_b^a - x_b^a(t)) + c2 * r2 * (g^a - x_b^a(t)) \qquad (1)$$

$$x_i^d(t+1) = x_i^d(t) + v_i^d(t+1) \qquad (2)$$

Where a=1, 2 …A, b=1, 2 …B. A is the number of dimensions of the particle and B is the population size. w is the inertia, g is the global best position of the particle, p is the particle best position. v and x are the velocity and position update of the particle. c1 and c2 are the constants that deal with cognitive and social behaviour of the particle. r1 and r2 are the random values ranging between 0 and1.

As the frequent updation of velocity and position of the particle at every time takes place, the particles can go out of the search space sometimes. So, to avoid this problem maximum velocity parameter vmax is calculated. If the new velocity of the particle is greater than the vmax then its velocity is set to vmax

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$$v_{pq}(t+1) = \begin{cases} v'_{pq}(t+1); v_{pq}(t+1) < v\max \\ v\max, q; otherwise \end{cases} \quad (3)$$

Where q is the qth dimension of the particle p. Value of vmax should be kept large to encourage exploration while vmax is kept smaller to encourage exploitation.

Teaching Learning based Optimization:

Teaching Learning Based Optimization (TLBO) is a one of the global optimization method based on population proposed by Rao et al [9, 10]. It also uses population of solutions to proceed to global solution just like other methods [11].It also used for parameter optimization in mechanical engineering, casting [12] etc. TLBO can be used in image processing for finding optimal coefficients for fusion of images [13].

Population in TLBO is described as group of learners. The different design variables are comparable to the subjects offered by Learners which are different. The learners result is comparable to fitness. TLBO working is divided into 'Teacher Phase' and 'Learner Phase'. Learning from the teacher is termed as 'Teacher Phase' and learning through interaction with learners is 'Learner Phase'.

Teacher Phase

The mean parameter is calculated here. It is denoted by M^l of each subject of learners at generation G is given as

$$M^l = [m_1^l, m_2^l, \ldots m_j^l \ldots . m_N^l] \quad (4)$$

The algorithm moves forward by shifting the mean of learners towards its teacher in Teacher Phase. A random weighted differential vector is formed to obtain a new set of improved learners using current mean and desired mean values and adding to existing population of learners.

$$Xnew_{(i)}^l = X_{(i)}^l + rand * (X_{Teacher}^l - T_F M^l) \quad (5)$$

Where T_F is the teaching factor. Value of T_F is decided randomly with equal probability as

$$T_F = round[1 + rand(0,1)\{2-1\}] \quad (6)$$

Experimentally, it is said that algorithm performs better if the value of T_F is between 1 or 2.

Learner Phase

Mutual interaction tends to increase the knowledge of the learner. The random interaction improves the learners knowledge. For One learner $X_{(i)}^g$ another learner is randomly selected. The i^{th} parameter of matrix in learner phase is given as

$$Xnew_{(i)}^l = \begin{cases} X_{(i)}^l + rand * (X_{(i)}^l - X_{(r)}^l) & if (f(X_{(i)}^l) < f(X_{(r)}^l)) \\ X_i^l + rand * (X_r^l - X_i^l); & otherwise \end{cases} \quad (7)$$

The algorithm terminates after MAXITE Iterations finally. By Optimal Coefficients we are going to obtain a fused image.

Proposed method Algorithm

Step1: Take two multifocused images as inputs.

Step2: Divide these two images into blocks of equal size

Step3: Calculate Contrast visibility for each image block using the formula

$$VI = 1/(m*n) \sum_{(i,j)\in B_k} \frac{|I(i,j) - \mu_k|}{\mu_k} \quad (8)$$

Continue this step for each block of two images

Step4: Performing TLBO algorithm to find Optimal Coefficients of the image.

Step5: With these Optimal Coefficients we are going to obtain Fused Image.

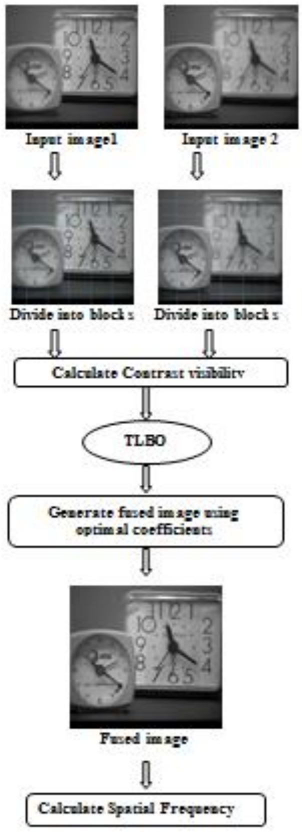


Fig1. Block diagram for proposed method.

Step6: Now for fused image calculate the Spatial Frequency value using the formula

$$SF = \sqrt{(RF)^2 + (CF)^2} \quad (9)$$

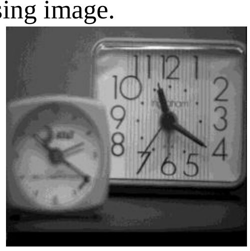
where

$$RF = \sqrt{\frac{1}{m*n}\sum_{i=1}^{m}\sum_{j=2}^{n}[F(i,j) - F(i,j-1)]^2} \quad (10)$$

$$CF = \sqrt{\frac{1}{m*n}\sum_{j=1}^{n}\sum_{i=2}^{m}[F(i,j) - F(i-1,j)]^2} \quad (11)$$

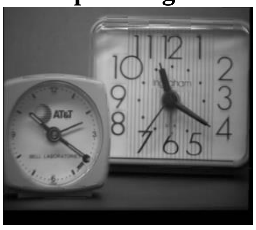
Experimental results

Experimental results are carried out by using different natural images like clock image, pepsi image and Remote Sensing image.



Input image 1

Input image 2



PSO Output Image

TLBO Output Image

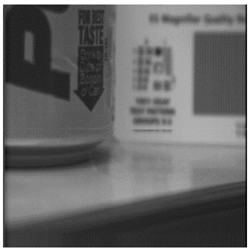
Fig 2. Clock Image.

Table1. Calculation of Performance measures for the input images with PSO and TLBO.

Fusion method	SF	PSNR	MSE	E	MI
PSO	9.96	7.50	1.15	0.32	3.90
TLBO	14.63	61.71	0.04	7.66	0.60

Where SF= Spatial Frequency, PSNR= Peak Signal to Noise Ratio, MSE= Mean Square Error, MI= Mutual Information, E= Entropy

Input Image 1



Input Image 2

PSO Output Image

TLBO Output Image

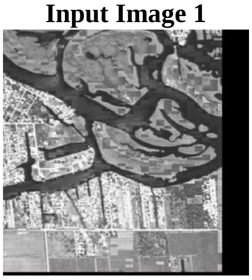
Fig 3. Pepsi Image.

Table2. Calculation of Performance measures for the Pepsi input images with PSO and TLBO.

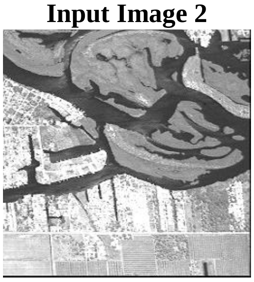
Fusion method	SF	PSNR	MSE	E	MI
PSO	13.24	7.96	1.03	0.49	2.12
TLBO	7.65	66.10	0.01	6.58	0.03

Input Image 1

Input Image 2



PSO Output Image



TLBO Output Image

Fig 4. Remote Sensing Image.

Table3. Calculation of Performance measures for the input images with PSO and TLBO.

Fusion method	SF	PSNR	MSE	E	MI
PSO	31.96	5.33	1.90	0.62	2.13
TLBO	33.31	59.87	0.06	7.33	1.01

Conclusion

This paper presents the optimal block size for the fusion of multifocus images by one of the global optimization technique Teaching Learning Based Optimization. Here, for a fixed number of iterations, algorithm is run and Optimal Coefficients are obtained. So, finally final fused image can be acquired. The obtained results are compared with Particle Swarm Optimization with respect to different quantitative measures. The difference between the quantitative measures shows that the proposed method has more accuracy than the existing method.

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