A Survey of Image Fusion using Genetic Algorithm

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ABSTRACT
Image fusion is a process of combining relevant information from input images. Several image fusion techniques are available and are used according to the application.Now-a-days advanced sensors are used for image acquisition. However these sensors usually cannot capture whole information.Hence images from different sensors are combined together to produce more informative image.When image fusion algorithm is applied, different solutions are available.Thus it is necessary to select an optimal solution for image fusion.This optimal solution fuses the input images giving a fused image which contains more information than either input images. Genetic algorithm is an optimization method used for searching solution of large number of problems.This paper gives a brief overview of image fusion techniques using genetic algorithms.

Keywords
Image fusion,Genetic Algorithm, Wavelet Transform, Optimization.

1. INTRODUCTION
With the advancement in sensors, the quality of images has definitely improved over recent past but the objective information given by a single image is limited.Image fusion is used to combine the information from multiple input images.Several applicationssuch as computer vision, automatic object detection, remote sensing, robotics, medical imaging, image classification, and military and law enforcement[3] require the image with both spatial and spectral information.In commercial applications also image fusion is used to combine multisensor or multifocus images. Many image fusion techniques are available that employ PCA,pyramid transform,averaging technique, wavelet transform,neural network and K-means clustering[4]. The block based fusion scheme is spatial domain image fusion [1] in which the images are divided into blocks. The block sharpness is calculated and then sharper block is selected. These steps are done by using one of the methods likepulse-coupled neural network, artificial neural network, genetic algorithm and support vector machine. The genetic algorithm has several advantages over other methods namely incorporation of parallelism in search operation, no need to calculate derivative information and ability to obtain multiple solutions[7].

The remaining paper is organized as follows:Section 2 gives a brief introduction to the image fusion and its types. Section 3discusses the use of genetic algorithm in image fusion and finally Section4 gives the conclusions.

2. IMAGE FUSION
An image fusion algorithm should verify and combine important feature in images.However while doing so,it should not produce artifact which would produce any distraction in fused image [3].An image contains spatial information as well as spectral information.However,a single image may not contain both the spatial and spectral information.Hencethe image having spatial information is fused with that having spectral information using image fusion. Fig 1 illustrates fusion of two images.

(a) (b) (c)

Fig.1:Fusion of multisensor images (a) image from infrared sensor (b) image from visible sensor (c) fused image [16].

Fig. 1(a) represents the image taken by infrared sensor and fig. 1(b) represents the image taken by visible sensor. These two images are fused by using suitable fusion technique to get fused image represented in fig. 1(c). The different techniques for image fusion are available that employ Principle component analysis, Brovey transform, High pass filtering, Wavelet transform etc.

The image fusion techniques are classified according to the image acquisition and level of processing. In image acquisition technique, it is multisensor, multitemporal, multifocusand multiview image fusion. Whereas in level of

processing, it is pixel level, block level, feature level and decision level image fusion[3].These techniques are further divided into subtypes as per the data processing method.In Kekreet al. [3], the principal component analysis is a technique that transforms the correlated variable into uncorrelated variable. But this method is not useful because it degrades the spectral information during image fusion.

Zhaoet al.[1] have addressed the problems of multi-focus image fusion based on neighbor distance filter. In this, first the images are decomposed into blocks using the neighbor distance multi-scale decomposition. The block having maximum value is taken for fusion.The parameters used for selection are standard deviation, average gradient and spatial frequency parameters.

Cao et al.[2] have proposed the multisensor image fusion method using discrete cosine transform for images used in wireless visual sensor network. In this, the input images are decomposed into blocks of size 8x8. Then spatial frequency of each block is calculated by considering the row frequency and column frequency. The block having higher spatial frequency is taken for fusion.

The wavelet transform technique is more suitable for image fusion compared with other techniques.Thediscrete wavelet transform decomposes the image into the components as detail and approximation. Then approximation components are decomposed into next level components. The discrete wavelet packet transform is a modified discrete wavelet transform in which the detail components are also decomposed into next level components[8].Also,wavelet transform can be modified as hybrid transform in which two transform methods are used together for image fusion [4].The hybrid matrix is generated by using the basic matrix of each transform. If input image size is not an integer power of 2,then the Kekre's wavelet transform is used for image fusion [5].By using any of the fusion method, the different solutions are produced. After this it is necessary to select proper or optimized solution suitable for that application. This can be achieved by using an evolutionary algorithm. The typical image fusion process is illustrated in Fig. 2. In this, suitable transform is applied on input images. By applying fusion rule, the coefficients from transformed images are selected for fusion. Appling inverse transform, the final fused image is generated.

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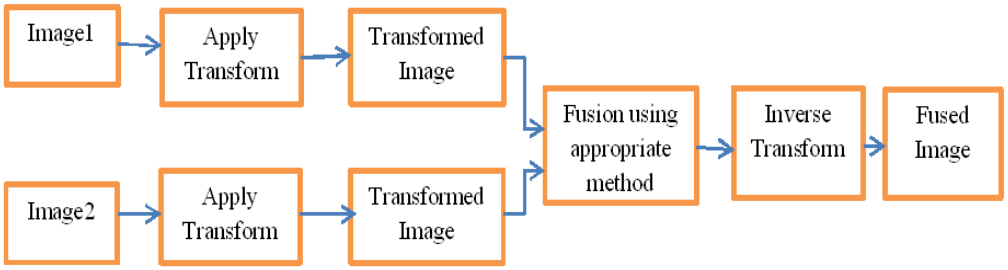

Fig 2:Typical image fusion process.

3. GENETIC ALGORITHM

Genetic Algorithm is an evolutionary algorithm that comes under the guided random search techniques.The GA is designed to simulate processes in natural systems necessary for evolution; especially those that follow the"survival of the fittest" principle. The genetic algorithm isbased on the principle of natural selection in which a string of bits is taken as genetic material [6].The fitness function evaluates each individual.From this,high fitness individuals will take part in next generation and low fitness individual are usually ignored [11].In selection step,several methods are available such as tournament selection, truncation selection,roulette wheel selection, rank based selection, steady state selection,elitism and stochastic universal selection[7].The genetic algorithm cycle is illustrated in Fig 3.GA has been used in many applications such as function optimization, system identification and control, image processing,robotics, facial recognition, parameter optimization and controllers and multi-objective optimization[7].In Cao et al. [2] and in Zhang et al. [14], the multifocus image fusion using quality assessment of spatial domain and genetic algorithm is explained. Similar to [1],the images are divided into blocks. The block size is determined using genetic algorithm. The quality assessment can be spatial domain assessment or frequency domain assessment. The image fusion is an iterative process. The GA is run until a fused image of desired quality is obtained or maximum numbers of iterations are completed. Sometimes GA is used for longer time to get optimized solution [9]. In medical applications, magnetic resonance image is considered for the feature elements. In this case, optimized feature vector is selected by using genetic algorithm [10].Das et al.[12] has proposed image fusion scheme in which input images are decomposed into two subbands as low frequency subband and high frequency subband by using wavelet transform. Theaveraging information from low frequency subbands and maximum information from high frequency subbands are selected by applying genetic algorithm. Finally inverse wavelet transform is applied to find fused image. In another approach proposed by Lacewell et al. [13], the genetic algorithm is used to fuse images using an approach that combines the pixel level and discrete wavelet transform information. The evaluation of fused imageis done by using the performance parameters such as Mean squared error, Peak signal to noise

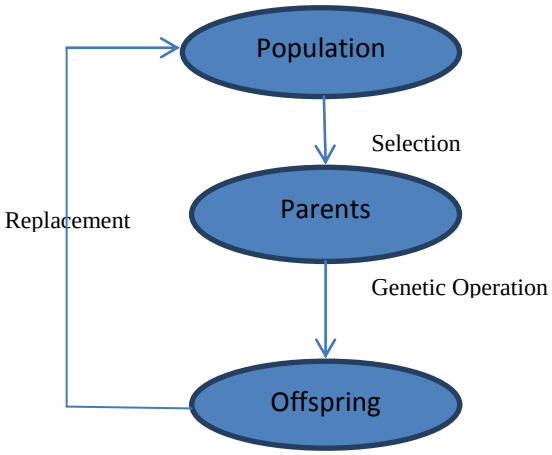

Fig. 3: GA cycle.

ratio, Root mean squared error, Mutual Information, Standard deviation, Spatial Frequency and entropy. GA based image fusion methods are time consuming so they cannot used in real time applications [15].

4. CONCLUSIONS

Image fusion increases the information contents in fused image. The input images for image fusion may be from different sensors or from same sensor with different focus or from same sensor with some time gap. The solutions are calculated by any image fusion methods. The optimized solution is selected by usinggenetic algorithm. The fitness function is important part in the implementation of genetic algorithm to find optimized solution. However the image fusion using genetic algorithm is not useful in real time application because of time consuming property of genetic algorithm.

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