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Performance Evaluation of Discrete Wavelet Transform & Genetic Algorithm in Image Fusion Techniques

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ABSTRACT: In this paper Performance evaluation of Discrete Wavelet Transform & Genetic Algorithm. In Image Fusion Techniques image fusion is the synthesis of multi source image information which is retrieved from the different sensors. It can synthesis the two or more images into one image which is more accurate, all-around and reliable. It can result in less data size, more efficient target detection, and target identification and situation estimation for observers. Also it can make the images more suitable for the task of the computer vision and the follow-up image processing. Various techniques of Multi-focus image fusion already exist and still researchers in the area are introducing new algorithms for improved results. Different parameters like PSNR, MSER and IQI can be used to evaluate the performance of these algorithms.

Keywords: Performance evaluation, Discrete Wavelet, pixel-level, multi-spectral image fusion.

I. INTRODUCTION

Fusing information contained in multiple images plays an increasingly important role for quality inspection in industrial processes as well as in situation assessment for autonomous systems and assistance systems. The aim of image fusion in general is to use images as redundant or complementary sources to extract information from them with higher accuracy or reliability. This dissertation Describes image fusion in detail, and firstly intrudes the three basic levels which Are pixel level, feature level and decision level fusion, and then compares with their properties and all other aspects. Then it describes the evaluation criteria of image fusion results from subjective evaluation and objective evaluation two aspects. According to the quantitative evaluation of the image fusion results and quality, this text uses and defines multiple evaluation parameters such as fusion image entropy, mutual information MI, the average gradient, standard deviation, cross-entropy, unite entropy, bias, relative bias, mean square error, root mean square error and peak SNR, and establishes the corresponding evaluation criteria . With the continuous development of sensor technology, people have more and more ways to obtain images, and the image fusion types are also increasingly rich, such as the Image fusion of same sensor, the multi-spectral image fusion of single-sensor, the image fusion of the sensors with different types, and the fusion of image and non-image.

Traditional data fusion can be divided into three levels, which are pixel-level fusion, feature-level fusion and decision-level fusion. The different fusion levels use different fusion algorithms and have different applications, generally, we all research the pixel-level fusion. Classical fusion algorithms include computing the average pixel-pixel gray level value of the source images, Laplacian pyramid, Contrast pyramid, Ratio pyramid, and Discrete Wavelet Transform (DWT). However, computing the average pixel-pixel gray level value of the source images method leads to undesirable side effects such as contrast reduction. The basic idea of DWT based methods is to perform decompositions on each source image, and then combine all these decompositions to obtain composite representation, from which the fused image can be recovered by finding inverse transform. This method is shown to be effective. However, wavelets transform can only reflect "through" edge characteristics, but can not express "along" edge characteristics. At the same time, the wavelet transform cannot precisely show the edge direction since it adopts isotropy. According to the limitation of the wavelet transform, curvelet transform was proposed which uses edges as basic elements, possesses maturity, and can adapt well to the image characteristics. Moreover, Curvelet Transform has anisotropy and has better direction, can provide more information to image processing.

Through the principle of Curvelet transform we know that: Curvelet transform has direction characteristic, and its base supporting session satisfies content anisotropy relation, except have multi-scale wavelet transform and local characteristics. Curvelet transform can represent appropriately the edge of image and smoothness area in the same precision of inverse transform. The low-bands coefficient adopts NGMS method and different direction high-bands coefficient adopts LREMS method was proposed after researching on fusion algorithms of the low-bands coefficient and high-bands coefficient in Curvelet transform. [1-2].

II. TRANSFORM TECHNIQUE

As a matter of fact, the image enhancement is very first step in digital image processing. As the name indicates in this technique, the original image is processed in such a manner that the result image will more suitable compared to the original image for some particular application the image is enhanced. Image enhancement is a purely subjective processing technique. This means that the required result varies from person to person. An image enhancement technique used to process images might excellent for a person, but the same result might not be good enough for another. It will be interesting to know that image enhancement is a cosmetic procedure it does not add any extra information to the original image. It basically improves the subjective quality of the image by working with the existing data.
Image enhancement may be achieved in following two domains:
(i) In the spatial domain.
(ii) In the frequency domain.

In spatial domain spatial details of image has been shown and in frequency domain image transform domain has shown because its difficult to apply various operation on image that's why image has transform into transform domain from spatial domain.

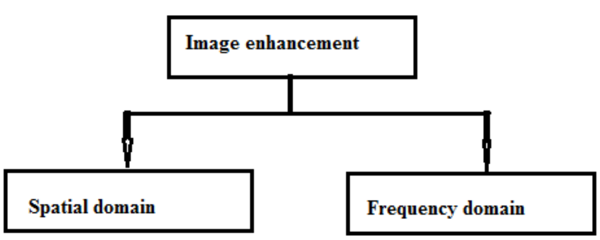

Fig. 1. Types of Image enhancement.

In fig 1 illustrates the details of image enhancement. In this figure both spatial and frequency domain has been seen and later we see various methods of both of this techniques.

Spatial domain. The word spatial domain means that we have to work in the given space, in this case, the image. In other words, the term spatial domain implies working with the pixels values or working directly with the available raw data.
Let g (x, y) be the original image where g is the grey level values and (x, y) be the original image coordinates. For an 8-bit image, g can take values from 0-255 where 0 represent black, 255 represent white and all the intermediate values represent shades of grey. In image of size 256x256, x and y can take values from (0,0) and (255,255) the modified image can be expressed as under:
$f(x,y) = T[g(x,y)]$
Here x and y is original image and T is transformation applied to get a new modified image (x,y) .for all spatial domain techniques, it s simply T that changes . The general equation is remaining same.
Thus, in brief, we can say that spatial domain techniques are those which directly work with the pixel values to obtain a new image based on above equation.
Spatial domain enhancement may be carried out in following two different ways as depicted in fig. 2.
(i) point processing
(ii) Neighborhood processing.

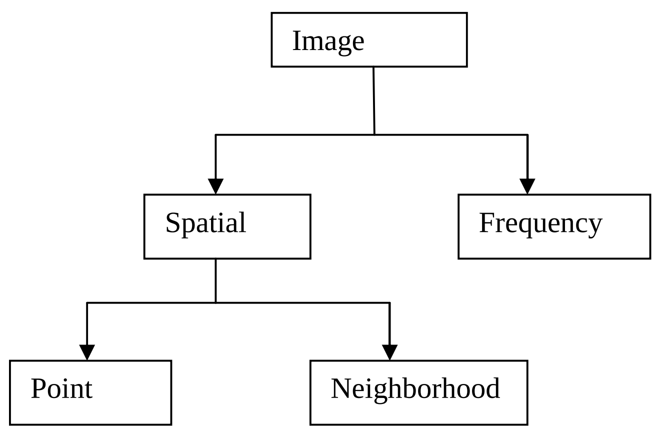

Fig. 2. Details of image enhancement.

Point processing. In point processing, we work with single pixels T is 1x1 operators. it means that the new value g (x,y) depend on the operator T and the present g(x,y) . This statement will be clear as we here are certain examples of it.

Examples:
(i) digital negative
(ii) constant stretching
(iii) threshold
(iv) grey level slicing
(v) bit plane slicing
(vi) dynamic range compression
(vii) Wavelet Transform

Wavelet transform (WT) is extensions of the idea of high-pass filtering. WT provide a multi-resolution framework where the signal being analyzed is decomposed into several components, each of which captures information present at a given scale. This enables the introduction of the concept of details between successive levels of scale or resolution and if the process is inverted, the original image can be exactly reconstructed from one approximation and from the different wavelet coefficients. Multi-sensor image fusion using the WT approach can provide a conceptual framework for the improvement of the spatial resolution with minimal distortion of the spectral content of the source image. The WT is suitable for image fusion, not only because it enables one to fuse image features separately at different scales, but also because it produces large coefficients near edges in the transformed image and reveals relevant spatial information. The WT decomposes the signal based on elementary functions i.e. the wavelets. Wavelets can be described in terms of two groups of functions: wavelet functions and scaling functions. It is also common to be defined the wavelet function as the "mother wavelet", and the scaling function is the "father" wavelet. So the transformations of the parent wavelets are "daughter" and "son" wavelets. In one-dimensional case, the continuous wavelet transform of a distribution f(t) can be expressed as

$$WT(a,b)=\frac{1}{\sqrt{x}}\ldots\int_{-\infty}^{\infty} f(t)\Psi\left(\frac{t-b}{a}\right)dt$$

Where WT (a, b) is the wavelet coefficient of the function f(t); ψ the analyzing wavelet and a (a > 0) and b are scaling and translational parameters, respectively. Each base function is a scaled and translated version of a function ψ (t) called Mother Wavelet [17]. By means of wavelet transformation, it can carry through image decomposition in multi-scale, multi-direction and multi-resolution. Therefore the fusion algorithm based on wavelet transformation has been widely used.

It can decompose the image into lots of sub-image [30], with different in direction, resolution and frequency characteristic, and sufficiently reflect local change character of the original image.
Because the wavelet transformation owns its direction characteristic it can make fusion image obtain visual effect better [18].

III. OPTIMIZATION APPROACH

Optimization is the process of making something better. In engineering, optimization algorithms have been extensively developed and well used in all respects for a long time. An engineer or a scientist conjures up a new idea and optimization improves on that idea. Optimization consists in trying variations on an initial concept and using the information gained to improve on the idea. Many optimization problems from the industrial engineering world, in particular the manufacturing systems, are very complex in nature and quite hard to solve by conventional optimization techniques. Genetic Algorithm (GA) is one of the optimization algorithms, which is invented to mimic some of the processes observed in natural evolution. The Genetic Algorithm is stochastic search techniques based on the mechanism of natural selection and natural genetics. That is a general one, capable of being applied to an extremely wide range of problems. The GA, differing from conventional search techniques, start with an initial set of random solutions called population. Each individual in the population is called a chromosome, representing a solution to problem at hand. The chromosomes evolve through successive iterations, called generations. During each generation, the chromosomes are evaluated, using some measures of fitness. To create the next generation, new chromosomes, called offspring, are form by either merging two chromosomes form current generation using a crossover operator or modifying a chromosome using a mutation operator. A new generation is form by selecting, according to the fitness values, some of the parents and offspring; and rejecting others so as to keep the population size constant. Fitter chromosomes have higher probabilities of being selected. After several generations, the algorithms converge to the best chromosome, which hopefully represents the optimum or suboptimal solution to the problem. The GA has received considerable attention regarding their potential as a novel optimization technique. There are three major advantages when applying the GA to optimization problems.

● The GA do not have much mathematical requirements about the optimization problems. Due to their evolutionary nature, the GA will search for solutions without regard to the specific inner workings of the problem.

● The evolution operators make GA effective at performing global search. The traditional approaches perform local search by a convergent stepwise procedure, which compares the values of nearby points and moves to the relative optimal points. Global optimum can be found only if the problem possesses certain convexity properties that essentially guarantee that any local optimum is a global one.

● GA provide a great flexibility to hybridize with domain dependent heuristics to make an efficient implementation for a specific problem.

In the above statement indicate, the GA have much advantages. Even though the GA can locate the solution in the whole domain, it does not solve complexes constraint problems easily, especially for exact constraints. And huge evaluations for generations and populations sometime are time-consuming. To account some of the defects and employ the advantages of the GA, the enhanced GA is proposed and applied for the optimization design.

IV. RESULTS

This method "Performance optimization of image fusion using DWT and Heuristic genetic algorithm" contain region based multi-focus image fusion scheme using discrete wavelet transform (DWT) and genetic algorithm (GA), which combines aspects of feature and pixel-level fusion. The basic idea is to divide the source images into blocks, and then select the corresponding blocks with higher quality assessment value to construct the resultant fused image. GA is brought forward to determine the suitable sizes of the block. This method produce an accurate fused image using discrete wavelet transform (DWT) for feature extraction and using genetic algorithms (GAs) to get the more optimized combined image. The performance of the proposed image fusion scheme is evaluated with Mean square error rate (MSER), Peak signal to noise ratio (PSNR) and Image Quality Index (IQI). Simulation results conducted with DWT and GA shows that this method outperforms the existing image fusion algorithms.

In this optimization technique different images of same size are fused together by using DWT and DWT-GA and the optimization of images are carried out by the image parameters like Mean square error rate (MSER), Peak signal to noise ratio (PSNR) and Image quality index (IQI). All resultant fused images gives better image quality enhancement for DWT-GA as compared to DWT.

This method "Performance optimization of image fusion using DWT and Heuristic genetic algorithm" is simulated by using MATLAB 7.8.0. MATLAB is a strong mathematical tool which provides help to engineers to solve, model, simulate the problems and find solutions assuming environment in to mathematical equations. It is standard engineering tool as it perform many different tasks using different tool box relevant to different particular cases e.g. Control systems, signal processing, image processing, communication systems, and support complex matrix manipulation, simulink etc. In different research field it provides platform for learning and comparison of theoretical hypothesis and simulated values. It even provides support to nonlinear system calculations and result.

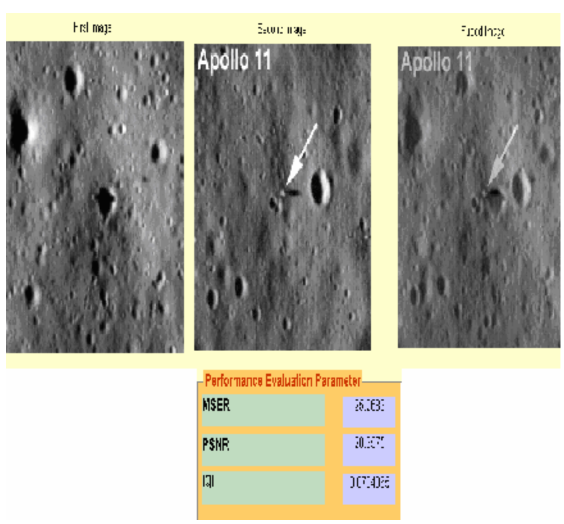

Fig. 3. The relation of MSER, PSNR and IQI based on DWT.

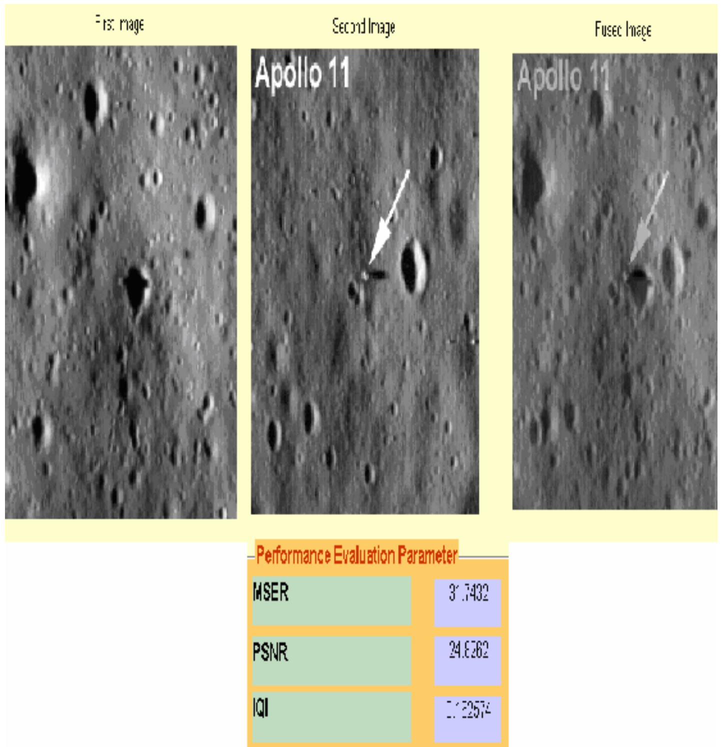

Fig. 4. The relation of MSER, PSNR and IQI based on DWT-GA.

Fig. 5. The relation of MSER, PSNR and IQI based on DWT.

Fig. 7. The relation of MSER, PSNR and IQI based on DWT-GA.

Table 1: Measured values of MSER, PSNR and IQI for DWT & DWT-GA of fused images.

Fuse Images	Image Fusion Methods	MSER	PSNR	IQI
1.	DWT	25.2683	20.3575	0.0704065
	DWT-GA	31.7432	24.8262	0.162574
2.	DWT	14.0383	9.89555	0.0242238
	DWT-GA	19.5055	13.2694	0.0868949
3.	DWT	21.5555	16.8925	0.0584226
	DWT-GA	28.263	21.5396	0.141052
4.	DWT	22.1628	17.4593	0.0603829
	DWT-GA	28.4099	21.6783	0.14196

CONCLUSION

There are a large number of applications in remote sensing that require images with both spatial and spectral resolution. the potentials of pixel level image fusion with DWT and DWT-GA transformation technique is used for better selection of features of an image and selected features are optimized by Genetic algorithm. The better combination of DWT-GA generates better image quality in existing method of DWT. These optimization methods are explored along with quality assessment evaluation measures. The DWT and DWT-GA are used to enhance the quality of different images and their results are compared. Simulation results demonstrates that the images fusion by using DWT-GA outperforms DWT based on MSER, PSNR and IQI measures. Fused images are primarily used to human observers for viewing or interpretation and to be further processed by a computer using different image processing techniques**.**

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