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A Statistical Analysis of Multiresolution Fused Images to Enhance the Image Quality

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Abstract

Image enhancement is an important tool in digital image processing, which is primarily used for better image visual quality. Image fusion attains attention because of its ability to produce enhanced image as resultant output by fusing multiple spectrums information (i.e. red, blue, Near Infra Red (NIR) and green) in reliable way. Line features visibility is excellent in blue and red bands while vein features are revealed in red band. Both vein structural information and partial line information are shown by near infra red (NIR) respectively. Multi-spectral imaging is proposed in proposed work to acquire accurate information compare to traditional methods. Wavelet transform is regarded as successful statistical transform technique in image fusion process. But it frequently suffers from discontinuities for limited number of coefficients. To overcome the discontinuities issue in effective way by curvelet is proposed in place of wavelet for better fusion efficiency.The simulation results are compared with different performance measurements for evaluation and the proposed curvelet method yields better results than popular wavelet statistical methods.

Keywords*:*Curvelet, Image Fusion, Multispectral, NIR, Spectrum, Wavelet.

1. INTRODUCTION

Image Fusion is a process of combining the relevant information from a set of images into a single image, where the resultant fused image will be more informative and complete than any of the input images. Image quality can be improved by applying various fusion techniques. Important applications of the fusion of images include medical imaging, microscopic imaging, remote sensing, computer vision, and robotics. Multisensor data fusion has become a discipline which demands more general formal solutions to a number of application cases. Several situations in image processing require both high spatial and high spectral information in a single image. This is important in remote sensing. However, the instruments are not capable of providing such information either by design or because of observational constraints. One possible solution for this is image fusion.

Image fusion is a process of combining two or more images into an image. It can extract features from source images, and provide more information than one image. In other words, image fusion is a technique to integrate information from multiple images. These images may come from one sensor or multiple sensors [3]. Image fusion provides a useful tool to integrate multiple images into a composite image that is more suitable for the purposes of human visual perception and can help us to extract more features. For example, in flight navigation, the fusion of visual and infrared images can aid pilots navigate in poor weather conditions and keep the safety of aerial sailing [2] in military fields, it can assist armed forces to ascertain where the enemies are in the night fighting; in biometric applications, the fusion of computer tomography and magnetic resonance images may display the whole structure in bioscience.

The aim of image fusion is to integrate complementary and redundant information from multiple images to create a composite image that contains a better description of the scene. By integrating information, image fusion can reduce dimensionality. This results in a more efficient storage and faster interpretation of the images. By using redundant information, image fusion may improve accuracy as well as reliability; and by using complementary information, image fusion may improve interpretation capabilities with respect to subsequent tasks. According to above characteristics, image fusion leads more accurate data, increased utility and robust performance.

2. BACKGROUND

(A) Discrete Wavelet Transform

Multi-resolution images are decomposed by Wavelet transforms tool that give various channels representing of image features by diverse frequency sub-bands at multi-scale. It is an acclaimed method in breaking down signals. Signal analysis is frequently done by wavelet transform method. At the point when decomposition is performed, the estimate and subtle element part can be isolated 2-D Discrete Wavelet Transform (DWT) changes over the image from the spatial domain to frequency domain. The image is isolated by vertical and horizontal lines and represent to the initially request of DWT, and the image can be divided in four sections those are LL1, LH1, HL1 and HH1.

(B) Curvelet Transform

The main feature of the curvelet transform is that it is sensitive to directional edges and capable of representing the highpass details of object contours at different scales through few sparse nonzero coefficients. curvelet transform [3] proposed the idea of which is to represent a curve as superposition of functions of various lengths and widths obeying the scaling law width _ length2. Curvelets differ from wavelet and related systems, and it takes the form of basic elements, which exhibit a very high directional sensitivity and are highly an isotropic. In two dimensions, for instance, Curvelets are more suitable for the analysis of image edges such as curve and line characteristics than wavelet.

The implementation of curvelet transform has been studied by many researchers. In this section, we introduce the implementation of the second generation curvelet which is simpler, faster, and less redundant [4]. The main benefit of Curvelets is their capability of representing a curve as a set of superimposed functions of various lengths and widths. The curvelet transform is a multiscale transform but, unlike the wavelet transform, contains directional elements. Curvelets are based on multiscale ridgelets with a bandpass filtering to separate an image into disjoint scales.

3. MULTISPECTRAL PALM IMAGE FUSION

A multispectral palmprint recognition system using wavelet based image fusion is proposed. It uses a multispectral capture device to sense the palm images under different illumination conditions, including red, blue, green and infrared. Further wavelet transform is

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used for combining the palmprint images obtained from different channels. During image acquisition the situation of hand movement is also considered. Finally, competitive coding scheme has been adopted for matching. It uses Wavelet based image fusion as data level. Again this system has been further extended where feature extraction and matching have been made of red, green, blue and NIR bands of a multispectral palm image. Finally these matching scores obtained from matching against different bands are fused using simple sum rule. Feature band selection based multispectral palmprint recognition has been proposed where the statistical features are extracted to compare each single band. Score level fusion is performed to determine the best combination from all candidates.

The most discriminative information of palmprint images can be obtained from two special bands. Region of Interest (ROI) is determined from hyperspectral palm cube using local coordinate system. Multispectral palmprint recognition has presented where multiple information related to hands are used. Hand shape, fingerprints and palmprint modalities are used for recognition. This system shows good recognition accuracy on a medium size database while fusion is performed with multiple fingers and fusion of finger and palm. [9] A comparative study of several multispectral palm image fusion techniques has been presented. Some well-studied criteria are used as objective fusion quality measure. However, the curvelet transform is found to be the best among others in preserving discriminative patterns from multispectral palm images.

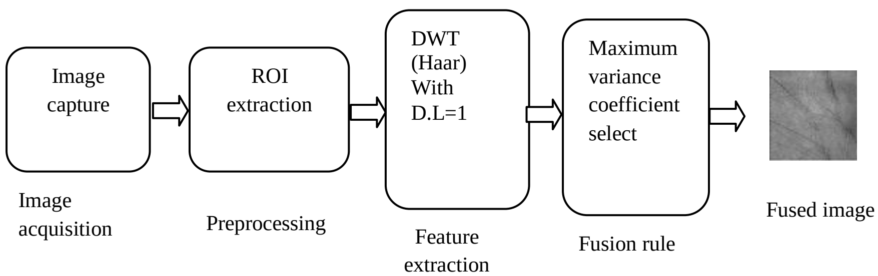

Fig.1 Multispectral palm image Fusion System

4. PROPOSED METHOD

(A) IMAGE FUSION

Image fusion is actualized by coordinating different source images with excess and reciprocal data. Consequently repetition can be reduced, while corresponding data can be used more effectively. As indicated by application motivation behind image fusion it can be isolated into pixel level, element level and decision level fusion. Most wavelet construct image fusion algorithm research in light of that how to choose the high frequency detail element coefficients of the image, however, low frequency approximation coefficients are prepared by "average" strategy. To some degree, the complexity of the image is reduced, low frequency segments including main vitality of the image; decide the outwork of the image. In this manner picking the right low frequency coefficients can enhance the visual impacts of the image. Considering to the nature of fused image and speed of execution, another image fusion algorithm in view of lifting wavelet transform is proposed. The fused image is better protected the information and edge of the input image, the output of fused image is excellent. This algorithm picks a different standard to fuse the images. Low frequency coefficients are

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joined by neighborhood spatial frequency and consistency check. The most extreme esteem based combination guideline is chosen for high frequency coefficients determination. Fused image is obtained by utilizing converse lifting wavelet transform.

(B) IMAGE FUSION TECHNIQUES

The principle component analysis (PCA) image fusion technique depends on the statistical standard. It exchanges the spatial detail element from the high spatial determination image utilizing the statistical properties of the high spatial resolution image. Image merging techniques do not check the relevant spatial data. Also, do not make utilization of the integral qualities of the images. Component substitution strategies are the high distortion of the original spectral information. Entropy, normal gradient, standard deviation of fused image utilizing a trous wavelet change is all higher than the after effects of Mallat's wavelet transform.

ALGORITHM FOR WAVELET BASED IMAGE FUSION

1. Input Red palm, Green palm, and Blue palm and near infrared images.
2. Apply haar wavelet change with single level deterioration.
3. Compute approximation, horizontal, vertical and diagonal segments of the information image.
4. For each A, V, H, D component compute variance of image by using the 3 by 3 window.
5. Add variance of all the blocks.
6. Compare the variances of all blocks and select the large variance block.
7. Image with larger variance having the more data, which will upgrade data content in the subsequent palm print image.

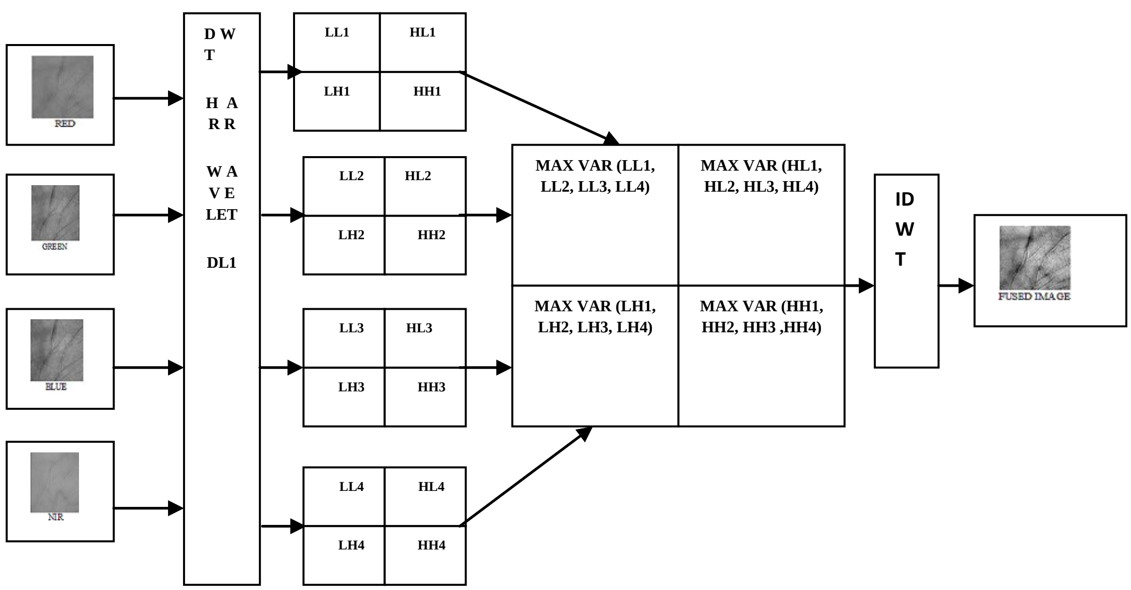

Fig.2 Wavelet Based Image Fusion.

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ALGORITHM FOR CURVLET BASED IMAGE FUSION

1. Input Red palm, Green palm, and Blue palm and near infrared images.
2. Compute Curvelet components of Red, Green, Blue and Infrared palm image.
3. Extract the whole Curvelet part from its structure.
4. For each block compute the variance of images. Compare the variances of all blocks and select the large variance block. Image with larger variance having the more data, which will upgrade data content in the subsequent palm print image.
5. Assemble all blocks with highest variance to get single Structure.
6. Inverse Curvelet transform is obtained to get the fused image.

(C) QUALITY ASSESSMENT

Target image quality measurements can be arranged according to the accessibility of a unique (distortion free) image, with which the distortion image is to be compared. Most existing methodologies are known as full-reference, which means that a complete reference image is thought to be known. In numerous useful applications, be that as it may, the reference image is not accessible, for example, in image fusion case, and a no reference or "blind" quality appraisal methodology is desirable. In a third sort of strategy, the reference picture is just in part accessible, as an arrangement of removing highlights made accessible as side data to assess the nature of the distorted image. This is referred to as reduced- reference quality appraisal.

An expansive number of target measures have been proposed to assess combination execution. Target measure characterized into four classes:

A. Methods based on statistical characteristics;

B. Methods based on information theory; and

C. Methods based on important features.

The broad utilization of image fusion strategies, in military applications, in surveillance, in medical diagnostics, and so forth., has prompted an expanding requirement for appropriate execution or quality assessment tools in order to compare results obtained with different algorithms or to get an ideal setting of parameters for a given fusion algorithm. In most cases, picture combination is just a preliminary stride to a few particular assignments, for example, human observing, and in this way the execution of the combination calculation must be measured in terms of change of the ensuing assignments.

a) Average Gradient

Average gradient can reflect the contrast level of image detail and highlight of surface variety furthermore reflects the image clarity. In general, the estimation of the normal slope is bigger, the picture is clearer. Average slope can reflects the complexity level of image detail and feature of texture variation furthermore reflects the image clarity. In general, the value of the average gradient is bigger, the image is clearer.

$$Mx = 1(i + I, J) - 1(i, J) \quad (1)$$

$$My = 1(i, J + 1) - 1(i, J) \quad (2)$$

In Image, M, N represents the rows and columns of the image; 1 (i, J) represents the gray value of the image pixel (I, J).

b) Edge Intensity

It results the original brightness of the image. In this test edge element is important parameter such that based upon the palm lines structure it conclude that the edge force of Curvelet is most when compared with wavelet.

c) Shannon Entropy (EN)

The Shannon Entropy is the term which evaluates the expected estimation of the data contained in the msg. Entropy is the factual measure of irregularity that can be used to characterize the texture of information image.

$$H(x)^n = \sum_{i=1}^{N} IW(Pi) \qquad (3)$$

WherePi is weighting coefficient.

Entropy is a index to assess the data amount contained in an image. If the estimation of entropy gets to be higher in the wake of fusion performance, it shows that the data increments and the fusion performance are enhanced. Entropy is characterized as $E = -pi \log 2L - 1\ i = 0pi$where L is the sum of gray levels, $p = \{p0, p1, \ldots pL - 1\}$ is the probability distribution of each level.

5. SIMULATION RESULTS

(A) WAVELET TRANSFORM

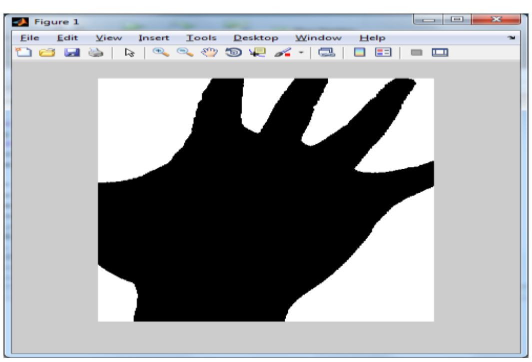

Figure.3: Binary form of an input image

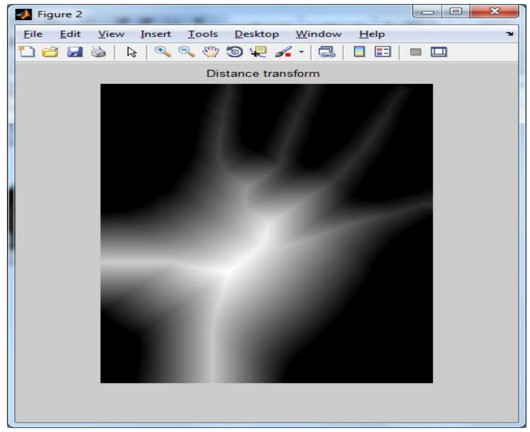

Figure.4: Distance transform image

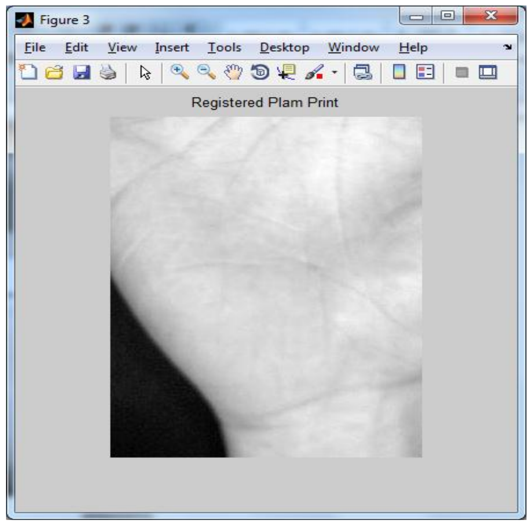

Figure.5: Registered palm print

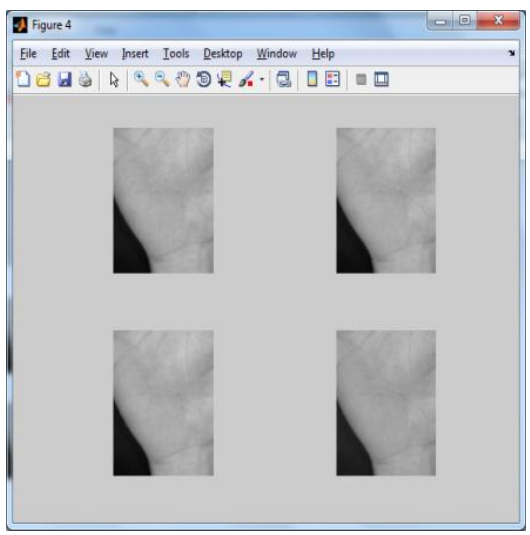

Figure.6: Red, green, blue and NIR images

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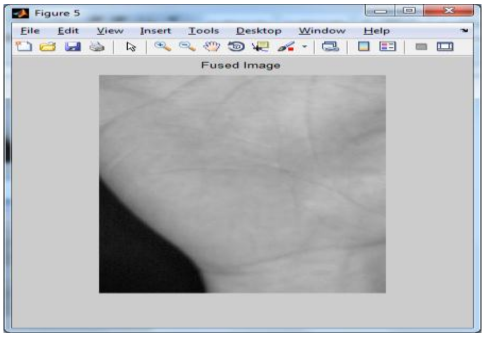

Figure.7: Fused image using wavelet transform

(B) CURVELET TRANSFORM

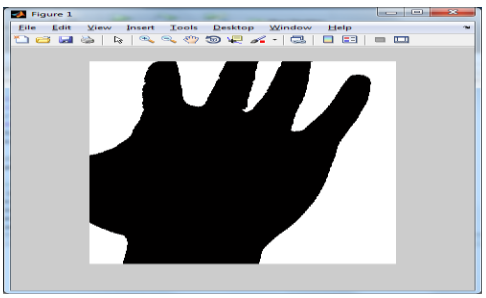

Figure.8: Binary form of an input image

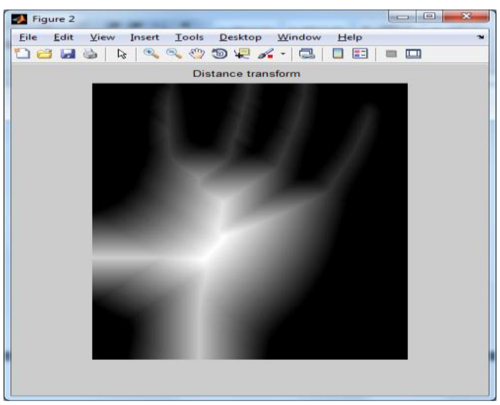

Figure.9: Distance transform image

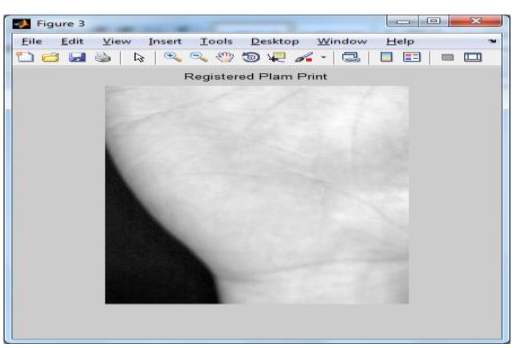

Figure.10: Registered palm print

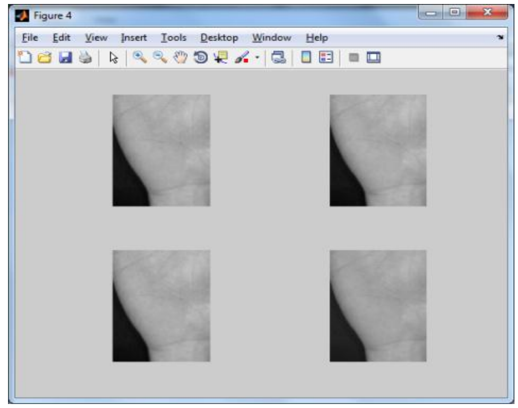

Figure.11: Red, green, blue and NIR images

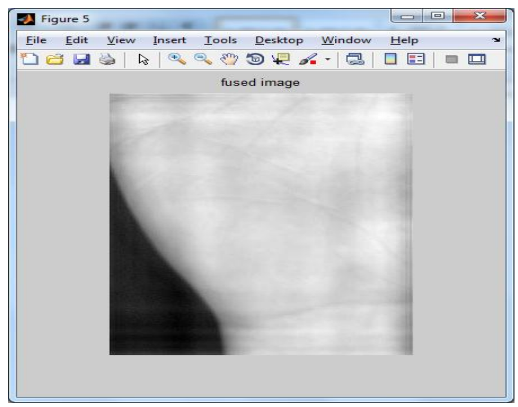

Figure.12: Fused image using curvelet transform

6. CONCLUSION

The transform techniques plays an important role in fusion process for good visual quality images as resultant output. The palm image enhancement needs accurate feature extraction based on multi-spectral analysis and curvelet transform mechanism in proposed work is highly successful in attaining the features than wavelet. Wavelet transform frequently fails to handle the curves discontinuities in efficient manner, while curvelet transform done task in ease way. Extracting linear edges in effective way by wavelet transform, while curve edges attain by curvelet. In Curvelet transform the curve portions and curved edges are clearer than wavelet transform method.

FUTURE SCOPE

Every aspect of digital image processing is optimized along with technology to improvise performance and application supportability. Image fusion has changed its mechanism a lot from 1960's to 2016 and still it improves by technology in future scope. In early 1960's Fourier Transform is primary component to access the fusion process later on it followed by wavelet then in proposed method curvelet is used for betterment. In future the contourtlet transform can be used for much more effective and efficient results.

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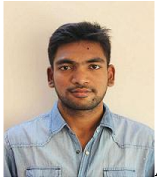

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