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Curvelet Image Fusion Using Decision Tree Algorithm

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ABSTRACT: This paper presents a novel image fusion method, suitable for pan-sharpening of multispectral (MS) bands, based on multi-resolution analysis. The low-resolution MS bands are sharpened by injecting high-pass directional details extracted from the high-resolution panchromatic (Pan) image by means of the Curvelet transform, which is a non-separable MRA, whose basis function are directional edges with progressively increasing resolution. The fusion of high-spectral but low spatial resolution multispectral and low-spectral but high spatial resolution panchromatic satellite images is a very useful technique in various applications of remote sensing. Recently, some studies showed that wavelet-based image fusion method provides high quality of the spectral content of the fused image. However, most of wavelet-based methods have a spatial resolution of the fused result less than the Brovey, IHS, and PCA fusion methods. In this thesis, we introduce a new method based on the Curvelet transform using Decision Tree which represents edges better than wavelets. Since edges play a fundamental role in image understanding, one good way to enhance spatial resolution is to enhance the edges. Curvelet-based image fusion method provides richer information in the spatial and spectral domains simultaneously. We will perform image fusion using Curvelet Transform with Decision Tree Algorithm. This new method has reached an optimum fusion result. For the implementation of this proposed work we use the Image Processing Toolbox under Matlab Software.

KEYWORDS: Edge detection, Fusion, Multi resolution analysis, IKONOS, Wavelet transform, Curvelet transform**.**

I. INTRODUCTION

Digital images are two-dimensional matrices in image processing. One important task is to adjust the values of these matrices in order to get clear features in images. The adjusting of values obeys a certain mathematical model. The main challenge is how to build suitable mathematical models for practical requirements. Taking image denoising as an example, many mathematical models are based on a frequency partition of the image, where components with high frequency are interpreted as noise that have to be removed while those with low frequency are seen as features to be remained. Curvelets, which are going to be reviewed in this paper, can be seen as an effective model that not only considers a multiscale time-frequency local partition but also makes use of the direction of features.

Most natural images/signals exhibit line-like edges, i.e., discontinuities across curves (so-called line or curve singularities). Although applications of wavelets have become increasingly popular in scientific and engineering fields, traditional wavelets perform well only at representing point singularities, since they ignore the geometric properties of structures and do not exploit the regularity of edges. Therefore, wavelet-based compression, denoising, or structure extraction become computationally inefficient for geometric features with line and surface singularities. For example, when we download compressed images or videos, we often see a mosaic phenomenon (i.e., block artifacts along edges of the images). This mosaic phenomenon mainly results from the poor ability of wavelets to handle line singularities. In fluid mechanics, discrete wavelet thresholding often leads to oscillations along edges of the coherent eddies, and consequently, to the deterioration of the vortex tube structures, which in turn can cause an unphysical leak of energy into neighboring scales producing an artificial “cascade" of energy.

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II. LITERATURE SURVEY

Vishal P.Tank, Divyang D. Shah,Tanmay V. Vyas, Sandip B. ChotaliyaManthan S. Manavadaria in 2013. They purposed Image Fusion Based on Wavelet and Curvelet Transform. In this paper we have put forward an image fusion algorithm based on wavelet transform andsecond generation Curvelet transform. The wavelet transform does not represent the edges and singularitieswell. So the second generation Curvelet transform is performed along with the wavelet transform and the imagefusion is done. Their proposed algorithm holds useful information from source multiple imagesquite well. This paper puts forward an image fusion algorithm based on Wavelet Transform and the SecondGeneration Curvelet Transform. It includes multi resolution analysis ability in Wavelet Transform, also has betterdirection identification ability for the edge feature of awaiting describing images in the Second GenerationCurvelet Transform. This method could better describe the edge direction of images, and analyzes feature ofimages better. According to it, this paper uses Wavelet and the Second Generation Curvelet Transform intofusion images, then makes deep research on fusion standards and puts forward corresponding fusion projects. Atlast, these fusion methods are used in simulation experiments of multi-focus and complementary fusion images.In vision, the fusion algorithm proposed in this paper acquires better fusion result than previous.

Myungjin Choi, Rae Young Kim, Moon-Gyu Kim in 2009. They proposed THE CURVELET TRANSFORM FOR IMAGE FUSION. The fusion of high-spectral but low spatial resolution multispectral and low-spectral but high spatial resolution panchromatic satellite images is a very useful technique in various applications of remote sensing. Recently, some studies showed that wavelet-based image fusion method provides high quality of the spectral content of the fused image. However, most of wavelet-based methods have a spatial resolution of the fused result less than the Brovey, IHS, and PCA fusion methods. In this paper, we introduce a new method based on the Curvelet transform which represents edges better than wavelets. Since edges play a fundamental role in image understanding, one good way to enhance spatial resolution is to enhance the edges. Curvelet-based image fusion method provides richer information in the spatial and spectral domains simultaneously. We performed IKONOS image fusion. This new method has reached an optimum fusion result. We have presented a newly developed method based on the Curvelet transform for fusing IKONOS images. In this paper, an experimental study was conducted by applying the proposed method, and also other image fusion methods, for fusing IKONOS images. A comparison of the fused image from the wavelet and IHS method was made.

Jianwei Ma and GerlindPlonka in 2012. He proposed A Review of Curvelets and Recent Applications. Multiresolution methods are deeply related to image processing, biological and computer vision, scientific computing, etc. The Curvelet transform is a multi scale directional transform, which allows an almost optimal non adaptive sparse representation of objects with edges. It has generated increasing interest in the community of applied mathematics and signal processing over the past years. In this paper, he presented a review on the Curvelet transform, including its history beginning from wavelets, its logical relationship to other multi resolution multidirectional methods like contour lets and shear lets, its basic theory and discrete algorithm. Further, we consider recent applications in image/video processing, seismic exploration, quid mechanics, simulation of partial different equations, and compressed sensing.

Navneet Kaur, Jaskiran Kaur in 2013. She proposed A Novel Method for Pixel Level Image fusion Based on Curvelet Transform. Image Fusion is one of the important and preprocessing steps in digital image Reconstruction. The objective of image fusion is to better the quality of fused images, extract all the useful information from the source images and do not introduce artifacts or inconsistencies which will distract human observers. Many algorithms have been developed for fusion of medical images as reported in the literature. Despite the significant research conducted on this topic, the development of efficient medical image fusion method is still a big challenge for the researchers. In this paper, new efficient method based upon Curvelet transform using log Gabor filter is proposed for image fusion of medical images. The proposed method is developed using Log Gabor Filter. The various matrices PSNR, Entropy, Standard deviation and Quality are calculated to compare the results. The proposed method is compared both subjectively as well as objectively with the other image fusion methods. The experimental results show that the proposed method is better than other fusion methods and increases the quality and psnr of fused image. To see the qualitatively as well as quantitatively performance of the proposed algorithm, some experiments are conducted on

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several medical images. The medical images are fused with four fused methods: Wavelet method, Multi wavelet method, Curvelet Transform and Proposed Method. A Curvelet transform using Gabor filter based approach is used in the Proposed Method. The Gabor filter approach is used in the proposed algorithm because it gives more visually pleasant images. The effectiveness of this approach has been justified using different medical images. The results are compared qualitatively (visually) as well as quantitatively using quality measures. In this paper three techniques have been used for comparison and they are: Wavelet. Method, Multi wavelet method and Curvelet Transformation. Four quality metrics have been used for calculating results to compare quantitatively these four techniques. Experimental results show that proposed method performs well than the Wavelet method, Multi wavelet method, Curvelet method in terms of quality of images. The proposed method increases the quality significantly, while preserving the important details or features. This also gives the better results in terms of visual quality. This algorithm can be used in other type of images like Remote sensing images, Ultrasound images, SAR images etc. Other quality metrics can be used to judge the performance of this algorithm. And further improvements can also be done in the algorithm to improve the quality. Instead of log Gabor approach, algorithm can be modified to improve the quality of the images.

Smt.G. Mamatha (Phd), L.Gayatri in 2012. They proposed AN IMAGE FUSION USING WAVELET AND CURVELET TRANSFORMS. This paper presents wavelet and Curvelet transform based approach for the fusion of digital image, magnetic resonance (MR) and computed tomography (CT) images. We looked at the selection principles about low and high frequency coefficients according to different frequency domain after Wavelet and the Curvelet Transform. In choosing the low-frequency and high frequency coefficients, the concept of local area variance and window property of pixels respectively. Some attempts have been proposed for the fusion of MR and CT images using the wavelet transform. The objective of the fusion of an MR image and CT images of the same organ is to obtain a single image containing as much information as possible about that organ for diagnosis. Since medical images have several objects and curved shapes, it is expected that the Curvelet transform would be better in their fusion. The simulation results show the superiority of the Curvelet transform to the wavelet transform in the fusion of digital image and MR and CT images from entropy, correlation coefficients and the RMS error points of view. The paper has presented a new trend in the fusion ofdigital image, MRI and CT images which are based onthe Curvelet transform. A comparison study has beenmade between the traditional wavelet fusion algorithmand the proposed Curvelet fusion algorithm. Theexperimental study shows that the application of theCurvelet transform in the fusion of MR and CT imagesis superior to the application of the traditional wavelettransform. The obtained Curvelet fusion results havehigher correlation coefficient and entropy values thanin wavelet fusion results and minimum values of RMSerror than in the wavelet transform. At last, thesefusion methods are used in simulation experiments ofmulti-focus and complementary fusion images. Invision, the fusion algorithm proposed in this paperacquires better fusion result. In objective evaluationcriteria, Curvelet fusion characteristic are superior totraditional DWT.

III. METHODOLOGY

First the images from different sources such as CT scan image and MRI image is loaded in the application. After preprocessing the wavelet and curvelet transform is applied. The resultant images are then fed to a decision tree algorithm and the results are calculated.

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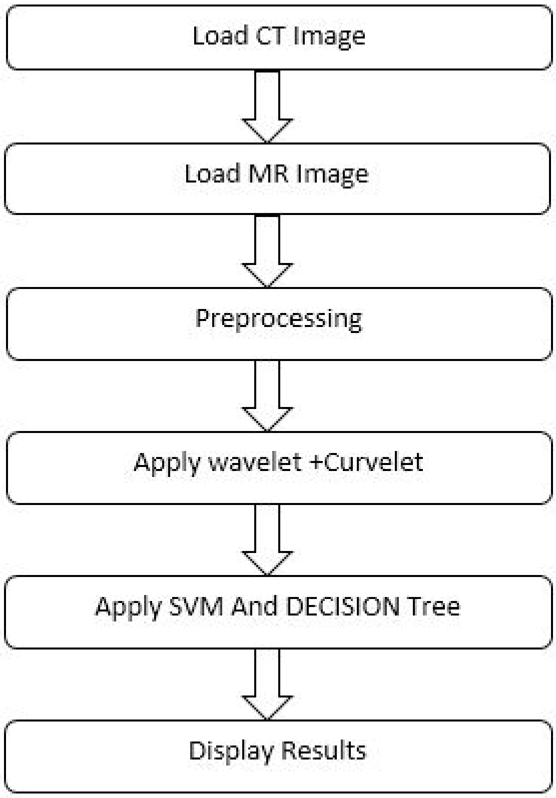

Figure 1.1.1 Methodology

IV. RESULTS & DISCUSSION

The techniques are implemented by using algorithm which defines the enhancement of Image Fusion. The proposed scheme successfully performs image fusion enhancement. Various image processing techniques applied on the sample images give the satisfactory numerical results as compared to the previously proposed algorithms. The parameters whose values were calculated include, PSNR, RMSE, ENTOPY, BER AND CC.

Snapshots

The snapshots of the various image processing operations of the proposed research methodology are as follows. Firstly, both CT image and MR image are browsed and then processed.

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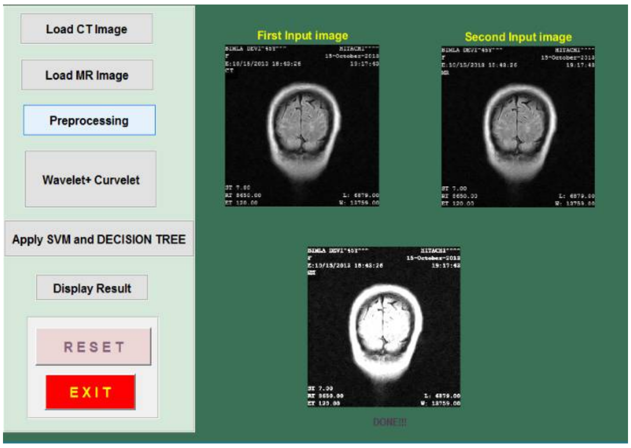

Figure 1: Main Interface

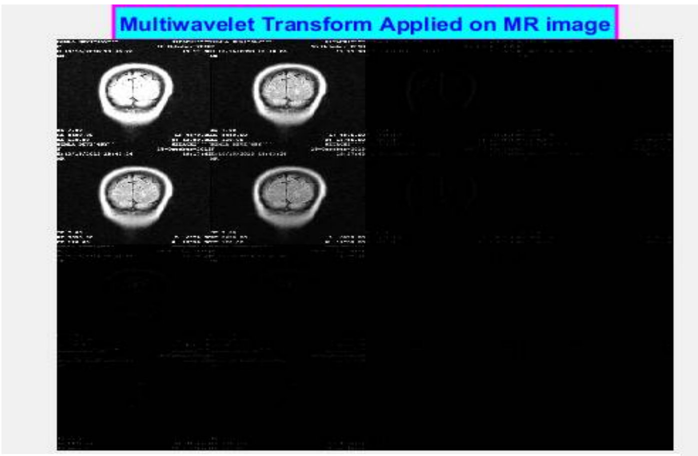

Figure 2: Wavelet Transform Applied To MR image

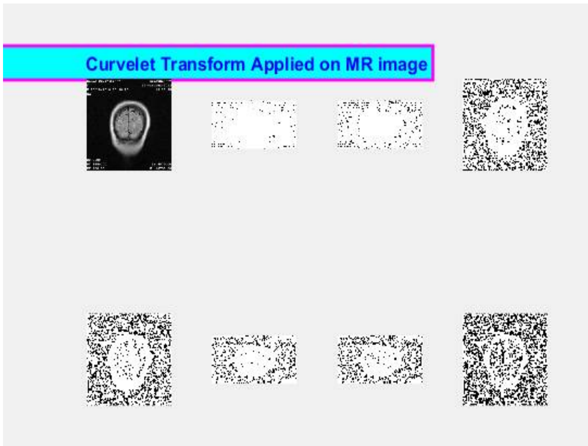

Figure 3: Curvelet Transform Applied To MR Image

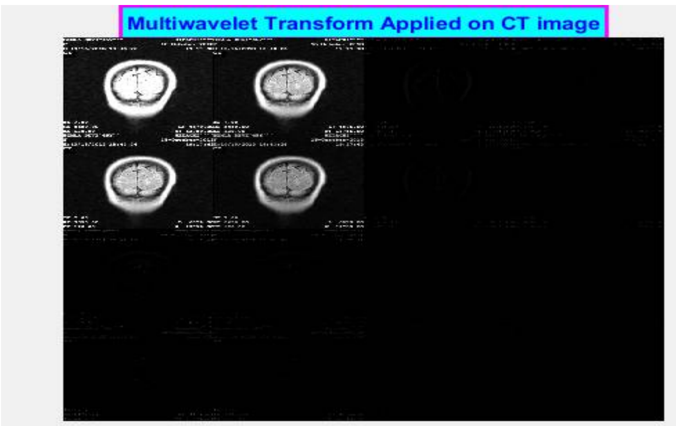

Figure 4: Wavelet Transform Applied To CT Image

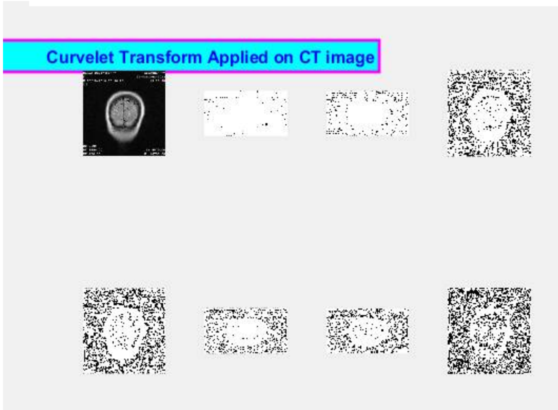

Figure 5: Curvelet Transform Applied To CT Image

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Now we apply wavelet as well as curvelet on both CT image as well as MR image. This is illustrated in following images

After that the results are retrieved and following values are obtained

1. **PSNR:-**PSNR is most commonly used to measure the quality of reconstruction of lossy compression codecs (e.g., for image compression). The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codecs, PSNR is an approximation to human perception of reconstruction quality. Although a higher PSNR generally indicates that the reconstruction is of higher quality, in some cases it may not. One has to be extremely careful with the range of validity of this metric; it is only conclusively valid when it is used to compare results from the same codec (or codec type) and same content. Typical values for the PSNR in lossyimage and video compression are between 30 and 50 dB, provided the bit depth is 8 bits, where higher is better. For 16-bit data typical values for the PSNR are between 60 and 80 dB.Acceptable values for wireless transmission quality loss are considered to be about 20 dB to 25 dB.. Values obtained from our algorithm are graphically shown as

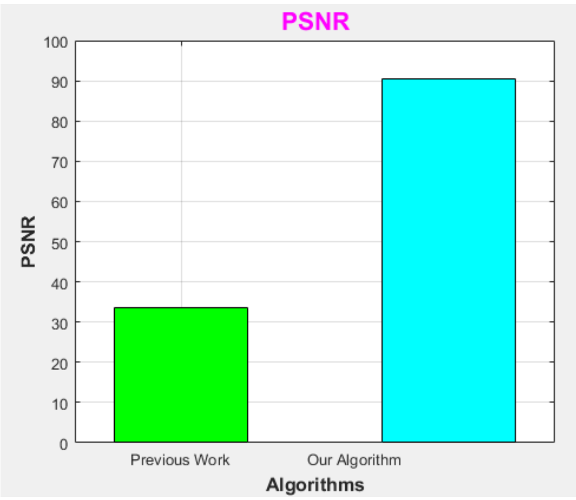

Figure 6: Comparison Graph For PSNR

Comparison of PSNR between Previous and our algorithm

	Previous Work	Proposed Work
PSNR	33.5750	90.4212

Figure 7: Obtained Values From The Proposed Work

2. **RMSE:-**Root Mean Square Error (RMSE) A commonly used reference based assessment metric is the Root Mean Square Error (RMSE). The RMSE between a reference image, R, and a fused image, F, is given by the following equation:

$$\text{RMSE}=\sqrt{\frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}(R(m,n)-F(m,n))^2}$$

Where R(m,n) and F(m,n) are the reference (CT or MR) and fused images, respectively, and M and N are image dimensions. Smaller the value of the RMSE, better the performance of the fusion algorithm. The plotted values of RMSE obtained from our algorithm are given in following figures

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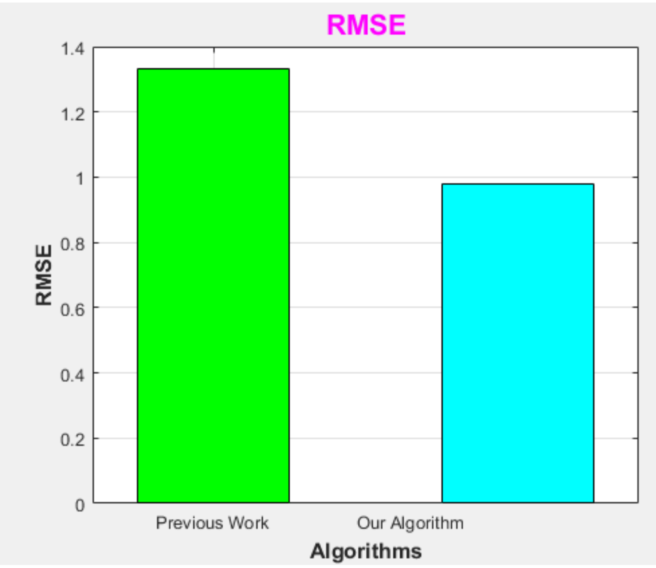

Figure 8: Comparison Graph For RMSE

Comparison of RMSE between Previous and our algorithm

	Previous Work	Proposed Work
RMSE	1.3310	0.9795

Figure 9: Obtained Values Of RMSE

3. **Correlation Coefficient:**-The correlation coefficient is the measure the closeness or similarity in small size structures between the original and the fused images. It can vary between -1 and +l .Values closer to + 1 indicate that the reference and fused images are highly similar while the values closer to -1 indicate that the images are highly dissimilar

$$CORR=(2C_{rf}) / (C_r+C_f)$$

Where

$$C_r= \sum_{i=1}^{M} \sum_{j=1}^{N} I_r(i,j)^2$$

$$C_f= \sum_{i=1}^{M} \sum_{j=1}^{N} I_f(i,j)^2$$

$$C_{rf}= \sum_{i=1}^{M} \sum_{j=1}^{N} I_r(i,j)^2 \ I_f(i,j)^2$$

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Cr is the reference image and C_f is the fused image respectively. The results are shown below

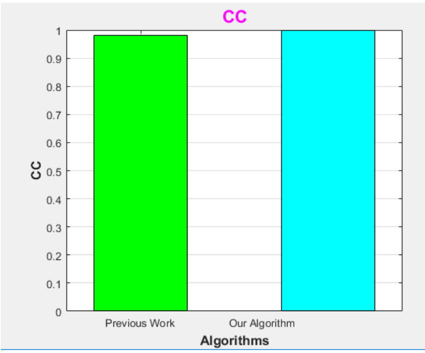

Figure 10: Comparison Graph For CC

Comparison of Correlation Coefficient between Previous and our algorithm

	Previous Work	Proposed Work
CC	0.9823	0.9998

Figure 11: Obtained Values For CC

4. **Entropy:-**The Entropy (H) is the measure of information content in an image. The maximum value of entropy can be produced when each gray level of the whole range has the same frequency. If entropy of fused image is higher than parent image then it indicates that the fused image contains more information.

$$H= -\sum_{g=0}^{L-1} p(g) \log_2 p(g)$$

The results for entropy are plotted as

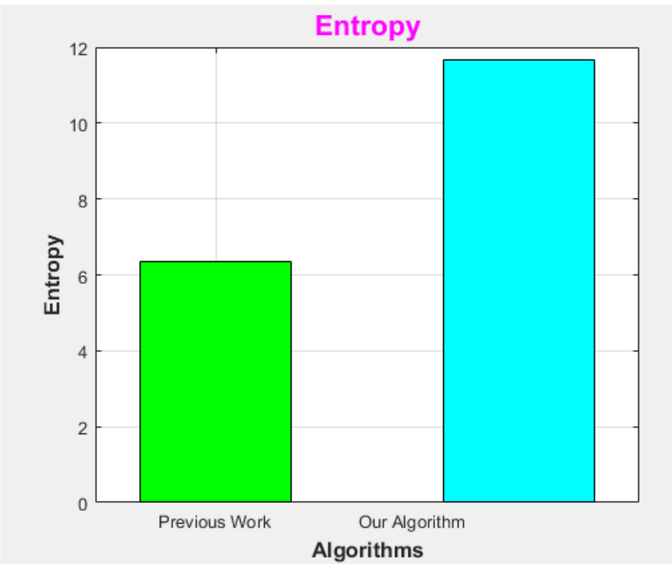

Figure 12:Comparison Graph For Entropy

Comparison of Entropy between Previous and our algorithm

	Previous Work	Proposed Work
Entropy	6.3521	11.6793

Figure 13: obtained Values Of Entropy

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V. CONCLUSION

Thus the two different modality images are fused using the various fusion rules based on the Curvelet transforms with the application of decision trees . Moreover the difference in performance of the two methods is clearly exhibited using four performance measures. It is observed that, fusion methodology based on the Curvelet transform with decision trees has given curved visual details better than those given by the Multi-Wavelet fusion algorithm. The fused image obtained using MWT and Curve let transform contains more useful information than the source images, thus enabling the radiologists to locate the imperfections accurately, making the treatment easier and perfect

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BIOGRAPHY

Muzafar Ahmad Dar is currently a research scholar at Bells Institute of Management and Technology. He is currently doing masters in computer science and engineering and is involved in many research projects. His choicest areas of research are networking, image processing, data mining etc. He has completed his Bachelor's degree in computer science and engineering at Islamic University of Science And Technology.

Asish Sharma is an assistant professor at the department of computer science and engineering, Bells Institute of management and technology. He has completed his M.Tech in computer science and engineering and is currently active in different research areas. His thrust areas are computer network security, image processing etc.