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Identification of Abnormality of Mri Images Using The Curvelets Transform Method

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Abstract: This paper describes the Curvelets Transform method to get the significant results for the MRI images. To study and understanding of different kinds of MRI Images and formats like jpg, bmp, tiff, png and conversion of real MRI Images into the basic standards using convertor (Image Viewer). Implementation of Curvelets method is done on different image formats. Also the calculation of Mean square error (MSE), Peak signal-to-noise ratio (PSNR), time and the percentage improvement using Curvelets is done. Thus, the idea behind using this technique is to get better results in terms of quality and in removal of noise and blurring of MRI images. Our main objective is to obtain a high resolution with as much details as possible for the sake of diagnosis of MRI images. Curvelets Transform Method is used to get the significant and higher results.

Keywords: Curvelets, MRI Images, Mean Square Error (MSE), Peak signal-to-noise ratio (PSNR), Time and Percentage.

I. Introduction

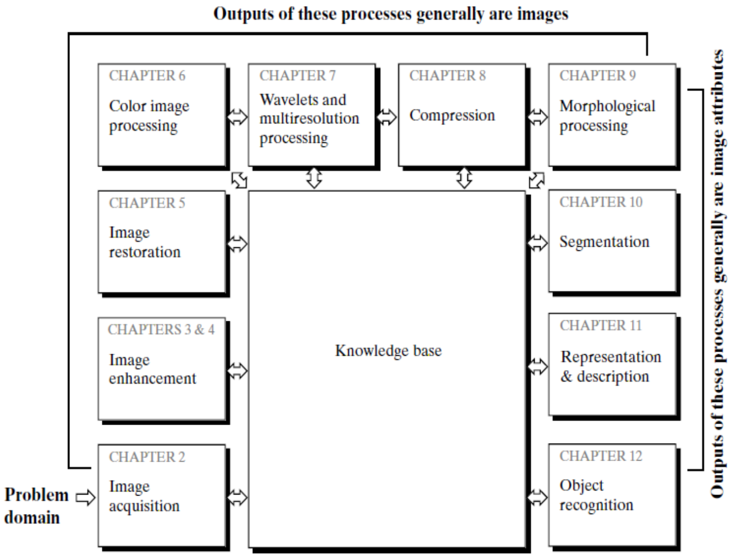
Curvelets basically are the extension of Wavelets. These are used for representing images which are smooth, minimum length scale. Basically Curvelets are used for curves. This transform holds for cartoons/Geometrical diagrams etc. as these define higher resolution. Curvelets transform was successfully used in image Denoising and obtained higher quality result image than common wavelets transform methods. Curvelets transform is defined in both continuous and digital domain. Moreover, it can be used for multi-dimensional signals. Curvelets also exhibit an interesting architecture that sets them apart from classical multiscale representations. Curvelets partition the frequency plane into dyadic coronae and (unlike wavelets) sub partition those into angular wedges which again display the parabolic aspect ratio. Hence, the Curvelets transform refines the visibility of the image

II. Segmentation

1. Segmentation- Segmentation is the process of partitioning an image into regions. Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The goal of image segmentation is to cluster pixels into salient image regions, i.e., regions corresponding to individual surfaces, objects, or natural parts of objects. Segmentation could be used for object recognition, occlusion boundary estimation within motion or stereo systems, image compression, image editing, or image database look-up.

2. Digital Image Processing {DIP} - An image may be defined as a two-dimensional function, f(x, y), where x and y are spatial (plane) coordinates, and the amplitude of at any pair of coordinates (x, y) is called the Intensity or gray level of the image at that point. When x, y, and the amplitude values of f are all finite, discrete quantities, we call the image a digital image. The field of digital image processing refers to processing digital images by means of a digital computer. A digital image is composed of a finite number of elements, each of which has a particular location and value. These elements are referred to as picture elements, image elements and pixels. Pixel is the term most widely used to denote the elements of a digital image. Vision is the most advanced of our senses, so it is not surprising that images play the single most important role in human perception. However, unlike humans, who are limited to the visual band of the electromagnetic (EM) spectrum, imaging machines cover almost the entire EM spectrum, ranging from gamma to radio waves. They can operate on images generated by sources that humans are not accustomed to associating with images. These include ultra-sound, electron microscopy, and computer-generated images. Thus, digital image processing encompasses a wide and varied field of applications.

III. Fundamental Steps In Digital Image Processing

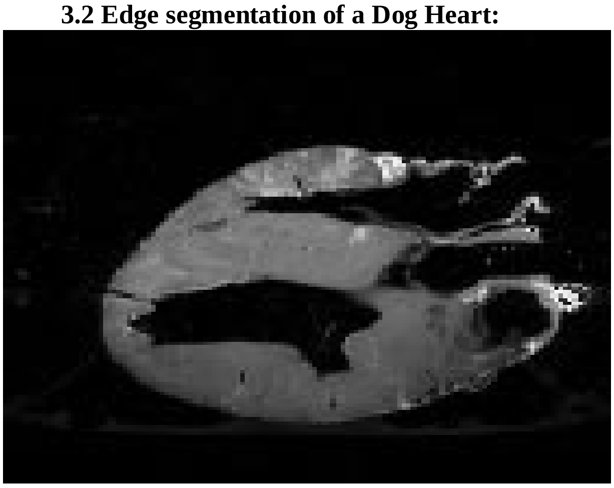


3.1. Image Segmentation - Segmentation is the process of partitioning an image into regions. Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

There are two approaches to segmentation.
1) Region segmentation
2) Edge segmentation
3.1.1 Region Segmentation - The pixels of the same object are grouped together and are marked to indicate that they form a region.
• Criteria for region segmentation: Pixels may be assigned to the same region if they have similar intensity values and they are close to one another.
3.1.2 Edge Segmentation - Find all pixels on region boundaries.

a. apply Gaussian smoothing
b. apply edge detection
c. remove false edges (e.g., noise)
d. Thin the edge -boundary is 1 pixel wide
e. Fill the gaps -recover missing edges
f. Put boundary pixels in order -all pixels in a list
g. Ideally closed boundaries

3.2 Edge segmentation of a Dog Heart:



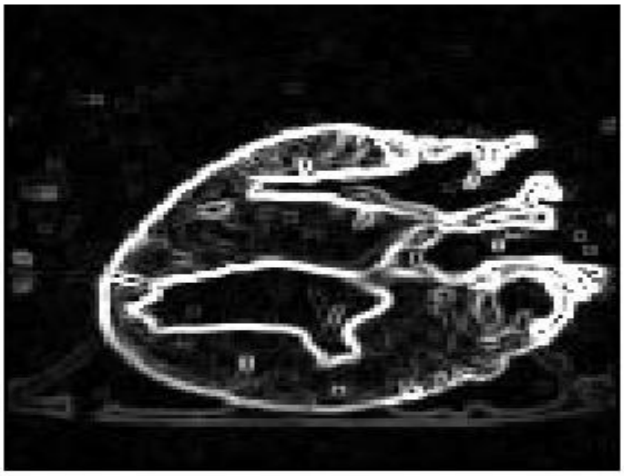


Figure3. Edge Detection Image

IV. Magnetic Resonance Imaging (Mri)

Medical Imaging is the technique and process used to create images of the human body (or parts and function thereof) for clinical purposes (medical procedures seeking to reveal, diagnose or examine disease) or medical science. MRI enables the discovery of abnormalities that might be obscured by bone with other imaging methods. MRI images allow the physician to visualize even hair line cracks and tears in injuries to ligaments, muscles and other soft tissues. It is a procedure used in hospitals to scan patients and determine the severity of certain injuries. MRI images are used to produce accurate and detailed pictures of organs from different angles to diagnose any abnormalities. There are two types of MRI high field for producing high quality images and low field MRI for smallest diagnosis condition. Magnetic resonance imaging is a noninvasive medical test that helps physicians diagnose and treat medical conditions. The differentiation of abnormal (diseased) tissue from normal tissues is better with MRI than with other imaging modalities such as x-ray, CT and ultrasound.

An MRI machine uses a magnetic field and radio waves to create detailed images of the body. Unlike CT scanning or general x-ray studies, no ionizing radiation is involved with an MRI. MRI also may show problems that cannot be seen with other imaging methods. Magnetic resonance imaging (MRI) is done for many reasons. It is used to find problems such as tumors, bleeding, injury, blood vessel diseases, or infection. MRI also may be done to provide more information about a problem seen on an X-ray, ultrasound scan, or CT scan The MRI is used to diagnose disorders of the body that cannot be seen by X-rays. The MRI is painless and has the advantage of avoiding the dangers X-ray radiation. Magnetic resonance imaging (MRI) of the brain and brain stem uses magnetic fields and radio waves to produce high quality two- or three-dimensional images of brain structures without use of ionizing radiation (X-rays) or radioactive tracers.

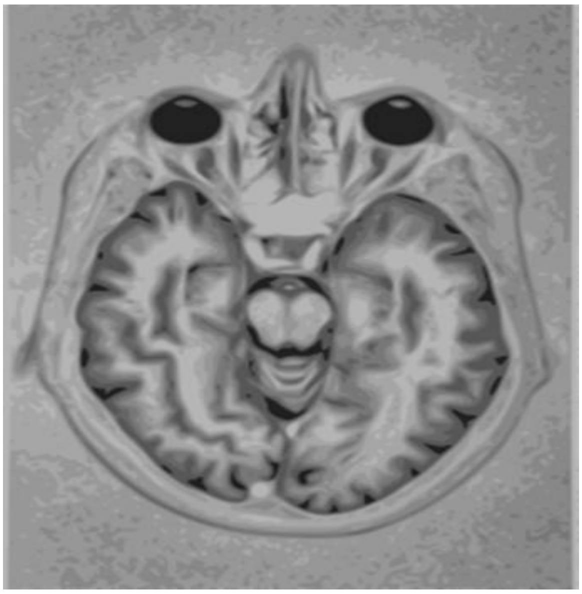


Figure4. Original Image

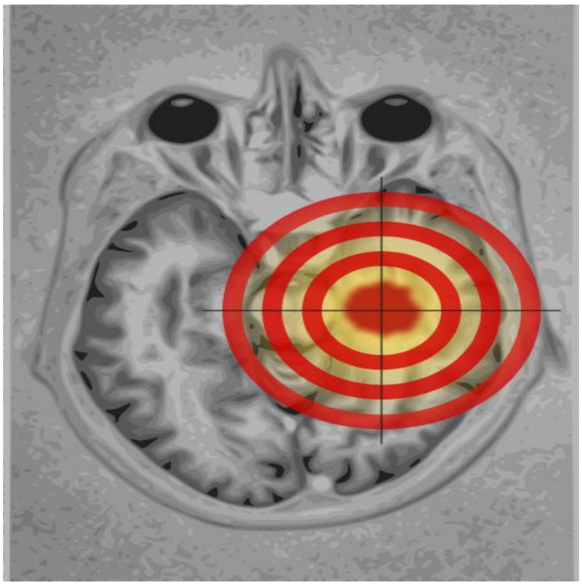


Figure5. Abnormality Identified Image

V. Methods

5.1 Wavelets - Transforms are based on small waves, called Wavelets. Many wavelets are needed to represent an edge (number depends on the edge, not the smoothness. They cannot "adapt" to geometrical structure. Traditional wavelets perform well only for line like structure. They ignore geometric properties of the structure. Wavelets do not supply good direction selectivity for the MRI images. We need a more refined scaling concept. The wavelet transform is better than Fourier transform because it gives frequency representation of raw signal at any given interval of time, but Fourier transform gives only the frequency-amplitude representation of the raw signal, but the time information is lost. So Fourier transform cannot be used where both time and frequency information is needed at the same time.

$$\left\| f - \tilde{f}_m \right\|_2^2 = O\left(m^{-1}\right)$$

5.2 Wavelets to Curvelets -Wavelets, because they are localized and multiscale, do much better in one dimension, but because of their poor orientation selectivity, they do not represent higher-dimensional singularities effectively. The discrete wavelet transform (DWT) has established an impressive reputation as a tool for mathematical analysis and signal processing; it has the disadvantage of poor directionality, which has undermined its usage in many applications. Significant progress in the development of directional wavelets has been made in recent years. The complex wavelet transform is one way to improve directional selectivity and only requires O (N) computational cost. One popular technique is the dual-tree complex wavelet transform (DT CWT) which added perfect reconstruction to the other attractive properties of complex wavelets. Discrete methods and wavelets didn't provided accurate results with respect to frequency, time and phase. Thus, to achieve the specified and accurate results, new method, and combination of both Wavelets and Fourier: Curvelets was introduced.

5.3 Curvelets - Curvelets basically are the extension of Wavelets. These are used for representing images which are smooth, minimum length scale. Basically Curvelets are used for curves. This transform holds for cartoons/Geometrical diagrams etc. as these define higher resolution. Curvelets transform was successfully used in image Denoising and obtained higher quality result image than common wavelets transform methods. Curvelets transform is defined in both continuous and digital domain. Moreover, it can be used for multi-dimensional signals. Curvelets also exhibit an interesting architecture that sets them apart from classical multiscale representations. Curvelets partition the frequency plane into dyadic coronae and (unlike wavelets) sub partition those into angular wedges which again display the parabolic aspect ratio. Hence, the Curvelets transform refines the visibility of the image.

$$\left\| f - \tilde{f}_m \right\|_2^2 = O\left(m^{-2} \log^3 m\right) \cong O\left(m^{-2}\right)$$

5.3.1 Discrete Wavelet Transform (DWT)

The discrete wavelet transform (DWT) is use to apply the wavelet transform to digital world. It captures both frequency and time information. It maps a function of continuous variable into a sequence of coefficients. If the function being expanded is discrete, the resultant coefficients are called discrete wavelet transforms (DWT). Filter is used to approximate the behavior of the continuous wavelet transform. The signal is decomposed with a high-pass (HP) filter and a low pass (LP) filter. The low-frequency component usually contains most of the frequency of the signal. This is called the approximation. The high-frequency component contains the details of the signal. Row by row wavelet decomposition is perform and then column by column.

Three Popular Wavelet Decomposition Structure On Image: (a) pyramid, (b) spacl, (c) wavelet packet.

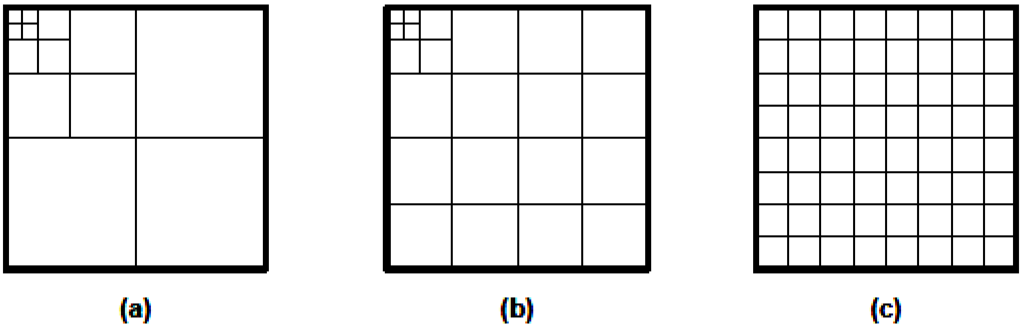


Figure6

(a) In the structure of pyramid decomposition, only the LL sub image is decomposed after decomposition into four more sub images.
(b) In the structure of spacl, after the first level of decomposition, each sub image is decomposed into smaller sub images, and then only the LL sub image is decomposed.
(c) In the structure of wavelet packet decomposition, each sub image (LL, LH, HL, HH) is decomposed after each decomposition.

Block Diagram of DWT:
(a) Original Image
(b) Output image after the 1-D applied on Row input
(c) Output image after the second 1-D applied on row Input.

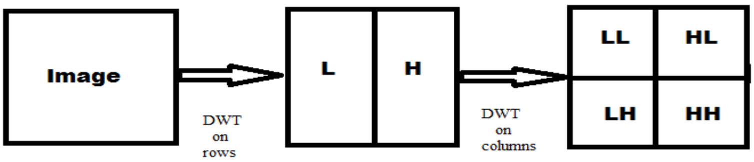


Figure7

5.3.2 Haar Wavelets

The Haar wavelet is a sequence of rescaled "square-shaped" functions which together form a wavelet family or basis. The Haar wavelet is also the simplest possible wavelet. For an input represented by a list of 2^n numbers, the Haar wavelet transform may be considered to simply pair up input values, storing the difference and passing the sum. This process is repeated recursively, pairing up the sums to provide the next scale: finally resulting in $2^n - 1$ differences and one final sum.

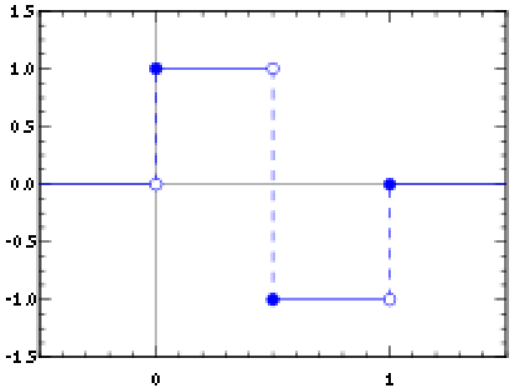


Figure8

5.3.4 Stationary Wavelet Transform (SWT)

The main application of the SWT is de-noising. The Stationary wavelet transform (SWT) is a wavelet transform algorithm designed to overcome the lack of translation-invariance of the discrete wavelet transform (DWT). Translation-invariance is achieved by removing the down samplers and up samplers in the DWT and up sampling the filter coefficients.

VI. Parameters

1 Peak Signal-to-Noise Ratio (PSNR)

2 Mean Squared Errors (MSE)

Peak signal-to-noise ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. PSNR is an approximation to human perception of reconstruction quality. Although a higher PSNR generally indicates that the reconstruction is of higher quality. PSNR is most easily defined via the mean squared error (MSE). Given a noise-free m×n monochrome image I and its noisy approximation K,

MSE is defined as:

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

PSNR is defined as:

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

VII. Results

Image A

1	Techniques	MSE	PSNR	RMSE	TIME
2					
3	Median	14.77	36.44	3.84	2.4
4	Wiener	16.38	35.99	4.05	2.5
5	Wavelet	3.27	42.98	1.81	6.43
6	Curvelet	2.93	43.46	1.71	42.75

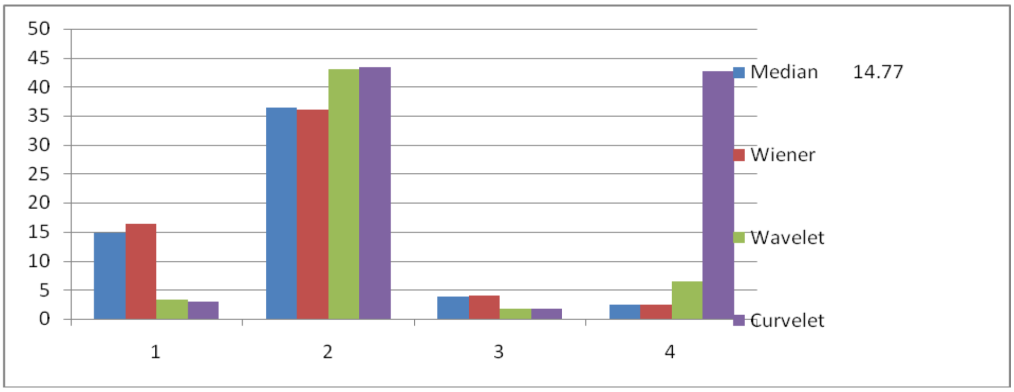


Image B

1	Technique	MSE	PSNR	RMSE	TIME
2					
3	Median	13.92	36.69	3.73	6.05
4	Wiener	15.38	36.26	3.92	6.91
5	Wavelet	3.07	43.26	1.75	17.19
6	Curvelet	3.79	42.34	1.95	98.8

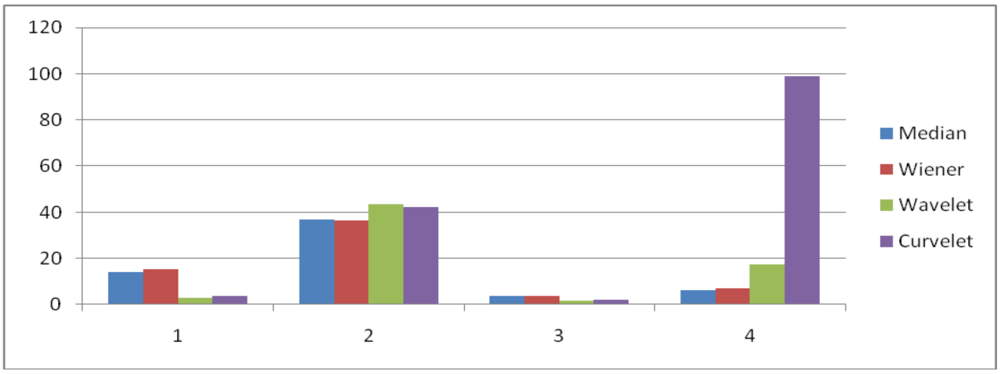
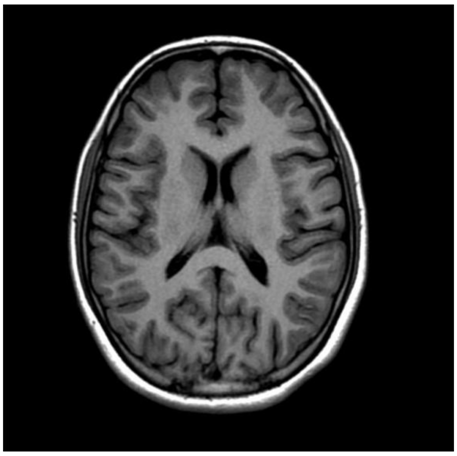
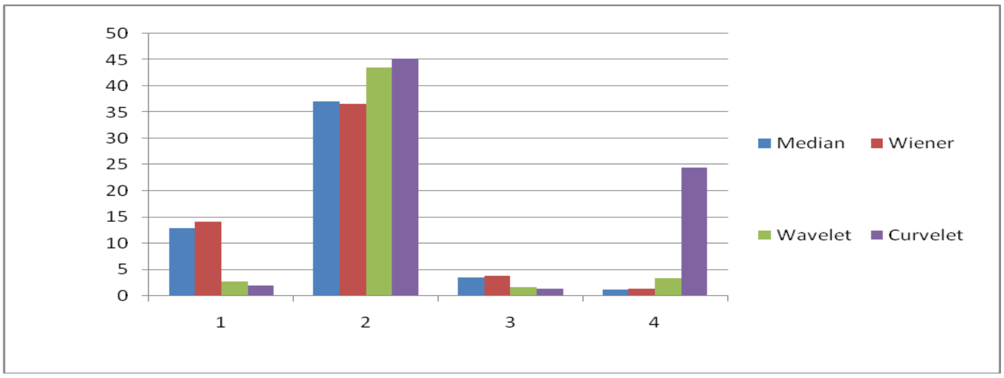


Image C



1	Technique	MSE	PSNR	RMSE	TIME
2					
3	Median	12.87	37.03	3.58	1.2
4	Wiener	14.23	36.6	3.78	1.37
5	Wavelet	2.84	43.6	1.69	3.38
6	Curvelet	1.95	45.24	1.4	24.46



VII. Conclusion

The main objective of this study was to investigate and evaluate the accurate results for the MRI images with respect to frequency and time. Previously, the methods were used for the analysis were like discrete: FFT, DFT and wavelets etc. The noise and the blurring of the images were removed but the significant results were not got. To get the significant results, the combination of both discrete and wavelets: Curvelets method is used so as to achieve the accurate results with respect to frequency and time which gave the higher accuracy results in minimum time. The images and their results show the differences between the results of older methods used as Wavelets etc. This technique has been applied on different images of different dimensions. The results are much better and significant using Curvelets Transform method.

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