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Abnormality Identification from MRI Images Using Curvelets Transform

Jasmeen
CSE, Asra Institute of Engg and Technology
Punjab Technical University, Jalandhar, India

Er. Parvinder Singh
Asst. Prof. CSE, Asra Institute of Engg
and Technology PTU, Jalandhar, India

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.

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

I. INTRODUCTION

A. 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.

B. 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.

Fundamental Steps in Digital Image Processing

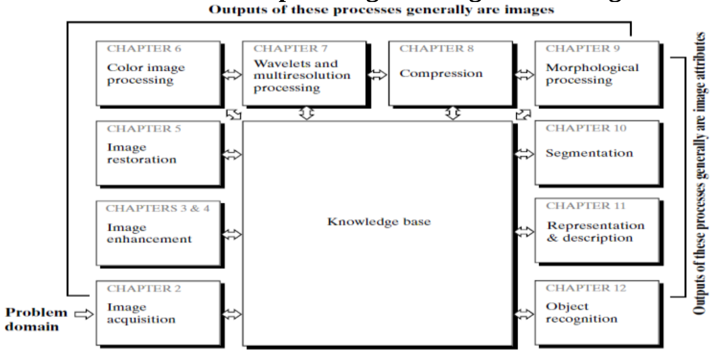


Figure 1

C. 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

Region Segmentation

• 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.

Edge Segmentation

• Find all pixels on region boundaries.

– apply Gaussian smoothing

– apply edge detection

-remove false edges (e.g., noise)

– Thin the edge -boundary is 1 pixel wide

– Fill the gaps -recover missing edges

– Put boundary pixels in order -all pixels in a list

Ideally closed boundarie

Edge segmentation of a Dog Heart:

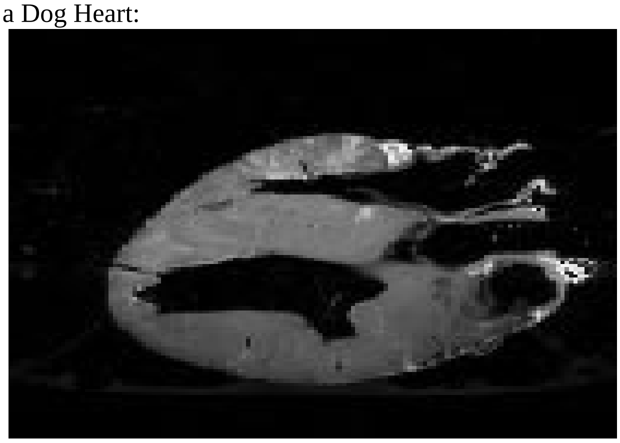


Fig2. Original Image

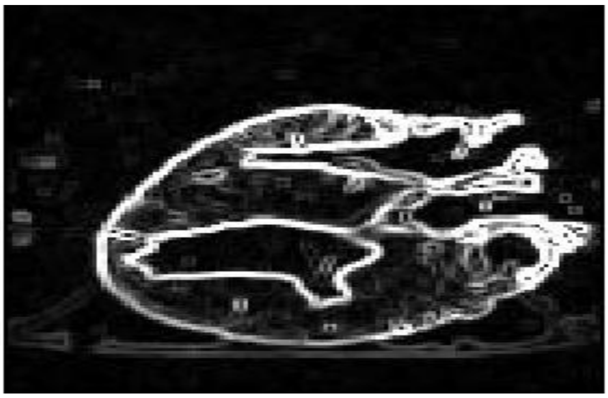


Fig3. Edge Detection Image

D. 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.

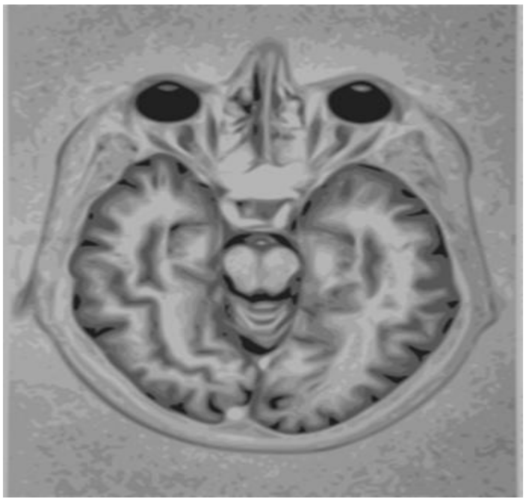


Fig4. Original Image

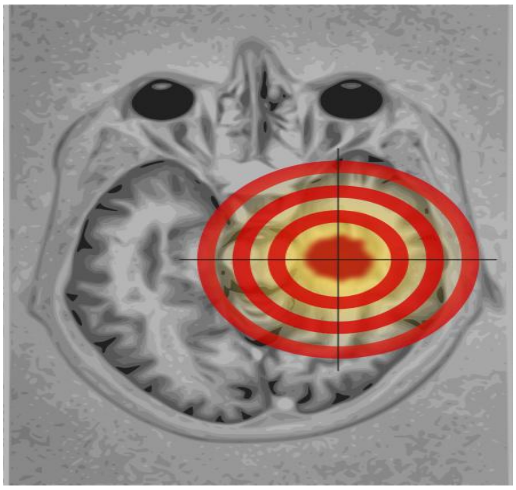
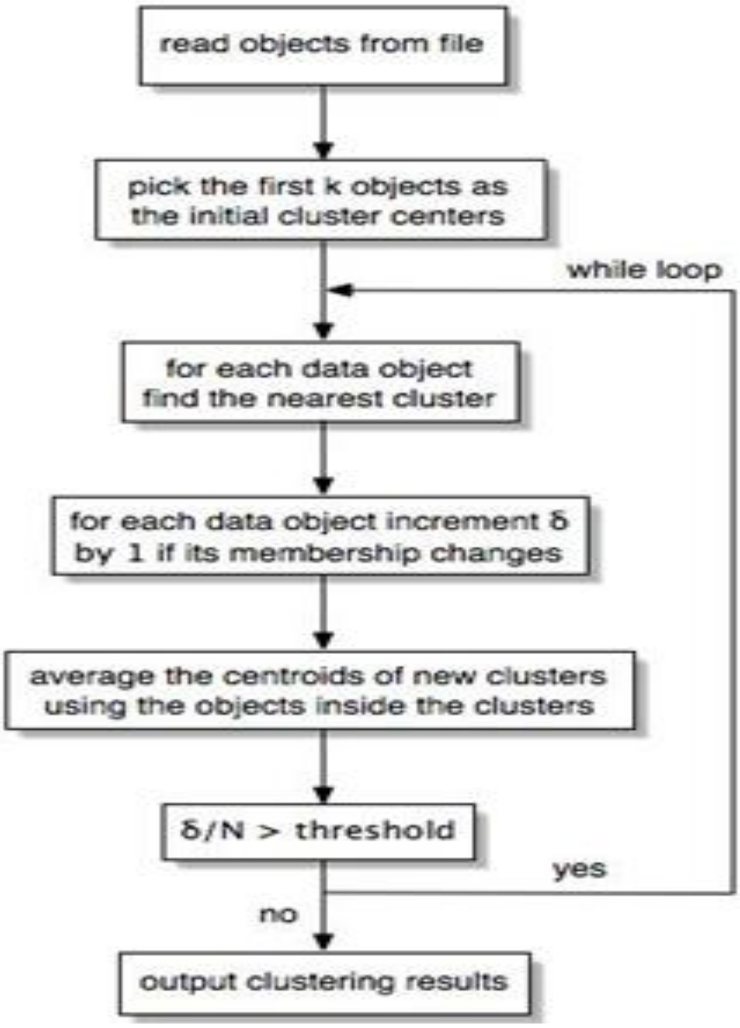


Fig5. Abnormality Identified Image

K MEANS ALGORITHM

K-means clustering is a method of vector quantization originally from signal processing. That is popular for cluster analysis in data mining. *K-means* clustering aims to partition *n* observations into *k* clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster. The K-Means algorithm is an algorithm to cluster n objects based on attributes into k partitions, k < n. It is similar to the expectation-maximization algorithm for mixtures of Gaussians in that they both attempt to find the centers of natural clusters in the data. It assumes that the object attributes form a vector space. Lloyd's algorithm and K-means are often used synonymously, but in reality, Lloyd's algorithm is a heuristic for solving the K-Means problem, as with certain combinations of starting points and centroids, Lloyd's algorithm can, in fact, converge to the wrong answer (i.e., a different and optimal answer to the minimization function above exists). K-Means algorithms have been designed that make use of core sets: small subsets of the original data.

In terms of performance, the algorithm is not guaranteed to return a global optimum. The quality of the final solution depends largely on the initial set of clusters, and may, in practice, be much poorer than the global optimum. Since the algorithm is extremely fast, a common method is to run the algorithm several times and return the best clustering found. A drawback of the K-Means algorithm is that the number of clusters k is an input parameter. An inappropriate choice of k may yield poor results. The algorithm also assumes that the variance is an appropriate measure of cluster scatter.



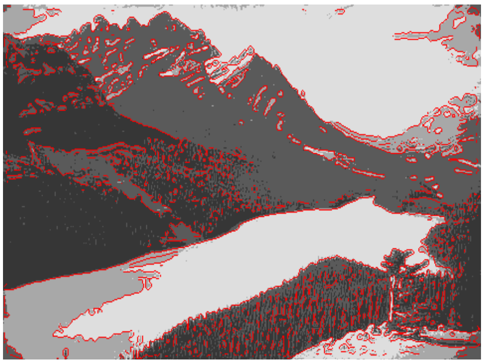
EM Algorithm

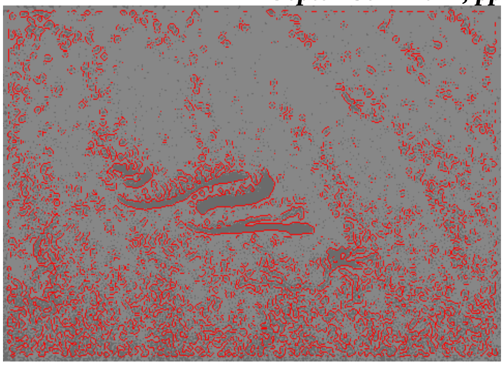
Expectation Maximization (EM) is one of the most common algorithms used for density estimation of data points in an unsupervised setting. The algorithm relies on finding the maximum likelihood estimates of parameters when the data model depends on certain latent variables. In EM, alternating steps of Expectation (E) and Maximization (M) are performed iteratively till the results converge. The E step computes an expectation of the likelihood by including the latent variables as if they were observed, and a maximisation step, which computes the maximum likelihood estimates of the parameters by maximizing the expected likelihood found on the last E step. The parameters found on the M step are then used to begin another E step, and the process is repeated until convergence.

The Grouping Algorithm

The eigenvector corresponding to the second smallest eigenvalue is the real- valued solution that optimally sub-partitions the entire graph; the third smallest value is a solution that optimally partitions the first part into two etc.

ORIGINAL IMAGE





K-MEANS IMAGE

The image has been segmented using the K-means algorithm. The clustering can be improved by assuming that neighboring pixels have a high probability of falling into the same cluster. In image segmentation application, the observations are based on the pixels in the image plane. Therefore, after K-means segmentation, the image is segmented into K non-continuous regions. The K-means segmentation algorithm is as follows:

Step 1: Select a value for K.
Step 2: Apply the K-means Algorithm.
Step 3: Apply the Connected Components Algorithm.
Step 4: Merge any components of size less than a given threshold to an adjacent component.
Step 5: Segmentation of the object and the background.

E. 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.

a) Wavelets to Curvelets

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.

II. PROPOSED METHOD

A. 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 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.

The Curvelets Transform includes four stages:

Sub-band decomposition
- Smooth partitioning
- Renormalization
- Ridgelet analysis

III. CONCLUSION

The main objective of this study is to investigate and evaluate the accurate results for the MRI images with respect to frequency and time. Latest issue in the field of bio-electronic is to acquire good quality image but due to electrical hazards and the motion produced by the product or person itself degrades the quality of image. Previously, the methods were used for the analysis were like discrete: FFT, DFT and wavelets etc. The noise and the blurring of the image 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.

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