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An Algorithm for detecting Brain Abscess in MRI Images

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ABSTRACT

In this paper, we present an algorithm for detection of brain abscess in MRI images. The proposed method uses multiresolution approaches namely Curvelet and Ridgelet transforms. Detection takes place in two ways with Curvelet transform detecting curves and Ridgelet transform detecting lines respectively in the image using their higher frequency coefficients. Image fusion of output of two approaches integrates the details thereby increasing the efficiency of abscess detection. Energy and pixel count are used for comparison. Correlation between curvelet and Ridgelet is found. The proposed algorithm produces appreciative results.

Keywords: Curvelet transform, Ridgelet transform, Wavelet Image fusion Energy, Correlation

1. INTRODUCTION

In abscess, the severity of soft tissue infection varies from healthy carrier to tumors cells. The conventional diagnostic method for patients depends mainly on needle biopsy of the tissue. It is an invasive method and results can be biased due to sampling error in the biopsy specimen. Multi resolution analysis finds a solution. Wavelet function operates on image linearly dealing with point singularities. Poor orientation selectivity of Wavelet leads in capturing limited directional information. Images are rarely a linear structure[2].

Ridgelet Transform is effective in detecting lines, that form a part of the images [4] .All singularities Along lines are translated into point singularities by Radon transform, on which the wavelet transform can provide a sparse representation [5] Curvelet transform is relatively new multiresolution analysis technique providing optimal sparse representation of objects. Curvelet Transform detects curves that forms a large portion of the medical images [6].Image Fusion is a process of combining the relevant information from images into a single image to give the resultant fused Image that will be more informative than any of the input images.[7]

2. RIDGELET TRANSFORM

Ridgelet transform has generated a lot of interest providing superior performance over the wavelet transform. Finite Ridgelet transform (FRIT) is computed in two steps by computing Finite Radon transform (FRAT) followed by discrete wavelet transform (DWT).FRAT is computed in two steps: a calculation of 2D Fast Fourier Transform (FFT) for the image and an application of a 1D inverse Fast Fourier transform (IFFT) on each of the 32 radial directions of the radon projection. [5]

Let Zp = {0,1, …. P} where p is a prime number. FRAT of a real function f on the finite grid Z_P^2 is defined in

$$r_k[l] = \frac{1}{\sqrt{p}} \sum_{(i,j)\in L(k,l)} f(i,j) \tag{2.1}$$

Here L k, l denotes the set of points that make up a lineon the lattice Z_{P2}

$$L_{k,l} = \{(i,j): J = ki + l(mod\ p)\ ; i \in Z_p \tag{2.2}$$

Lower level coefficients are set to zero and reconstruct the image to carry out the edge detection by using the Ridgelet coefficients.

3. CURVELET TRANSFORM

Two fast discrete curvelet transforms (FDCT) exist and they are Curvelets via USFFT, and Curvelets via wrapping. Both FDCTs run in O(n2 log n).It is efficient for those images that display curve punctuated smoothness. for a Cartesian array f[m,n] , where $0 \le n \le N$ and $0 \le m \le M$ and M,N are dimensions of the array collection. Curvelet Coefficients $C^D(j,l,k_1,k_2)$ indexed by a scale j, an orientation l and spatial location parameters k_1 and k_2 is given by

$$C^D(j,l,k_1,k_2) = \sum_{0 \le n \le N}^{0 \le m \le M} f[m,n]\varphi^D_{(j,l,k_1,k_2)}[m,n] \qquad (3.1)$$

j,l,k_1,k_2 [m, n] is the curvelet waveform. This is a part of Riesz representation. Curvelet transform = IFFT [FFT (Curvelet) x FFT (Image)], and the product from the multiplication is a wedge. The following steps follow for fast discrete curvelet transform via frequency wrapping:

1. Apply the 2D fast Fourier transform (FFT) and obtain Fourier samples $f\hat{}$ [n_1, n_2], where $-n/2 \le n_1$, $n_2 < n/2$.

2. For each scale j and angle l obtain Ũj, ℓ [n1, n2] f^ [n1, n2] by forming the product with Cartesian window

3. Wrap this product around the origin f`j,ℓ[n1, n2]=W(Ũj,ℓf^)[n1,n2] where the range for n1 and n2 is now $0 \le n1 < L1,j$ and $0 \le n2 < L2,j$ and θ in the range (- $\pi/4$, $\pi/4$).

4. Apply the inverse 2D FFT to each and hence collecting the discrete coefficients f`j,ℓ hence collecting the discrete coefficients CD(j, ℓ, k).[1]

The software package CurveLab is used in implementing the curvelet transform fonts only for special purposes, such as distinguishing source code text. Right margins should be justified, not ragged.

4. WAVELET IMAGE FUSION

Image fusion of multiple images combines the details from the input images creating a more informative image. Many techniques of image fusion exist. Wavelet transform is a multiresolution image decomposition tool representing the multiscale. It decomposes the image into approximation and detail components thereby separating the image from the spatial domain to frequency domain. The decomposed data of input into various bands based on frequency are then combined and reconstructed to obtain the fused image.

5. PROPOSED METHODOLOGY

Figure 1 shows the block diagram of our methodology. Our methodology uses the detected output from Ridgelet transform and Curvelet transform and combines them using wavelet based image fusion hence improving the details in the image.

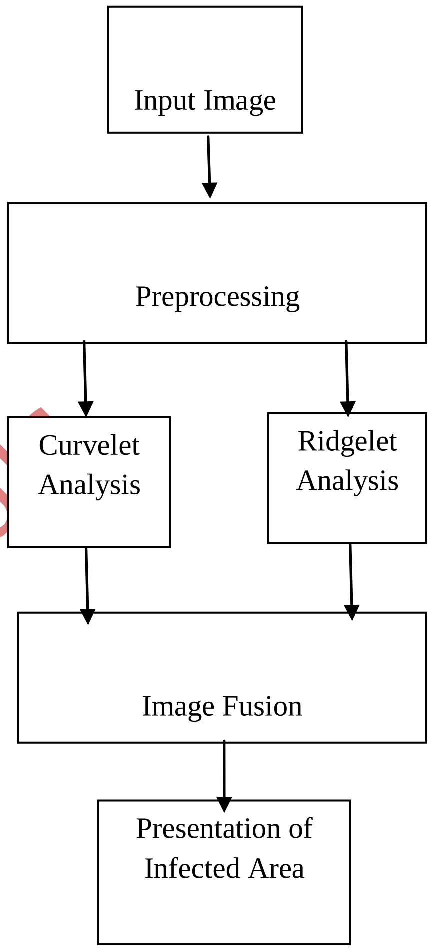

Figure 1 Our methodology for Brain Abscess Detection

It can be summarized as follows:
Step 1: Convert the input image into gray scale.
Step 2: Removal of noise using median filter and Curvelet based denoising.
Step 3: Curvelet and Ridgelet based detection by selecting high frequency component coefficients in their domain.
Step 4: 2D Wavelet Image fusion.
Step 5: Thresholding the image for binary representation.

6. RESULTS

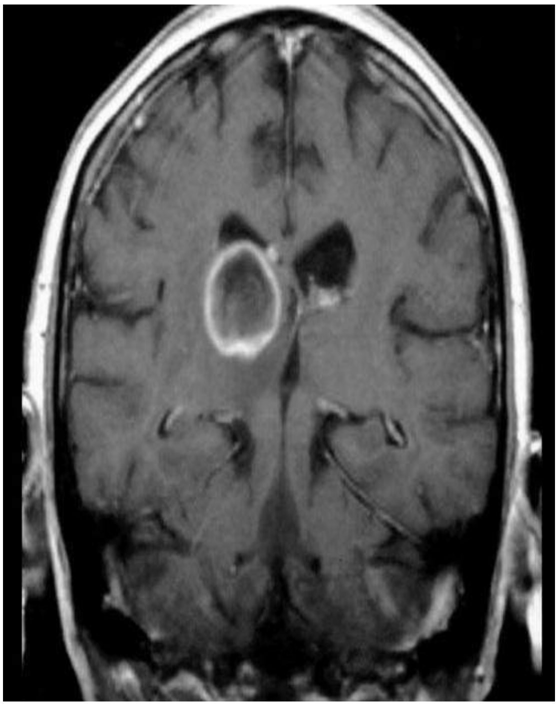

Figure 2 Input Image

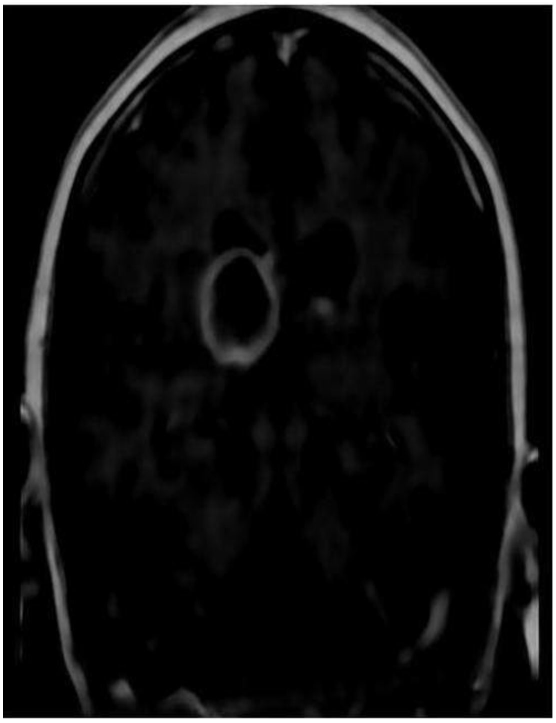

Figure 4 Detection using Ridgelet Transform

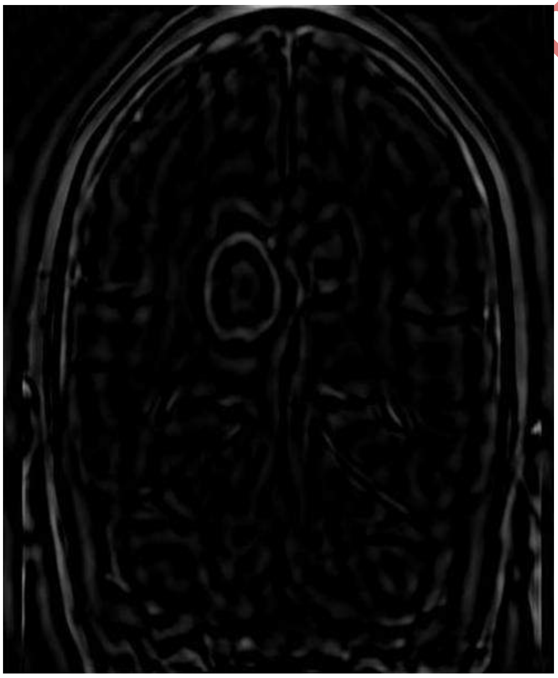

Figure 3 Detection using Curvelet Transform

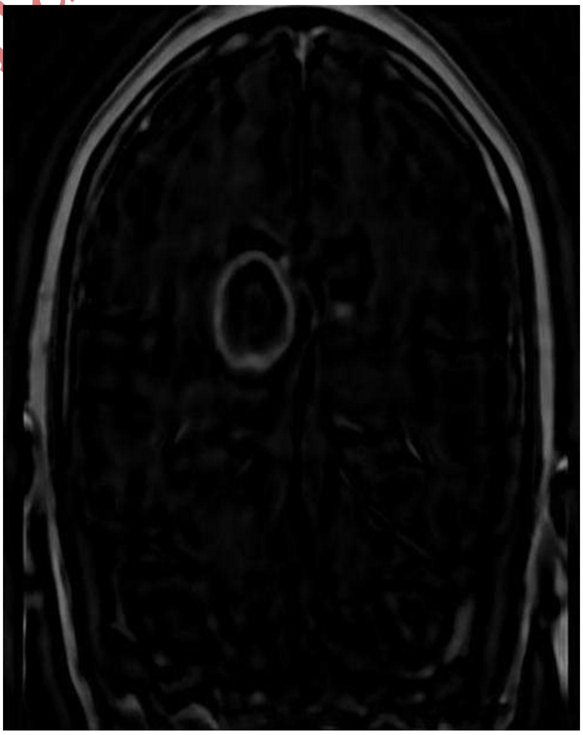

Figure 5 Detection using our approach

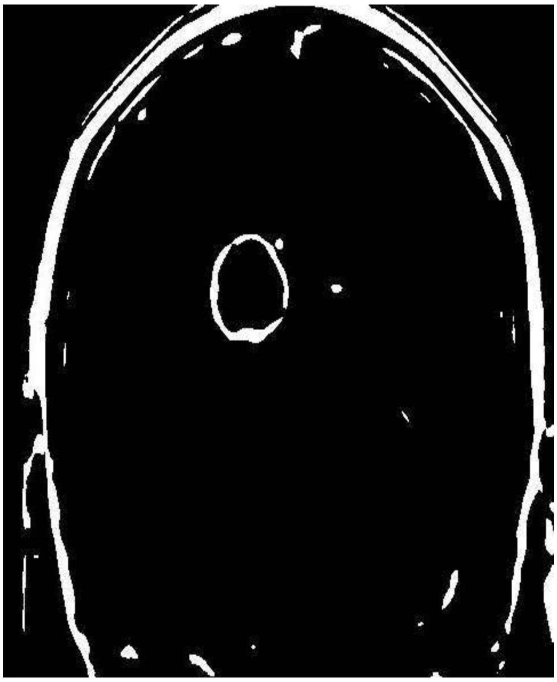

Figure 6 Detected output in binary

Table 1. Table showing output pixel count based comparison of our method with Curvelet and Ridgelet for various images

Sl.no	Our Method	Curvelet	Ridgelet
1	16947	21952	16397
2	14747	15546	15694
3	2718	1050	4145
4	47804	34078	53664
5	54908	38226	62825
6	108969	55433	141525
7	24997	20052	24304

Table 2. Table showing energy of our method with Curvelet and Ridgelet for various images

Sl.no	Our Method	Curvelet	Ridgelet
1	1.0e+010 *4.8310	1.0e+010 * 4.6142	1.0e+010 *4.7358
2	1.0e+010 *5.2606	1.0e+010 *5.3713	1.0e+010 *4.8505
3	1.0e+009 *6.2962	1.0e+009 *5.8518	1.0e+009 *5.7766
4	1.0e+010 *3.3875	1.0e+010 * 4.2272	1.0e+010 * 3.1223
5	1.0e+011 *4.7887	1.0e+011 * 5.1431	1.0e+011 * 4.4901
6	1.0e+011 * 5.2221	1.0e+011 *5.6652	1.0e+011 *4.3425
7	1.0e+010 * 5.0331	1.0e+010 * 5.0331	1.0e+010 * 5.4139

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