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Identifiaction Of Alzheimer's Disease Based On The Brain Iron Analysis Using Modified Quantitative Susceptibility Mapping (Mqsm)

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ABSTRACT*: Iron deposition takes place in certain region of the brain due to the neurodegenerative disorder. The magnetic susceptibility of the tissue is altered by the deposition of the iron, which alter the magnetic resonance signal phase and allows estimation of differences in susceptibility using quantitative susceptibility mapping (QSM).An inversion of a perturbation model (or) QSIP method is proposed in this paper. This model relates phase to susceptibility using a kernel that is calculated in a spatial domain which differs from the earlier Fourier based techniques. The B0 homogeneity is estimated using a tissue/air susceptibility atlas. The postmortem iron estimates are compared with the QSIP estimates of the young and the elderly samples. It is then mapped to the Field Dependent Relaxation Rate Increase (FDRI) and L1-QSM results. Thus QSIP method showed significant improvements over FDRI and L1-QSM in which it has reduced variance in susceptibility estimates. The significant differences were also detected in the striatal and brain stem nuclei, which is consistent with age dependent iron accumulation in these regions.*

Keywords*: Susceptibility, QSIP, Brain iron*

1.INTRODUCTION

Alzheimer's disease(AD) is a mental deterioration that occurs in middle (or) old age due to premature senility. This leads to memory loss. The vigorous form of dementia will lead to AD. The common symptoms of this disease include difficulty in speech, confusion, language and behavioral deficiency, memory manifestation etc.

This disease was discovered by Alois Alzheimer in 1906.There are 3 stages in AD. it includes (i)early stage, it is a mild stage in which the disease lasts 2 to 4 years and the symptoms of it includes decline in the patient's cognitive ability.(ii)moderate stage, In which the disease lasts up to 10 years and the symptoms of it include increased difficulty with memory of daily activities(iii)severe stage, which is the final stage and the symptoms of it includes decline of the cognitive capacity and physical ability.

Neurofibrillary tangles and senile plaques are the two definite deformities in the brain. These changes occur usually when the brain is affected by AD. the death rate of AD has become significantly high in recent years. The primary cause of the death is not only due to the changes that had been caused by AD but also due to the trouble in swallowing and immobility. Thus this results in the death of the patients because of the malnutrition and high risk of pneumonia.

The risk factors of this disease include age, genetics and education. the proper diagnosis method for alzheimer's disease is still unknown and hence early detection is necessary in order to prevent and provide essential treatments to the patients. This paper aims at improving the diagnosis capability in MRI scans by applying necessary filters and algorithms. The brain appears as fig.1.1 in the MRI scan. The MRI

scans are effective in the detection of the atrophy of the brain hence it is used for the analysis in this paper.

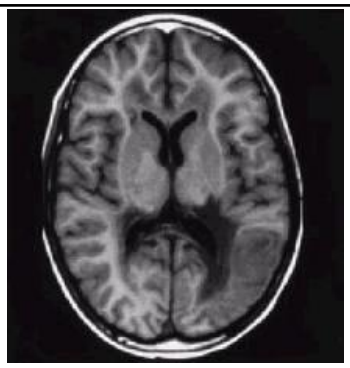


Figure 1.1. Brain scan in MRI

2. RELATED WORK

In the existing methods, Jonathan H. Morra[1] has proposed a method in which 4 methods for segmentation is compared in which the accuracy is less. Then Robi Polikar [2] described an ensemble of classifiers based data fusion approach to combine information from two or more sources for the early diagnosis of Alzheimer's disease and this method has a drawback that data from different sources has to be combined which is time consuming.Hence Francisco J. Fraga[3] an EEG-based used a biomarker for automatic diagnosis of AD based on extending "percentage modulation energy" (PME) metric. In this manual testing of EEG epochs is necessary. Then Deepti Pachauri [4] proposed a topology-based kernel construction algorithm for measurement of the cortical surface thickness. The accuracy achieved by this method is about 75%. Later Clare B. Poynton [5] calculated the neurodegenerative disorder by comparing results of normal humans and diseased human. The susceptibility difference between the brain tissue and the iron rich tissue gives the extent of the disease affected. An important limitation of the validation presented herein is the lack of direct comparisons to other QSM results using a single phantom data set.

Hence the main aim of this paper is to overcome all these limitations and to achieve higher accuracy than the previous existing methods.

3. TECHNICAL APPROACH

The changes in the brain due to the AD should be identified in the early stage so that necessary preventive measures can be taken and the cause for the disease is analyzed. The analysis is done using the MRI scan report of the disease affected patients and then the comparison of the brain images are done with the normal people's brain in order to differentiate the differences that are caused due to AD.

This paper aims at analyzing the brain iron, which normally increases among aged people when compared to the adult. the susceptibility mapping by QSIP helps in the determination of the affected areas by considerably decreasing th variance value of the affected regions where iron deposition occurs.

3.1 Workflow

The figure 3.1 describes the overall process of the paper from which the required features are extracted by applying necessary filters

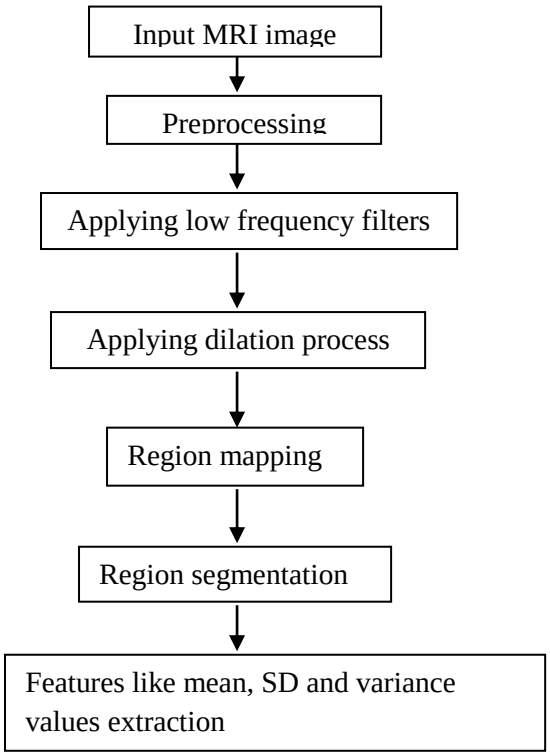


Figure 3.1 Block diagram of the system

3.2 . Anisotropic diffusion

This method is also known as Perona-malik diffusion, this process reduces the noise in the image, without eliminating the notable parts of the image contents like edges, lines etc.

The basic equation of anisotropic diffusion is

$$\frac{\partial I(a,b,t)}{\partial t} = \text{div}[p(\|\nabla I(a,b,t)\|)\nabla I(a,b,t)] \quad (4.1)$$

where t is the time parameter,

$I(a,b,t)$ is the original image,

$\nabla I(a,b,t)$ is the gradient of the version of the image at time t .

And p(.) is the so-called conductance function. This function is chosen to satisfy $\lim_{x\to\infty} p(x) = 1$, so that the diffusion is maximal within uniform regions, and so that the diffusion is $\lim_{a\to\infty} p(x) = 0$ stopped across edges.

4. RESULTS AND DISCUSSION

The database for the diagnosis of the disease is collected from the hospitals. It is processed using MATLAB 15a software. The input of the image can be of MRI, CT scan images. Here MRI scan images are used for the further processing. The input and resized image after preprocessing is given in the fig 4.1.

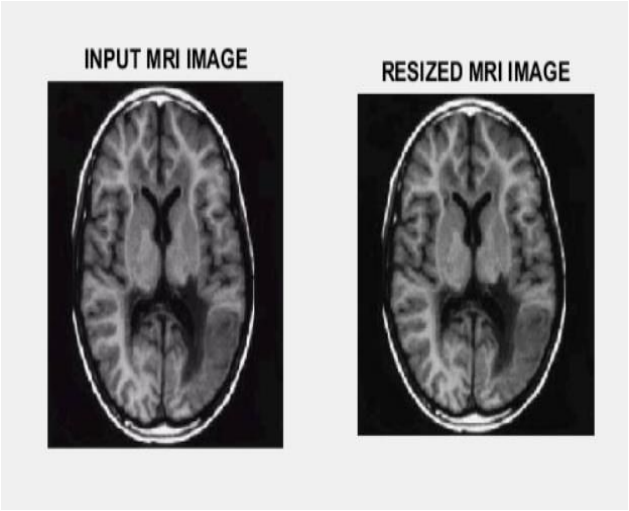
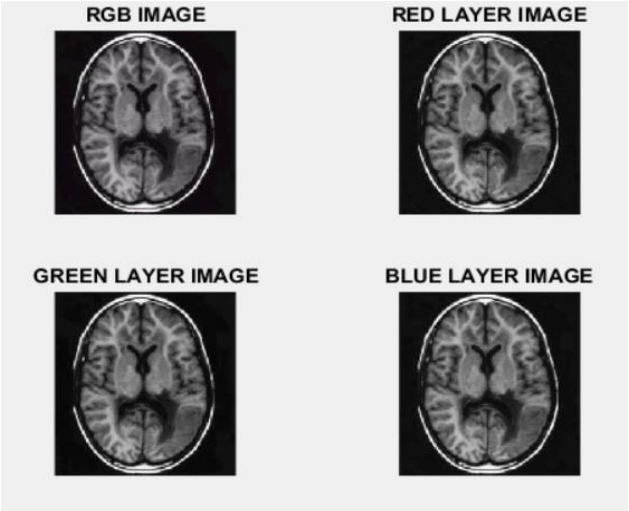
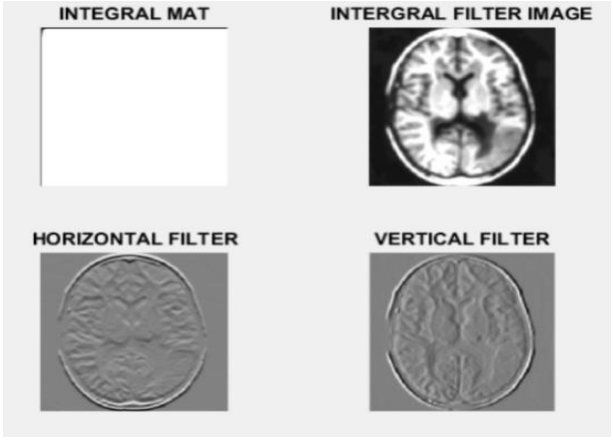


Figure 4.1 Input MRI scan image

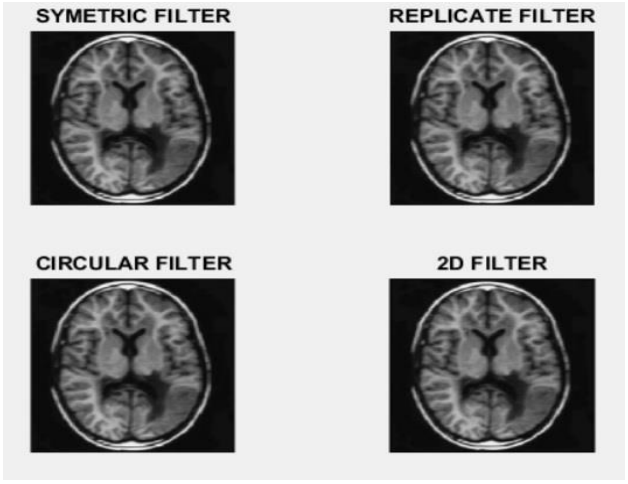
In this the input image undergoes double precession in order to increase its size.



(a)



(b)



(c)

Figure 4.2 Filter outputs (a) Image reconstruction process (b) Low frequency filter outputs(c) Applying symmetric and circular filters

Then the dimension of the image is calculated. The image then undergoes the gray conversion and the red layer, green layer and the blue layer is separated from the image as in the fig 4.2 (a) and its kernel values are calculated. Later image reconstruction process is carried out. Filtering is done in order to remove the noise from the MRI scan image. Low frequency filters like horizontal and vertical filters are used in order to remove the pixel noise from the image and the output of the filtered image is shown in the fig 4.2(b).

Then the image undergoes enhancement process by applying the symmetric filter, replicate filter, circular filter and the 2D filtering process. By this the noise from the image is completely

removed and the output at each filtering process is represented in the fig 4.2(c). Next the image undergoes mapping and the segmentation process.

The final filtered output after applying various filters will as in the fig 4.5.

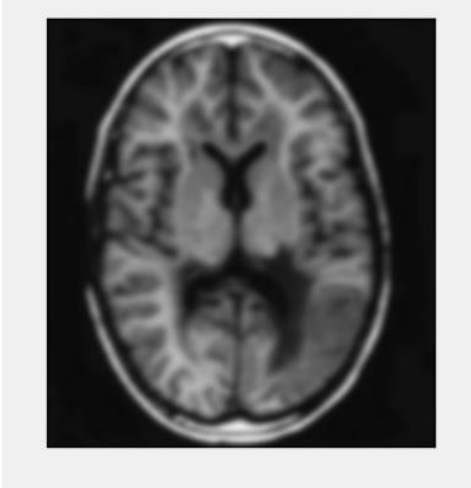


Figure 4.5 Final filtered output

Prewitt algorithm is applied for the susceptibility estimation. Then dilation process takes place for the mapping of the image and image fusing. Then the AD diseased pixel are extracted as shown in the fig 4.6.

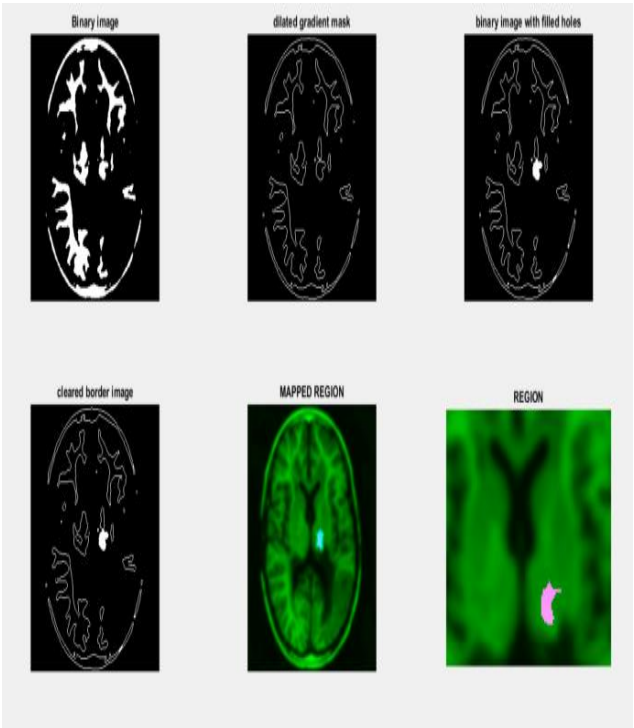


Figure 4.6 Applying dilation process

Then the final step involves calculating the pixel that are extracted from this the features like standard deviation, variance and mean values are extracted. The final output appears as in the fig 4.7 and the extracted values are represented in the table 4.1.

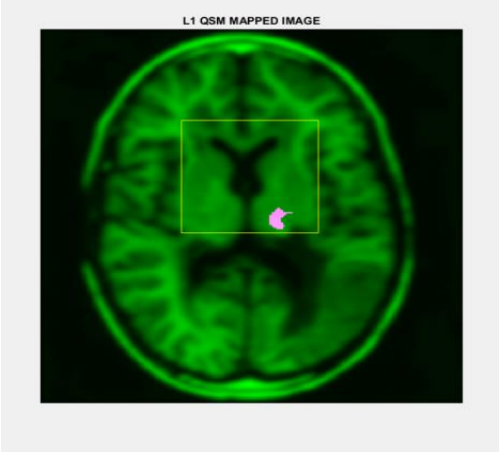


Figure 4.7 QSM mapped image

Thus this is the final output image after QSM has been mapped and the features are extracted.

Table 4.1 Feature extraction values

FEATURE	**VALUES OBTAINED**
Standard deviation	**5.603367**
Mean	**3.56770**
Variance	**0.093**

Thus the values obtained are more accurate and efficient than the previous existing methods

5. CONCLUSION AND FUTURE WORK

In this project, a quantitative susceptibility mapping algorithm that inverts a spatial formulation of the forward model and incorporates a tissue susceptibility atlas to quantify susceptibility is implemented. QSM algorithm provides accurate susceptibility maps from data acquired at single field strength without the need for patient re-positioning or strong agreement with observed magnitude data. The reduced variance in susceptibility estimates may also provide increased statistical power for detecting group differences. The features like Mean, Standard Deviation and Variance are calculated. The future work in Alzheimer disease detection and analysis is developing a friendly user application Using GUI in MATLAB.

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