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A Matrix Symmetry Based Method for Brain Abnormality Detection

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ABSTRACT

Medical imaging is becoming a very important area of research in today's world and contributes a lot in medical informatics. It is mostly based on Magnetic Resonance Imagery (MRI). One integral part of such kind of research is indexing of patient databases based on size, location and other characteristics of diseases such as brain tumors and edemas. This requires segmenting tumors and edemas within source images. Automated brain tumor or edema segmentation is remaining a challenging, computationally intensive task. The proposed approach is based on an unsupervised change detection method that searches for the dissimilar region between the right and left halves of a brain in an axial view MR slice. It is also considered that the noise which may creep in due to some human and technical error during MR test. This noise may lead to decrease in efficiency of brain abnormality detection system.

Keywords: Magnetic Resonance Imagery (MRI), Brain Tumor, Edemas, Brain Abnormality, Noise, Segmentation, Chan-Vase Algorithm.

1. INTRODUCTION

MR images are very useful for the physicians and radiologists for diagnosis of various critical diseases. Specifically, in detection of different types of brain abnormality it helps a lot. They may gain information on effectiveness of various treatments on previous patients with similar abnormality. As these archived magnetic resonance (MR) image databases [1] may contain lots of studies, it is important to index their contents effectively. The current practice of indexing and retrieving these images is typically based on only patient names, identifiers, keywords and manual annotations. Unfortunately, this technique is very inefficient. Hence the need for automatic brain abnormality detection system arises. Today, many algorithms for detecting abnormality in brain exists but they are either computationally intensive or require some kinds of human interference. This leads to the use of an efficient segmentation technique [2] based on symmetry of the human brain as an alternative to the highly complex algorithm. The symmetry technique automatically detects abnormality in the input MR image by exploiting symmetry property of human brain.

2. RELATED WORKS

There are several works available in literature on automatic brain abnormality detection. Some of the influential works relevant to this work have been referred here.

A brain tumor detection technique by using symmetry analysis is discussed in [3]. Similarly, a SVM based method is discussed in [4]. K Somojundran et al. [5] proposed a pixel to pixel approach for detecting brain abnormality by finding the difference in intensity of pixels. In his technique, abnormality location is detected by finding regional maxima. M. Cap et al. [6] proposed technique to detect brain abnormality

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using Chan-Vese algorithm. There are three steps involved in it, namely data acquisition, image registration and segmentation based on Chan-Vese algorithm. But, it has a disadvantage, that, it needs image registration and Chan-Vese algorithm has high time complexity. A similar technique is found in [7]. Pankaj Sapra et al. [8] proposed abnormality detection technique using an artificial neural network and used modified canny edge detection technique to detect the edge of skull. The motive to detect edge of skull in MR images is to significantly reduce the amount of data in image. A comparative analysis on fuzzy c_Means algorithm, k-Means clustering [9] and a bounding box method for segmentation of abnormal region from MR brain scan is found in [19].

3. PROBLEM ANALYSIS

In this work, a brain abnormality detection system is proposed, which is completely automatic, does not require any kind of human interference and is computationally less intensive. Though there are lots of techniques found for the same, some of the common problems in majority of the approaches are:

High Time Complexity. This is found mostly in region growing based Abnormality detection techniques. These techniques cannot be implemented in real time.

Image Registration. It is an important step towers differentiation of healthy and unhealthy brain.

Training. Requirement of special training leads to additional processing time.

Intensity Standardization. Followed by many techniques in MR image.

The results of existing techniques revels that there are few drawbacks of the same. Such as:

Noise. Noise in an image is not considered in majority of the techniques.

Prior Knowledge. Requirement of prior knowledge and user interaction leads to less automation.

Training. Special training is required for the classification techniques used by majority of the existing methods and leads to high time complexity.

4. PROPOSED WORKING METHODOLOGY

To overcome the disadvantages of already existing techniques using Artificial Neural Network, Chan-Vese algorithm, K-means clustering algorithm etc. an algorithm is proposed using symmetry technique. It is based on the fact, that, human brain is symmetric.

The proposed algorithm for detection of abnormality in MR scans of human brain is completely automatic, runs in a real time, and does not require any kind of special training which leads to the increase in complexity of algorithm. The symmetry technique exploits left right symmetry of the human brain to identify the abnormal region in MR scan.

4.1. Noise Removal

Median filter is used to reduce noise in an image. The best-known order statics filter is the median filter, which as its name implies replace the value of a pixel by the median of the intensity levels in the neighborhood of that pixel. In a median filter, a window slides along the image, and the median intensity value of the pixels within the window becomes the output intensity value of the pixel being processed. Median filter preserves edges in an image while reducing random noise. While acquiring MR images from the computer aided machines. Due to human error, noise may occur which may lead to problem in Abnormality detection so it is very necessary to remove all the noise from MR images before diagnosis.

To classify MR image as normal or abnormal symmetry method is used. Advantage of using this method is that, it has linear time complexity and does not require any kind of special training. The final output of

the system is an image showing only abnormal region in the MR image. The experiments performed demonstrated that the system can achieve preferable abnormality detection rate.

4.2. Proposed Algorithm

{input: MR image of patient}

{output: image showing abnormal region or display message “scan is normal”}

Step 1: Start.

Step 2: Read MR image.

Step 3: Noise Removal by median filter - medfilt2().

Step 4: Calculate Centroid of input image.

Step 5: Identify line of symmetry

Step 6: Split the image into two parts along line of symmetry.

Step 7: Compare the histogram of two image using

f = Sum ((histogram1-histogram2)) 2.

Step 8: if (f<threshold)

Display” The MR image analyzed is normal”

GO TO Step 12.

else

Display” The MR image analyzed has abnormality.

Step 9: Find entropy of the image on right and left side of line of Symmetry.

V=entropy (image1)

R=entropy (image2)

Step 10: Compare values of V and R

if (V>R)

Display “Abnormality is Left side”

else

Display “Abnormality is Right side”

Step 11: Display the image showing only the abnormal region in the brain using bw_boundaries().

Step 12: Stop.

5. RESULTS AND DISCUSSION

The proposed technique is implemented in MATLAB. The results obtained in various phases of development are discussed in this section.

During implementation input figures were considered with salt and pepper noise, poison noise [11] and combination of both. All kinds of noises under consideration were successfully removed. Figure 1 shows a MR scan corrupted by salt and pepper noises and the same MR scan after removal of noise from it. The figure 2 shows a MR scan corrupted by Poisson noise and the same MR scan after removal of Poisson noise

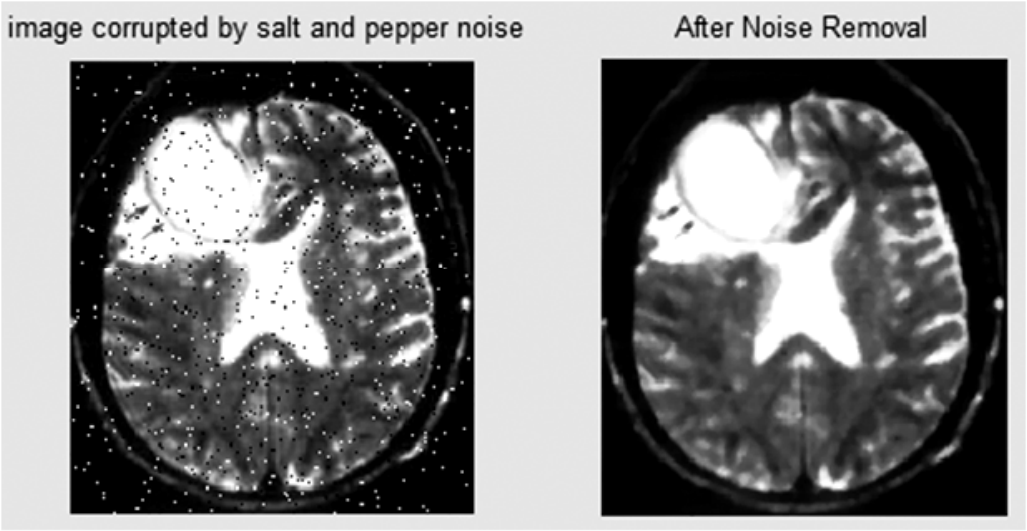


Figure 1: Removal of Salt and Pepper Noise

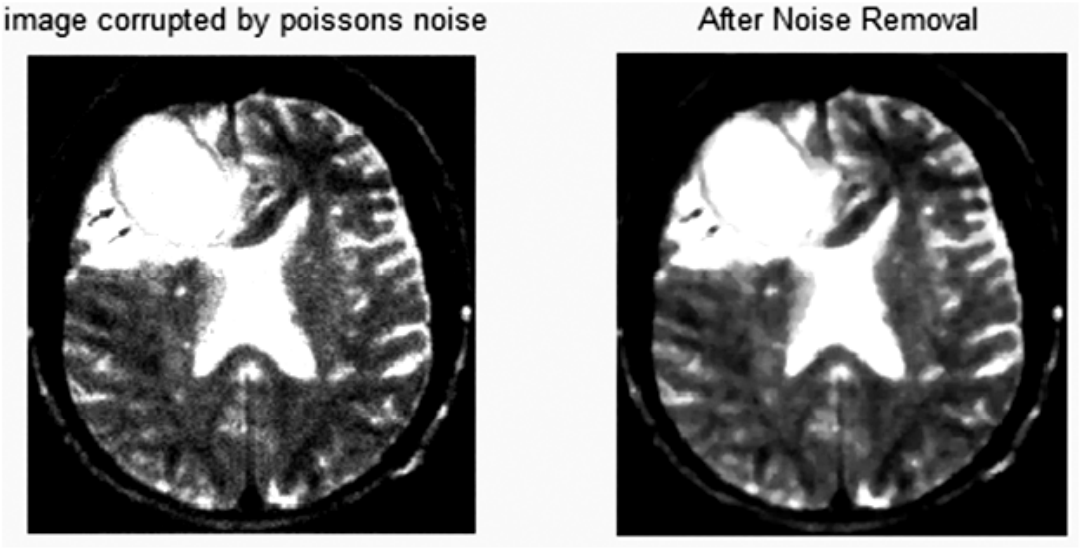


Figure 2: Removal of Poisson Noise

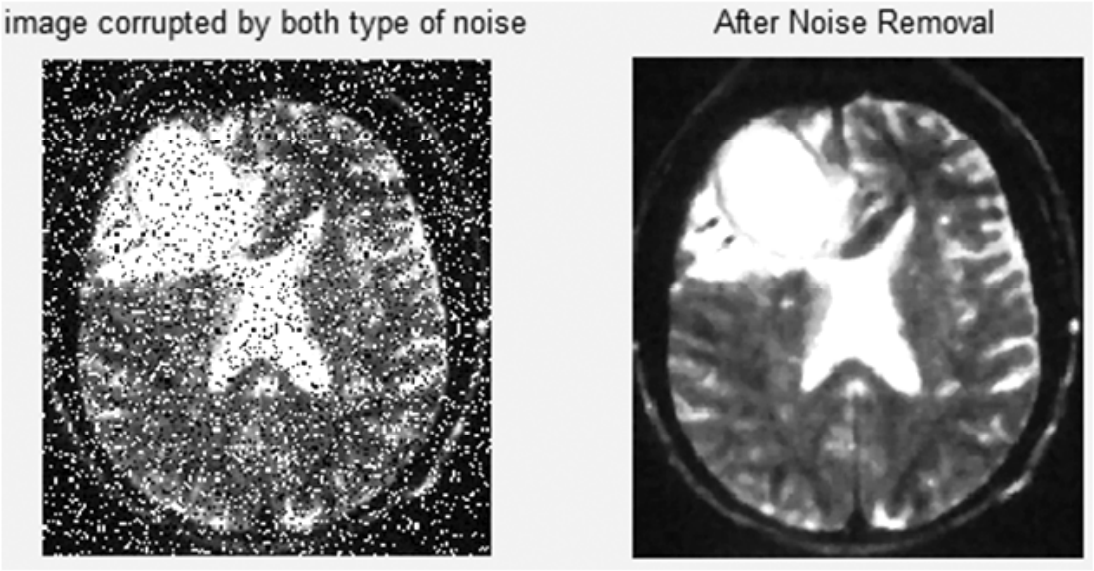
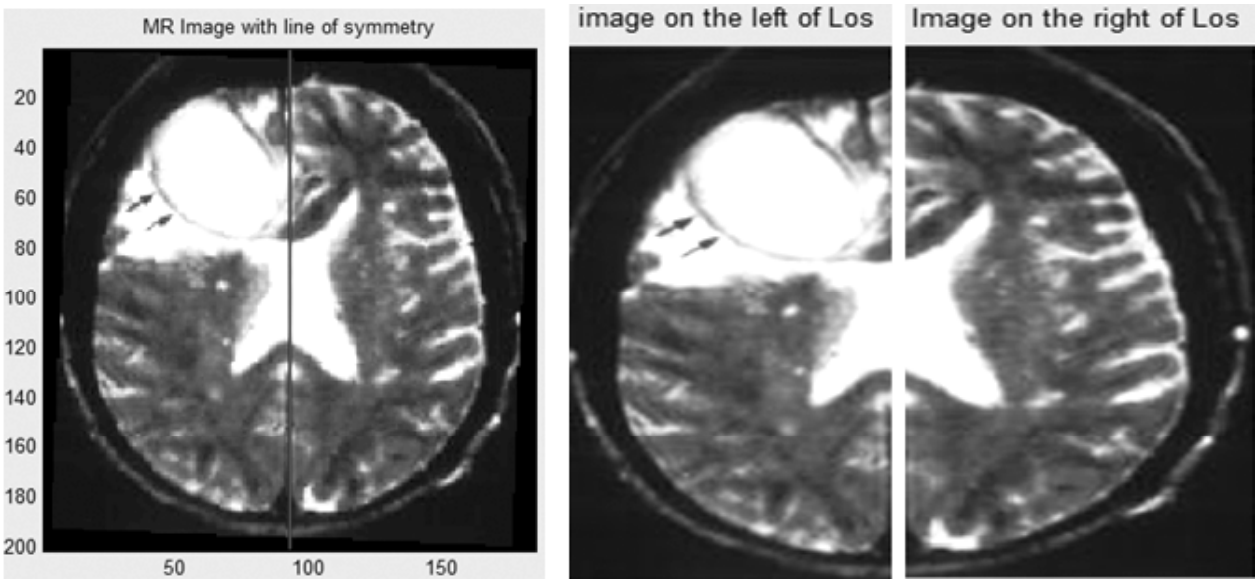


Figure 3: Removal of Poisson Noise and Salt and Pepper Noise

from it. The figure 3 shows a MR scan corrupted by both Poisson noise and salt and pepper and the same MR scan after removal of both the noise from it using median filter.

After pre-processing phase, vertical line of symmetry is found out. The next figure (fig. 4) shows the pre-processed MR scan with vertical line of symmetry dividing the MR scan into two equal halves.

In the next phase, histogram is generated for the segmented images. The figure below shows the Histogram plot for left and right side of input MR scan which is compared for detection of symmetry finally leading to detection of abnormality.



a) MR Image with Line of Symmetry **b) Image on Left Side of Line of Symmetry** **c) Image on Right Side of Line of Symmetry**

Figure 4: Vertical Line of Symmetry

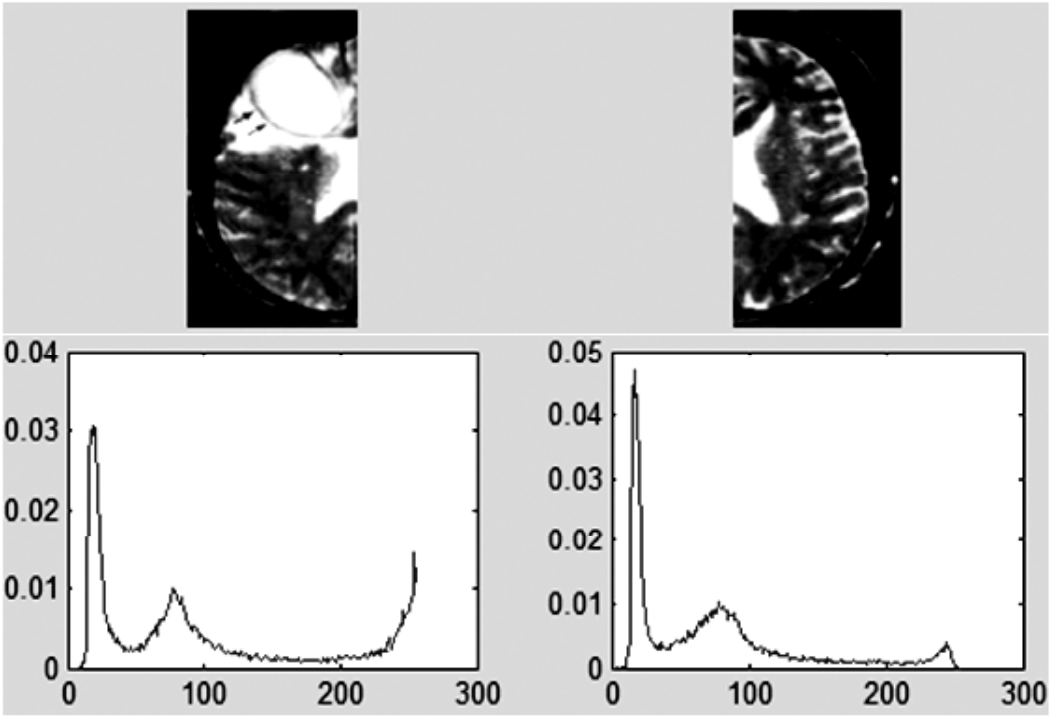


Figure 5: Histogram Plots of Abnormal MR Brain Scan

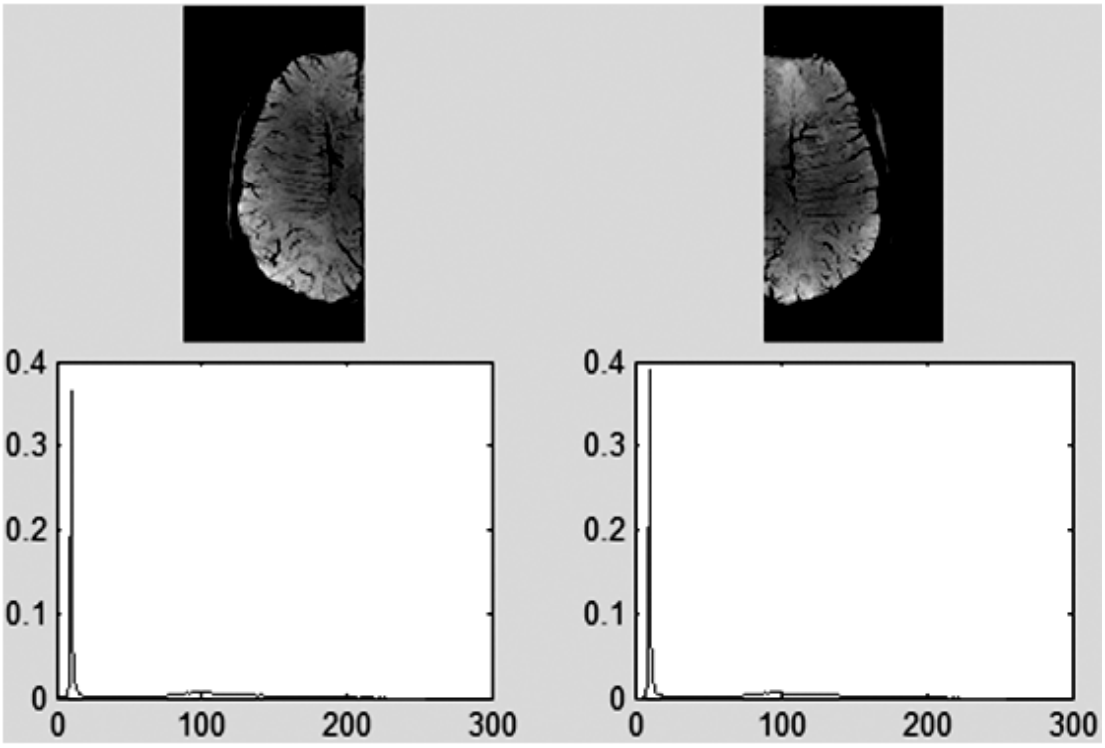


Figure 6: Histogram Plots of Normal MR brain scan

Finally, the image is processed again to find out the possible abnormal regions. The figure 7 shows the segmented abnormal region from the input MR scan.

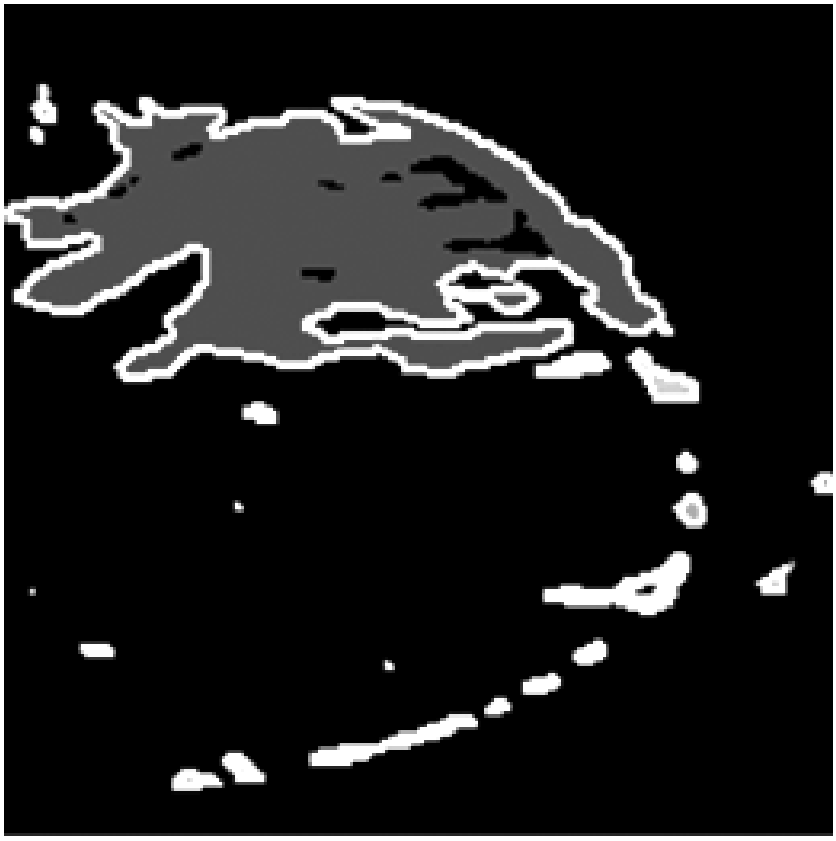


Figure 7: Abnormal Region in input MR Scan

7. CONCLUSION

Digital image processing is being widely used in clinical diagnosis presently. Used of image processing in biomedical field can reduced the workload of doctors and medical practitioner. Learning about the use of image processing in biomedical field is not an easy job and is a big achievement to start with. Symmetry approach to identify the abnormality in brain is one of the most efficient approaches in MR image analysis. Finally, being able to identify the abnormality in the brain along with its location and shape required lots of hard work and details study. To be able to create a system that can take MR scan of patients as input and then automatically generate an image is showing shape and size of abnormality in input MR scan if abnormality occurs. Otherwise, display a message that MR scan is normal is the biggest achievement and would definitely be appreciated by a person having good knowledge about the subject.

There are few drawbacks of the symmetry technique for detection of abnormality in a brain. The system fails in case of symmetrical abnormality across line of symmetry and that lies on line of symmetry. Again, the developed system may fail to detect the abnormality sometimes, if it is very small. The system supports only those MR scans that give the axial view of the patient's brain.

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