FRAMEWORK FOR DETECTION OF ABNORMALITIES IN BRAIN MAGNETIC RESONANCE IMAGES

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ABSTRACT: In brain MR Image analysis, the image segmentation majorly used for measuring and visualizing the brain anatomical structures, analyzing brain abnormalities, and surgical planning. The Brain MR Images are extensively used for medical diagnosis since it exhibits the inner section of the brain. The analogous research results expressed the enhancement in identification of abnormalities in Brain MR Image segmentation by merging diverse methods and techniques. However the specific results are not been projected and established in the similar researches. Hence, this work proposes framework for detection of anomalies in Brain MR Images using most conventional EMGM and Watershed Method with the proposed efficient amalgamation technique. The main focus of the proposed work is to enhance the accuracy of the detection of brain anomalies for Brain MR Image and the results are optimally merged and accomplished improved accuracy. The application is equipped with the bilateral filter to enhance the MR image edges for better segmentation and then the bilateral filter employed to the EMGM, Watershed and Proposed Method for identification of abnormalities in Brain MR Images. The comparative performance of the EMGM, Watershed and Proposed Method is also been demonstrated with the help of multiple BRATS T2-weighted Brain MR Image datasets.

KEYWORDS: Watershed Method, EMGM Method, Proposed Method, Bilateral Filter, T2-weighted Brain MR Image.

1. INTRODUCTION

With the massive development in the brain MR imaging technique have discovered the comprehensive possibilities of brain anatomy analysis based on T2-weighted Brain MR Images. The T2-weighted Brain MR Images presents the noninvasive broad visualization of internal anatomical understanding of the brain. In order to enhance the accuracy for identification of abnormalities in T2-weighted Brain MR Images, the imaging techniques have extended the quality of the Brain MR images. Hence the investigation of this complex and high quality T2-weighted Brain MR Images became the major tedious task for the technicians [Por14]. Furthermore, due to the human intervention the investigations are bound to be erroneous. Also these manual analyses are a lot of time-consuming and restricted in discovering of abnormalities in T2-weighted Brain MR Images as compared with the computerized methods [Por14].

The mostly used method for analysis of MR images is segmentation based imaging in clinical analysis. Image segmentation is generally used for measuring and visualizing the brain's anatomical structures, for analyzing brain changes, for delineating pathological regions, and for surgical planning and image-guided interventions. The limitations identified from the study demonstrates various segmentation techniques are restricted in generating high accuracy and mostly focused in brain tumor detection. The recent researches also fail to achieve the unsurpassed accuracy [B+13]. MR Image is mainly used for analysis and detection of brain disorder. In MR images have diverse series such as T1 MR Image, T1C MR Image, T2 MR Image and FLAIR MR Image. This work presents the identification of abnormalities in T2-weighted Brain MR Image shown in [Figure 1]. The usually T2 Brain MR Images provides superior anatomical details.

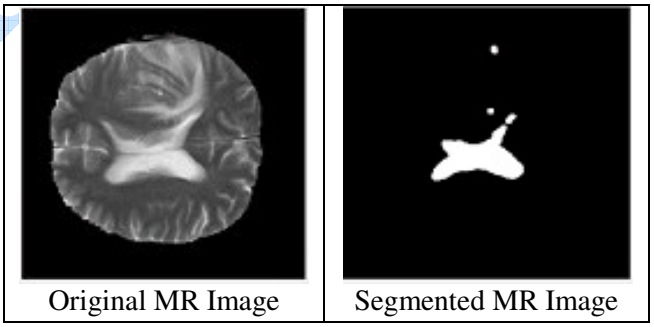

Fig. 1. T2-weighted Brain MR Image Segmentation

Bilateral filtering is most popular techniques used to smooth MR images though preserving edges. The applications of bilateral filter has grown-up drastically and it's now used for MR image denoising, MR image enhancement etc. The bilateral filter is frequently used for improving the input image variance and standard deviation [Wei12]. In this work we analysis the accuracy of major accepted methods such as watershed and expectation maximization of Gaussian mixture are normally used for brain T2 MR image segmentation and detection of brain disorder. Henceforth the rest of the paper is organized with the focus to demonstrate the enhancement in accuracy of disorder detection for T2-weighted Brain MR Image.

The rest of the paper is organized as follows, in Section 2 this paper discuss about the Existing techniques for identification of abnormalities in Brain MR Images, in Section 3 this paper discuss about Framework for Detection of Abnormalities in Brain Magnetic Resonance Images, in Section 4 presents the results tested on multiple T2 MR Image datasets and discussion about results and in Section 5 presents the conclusions.

2. Related Works

The extraction of the features from the medical images makes the major outcome of the analysis. The segmentation techniques of the medical image are the most widely used for medical analysis [B+13, L+14, L+12]. The parallel researches have proposed multiple significant algorithms for image segmentation in 3D image visual analysis for detecting medical disorders. The researches carried out in image segmentation are classified into two major categories as supervised and unsupervised. The supervised techniques are automatic and outcomes into a high density output images and in the other hand the unsupervised techniques extracts the features and results into a feature extracted image. A wide variety of medical image segmentation techniques are been deployed to detect the brain tumors from the MR images. Some of the techniques [S+09, L+14, GS13, L+12, S+10] are compared here [Table 1]. Hence with this understanding, the next research direction is clear to have some segmentation technique to improve the possibilities of the accuracy with the scope of reduced time complexity.

Table 1. MR image analysis techniques for brain tumor detections

Technique	Observation
K – Mean Technique	High Accuracy and High Complexity
C – Mean Technique	High Accuracy and High Complexity
Fuzzy Knowledge-Based Seeded Region Growing Technique	Low Accuracy and Low Complexity
Gaussian Mixture Technique	Medium Accuracy and Medium Complexity
Expectation Maximization – Gaussian Mixture Technique	Medium Accuracy and Medium Complexity
Watershed Techniques	Medium Accuracy and Medium Complexity
Support Vector Mechanism	High Accuracy and Low Complexity for specific datasets
Conditional Random Field with Global Classification	High Accuracy and Low Complexity for specific datasets

Thus this work presents the improvement of the accuracy for the detection of abnormalities in T2-weighted Brain MRI and also presents the comparative performance of the EMGM, Watershed and Proposed Method for the identification of abnormalities in T2-weighted Brain MR Images.

3. Framework for Detection of Abnormalities in Brain Magnetic Resonance Images

The major principles behind this work is the identification of abnormalities in T2-weighted Brain MR Images, Improve the accuracy of the detection of brain anomalies in T2-weighted Brain MR Image with Proposed Method and also obtain the relative performance of EMGM, Watershed and Proposed Method for the detection of brain anomalies in T2-weighted MR Images.

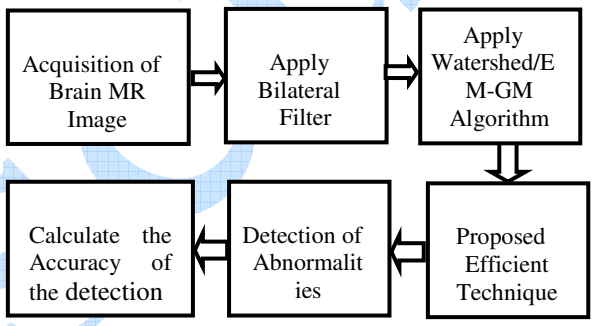

Fig. 2. Block Diagram of the Proposed Work

The MR Image techniques for producing the visual representation of brain images result in different types such as T1 MRI, T1C MRI, T2 MRI and FLAIR MRI and the analysis exhibits the accuracy of T2 images is elevated for detecting the anomalies. Therefore in this work focused on T2-weighted Brain MR Image to carry out the proposed method. The presented methods of EMGM, Watershed and Proposed Method shown in [Figure 2] are equipped with the bilateral filter for the better segmentation of T2-weighted Brain MR Image and detection of brain anomalies in brain. The core framework of presented approach has been demonstrated in [Figure 3].

3.1 EMGM Method

The Expectation maximization (EM) method [GBD11, Wei12] is an iterative two phase method mostly used to locate maximum likelihood factor of a given statistical model and the name of the method is specified by the names of the two phases such as Expectation and Maximization. The EM method is representation of distribution of intensities by mixture of weighted Gaussians. The EM method is an iterative process used to estimate the maximum-likelihood when the observations are incomplete and EM method has two

phases such as Expectation (E) and Maximization (M), these phases are carries out iteratively till the end results converge. The as Expectation (E) phase estimates an expectation of the likelihood by including the latent variables as if they were observed and a Maximization (M) phase, which calculate the maximum likelihood estimates of the parameters by maximizing the expected likelihood found on the previous Expectation (E) phase. The parameters found on the Maximization (M) phase are subsequently used to initiate a further Expectation (E) phase and the procedure is repeated until convergence

The EMGM method for identification of abnormalities in T2-weighted Brain MR Image is described as follows:

The Step1 and Step7 are common to all methods such as EMGM, Watershed and Proposed Method.

Step1 Bilateral Filter is applied on T2-weighted Brain MR Image to suppress the image region from the surrounding. (This step is common to all the Methods).

Step2 EM-GM method is applied on T2-weighted Brain MR Image for segmentation of Anomalous regions.

Step3 Mean and variance matrix are initialized and prior probability is initialized uniformly.

Step4 Expectation Step (E-Step), in this step the algorithm finds the maxima in each region. Calculate membership probability of each image region.

Step5 Maximization Step (M-Step), Calculate mean and variance of each Gaussian component using membership probability obtained in E-Step.

Step6 E and M steps are repeated until convergence. Detect the anomalous region on the brain MR image.

Step7 Segmented T2-weighted Brain MR Image is compared with corresponding Truth MR Image to determine the accuracy of the detection. (This step is common to all the Methods).

Finally, the likelihood to be calculated to converge and EMGM method is shown in proposed Framework for identification of Abnormalities in T2-weighted Brain MR Image is depicted in [Figure 3].

3.2 Watershed Method

The watershed [S+09, RM00, Li11] method is described as morphological gradient based segmentation for this work and the minimal watershed method is illustrated in [Figure 2].The objective of the watershed algorithm [Por14, B+13, S+16, GS13] is to improve the accuracy of the image segmentation, Watershed algorithm is depicted in [Figure 3]. A markers [B+13, S+16] are connected component belong to an image, Marker overcome the over-segmentation difficulty in the watershed method and markers consist of the internal markers and external markers, the internal marker related among objects of interest and the external markers related among the background.

The marker usually consists of two steps that is preprocessing and find the condition those markers essential to persuade and detection of anomalies in Brain MR Image using Marker based watershed method is shown in [Figure 3].

- Employ the internal markers to acquire watershed lines of the gradient of the Brain MR image to be segmented.
- Employ the obtained watershed lines as external markers.
- Each region defined by the external markers contains a single internal marker and part of the background
- The problem is reduced to partitioning each region into two parts i.e. object such as containing internal markers and a single background such as containing external markers.

The Watershed method for identification of abnormalities in T2-weighted Brain MR Image is described as follows:

The EMGM method Step1 and Step7 are common to all methods and same steps are applied to Watershed method.

Step2 Internal and External markers are applied on T2-weighted Brain MR Image.

Step3 Internal markers are the connected component of pixels associated with T2-weighted Brain MR Image and obtain watershed lines of the gradient of the T2-weighted Brain MR image to be segmented.

Step4 External markers are the connected component of pixels associated with the background of the T2-weighted Brain MR image and are used to obtained watershed lines as external markers

Step5 Marker based Watershed method is applied on T2-weighted Brain MR Image for segmentation of Anomalous regions.

Step6 Detect the anomalous region on the T2-weighted Brain MR Image.

3.3 Proposed Method

The major focus of the proposed method is to enhance the accuracy of identification of abnormalities in T2-weighted Brain MR Image by finest merging of segmented regions of Watershed and EMGM methods. The Proposed method is equipped with the bilateral filter to enhance the MR image edges for better segmentation and subsequently the bilateral filter is employed to the EMGM Method, Watershed Method and Proposed method for identification of abnormalities in T2-weighted Brain MR Images. The Proposed method is depicted in [Figure 3].

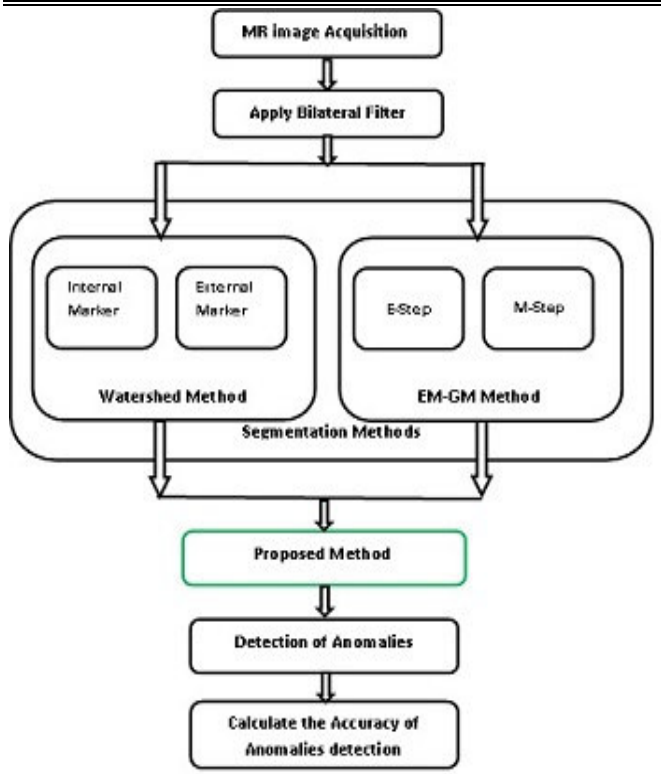

Fig. 3. Proposed Framework for identification of Abnormalities in T2-weighted Brain MR Images

The proposed method for identification of abnormalities in T2-weighted Brain MR Image is described as follows:

The EMGM method Step1 and Step7 are common to all methods and same steps are applied to proposed method.

Step2 Proposed method is applied on T2-weighted Brain MR Image for segmentation of Anomalous regions.

Step3 Proposed method determines the number of segmented T2-weighted Brain MR Image regions in Watershed Method and EMGM Method.

Step4 Compare all the segmented T2-weighted Brain MR Image regions of Watershed Method and EMGM Method to find the unique regions.

Step5 Compare each Segment T2-weighted Brain MR Image from Watershed Method and EMGM Method to find the similar regions, if the regions are nearing neighbors, and then merge the regions.

Step6 Mark the T2-weighted Brain MR Image regions with anomalies and detect the anomalous region on the Brain MR Image.

4 RESULTS AND DISCUSSIONS

In order to demonstrate the results and theoretical construction presented in this work, we provide the MATLAB implementation of the framework to test the visual advantages of EMGM, Watershed and Proposed Method for the identification of abnormalities in T2-weighted Brain MR Images. The presented applications has been tested for ten dissimilar dataset's of T2-weighted Brain MR Images and provided better results with proposed approach.

In our presented approach, we have analyzed the efficiency of EMGM, Watershed and Proposed Method for the identification of abnormalities in T2-weighted Brain MR Images and for this analysis; we have used the datasets from the most popular brain MR image BRATS datasets that contained the brain scan MR images along with their ground truth image. The segmentation results of the EMGM, Watershed and Proposed Method is presented in [Figure 4], [Figure 5] and [Figure 6].

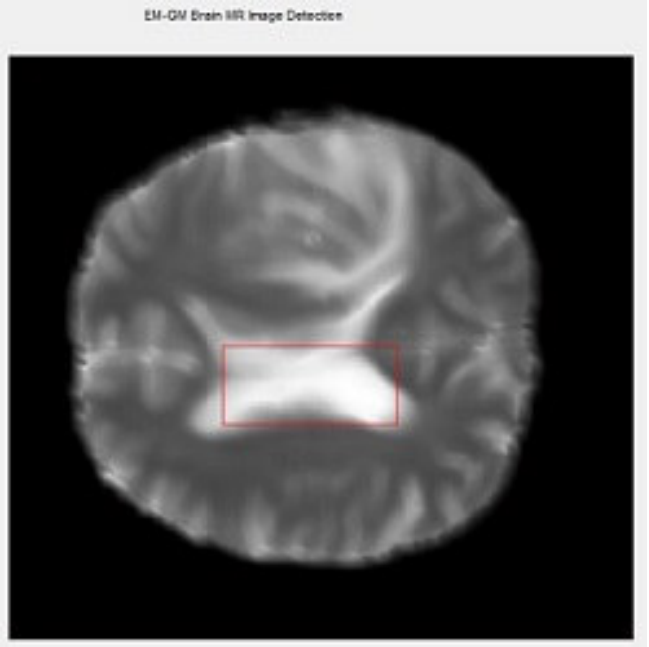

Fig. 4. T2-Weighted Brain MR Image Segmentation with EMGM Method

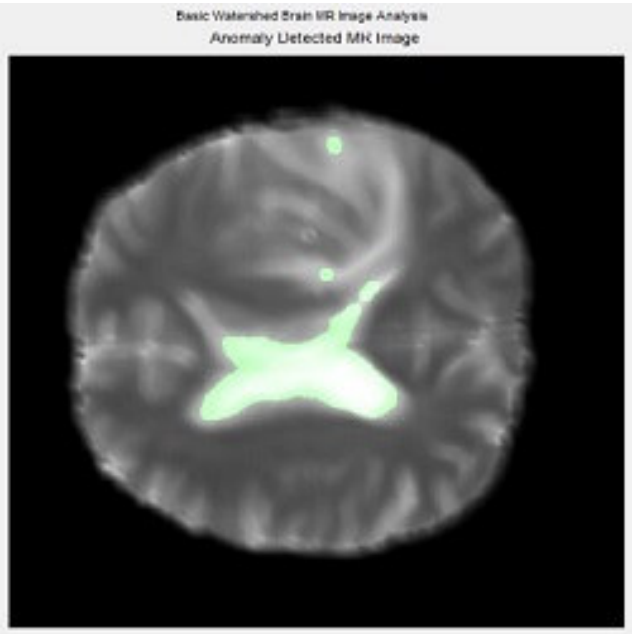

Fig. 5. T2-Weighted Brain MR Image Segmentation with Watershed Method

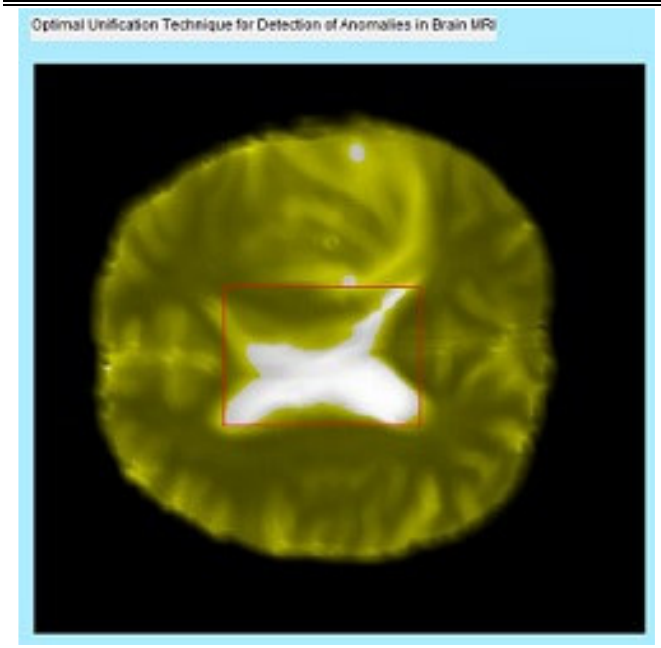

Fig. 6. T2-Weighted Brain MR Image Segmentation with Proposed Method

The accuracy of EMGM, Watershed and Proposed Method methods is measured by finding the comparison between the anomalies extracted from input T2-weighted Brain MR Images and the ground truth image of the parallel input image that is presented in the dataset. The comparative accuracy for EMGM, Watershed and Proposed Method is presented in is presented in [Table 2], [Table 3] and [Table 4].

Table 2. The performance of the EMGM Method T2-Weighted Brain MR Images

Image Dataset In MHA format	Input File Name	Truth File Name	EM-GM Method Accuracy (%)
Dataset 1	MRI01_T2	MRI01_truth	95.99
Dataset 2	MRI02_T2	MRI02_truth	98.29
Dataset 3	MRI03_T2	MRI03_truth	91.64
Dataset 4	MRI04_T2	MRI04_truth	91.86
Dataset 5	MRI05_T2	MRI05_truth	95.36
Dataset 6	MRI06_T2	MRI06_truth	92.87
Dataset 7	MRI07_T2	MRI07_truth	92.19
Dataset 8	MRI08_T2	MRI08_truth	91.57
Dataset 9	MRI01_T2	MRI01_truth	85.5
Dataset 10	MRI02_T2	MRI02_truth	97.47

The input T2-weighted Brain MR Image dataset is segmented with EM-GM method and the acquired average accuracy is 93.274 %.

Table 3. The performance of the Watershed Method for T2-Weighted Brain MR Images

Image Dataset In MHA format	Input File Name	Truth File Name	Watershed Method Accuracy (%)
Dataset 1	MRI01_T2	MRI01_truth	96.09
Dataset 2	MRI02_T2	MRI02_truth	98.29
Dataset 3	MRI03_T2	MRI03_truth	96.05
Dataset 4	MRI04_T2	MRI04_truth	93.02
Dataset 5	MRI05_T2	MRI05_truth	95.6
Dataset 6	MRI06_T2	MRI06_truth	93.32
Dataset 7	MRI07_T2	MRI07_truth	92.72
Dataset 8	MRI08_T2	MRI08_truth	91.88
Dataset 9	MRI01_T2	MRI01_truth	88.48
Dataset 10	MRI02_T2	MRI02_truth	97.46

The input T2-weighted Brain MR Image dataset is segmented with EM-GM method and the acquired average accuracy is 93.274 %.

Table 4. The performance of the Proposed Method for T2-Weighted Brain MR Images

Image Dataset In MHA format	Input File Name	Truth File Name	Proposed Method Accuracy (%)
Dataset 1	MRI01_T2	MRI01_truth	97.09
Dataset 2	MRI02_T2	MRI02_truth	99.29
Dataset 3	MRI03_T2	MRI03_truth	97.05
Dataset 4	MRI04_T2	MRI04_truth	94.02
Dataset 5	MRI05_T2	MRI05_truth	96.6
Dataset 6	MRI06_T2	MRI06_truth	96.65
Dataset 7	MRI07_T2	MRI07_truth	93.72
Dataset 8	MRI08_T2	MRI08_truth	92.88
Dataset 9	MRI01_T2	MRI01_truth	89.47
Dataset 10	MRI02_T2	MRI02_truth	98.46

The input T2-weighted Brain MR Image dataset is segmented with EM-GM method and the acquired average accuracy is 95.52 %.

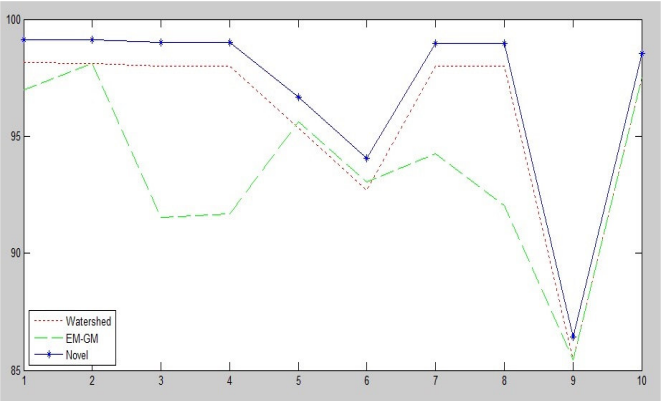

Fig. 7. Comparison of Watershed Method, EM-GM Method and Proposed Method

Thus this work exhibits the relative performance of the Watershed Method, EM-GM method and Proposed Efficient Method with the help of multiple T2-weighted Brain MR Image datasets for detection of brain anomalies is depicted in [Figure 7]. In the Fig. 7, x-axis shows the dataset and y-axis shows the accuracy. The testing results clearly demonstrate that the proposed method presents enhanced accuracy for T2-Weighted Brain MR Images.

CONCLUSION

The considerable amount of analysis has been done for the identification of abnormalities in T2-weighted Brain MR Images with EMGM Method, Watershed Method and Proposed method. The proposed method in this work has been tested on ten different BRATS T2-weighted Brain MR Image datasets and demonstrated the enhancement in the accuracy. The work also concludes the comparative analysis for T2-weighted Brain MR Image segmentation and detection of brain anomalies using EMGM Method, Watershed Method and Proposed method. Evaluated with the existing research outcomes, this work presented the improvement in detection of brain T2-weighted Brain MR Image. In this work, proposed method presents an elevated value of average accuracy therefore proposed method is accurate in extracting the anomalies in brain MR images. With the final outcome of accuracy improvement, this work surely and satisfyingly extends the possibilities of better detection of abnormalities in T2-weighted Brain MR Images.

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