
Results and Discussion

4. RESULTS AND DISCUSSION

As given in the literature review, (S.Murugavalli et al. (2007), (T.Logeswari et al. 2010), used as HSOM for segmentation. As per the proposed study, the segmentation is done in 13.76 seconds. In the proposed method, mean standard deviation is used for feature extraction and the execution time for HSOM is between 7-10 seconds. Hence there is a reduction in execution time when compared to existing methodology.

4.1 Dataset Used

For evaluating the proposed algorithm and to study their effectiveness, the dataset containing 60 MRI images was considered, among this 25 images were collected from Government Hospital Lab (GH), Coimbatore and remaining collected from Websites. For discussion, 16 images were randomly selected and used as test images which is shown in (Figure 4.1)

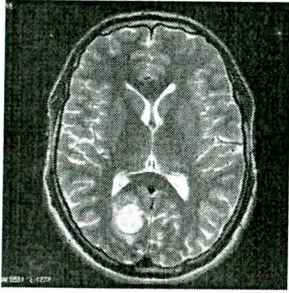


Image 1

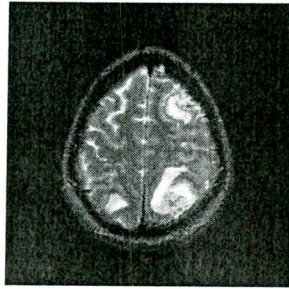


Image 2

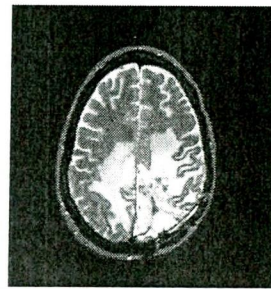


Image 3

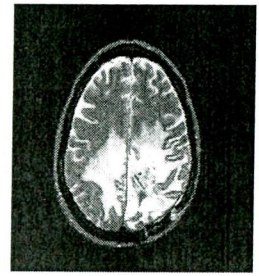


Image 4



Image 5

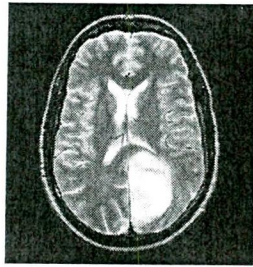


Image 6

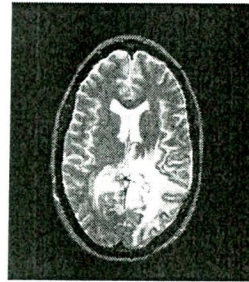


Image 7

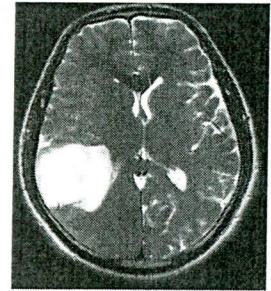


Image 8



Image 9

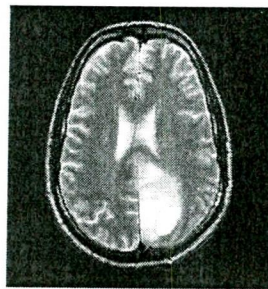


Image 10

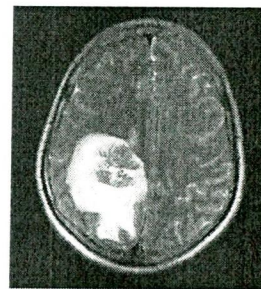


image 11

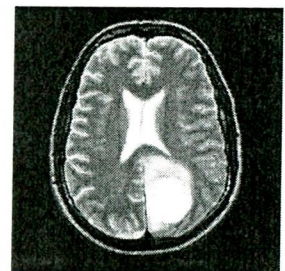


Image 12

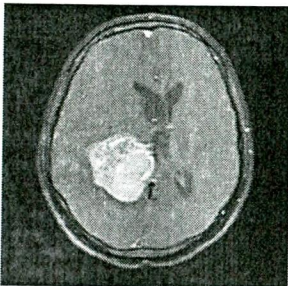


Image 13

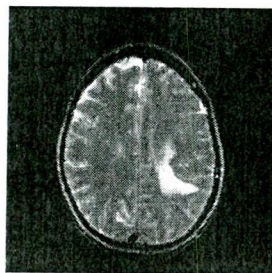


Image 14

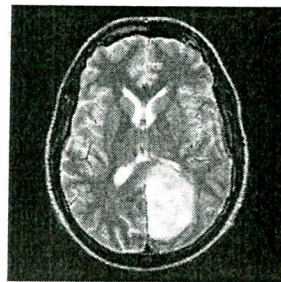


Image 15

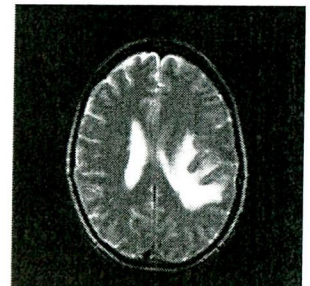


Image 16

Figure 4.1: Sample MRI brain tumor Images

4.2 Performance metrics used:

Performance evaluation of the enhancement methods developed is the most important step in any research. Different researches use different parameters for analysis. To evaluate the proposed models, two performance metrics were used.

They are,

- * Execution Time
- * Accuracy

4.2.1 Execution time:

The computation time is calculated by stopwatch timer function in Matlab 7.0. The stopwatch timer functions,

- tic
- toc

Once the tic function is used the stopwatch timer function starts its execution to evaluate the time. When the toc function is read the timer used to evaluate gets stopped and the elapsed time is calculated, which is displayed in the command window.

Sample command for Stopwatch Timer,

Use tic and toc as shown here:

```
tic
A=5;
B=5;
C=a+b;
Toc
Result:
Elapsed time: 0.1 second
C=10
```

4.2.2 Accuracy

Support Vector Machine (SVM) is supervised learning model with associated learning algorithms. It is used to evaluate the data and recognize the patterns, used for classification. The basic SVM takes a set of input data and for each given input, calculates which of two classes forms the input, making it a non-probabilistic binary linear classifier and the accuracy is mentioned in terms of percentage of classification.

4.3 Experimental results

The result of the various techniques applied for the test images are presented in this section.

4.3.1 Preprocessing

When median filtering is applied, the noise from the image is removed and clarity of the image is achieved. The comparison between the original image and filtered images is show in Figure (4.2.a, 4.2.b).

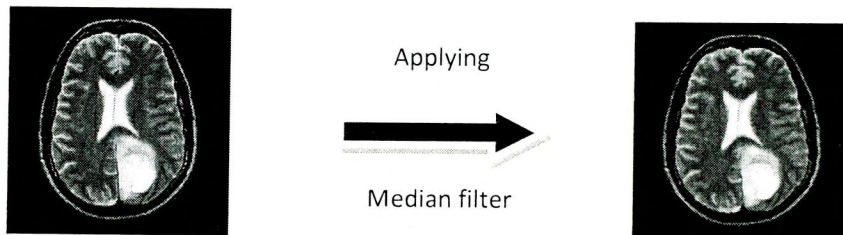


Figure 4.2.a Original image

Figure 4.2.b Filtered image

Skull Removal

The skull removal method is used to separate the brain portion from the non-brain portion. In the proposed method the preprocessing is performed by using the techniques like threshold value, connected components, morphological operation and erosion.

The comparison between the preprocessed image and skull removed image is shows in Figure (4.3.a, 4.3.b).



Figure 4.3.a Preprocessed Image

Figure 4.3.b Skull removed image

4.3.2 Clustering technique

Fuzzy C Mean technique is used to cluster the image. The clustered image makes the subsequent tasks of the system easier. The clustered image is shown in Figure (4.4.b).

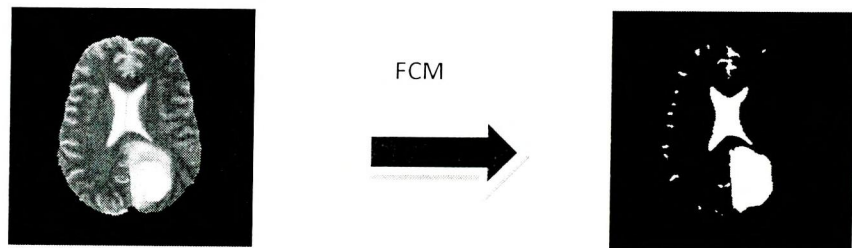


Figure 4.4.a Skull removed image

Figure 4.4.b Clustered image

4.3.3 HSOM Segmentation

This HSOM segmentation work efficiently by extracting the tumors in less computational time, tumor size and accuracy is achieved in effective manner. The segmented image is shown in Figure (4.5.b):

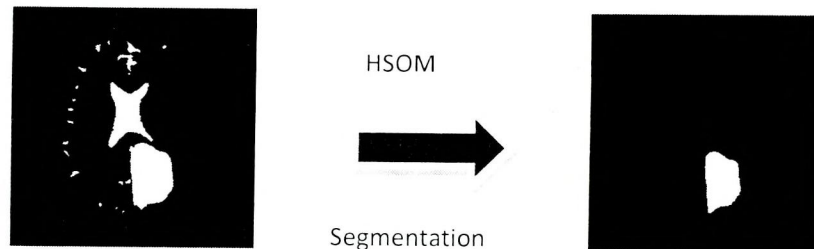


Figure 4.5.a Clustered image

Figure 4.5.b Segmented image

4.3.3.1 Accuracy

In the proposed method, accuracy was calculated by using SVM classification based on Hierarchical Self-Organizing Map (HSOM) segmentation result and from the results, the accuracy obtained was 98.88% on the average.

The overall performance, accuracy is evaluated and the result are projected in Table 4.1

Images	SVM Accuracy (%)
Image 1	98.88
Image 2	98.87
Image 3	98.88
Image 4	97.66
Image 5	97.88
Image 6	97.78
Image 7	97.77
Image 8	97.52
Image 9	98.89
Image 10	97.98
Image 11	98.82
Image 12	97.59
Image 13	97.65
Image 14	98.88
Image 15	98.25
Image 16	97.88

TABLE 4.1: ACCURACY (%)

From the results, 98.88% accuracy is achieved, while using SVM for HSOM segmentation result.

4.3.3.2 Elapsed Time:

The execution time taken to detect the tumor using proposed method HSOM is shown in Table 4.3, which is comparatively less than the time taken for other segmentation techniques specified in the literature. As per the literature review (T.Logeswari and M.Karnan ,2010) the time taken for segmentation is 13.76%.

Images	Time (seconds)
Image 1	7.57
Image 2	7.29
Image 3	8.87
Image 4	7.25
Image 5	8.52
Image 6	7.32
Image 7	8.46
Image 8	8.99
Image 9	9.20
Image 10	8.59
Image 11	10.02
Image 12	7.98
Image 13	8.22
Image 14	10.30
Image 15	9.99
Image 16	8.98

TABLE 4.2: Elapsed time (seconds)

From the table, it is proved that the tumor is detected in less computational time between 7-10.3 seconds by using HSOM segmentation.

4.3.3.3 Tumor Size

The tumor size is calculated for the purpose of evaluating the methodology used. Further it is compared with the manual results and it was found that, the results are very much satisfactory.

The tumor size is evaluated and the result are projected in Table 4.2

Images	Tumor Size(mm)
Image 1	22.9213
Image 2	37.7881
Image 3	32.3821
Image 4	28.7234
Image 5	74.5662
Image 6	40.6896
Image 7	33.3694
Image 9	40.4404
Image 10	40.2652
Image 11	24.1674
Image 12	5.1095
Image 13	49.7958
Image 14	54.7885
Image 15	12.2981
Image 16	36.3456

TABLE 4.3: Tumor Size (mm)

The step by step process of proposed methods are shown in Figure 4.6


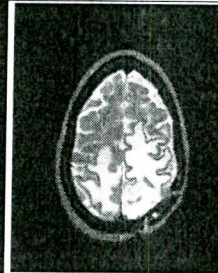

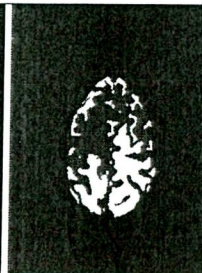
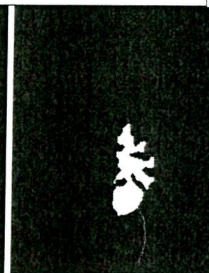
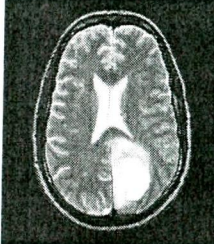
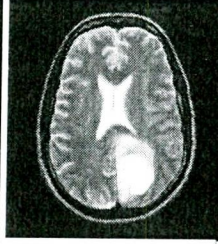



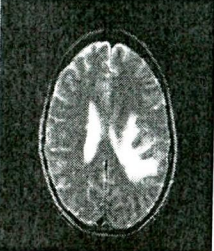
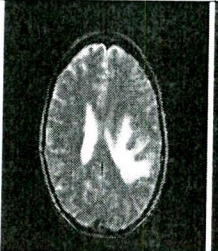
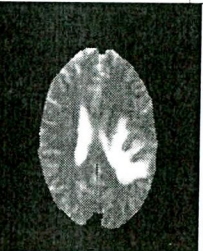


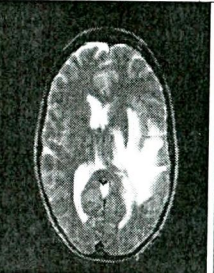

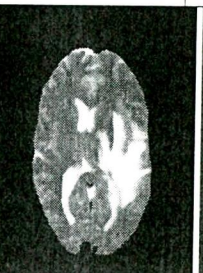
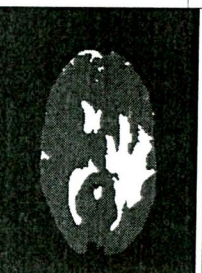

Original image	Filtered image	Skull removal image	Clustered image	Segmented image
				
				
				
				

Figure: 4.6 Step by step process of the proposed system

In the proposed method, Hierarchical Self-Organizing Map (HSOM) segmentation uses the following phases. They are preprocessing, clustering and segmentation. By adopting HSOM segmentation accuracy attained was about 98.88% on an average and computational time was reduced to an extent of 7 to 10.3 seconds.