CHAPTER VII

PERFORMANCE ANALYSIS
CHAPTER 7

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7.1 PREFACE

Performance evaluations determine how well a system performs relative to some requirement the results of the implementation of the hybrid fuzzy segmentation process are discussed in this chapter. Any computer aided analysis, the execution time is one of the important parameters for analyzing medical images.

The Free Receiver Operating Characteristics Curve (FROC) is a popular tool in Medical and Image processing research to analyze the rate of classification. ROC Analysis is based on statistical decision theory developed in the context of electronic signal detection and has been applied extensively to diagnostic systems in Clinical medicine. The FROC curve is a plot of the classifier’s true positive detection rate and its false positive rate. True positive (TP) detection rate is the probability of correctly classifying a target object and False positive (FP) detection rate is the probability of incorrectly classifying a target object.

7.2 RELATED WORK

Several Researchers suggested various techniques of ROC and they are available in the survey. Each classifier is constructed using the training set and is evaluated by ROC Analysis. Devos et al classified health versus tumor tissue from 25 patients with 142 Data’s from database using MRI, Linear Discriminant Analysis(LDA) and Least Squares Support Vector Machines(LS-SVM) [31,32] and got patterns greater than 0.95. Devos used MRI with
peak integration for normal tissue and received high performance 0.99 by 76 patients with 142 data’s [31,32]. Kiftekharuddin et al performed analysis using Support vector Machine (SVM) classifier and got area under curve is 0.9 from 20 datasets [56].

The number of tumor pixels detected by various methods with the execution time is presented. In these results, the numbers of pixels affected by the tumor cells are calculated and the results have been compared with the existing results. The proposed HPACO with fuzzy based segmentation technique provides better values. The accuracy of the brain tumor segmentation process is compared with the existing methods. The percentage detection of tissues like tumor is 99.87.

There are three Techniques are used for detection of brain tumor such as registration, Hybrid MRF-PSO with Fuzzy C-Means and Hybrid MRF- parallel Ant Colony Optimization with Fuzzy C-Means. Each of these techniques performance analysis and the pixel and position accuracy is calculated for 120 MRI brain images.

True Positive (TP) and False Positive (FP) rates are calculated at 10 different thresholds selected on asymmetry image pixels to generate an FROC curve. A region extracted in the asymmetry image, which overlaps with a true abnormality as provided in the ground truth of the image, is called a true positive detection.

An overlap means that at least 60% of the region extracted lies within the circle indicating a true abnormality as determined by database.
For example, the MRI 10, the spatial coordinate position of the suspicious region, x and y are 100, 250 respectively, and the radius is 25 pixels. The resultant asymmetry image contains the suspicious region at 101, 251, with the radius of 25 pixels. Compared to the radiology report, results from the proposed method overlaps 90% of the specified region and this image is classified as true positive image. Suppose the overlap is less than 60% of the specified region, and then the image is considered as false positive image. In the previous methods such as Sallam and Bowyer, Lau and Bischof have taken the overlap region of only 40% are considered as true positive. But in this paper, the true positive is considered only at 60% of overlap occurs [147,148].

All other regions extracted by the algorithm are labeled as false positives. Figure shows the FROC curves generated on the full test set, using 10 operating points. In general, it is expected that the true positive detection rate in an FROC curve will continue to increase or remain constant as the number of false positives increase. In this case the true positive rate actually drops at certain points. If the threshold value is low true detections may become merged with false positive regions.

7.2.1 CLASSIFICATION RATIO

The area under the FROC curve ($A_z$ value) is an important criterion for evaluating diagnostic performance. The $A_z$ value of FROC curve should be computed by normalizing the area under the FROC curve by the range of the abscissa. The value of $A_z$ is 1.0 when the diagnostic detection has perfect performance, which means that TP rate is 100% and FP rate is 0%. The $A_z$ value for the proposed HPACO algorithm is 99.87%. 
Initially the MRI brain image is acquired from MRI brain data set to MATLAB 7.1. After acquisition the MRI is given to the preprocessing stage, here the film artifacts (labels) are removed using the tracking algorithm. Next, the high frequency components and noise are removed from MRI using the following filters. Such as Median filter, Weighted Median filter, Adaptive filter and spatial filter. The Computational result is used to enhance the Image and the performance of the system was investigated. The performance of above filters are measured and evaluated. Finally the best filter of weighted median filter is identified and used for MR brain image enhancement. It is used for removing noise from MRI brain images with high contrast.

7.3 PERFORMANCE EVALUATION – REGISTRATION

In non rigid method the block based technique is implemented. The normal image and target images are split as several blocks of size 64 × 64. Intensity pair of each block of those images is compared. If any changes occur in those blocks then it will be assigned as a new image and it is given to the next stage.

Then morphological operation such as dilation and erosion is applied on the resultant block image so that the segmentation of suspicious region is measured. In rigid method, Statistical similarity measures test such as contrast checking, sum of squared intensity differences (SSD), calculation of white cells and point mapping are performed on both the images. Then GA is implemented to determine the border of suspicious region. A Fuzzy C Means with HYBRID MRF-Particle Swarm Optimization based Segmentation process to
detect Brain Tumor was implemented. In that performance of the MRI Image in terms of Weight vector, execution time and Tumor pixels detected using the HYBRID MRF-PSO with FCM approach, it can be concluded that the proposed approach has lower tumor value and lesser execution time. There is a decrease in both the values when compared to any other existing approach.

7.4 PERFORMANCE EVALUATION – HPACO WITH FUZZY C MEANS

The results are compared with the existing approaches. Computational result indicates that the Hybrid Parallel Ant Colony Optimization algorithm improves the performances of the segmentation and can find the optimum solution faster than the other two methods. The number of tumor pixels detected by various methods with the execution time is presented. In these results, the number of pixels affected by the tumor cells have been calculated and the results have been compared with the existing results. The proposed HPACO with fuzzy based segmentation technique provides better values. The accuracy of the brain tumor segmentation process is compared with the existing methods. The percentage detection of tissues like tumor is 99.87.

7.5 COMPARISON OF TECHNIQUE

The execution time for different segmentation techniques, HYBRID MRF-PSO with Fuzzy C Means and HYBRID MRF-HPACO with Fuzzy C Means require more time than the proposed HPACO with Fuzzy C Means. The weight vector value obtained for the proposed method is less compared to the existing results.
This is due to the clustering process and abstraction level technique. The weight vector for the REGISTRATION is 8x8. The weight vector for the HYBRID MRF-PSO with FCM is about 3x3. This weight vector value for the REGISTRATION is higher but it is less in our proposed method.

The value of the tumor cells detected with our proposed implementation is about 795 for the HYBRID MRF-PSO with FCM but the value of the tumor pixel detected for the HPACO with FCM is only 2772. The increase in the value of the detected tumor cells is due to the abstraction level and FCM clustering process.

Performance evaluations determine how well a system performs relative to some Requirement the results of the implementation of the hybrid fuzzy segmentation process are discussed in this section. Any computer aided analysis; the execution time is one of the important parameters for analyzing medical images.

The execution time for the HYBRID MRF-PSO with FCM is 93.39 seconds and HPACO with FCM is 90.03 seconds. The increase in the execution time for the proposed implementation is due to the layer by layer abstraction level and FCM clustering techniques.
Table 7.1 Performance Analysis of the Algorithm

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Accuracy (%)</th>
<th>Error Rate (%)</th>
<th>Detection Rate(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block based technique</td>
<td>68.6</td>
<td>0.4273</td>
<td>92</td>
</tr>
<tr>
<td>PSO with FCM</td>
<td>74.6</td>
<td>0.3919</td>
<td>94.8</td>
</tr>
<tr>
<td>HPACO with FCM</td>
<td>95.16</td>
<td>0.008</td>
<td>99.87</td>
</tr>
</tbody>
</table>
Figure 7.1(a) Accuracy and Error Rate of Various Brain tumor detection Methods
Figure 7.1(b) Accuracy and Error Rate of Various Brain tumor detection Methods
In the accuracy percentage and the error rate of different algorithms are calculated and shown above. HPACO gives the best accuracy comparing with other optimization techniques. Overall accuracy of tumor pixel using HPACO is 95.16%
## Table 7.2 Comparison of Existing Approaches

<table>
<thead>
<tr>
<th>S.No</th>
<th>Author</th>
<th>Method</th>
<th>Result</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>SOM with fuzzy. (Murugavalli.S, Rajamani.V (2007))</td>
<td>HSOM-FCM</td>
<td>The detection of tissues like tumor detection rate is 97.3%.</td>
<td>They Consider only Colour Region of the brain Image</td>
</tr>
<tr>
<td>2.</td>
<td>The Proposed approach with Adaptive Threshold, Execution Time, Number of tumor pixel and Weights</td>
<td>Block based Technique</td>
<td>The Accuracy is 68.6% and Error rate is 0.4273 &amp; tumor detection rate is 92%</td>
<td>consider only tumor part of the brain</td>
</tr>
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<td></td>
<td></td>
<td>PSO</td>
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</tbody>
</table>
Figure 7.2 Detection Ratio of Various Brain tumor detection Methods
7.6 SUMMARY

Hundred and twenty brain image obtained from the KMCH hospital database is used to design the proposed diagnosing system. In Preprocessing and Enhancement, The tracking algorithm is proposed to remove film artifacts such as labels and X-ray marks from the MRI Image to increase the reliability of the segmentation. The three filtering technique such as Median Filter, Weighted Median Filter and Adaptive Filter is applied to remove the high frequency components in the MRI image.

The result is compared in that the advantage of using Weighted Median Filter removes the noise without disturbing the edges boundaries etc., and the performance evaluation is measured. In this Chapter three techniques are adopted Registration, PSO with FCM, and HPACO with FCM. The pixel and position accuracy for Registration is 68.6, PSO with FCM is 74.6 and HPACO with FCM is 95.16. The overall accuracy of proposed algorithm such as HPACO with FCM is high when compared with other two techniques.

Segmentation is the second stage where Optimization forms an important part of our day to day life. Many scientific, social, economic and engineering problems have parameter that can be adjusted to produce a more desirable outcome. Over the years, numerous techniques have been developed to solve such optimization. This study investigates the most effective optimization method, known as Hybrid Parallel Ant Colony Optimization (HPACO) is introduced in the field of Medical Image Processing.
New CAD System is developed for verification and comparison of brain tumor detection algorithm. The suspicious region is segmented using algorithm HPACO. It automatically determine the optimal threshold value of given image to select the initial cluster point then the clustering algorithm Fuzzy C Means automatically calculates the adaptive threshold for the brain tumor segmentation. The results are compared with the existing approaches. Computational result indicates that the Hybrid Parallel Ant Colony Optimization algorithm improves the performances of the segmentation and can find the optimum solution faster than the other two methods.