Diagnose Brain Tumor Through MRI Using Image Processing Clustering Algorithms Such As Fuzzy C Means Along With Intelligent Optimization Techniques

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Abstract - **Magnetic Resonance Imaging (MRI) is one of the best technologies currently being used for diagnosing brain tumor. Brain tumor is diagnosed at advanced stages with the help of the MRI image. Segmentation is an important process to extract suspicious region from complex medical images. Automatic detection of brain tumor through MRI can provide the valuable outlook and accuracy of earlier brain tumor detection. In this paper an intelligent system is designed to diagnose brain tumor through MRI using image processing clustering algorithms such as Fuzzy C Means along with intelligent optimization tools, such as Genetic Algorithm (GA), and Particle Swarm Optimization (PSO). The detection of tumor is performed in two phases: Preprocessing and Enhancement in the first phase and segmentation and classification in the second phase**

Keywords - **Magnetic Resonance Imaging, Fuzzy C Means, Genetic Algorithm, Particle Swarm Optimization.**

I. INTRODUCTION

The incidence of brain tumors is increasing rapidly, particularly in the older population than compared with younger population. Brain tumor is a group of abnormal cells that grows inside of the brain or around the brain. Tumors can directly destroy all healthy brain cells. It can also indirectly damage healthy cells by crowding other parts of the brain and causing inflammation, brain swelling and pressure within the skull. Over the last 20 years, the overall incidence of cancer, including brain cancer, has increased by more than10%, as reported in the National Cancer Institute statistics (NCIS), with an average annual percentage change of approximately 1%.2-6 between 1973 and 1985, there has been a dramatic age-specific increase in the incidence of brain tumors. Death rate extrapolations for USA for Brain cancer: 12,764 per year, 1,063 per month, 245 per week, 34 per day, 1 per hour, 0 per minute, 0 per second. The National Cancer Institute statistics reported as the average annual percentage increases in primary brain tumor incidence for ages 75-79, 80-84, and 85 and older were 7%, 20.4%, and 23.4%, respectively.5-8 Since 1970, the incidence of primary brain tumors in people over the age of 70 has increased sevenfold. Canadian Cancer Statistics, National Cancer Institute of Canada (NCIC) in 2004, 5 per 100,000 deaths in men from brain tumor or cancer in Canada and 4 per 100,000 deaths in women from brain tumor in Canada. Now days, MRI is the noninvasive and very much sensitive imaging test of the brain in routine clinical practice. Magnetic resonance imaging (MRI) is a noninvasive medical test that helps physicians diagnose and treat medical conditions [1, 2]. MR imaging uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures. It does not use ionizing radiation (x-rays) and MRI provides detailed pictures of brain and nerve tissues in multiple planes without obstruction by overlying bones. Brain MRI is the procedure of choice for most brain disorders. It provides clear images of the brainstem and posterior brain, which are difficult to view on a CT scan. It is also useful for the diagnosis of demyelinating disorders (disorders such as multiple sclerosis (MS) that cause destruction of the myelin sheath of the nerve).

According to that study it is noted that the particle swarm optimization (PSO) has not been implemented in the field of brain image analysis. PSO algorithms have been successfully applied to diverse combinational optimization problems. A good review of this optimization technique is studied and observed that PSO algorithms can perform well in brain interpretation. Recently, many researchers have focused their attention on a new class of algorithms, called metaheuristics [4, 10]. A metaheuristic is a set of algorithmic concepts that can be used to define heuristic methods applicable to a wide set of different problems. In other words, a metaheuristic can be seen as a general-purpose heuristic method designed to guide an underlying problem specific heuristic toward promising regions of the search space containing high-quality solutions.

A metaheuristic therefore a general algorithmic framework, which can be applied to different optimization problems with relatively few modifications to make them, adapted to a specific problem. The use of metaheuristics has significantly increased the ability of finding very high-quality solutions to hard, practically relevant combinatorial optimization problems in a reasonable time. This is particularly true for large and poorly understood problems. Several meta-heuristics, such as Genetic Algorithms, Tabu Search and Simulated Annealing , have been proposed to deal with the computationally intractable problems. Particle Swarm Optimization (PSO) is a new meta-heuristic developed for composing approximate solutions.

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II. OVER VIEW OF THE CAD SYSTEM

Magnetic Resonance Imaging (MRI) is one of the best technologies currently being used for diagnosing brain tumor. Brain tumor is diagnosed at advanced stages with the help of the MRI image. Segmentation is an important process to extract suspicious region from complex medical images. Forty two brain image obtained from the KG 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 filtering technique such as Median Filter is applied to remove the high frequency components in the MRI image and the performance evaluation is measured.

Over the years, numerous techniques have been developed to solve such optimization. This study investigates the most effective optimization method, known as Particle Swarm Optimization (PSO) is introduced in the field of Medical Image Processing.

The suspicious region is segmented using two algorithms GA and PSO. New CAD System is developed for verification and comparison of brain tumor detection algorithm. PSO and GA automatically determine the optimal threshold value of given image to select the initial cluster seed point then the clustering algorithm Fuzzy C Means calculates the adaptive threshold for the brain tumor segmentation. The results are compared with the existing approaches. Computational result indicates that the Particle Swarm Optimization algorithm improves the performances of the segmentation and can find the optimum solution faster than the other two methods.

The similarity between segmented results using various segmented algorithm with the Radiologist tumor identification report as per the hospital database is used to classify the images. The GA with Fuzzy and PSO with Fuzzy algorithms are used to identify tumor position and pixel similarities are measured with Radiologist report[5, 6, 7]. The true positive detection rate and the number of false positive detection rate at various thresholds of the images are used to measure the algorithm's performance. These rates are represented using Free-Response Receiver Operating Characteristic (FROC) graph.

III. SEGMENTATION USING PSO

Particle Swarm Optimization (PSO) is a recent heuristic search method whose mechanics are inspired by the swarming or collaborative behavior of biological populations. The evolutionary heuristics are population-based search methods. In other words, PSO move from a set of points (population) to another set of points in a single iteration with likely improvement using a combination of deterministic and probabilistic rules.

This paper attempts to examine the claim that PSO has the same effectiveness (finding the true global optimal solution) the performance of the PSO is implemented using brain image analysis. The major objective of this paper is to extracting suspicious region from back ground tissue.

The PSO algorithm consists of three steps, namely, (1) generating particles, positions and velocities, (2) velocity update, and finally, (3) position update. Here, a particle refers to a kernel in the entire brain image that changes its position from one move (iteration) to another based on velocity updates.

PSO is a population-based stochastic optimization algorithm modeled after the simulation of the social behavior of bird flocks and follows similar steps as evolutionary algorithms to find near-optimal solutions. In this work, the dissimilar patterns available in the pattern matrix, the corresponding labels and the posterior energy function values are stored in a solution matrix. Initially the parameters such as number of iterations (N), number of birds (K), initial velocity value (V_0) is assigned with the values of 50, 10, and 0.001 respectively. Also the solution matrix contains separate columns for velocity and position and flag values of each bird. The flag value is used to mention whether the kernel has been selected previously or not. Initially all the flag values are set to 0 and the velocity values are assigned with V_0. At the initial step, all the birds are assigned with the random kernels, and their velocity values are updated. Select the bird, which generate the global best and change the position of the bird to the next pixel which is unvisited. Change the position of the remaining birds in the direction of the bird which generates global optimum. Repeat the procedure all the pixels have been visited by all the birds.

IV. EXPERIMENTS AND RESULTS

There are three Techniques are used for detection of brain tumor such as Hierarchical Self Organizing Map with Fuzzy C-Means, Genetic Algorithm with Fuzzy C-Means and Ant Colony Optimization with Fuzzy C-Means [5, 6, 8, 9, 11]. Each of these techniques performance analysis and the pixel and position accuracy is calculated for 120 MRI images. Figure 1 shows the tumor Segmented Pixel using PSO with FCM tumor and ACO with FCM segmented Pixel.

Figure 1: Tumor Segmented Pixel using PSO with FCM tumor and ACO with FCM segmented Pixel.

V. PERFORMANCE EVALUATION

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.

In these results, we have calculated the number of pixels affected by the tumor cells and the results have been compared with the existing results. The proposed PSO 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 98.87.

VI. COMPARISON OF TECHNIQUE

The execution time for different segmentation techniques, GA with Fuzzy C Means require more time than the proposed PSO with Fuzzy C Means [3]. The weight vector value obtained for the proposed method is less compared to the existing results. The input features for the segmentation process are mean, median, and standard deviations. The variation of the total number of tumor pixels detected of an image with various segmentation techniques. The value of the tumor cells detected with our proposed implementation is about 815 for the GA with FCM but the value of the tumor pixel detected for the PSO 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.

In image processing, execution time is an important parameter to analyze any image in general and in medical image is particular. Variation of the execution time for various segmentation processes is depicted in Fig.1. The execution time for the GA with FCM is 93.39 seconds as against 24.98 seconds and PSO with FCM is 100.03 seconds as against 100.03 seconds. The increase in the execution time for the proposed implementation is due to the layer by layer abstraction level and FCM clustering techniques.

VII. PIXEL ACCURACY AND POSITION ACCURACY

To compare the manual segmented pixel intensity value with system segmented pixel intensity value to find the accuracy of the pixel level. To calculate position between the manual segmented tumors position with system segmented tumor position to find the accuracy of the position level.

A. Overall Accuracy

Overall Accuracy = 75 %(Pixel accuracy) + 25% (Position Accuracy)

Here consider the tumor pixel Accuracy with weight 75% and Position accuracy 25% because the number of tumor segmented pixel should have the correct accuracy than the position of axis to be considered

B. Error Rate

The Success of this approach to identify the number of tumor pixel in terms

- Pixel Error Rate
- Position Error Rate

Pixel Error Rate is the tumor pixel accuracy less than 80% is rejected as a True Negative. Position Error Rate is the tumor Position with minimum of 50% Accuracy. In the paper, the lowest error Rate is 20%. The GA with FCM configuration is compared with PSO with FCM. The Lowest Error Rate

TABLE 1
PERFORMANCE ANALYSIS OF THE ALGORITHM

Algorithm	Accuracy (%)	Error Rate (%)
GA with FCM	74.6	0.3919
PSO with FCM	92.3	0.1273

In the accuracy percentage and the error rate of different algorithms are calculated and shown above. PSO gives the best accuracy comparing with other optimization techniques. Overall accuracy of tumor pixel using PSO is 92.3%.

VIII. CONCLUSION

A Review of the significant result obtained in the course of the work and scope for future research are highlighted in this chapter. The primary objective of this thesis is to develop more accurate, efficient for detection of brain tumor. A novel approaches to segmentation using image processing clustering algorithm such as Fuzzy C Means and optimization tools such as GA and PS0 were proposed. In Preprocessing and enhancement the proposed method has been used to remove the film artifacts using tracking algorithm. In the enhancement stage for remove high frequency components, the Median is used to enhance the image and the performance of the system was investigated.

Segmentation was done by Fuzzy C Means along with metaheuristic algorithms such as GA and PSO. The population based optimization Genetic algorithm is investigated in that the pixel intensity values were considered as population strings, reproduction was applied to those strings to generate parent strings using fitness values. Crossover and mutation operator were used to generate the new population. The optimum value was considered to select the initial cluster point to find the adaptive value (the out put of the FCM) for tumor

detection. In that 3×3, 5×5, 7×7, 9×9, 11×11 windows are analyzed the GA with Fuzzy C Means of 3×3 window is chosen based on the high contrast than 5×5, 7×7, 9×9, and 11×11.

In the PSO the optimum value was considered to select the initial cluster point to find the adaptive value (the out put of the FCM) for tumor detection.In that 3×3, 5×5, 7×7, 9×9, 11×11 windows are analyzed the PSO with FCM of 3×3 window is chosen based on the high contrast than 5×5, 7×7, 9×9, and 11×11. In performance of the MRI image in terms of weight vector, execution time and tumor pixels detected using the PSO with Fuzzy C Means.

PSO which is computationally very efficient optimization technique is proposed for brain tumor image segmentation. The proposed method is relatively simple, reliable, and efficient. The efficiency was compared with GA. PSO provides better performance comparing with GA. PSO with FCM algorithm has been used to find out the optimum value. It can be concluded that the proposed approach has lower tumor value and lesser execution time. There is a decrease beyond 80% in both the values when compared to any other existing approach.

The average classification error of GA is 0.078%. The average accuracy GA is 89.6%. PSO gives best classification accuracy and average error rate. The Average classification error of PSO is 0.059% and the accuracy is 92.8% and tumor detection is 98.87%.

The average classification error is reduced when the number of sample is increased. The results have provided substantial evidence that for brain tumor segmentation of PSO algorithm performed well.

TABLE 2
COMPARISON OF EXISTING APPROACHES

Author	Method	Result
SOM with fuzzy. (Murugavalli .S, Rajamani.V (2007))	HSOM-FCM	The detection of tissues like tumor detection rate is 97.3%.
The Proposed approach with Adaptive Threshold, Execution Time, Number of tumor pixel and Weights	GA	The Accuracy is 71.6% and Error rate is 0.4.& tumor detection rate i
	PSO	The Accuracy is 95.8% and Error rate is 0.13%,.& tumor detection rate is 98.87%

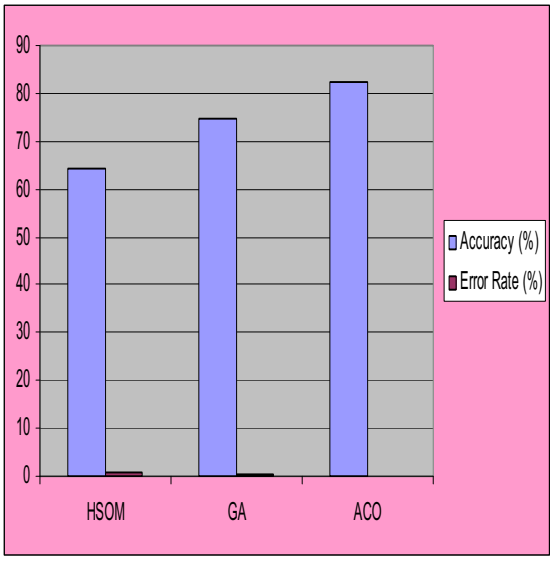

Figure 2: Performance Analyses of Accuracy and Error Rate

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