CSVTU International Journal of Biotechnology, Bioinformatics and Biomedical

Vol. 6(2), 18-32 2021 ISSN: 2455-5762

Valuable Segmentation Strategy for Tumor Detection in MRI Images

Ullas Kumar Agrawal[1], *Pankaj Kumar Mishra*[2*]

[1]PhD Scholar, Electronics & Telecommunication, Rungta College of Engineering and Technology, Bhilai, India, Email: ullasagrawal361@gmail.com

[2]Professor, Rungta College of Engineering & Technology, Bhilai, (C.G.) India
Email: pmishra1974@yahoo.co.in

Received June 18, 2021; received in revised form August 15, 2021; accepted August 2021; Available online August 2021

Abstract

Brain tumor extraction and its evaluation are tough obligations in clinical photograph processing due to the fact mind photograph and its shape is complex that may be analyzed simplest through professional radiologists. Segmentation performs an crucial function within side the processing of clinical images. MRI (magnetic resonance imaging) has come to be a in particular beneficial clinical diagnostic device for analysis of mind and different clinical images. This paper gives a comparative take a look at of 3 segmentation techniques carried out for tumor detection. The techniques consist of k-method clustering with watershed segmentation set of rules, optimized k-method clustering with genetic set of rules and optimized c- method clustering with genetic set of rules. Traditional k-method set of rules is touchy to the preliminary cluster centers. Genetic c- method and k-method clustering strategies are used to locate tumor in MRI of mind images. At the stop of technique the tumor is extracted from the MR photograph and its genuine function and the form are determined. The experimental effects imply that genetic c-method now no longer simplest dispose of the over- segmentation problem, however additionally offer rapid and green clustering effects.

Keywords: MRI, brain tumor, segmentation, k-means clustering, genetic algorithm, c-means clustering.

Research Article

1. Introduction

The mind is the maximum crucial a part of the significant worried system. The shape and feature of the mind want to be studied noninvasively via way of means of docs and researchers the use of MRI imaging techniques. The frame is made of many sorts of cells. Each kind of molileular has unique functions. When cells lose the cap potential to manipulate their growth, they divide too frequently and with none order. The more cells shape a mass of tissue referred to as a tumor [1-2]. MRI acts as an assistant diagnostic device for the docs at some point of sickness analysis and treatment. This imaging modality produces pics of gentle tissues. The received scientific pics display the inner shape, however the docs need to understand greater than peer pics, including emphasizing the extraordinary tissue, quantifying its size, depicting its shape, and so on [3]. If such duties are blanketed via way of means of the docs themselves, it could be inaccurate, time ingesting and

burden them heavily.

Segmentation is an critical method to extract suspicious place from complicated scientific images. Initially, Genetics is applied on entire t mage, due to this the preliminary populace set is pretty huge however now the scale of the populace set for the genetics is reduced [4-5]. The primary goal of the prevailing paintings is a good segmentation technique is to stumble on and extract the tumor place in MRI Images

The paper is prepared as follows: Related paintings are represented in Section II. Proposed techniques are defined in Section III. Section IV incorporates experimental consequences and discussion. Conclusions are mentioned in Section V.

1. RELATED RESEARCH

A quantity of studies papers associated with scientific photo segmentation strategies had been studied. A file of the literature survey is supplied here.

Datta et al (2011) introduced colour-based segmentation using k-means clustering for brain tumor detection. The developed algorithm shows better result than Canny based edge detection [6]. Nandha et al (2010) designed intelligent system 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) [7]. Jobin et al (2012) proposed a method which integrated the k-means clustering algorithm with the marker-controlled watershed segmentation algorithm [8]. Yang et al (2010) presented a new image segmentation algorithm W-SPK (combining watershed and K-means clustering method based on simulated annealing particle swarm optimization) to overcome the shortcomings of watershed and realize fast and accurate image segmentation [9]. Sasikala et al (2006) presented an automatic segmentation of malignant tumor in magnetic resonance images (MRI's) of brain using optimal texture features. Texture features are extracted from normal and tumor regions (ROI) in the brain images under study using spatial gray level dependence method and wavelet transform [10].

Kalaiselvi, et al (2011) proposed a method to obtain an optimal solution depends on the initial positions of the centroids of the clusters. In the existing FCM, the centroids are initialized randomly.

This leads to increase in time to reach the optimal solution. In order to accelerate the segmentation process an application specific knowledge is used to initialize the centers of required clusters [11].Not all the techniques are suitable for medical image analysis because of complexity and inaccuracy. There is no standard image segmentation technique that can produce satisfactory results for all imaging applications like brain MRI, brain cancer diagnosis etc. Problems and challenges of brain image segmentation are:

- Traditional K-means algorithm is sensitive to the initial cluster centers; cluster results fluctuate with different initial input and are easy to fall into local optimum.
- Over segmentation of Image due to limitations of the conservative watershed algorithm.

To overcome the above problems we developed an integrated k-means clustering

algorithm with watershed and optimized k-means and c-means clustering algorithm. Our work demonstrated that the method can successfully detect the brain tumor and thereby help the doctors for analyzing tumor size and region. The performance of our algorithm is evaluated based on execution time and accuracy of the algorithms. We evaluated the area of the tumor with high accuracy.

2. PROPOSED METHODS

This segment offers 3 essential strategies of photo segmentation for extraction of tumor within side the MRI images. The strategies encompass k-method clustering with watershed segmentation set of rules, optimized k– method clustering with genetic set of rules and optimized c-method clustering with genetic set of rules. The Basic method of the contrast is to enforce one-of-a-kind set of rules for segmentation of tumor place of MRI Images.

2.1. Segmentation of brain MRI images for Tumor Extraction

Segmentation of brain MRI images is implemented by combining k-means clustering and watershed algorithm. K-means clustering method helps to segment the brain tumor image and the second method improves the primary results of segmentation of tumor. The method is implemented using following steps:

i. Original image of brain tumor is acquired.
ii. The original image is converted into gray scale image since color image requires lot of time.
iii. Suitable preprocessing is applied such as reformatting the data. For example, some commands of MATLAB do not work with unsigned integer and hence the data needs to be converted into double.
iv. Histogram is obtained and two limits are determined. Generally LOW lmit indicates for black pixel and HIGH limit corresponds to white pixel.
v. The intensity values of image are complemented and adjusted so that the histogram is displayed whose number of bins can be specified. For gray scale images, 256 bins are used as default value but for 2 bins for binary image. Flow of procedures for k- means and watershed algorithm can be seen in Fig. 1.

2.1.2 Optimized k-means Clustering using Genetic Algorithm (GA)

Brain tumor detection is achieved with the help of k-means clustering which involves a number of post-processes such as visualization and analysis. The k- means algorithm is very effective; however, traditional k-means algorithm is sensitive to the initial cluster centers. If these clusters fluctuate with different initial input then problem arises [12]. Over segmentation and sensitivity to false edges are other difficulties in ordinary k-means method. Determination of exact location and area of brain tumor using k-means method becomes very difficult and hence use of genetic algorithm is suggested. GAs with the modification of mutation operations improves the speed of convergence and computing time is reduced also.

Several experimental results suggest that genetic algorithm based k-means algorithm not only eliminates the over-segmentation problem but provides fast and efficient clustering also.

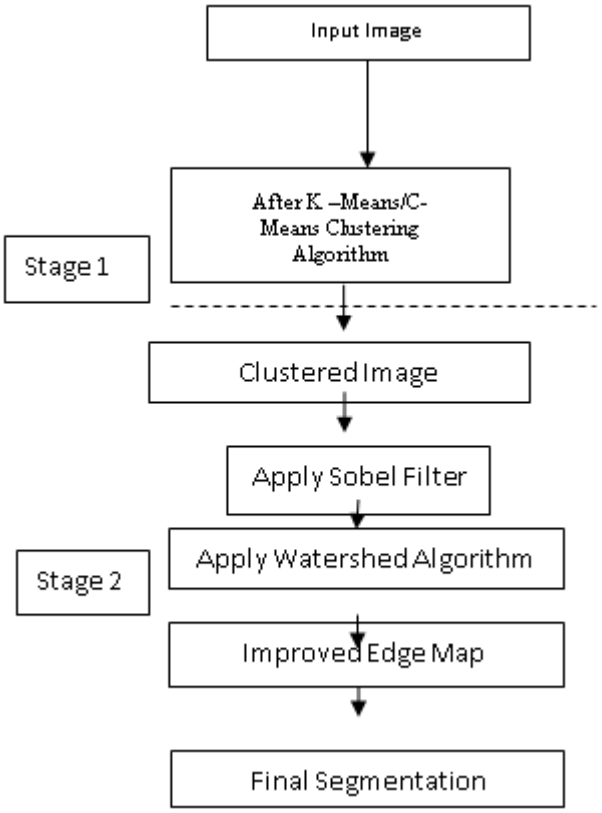

Fig. 1. Combined clustering approach

Various major steps of optimized k-means algorithm for tumor detection are:

i. Step 1: Determine the parameters of GA and generate initial population randomly.

ii. Step2: Determine upper and lower bounds of parameters.

iii. Step 3: Evaluate the fitness function of individuals of the initial population before and after optimization.

iv. Step 4: Create new set of populations by using selection, crossover and mutation operators.

v. Step 5: Evaluate the fitness of individuals of the new population and repeat Step 4 until fitness requirements are met.

vi. Step 6: Obtain clustering results and apply filtering over clustering results.

vii. Step 7: Apply morphological operation and then apply watershed algorithm to extract the tumor area.

Using the above steps, brain tumor extraction and detection is achieved using following steps:

i. Step 1: Get an original image and convert into gray scale image.

ii. Step 2: Apply some pre-processing methods such as image de-noising.

iii. Step 3: Initialize the population for GA.

iv. Step 4: Apply the clustering algorithm.

v. Step5: Assume any suitable fitness function initially.

Now, for i=1 to maximum value of iterations: repeat Step vi to Step x

vi. Step 6: Perform the Selection operation on training dataset.

vii. Step 7: Determine the Crossover of selected parents; and generate the next level.

viii. Step 8: Perform the Mutation for ignoring the values mot following fitness function.

ix. Step9: Recombine the generated child with existing population; and generate new population.

x. Step 10: Apply clustering algorithm over new set.

xi. Step 11: Generate mean of the resulting image; compare the result with suitable threshold value and obtain tumor detection resulted in final image.

2.1.3 Optimized c-means Clustering

MRI pictures of mind are segmented and tumor may be correctly extracted and detected is c-manner clustering is optimized. The c-manner clustering approach has been carried out and its overall performance may be stepped forward via way of means of the usage of optimization with using genetic algorithm. The blended approach outcomes and development in segmentation performance and better location of affected area extraction and detection. The goal of optimized clustering and its evaluation is to divide a given set of data into a number of clusters which should follow the properties given below:

i. Homogeneity inside clusters: The information or the data of a cluster is as similar as possible.

ii. Heterogeneity between the clusters: Here the data belongs to different clusters are different.

A clustering technique is used to obtain a partition of N objects using a suitable measure such as resemblance function as a distance measure''. The method involves following steps.

i. Step 1: Choose a suitable number of clusters (say 'k').

ii. Step 2: Set initial centers of clusters as c1, c2… ck.

iii. Step 3: Classify each vector x into the closest centre ci by using Euclidean distance:

a. $||xi - ci|| = Nin || xi - ci||$ (1)

iv. Step 4: Recomputed the estimated cluster centers.

v. Step 5: If no any cluster centers changes then go to Step 3.

2.1.4 Genetic Algorithm (GA)

The term Genetic is derived from Greek word "genesis" which means "to grow" or "to become", and therefore the algorithm makes a function grow. This algorithm was introduced by John Holland on the basis of a heuristic method. The method grows in search of "survival of the fittest"[13]. Since fittest is searched by the algorithm and hence used in optimization tasks, the implementation of genetic algorithm begins with an initial population of chromosomes which are randomly selected. A chromosome is a long thread of DNA (deoxyribonucleic acid). Particular traits determine the hereditary of an individual where each trait is coded by some combination of DNA bases. The four main bases of DNA are A (Adenine), C (Cytosine), T (Thymine) and G (Guanine). Just like English alphabet, the combinations of various letters give some meaningful information; GA also follows the same concept. Flow diagram of implementation of GA for an application is shown in Fig. 2.

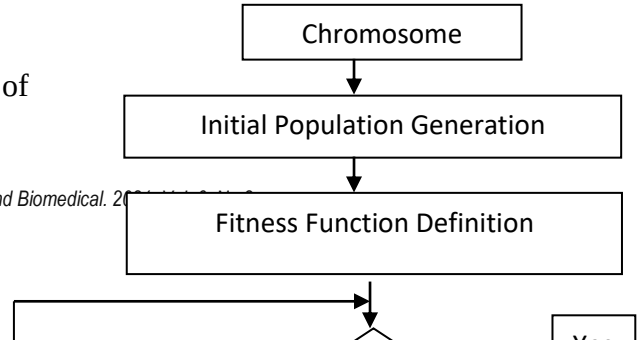

Fig. 2: Flow diagram of implementation of Genetic algorithm.

3. RESULTS AND DISCUSSION

The looking time and location of tumor area have been taken into consideration as evaluation parameters for evaluation of numerous strategies. The c-manner clustering produced properly outcomes and done higher than different optimized clustering strategies. A range of experimental outcomes have been received making use of current algorithms. In this work, round 50 MRI pictures of mind have been accrued as actual time pictures. This becomes finished with the assist of radiologists of analysis center. Some mind MRI pictures are proven in Fig. 3. These pictures are subjected to distinctive strategies for photo segmentation and detection of tumors gift within side the pictures. MRI pictures have been segmented the usage of k-manner clustering and Watershed set of rules. The approach is applied the usage of procedure of stages. The first level of the procedure makes use of k-manner clustering and number one segmentation outcomes are produced for the mind MRI pictures. Second level of the procedure is implemented as watershed segmentation set of rules to enhance the outcomes of the number one segmentation; and the outcomes received are very last outcomes.

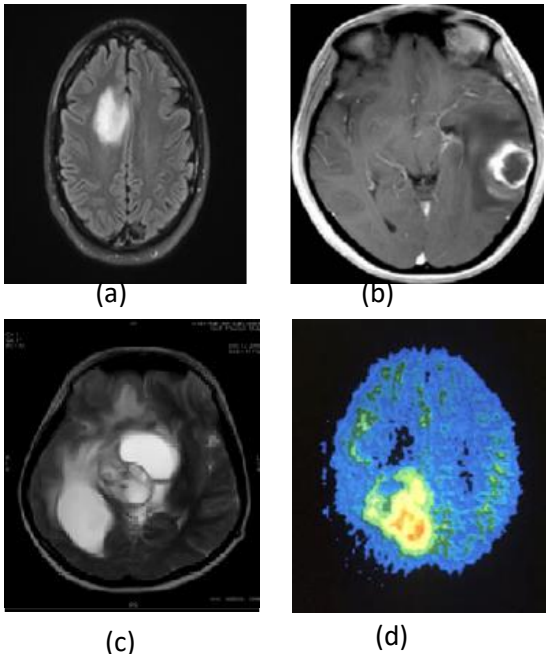

Fig 3. MRI images of brain as test images for medical image segmentation (a)-(d).

MRI images of brain were subjected to the two-stage method, whose results for first stage can be seen in Fig. 4. The results are for the test images shown in Fig. 3. Extracted tumor regions can be clearly seen in the results.

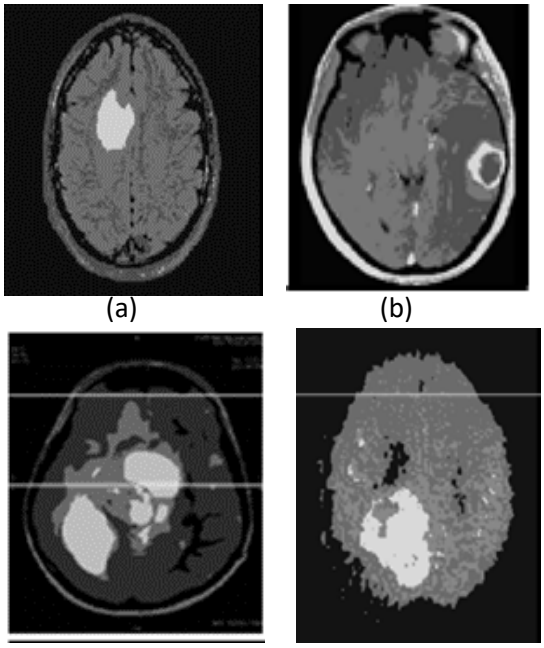

Fig. 4. Results for first stage as k-means clustering

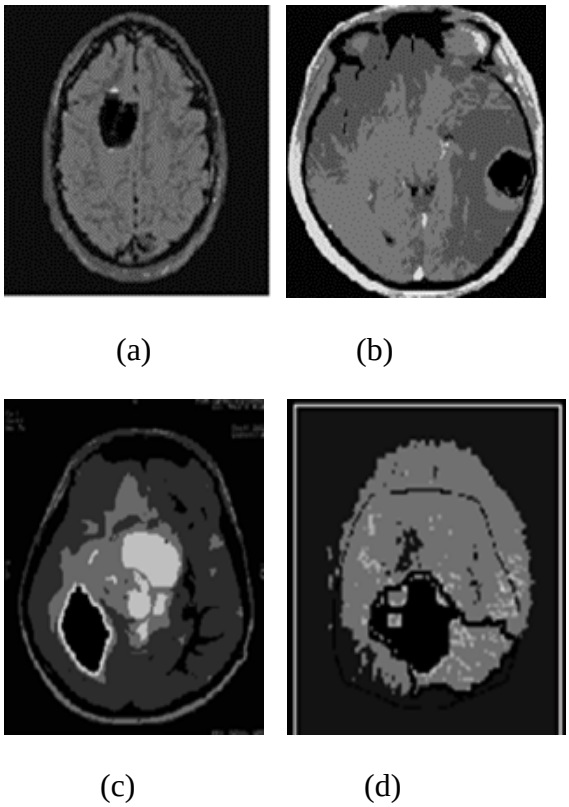

Fig. 5. Results of Watershed algorithm

Results of Watershed algorithm applied over the same test images are shown in Fig. 4; and the results of this second stage applied over the results of k- means clustering are shown in Fig. 4. A comparison of the results in terms of area is reported in Table 1.

Table 1. Comparison of Segmentation Results Produced By K-Means And Watershed Algorithm

S. No.	Test images	Total Area of image (Pixel value)	Tumor area by using Watershed algorithm (Pixel value)	Tumor area by using k-means clustering (Pixel value)
1	MRIa	55231	2419	1624
2	MRI_b	66421	1975	1246
3	MRI_c	59849	2103	1786
4	MRI_d	53179	4425	2451

The techniques have been in comparison in phrases of location which has been mentioned in Table 1. Table 2 compares conventional k-manner clustering approach with watershed Fig. 6: Fig.6. Results of combination of Watershed algorithm and k-means clustering method tumor region.

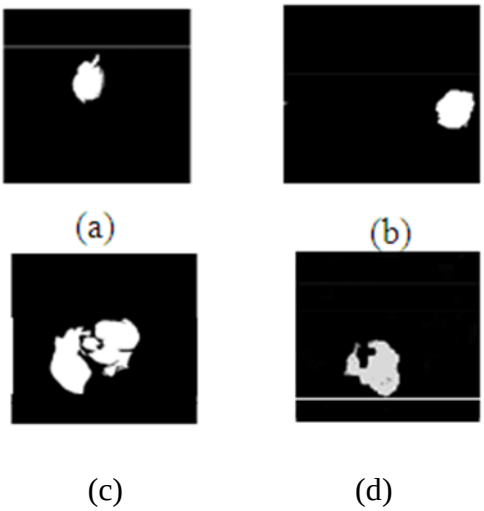

Fig.6. Results of combination of Watershed algorithm and k-means clustering method tumor region.

Table 2. Comparison of Traditional K-Means And Optimized Method

S. No.	Test images	Tumor area using traditional k- means clustering (pixel value)	Tumor area using optimized k- means clustering (pixel value)
1	MRI_a	698	823
2	MRI_b	597	798
3	MRI_c	624	729
4	MRI_d	729	913

Table 3. Comparison C-Means And Optimized Clustering Methods

S. No.	MRI test images	Traditional c-means clustering (Tumor area in pixels)	Optimized c-means clustering (Tumor Area in pixels)
1	MRIa	642	902
2	MRIb	623	856
3	MRIc	598	829
4	MRId	689	1013

Performance of the approach come to be evaluated and in comparison, the methods. The optimized c-method has addressed the trouble of over segmentation and given better results in terms of segmented and extracted area. Level of segmentation in clustering set of regulations in case of optimized approach is an entire lot better than that of normal clustering set of regulations. The trouble of over segmentation has moreover been reduced. The tumor area is extracted well from corners of the segmented regions moreover. The approach produces sharp results for thoughts tumor detection of MRI images. Table 3 compares the two methods. Table 4 gives a evaluation amongst optimized k-method and optimized c-method clustering methods. It can be seen that optimized c-method perform better that optimized k-method approach; due to the fact the segmented area and degree of find out area is better in optimized c-method clustering.

Table 4. Comparison Of Optimized K-Means And Optimized C-Means Clustering.

S. No.	Test images	Tumor area using optimizedk-means clustering (pixel)	Tumor area using optimized c-means clustering (pixel)
1	MRI_a	823	902
2	MRI_b	798	856
3	MRI_c	729	829
4	MRI_d	913	1013

Table 5. Comparison Optimized Methods In Terms Of Search Time.

S. No.	Test images	Search time for optimized k-means clustering with number of iterations (sec.)	Search time for optimized c-means method with number of iterations (in sec.)
1	MRI_a	66.879(104)	3.998(104)
2	MRI_b	64.568(102)	3.998(102)
3	MRI_c	70.435(105)	4.125(104)
4	MRI_d	73.249(107)	5.987(103)

Another comparison was also made in terms of search time for optimized k-means and c-means methods reported in Table 5. The time required is less in optimized c-means clustering method as compared to k-means method. Therefore, c-means clustering method can be considered as more efficient than optimized k-means clustering algorithm.

5. CONCLUSION AND FUTURE SCOPE

The segmentation of brain MRI images using k- means, c-means and optimized methods were implemented. Following are the outcomes of the work:

i. Segmentation was achieved for all the proposed methods tumor detection was done.

ii. The k- means clustering with watershed segmentation algorithm, optimized k –means clustering with genetic algorithm and optimized c- means clustering with genetic algorithm were the main methods.

iii. A comparison was also made in terms of tumorregion and search time.

iv. The c-means clustering after optimization was found better than other methods.

v. The problem of over segmentation was also addressed.

vi. The genetic algorithm improves the convergence and computing time is reduced.

The further research scope of present work is to implement the methods for 3D images of brain tumor MRI. Other parameters such as volume and growth rate of tumor can be extracted to produce better segmentation results and their performance

Conflicts of interest: Authors have no conflict of interest to declare.

REFERENCES

[1] Selvy, P. T., Palanisamy, V., & Purusothaman, T. (2011). Performance analysis of clustering algorithms in brain tumor detection of MR images. European Journal of Scientific Research, 62(3), 321-330.

[2] Ratan, R., Sharma, S., & Sharma, S. K. (2009). Brain tumor detection based on multi-parameter MRI image analysis. ICGST-GVIP Journal, 9(3), 9-17.

[3] Bandyopadhyay, S. K., & Saha, D. (2011). Brain region extraction volume calculation. UNIASCIT, 1(1), 44-48.

[4] Gopal, N. N., & Karnan, M. (2010, December). Diagnose brain tumor through MRI using image processing clustering

algorithms such as Fuzzy C Means along with intelligent optimization techniques. In 2010 IEEE international conference on computational intelligence and computing research (pp. 1-4). IEEE.

[5] Kaur, A., & Jindal, G. (2013). Overview of tumor detection using genetic algorithm. International Journal Of Innovations In Engineering &Technology (IJIET) Vol, 2.

[6] Datta, S., & Chakraborty, M. (2011). Brain Tumor Detection from Pre-Processed MR Images using Segmentation Techniques. In IJCA Special Issue on "2nd National Conference-Computing, Communication and Sensor Network" CCSN. Published by Foundation of Computer Science, New York, USA. vol.2, pp.1-5.

[7] Gopal, N.N.; Karnan, M. (2010), "Diagnose brain tumor through MRI using image processing clustering algorithms such as Fuzzy C Means along with intelligent optimization techniques," IEEE International Conference on Computational Intelligence and Computing Research (ICCIC),vol.2, no.3, pp.1-4.

[8] Christ, M. J., & Parvathi, R. M. S. (2012). Magnetic resonance brain image segmentation. International Journal of VLSI design & Communication Systems, 3(4), 119..

[9] Yang, W., Zeng, Z., & Zhang, S. (2010, January). Application of combining watershed and fast clustering method in image segmentation. In 2010 Second International Conference on Computer Modeling and Simulation 3, 170-174. IEEE. doi:10.1109/ ICCM2010.407.

[10] Sasikala, M., Kumaravel, N., & Subhashini, L. (2006). Automatic tumor segmentation using optimal texture features. IET 3rd International Conference On Advances in Medical, Signal and Information Processing, MEDSIP, pp.1-4.

[11] Kalaiselvi, T., & Somasundaram, K. (2011, June). Fuzzy c-means technique with histogram based centroid initialization for brain tissue segmentation in MRI of head scans. In 2011 international symposium on humanities, science and engineering research (pp. 149-154). IEEE.

[12] Christ, M. J., & Parvathi, R. M. S. (2012). Medical Image Segmentation using Fuzzy C-means clustering and Marker Controlled Watershed algorithm. International Journal of modern engineering research, 2(1), 408-411.

[13] Camastra, F., & Verri, A. (2005). A novel kernel method for clustering. IEEE transactions on pattern analysis and machine intelligence, 27(5), 801-805.