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Novel Mechanism of Segmentation of Brain Tumor Using Firefly Algorithm

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ABSTRACT

In general, techniques such as clustering, thresholding and region growing are widely used in bio-medical applications. However, these techniques are computationally intensive and suffer from segmentation faults. Currently, there are 120 different types of brain tumors are recorded all over the world. Amongst all tumors, brain tumors cause the second largest amount of deaths in children and young adults. Early detection and treatment for these tumors will save many lives. In this paper, we are automating the traditional tumor detection procedure by applying nature-inspired algorithm called firefly algorithm. The ***firefly algorithm*** *is a higher level procedure that gives a very good solution to the optimization problem. The optimization is achieved by the fire flies with their sporadic behavior[4,13]. Here, the firefly algorithm is used to detect tumors in MR images by using clustering technique. Among all the traditional clustering algorithms such as Fuzzy C-means, thresholding, K-means, region of interest, the firefly algorithm is more efficient and gives better result in clustering the brain tumor images.*

Keywords- *Brain tumor, Fuzzy C-means, Firefly Algorithm, K-means,MRI*

I. INTRODUCTION

Tumors are formed when cells divide and grow uncontrollably in the body. Tumors are abnormal growths of body tissue. They can be cancerous (malignant) or non-cancerous (benign). It is quite natural that newer ones replace the older cells in human body. A tumor (cancerous) may form when the balance between cell growth and cell death is disturbed. In tumor the ratio of cell growth is more compared to cell death. These abnormal cell growths will be accumulated in the brain or in central spinal canal forming the tumor. Currently, the number of cancer patients outnumbers the experienced radiologists by a great extent. There have been a number of cases, where inexperienced radiologists have produced incorrect reports, so the automation of entire procedure of tumor detection is in great demand and motivation for the researchers to accomplish accuracy in the tumor detection in a very less time as well as in cost effective manner. The major issue with the segmentation is to mark the tumor which includes other substance in the brain such as grey matter, white matter and cerebrospinal fluid [2]. Automated tumour segmentation is very complicated. The accuracy of segmentation depends on intensity, location, size and shape of the tumor. It is difficult to come out with proper model of automated segmentation. Some of the problems encountered while detecting and automating the tumour are specified [3]

II.RELATED WORKS

Some of the existing classical methods are based on thresholding, edge, region based techniques and region growing. In the method of thresholding special information is ignored. Typically, spatial information plays a prominent role in detecting the tumour. In addition to this limitation, it considers the images having only two limits. The upper limit is considered to be white and lower limit is considered to be as black. Normally, bit map images contain 0 to 255 grey scale values. Hence, the consideration of just two values (black or white) instead of all the grey scale values may lead to segmentation faults as seen in Deepthi Murthy T S et al[1].

In the region growing algorithm proposed by A.R.Kavitha [5] the selection of seeds is chosen by interacting the user.(Centre of Tumour cell). The chosen seed has to be the centre of the tumour for the correct implementation of this method. Due to the complication in selection of seeds, this method suffers from accuracy problem.

In the last few decades, the most common segmentation algorithm used is fuzzy c-means algorithm. In this algorithm, fuzziness was introduced in order to create a membership for each image pixel. This produces a clustering method with the ability to preserve extra information and details from the original data when compared to the brusque K-means clustering algorithm as per Vijay et al [6].

Recently, many researchers such as Kouhi et al[7], have improved the performance of the FCM algorithm by incorporating local spatial information (FCM_S). The improvisation of this algorithm not only introduces the fuzziness among the pixel but also to exploitation of special contextual information. However, this algorithm is sensitive to the noise and the main disadvantage with the FCM_S technique is, large delay encountered, when generating the output as all its iterations preconditioned in order to calculate the fresh neighborhood term. FCM_S1 and FCM_S2, two variants of FCM_S algorithm in order to decrease the computational time. These two algorithms introduced the extra mean and median filtered image, respectively, which can be computed in advance, to replace the neighborhood term of FCM_S. Thus, the execution times of both FCM_S1 and FCM_S2 considerably reduced.

In enhanced fuzzy c-means (EnFCM) the image segmentation process is accelerated as proposed byBalafar et al [8]. In EnFCM “the number of gray levels is generally much smaller than the size of the image” and hence the computation time as well as the complexity decreased drastically. Above all algorithms share common parameter called α. The selection of α is extremely important and should be very accurate else the prediction of tumor goes wrong.

Recently, neural network proposed by Joshi et al [9] has been used to solve the tumour detection problem. In this approach, initially MR image is processed to remove the noise. Typically, Gaussian Filter is used in this stage. Pre-processing stage also involves RGB to Grey image convertor. Latter stages mainly involves in training the neural nets by using the extracted features such as mean, area, co-variance and correlation. Finally, by using the trained neural nets tumour region is detected in MR image. This approach suffer from many drawbacks like very difficult to select the appropriate feature very monotonous and time consuming to train the neural nets for exhaustive data set.

Moreover, NN majorly depends on the training algorithm; in practice, it is very difficult to design a training algorithm for exhaustive database. All these setbacks call for an algorithm, which works independent of training algorithm[10] and efficient enough to detect the brain tumor. We have developed an unsupervised method for brain tumour detection in MRI using a nature inspired algorithm namely Firefly Algorithm [11][12].

III ALGORITHM : TUMOR DETECTION

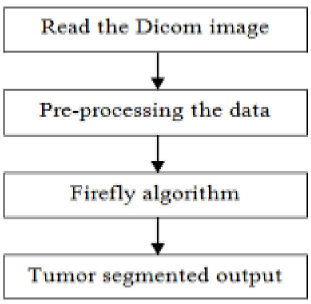

Fig1: Block diagram for tumor detection

The tumor detection is carried out as shown in fig1. After reading the DICOM image, pre-processing is carried out. Pre-processing is a stage where unwanted noise signal and specular reflections are removed in Dicom images. There are many pre-processing algorithm, such as median filter, Gaussian filter, Histogram equalization, linear and non linear approach.

3.1 FIREFLY ALGORITHM

The Firefly Algorithm is very good at detecting optimal values from a dataset. This property of the Firefly Algorithm can be used to deduce optimal values from objective functions. By doing so, we can perform various tasks such as image segmentation, image classification and object detection. The flashing patterns of the fireflies are often solely representative of a particular species. The primary functions of these flashes are to catch the attention of partners for mating and to pull towards the prey.

- All fireflies catch attention of each other by their flash despite of their gender.

- Catching the attention is directly proportional to their brightness. Attractiveness as well as brightness decrease as there is an increase in distance between the concerned fireflies. The duller firefly will move towards the brighter one. If both fireflies have same levels of brightness, the movement of one firefly to the other will be decided in a random manner.
- The brightness of the firefly is decided by the objective function.

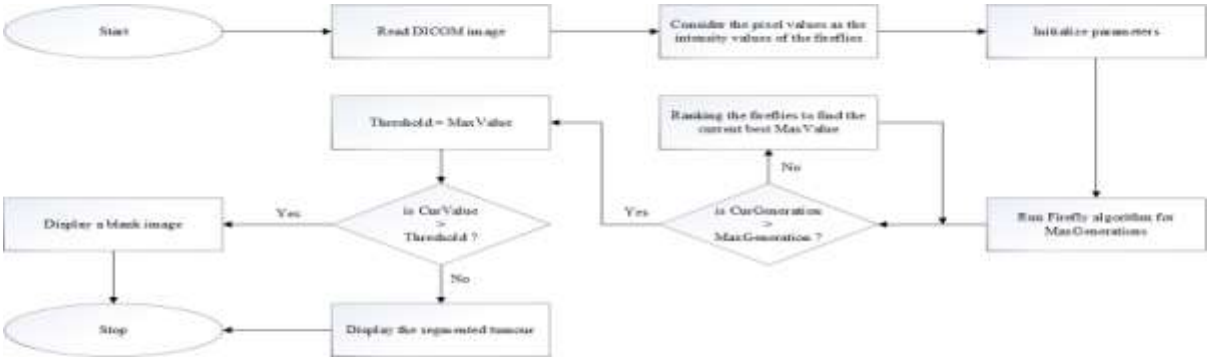

Fig2: Flow chart of proposed algorithm.

We have proposed an algorithm to detect tumour based on the existing firefly algorithm. In our algorithm, we have assumed the pixels of MR Image as "intensities". Initially, we find the threshold in the MR image. This threshold plays a prominent role in reducing the computation time and as well complexity. Upon finding the threshold, entire tumour detection problem boils down to binary cluster problem with only two values. We brief our algorithm in three steps.

Step 1: Read DICOM image. Consider the pixel values of image as intensity of fireflies. Initialize number of fireflies (n), number of generations, degree of randomness in movement of fireflies (It is determined by the alpha value (α)). Attraction coefficient beta (β) which determines the strength of attraction with respect to distance, absorption coefficient gamma (γ) which ensures that attraction reduces with increase in distance and finally, delta value (δ) which reduces random nature of moving fireflies with each iteration (generation).

Step 2: According to the lemma, "The fireflies of lesser brightness move toward the brightest firefly in its vicinity". In our work, we have used this property of the Firefly Algorithm to determine the "threshold". This is done by ranking the fireflies in the order of increasing intensities. By doing so we get the fireflies with maximum intensity, which is intern used to cluster all the intensity values into two groups.

Step 3: In this step tumour detection problem boils down to a two-cluster problem. If the tumour is present in the image, the movements of the fireflies ensure the brightest fireflies represent the tumour. In the absence of tumour, the movement of fireflies will be random, which is determined by the unique intensity values.

VI. RESULTS AND DISCUSSION

In this work, we applied the Firefly algorithm on MR Images to detect the presence or absence of a tumour. We presented the results obtained using the Firefly algorithm

4.1 Dataset description

We have used the raw DICOM (Digital Imaging and Communication in Medicine) images, to verify the efficiency and effectiveness of the Firefly Algorithm. The 10 axial, T2 weighted MR brain image slices are considered as the test images, which is of size 512 x 512. In order to assess the efficiency of the proposed algorithm, it has been compared with algorithms like Fuzzy C-means and Region of interest property.

4.2 The results of region of interest

We created the database of DICOM images and performed binarization filtering and then we found the areas of connectivity in the images. The results were inaccurate for the real time images, since it suffers from segmentation faults as shown in fig 3

4.3 The results of Fuzzy C-means clustering technique.

We used Fuzzy C-means to segment the images. Initially, we used K-means to segment the image in to two segments and then generalized the technique to get 'n' segments from images by slightly modifying the algorithm. The obtained results were not promising since it suffers from segmentation faults as shown in fig4.

4.4 The results of fire fly algorithm

In our method we're using the converging nature of the Firefly Algorithm with the intention of finding the best possible threshold for tumour detection in the magnetic resonance images (MRI). The main aim is to ensure that tumours are detected only when present. The obtained result clearly indicates the accurate segmentation as shown in fig5

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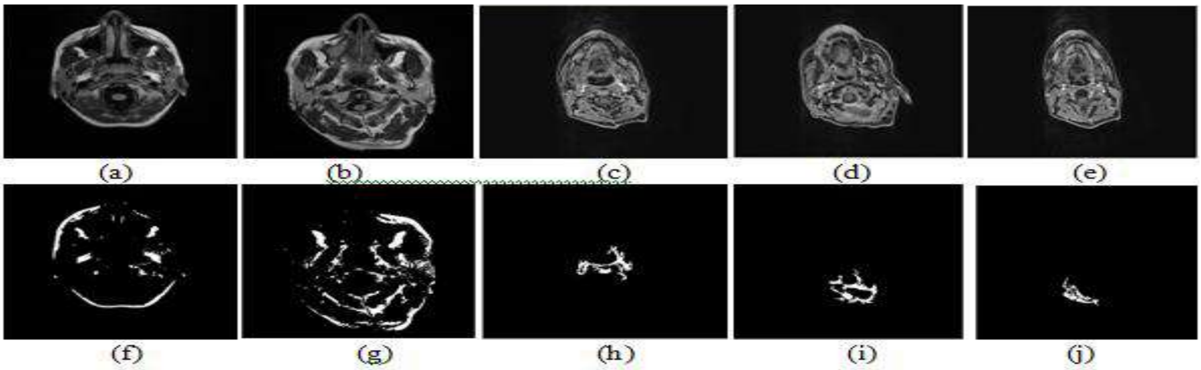

Fig 3: Results of region of interest, (a) and (b) MR images without tumour, and (c) through (e) are MR images with-tumour. (f) through (j) are segmented MR image

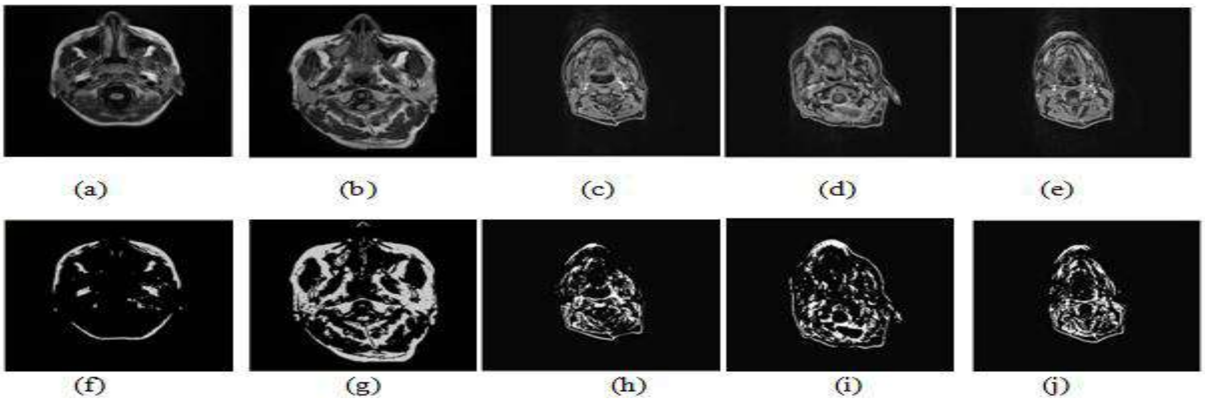

Fig 4: Results of Fuzzy C-means clustering technique. (a) and (b) MR images without tumour, and (c) through (e) are MR images with-tumour. (f) through (j) are segmented MR image.

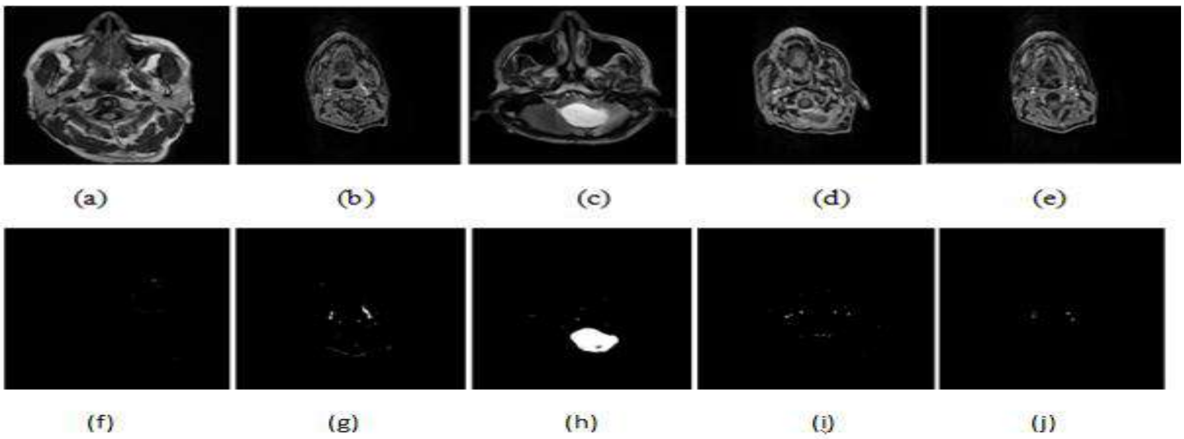

Fig 5: Results of fire fly algorithm (a) and (b) MR images without tumour, and (c) through (e) are MR images with-tumour. (f) through (j) are segmentedMR images

V. CONCLUSION

In this paper, we have presented an unsupervised algorithm i.e. Firefly Algorithm for the detection of brain tumours. The MRI image dataset has been taken and the performance of proposed technique is estimated by comparing it with other well-known techniques such as Region of interest analysis and fuzzy C-means. Detection of the tumor is assessed with performance metrics specifically sensitivity, specificity and accuracy. From the results obtained, we could conclude that our unsupervised technique acknowledged a better quality results for the entire data set of input images.

VI. ACKNOWLEDGEMENT

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