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Computer Aided and Invasive Weed Optimization Based Dicom Image Diagnosis

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Abstract: Tumor diagnosis using dicom images were improved by different machine learning models. These machine learning models need specific image feature values for training. Algorithms should be dynamic to adopt any kind of input diacom image for tumor detection without prior training. Preprocessing steps of tumor detection increase the final accuracy of models. Input image noise and skull play an adverse effect on tumor diagnosis, so this needs to be preprocessed before detection. This paper has proposed IWOTD (Invasive Weed Optimization Tumor Detection) a model for brain tumor detection for Dicom images. Pre-processing of input image was done by Computer-Aided Diagnosis in which a second-order statistic filter was applied for noise removal and skull pixel extraction. Further paper has applied a Invasive Weed Optimization algorithm for identifying the cluster center pixels in the image. Finally, the image gets clustered into the tumor and non-tumor regions. The experiment was done on a real daicom image dataset. Results show that the proposed work has increased the evaluation parameter values as compared to other existing models.

Index Terms— Brain Tumor Detection, Image De-noising, Image Processing, Genetic Algorithm.

I INTRODUCTION

When in concern about the human body and its functioning, the brain is the most important part to be on the alert with. As it is the like the governor of the body without whose, there can't be any functioning to allow and happened. It controls all the body parts of humans and takes action over it like emotions, intelligence, speech, movements, senses, thoughts, physical activity, taste, creativity, etc. [1] therefore, a small damage or mishap in any part of it or even a tiny defect can lead to totally disturb in the system of the human body or may cause change in behavior that is abnormal behavior. So, there always requires to have proper care of this crucial part.

Nowadays there have been various problems indulges in the humans of the brain and its diseases among these the serious concerns are about the common problem is that of the brain tumor, which is life threatening too. This tumor is been diagnosed by almost nearly 11,000 people per year [2]. Basically, a brain tumor is the anomalous growth of the flesh in the brain having uncontrolled growth and multiplication of cells [3]. There are almost 130 types of brain tumor that are varying due to their speed of growth, size and expansion, cells multiplication, a position they

are, the position of existence, etc. typically there are only two types of primary brain tumor and secondary brain tumor [4]. A primary brain tumor is a type that stems inside while the secondary brain tumor has the origination in some other part of the body as like lungs but the stems drifts towards brains mostly because of a stream of blood [5].

MRI is being a common name under the scanning of the brain tumors and its related images, due to the easy tracing of tumors through this. It provides the digital representation of tissue and its characteristics in any tissue plane. The MRI is being popular because of its advantages of displaying images in vertical and horizontal slicing of two planes. Also, they are easy to identify, detect, and classify the tumor easily. Today's techniques are human experience interpretation which causes errors in images. Digitally images can be clear and segmentation is used to gain the information from its complexity [6]. MRI (magnetic resonance imaging) that the major technique used to diagnosed brain tumors and its treatment. Different modalities of patients depending upon the handling of complexity, time, and constraints are to take the computer-based image analysis method [7].

II. Related Work

H.N. et. al.in 2017 proposed using a blind source separation technique for the extraction of MRSI data from the tissue-specific profiles and their distribution. A novel algorithm is used for the detection of the tumor, necrotic, and normal tissues from the MRSI signals. In which firstly this algorithm uses the window method for the peaks enhancing an reducing the length, which later builds the 3-D MRSI tensor. Thus, for finding the tissue-specific spectral profiles of the NCPD (nonnegative polyadic decomposition), there occurs the decomposition of the tensor using this NCPD by allowing in mode 1 and mode 2 common factor to retrieve tissues.

Alexander Zotina et. al. in 2017 describes the solution of the image clarity and clearance by using the minimum number of the configuration parameters upon input image. For this, they acquired the medical specialist procedure by distributing into two sets of digital procedures. In which in set one they concentrate upon the quality of image and segmentation of object of concern that is tumor by forming the edge map. In the set two, they made the analysis of data by calculating those parameters obtained by the diagnosis.

M. Li. Et. al. in 2019 experiments the two-methods combination of the multi-modal combination fusion and convolution neural network detection method. In this paper, there wa use of the 2D CNN and 3D CNN multimodal extension by getting brain lesion for different characteristics in 3D. by solving the 2CNN of raw input for the different modal information at raw input faults. To eliminate the problem of overfitting there ws the addition of real normalization layer in the convolution and pooling layer to improve the convergence speed. Resulting in the improvement of loss function, so weighted loss function is added in the lesion area to develop the feature learning.

Hong huang et. al. in 2019 for the image segmentation method uses the FCM clustering algorithm with a rough set theory. The authors construction the attribute table by the values obtained from the FCM segmentation result and the image is divided into small areas on the basis of the attributes. Weighted values are obtained by value reduction and used for the calculated difference between the region and similarity of the region. Later was realized through equivalence difference degree. This final value of equivalence degree is used to evaluate the segmentation of images and merge regions. The method has the limitations up to only MRI images of brain and CT, artificially generated images.

N. Noreen et. al. in 2020 utilizes the techniques of multilevel feature extraction and concatenation to detect early diagnosis of the tumor. In this project uses the two models that are Inception V-3 and DensNet201 for the creation of the two different modes for the identification and diagnosis of tumors. At initially the features of the inception model were extracted from the pre-trained

inception model V3 and concatenated also for the tumor detection. Later passed through the SoftMax classifier for the classification of the brain tumor. Similarly done with the DensNet201 for the extraction of features from the Dens Netblock and concatenation completed and later passing through SoftMax classifier for determining the tumor. Thus, both modes are check by three class tumor datasets which is publicly available.

Hari Mohan Rai et. al. in 2020 develops the deep neural network with a minimum number of layers and less complexity in the design of U-Net for diagnosing tumor. There the motive of classification of normal and Abnormal images of the MRI images from the data sets of 253 images. Before this MRI images were resized, cropped, pre-proceed, and augmented for the accurate result and fast training for the deep neural network.

III. Proposed Methodology

Proposed IWOTD (Computer-aided and Genetic Algorithm Based Brain Tumor Detection) model working steps were shown in fig. 1. Whole model was divide into three sections first was Computer-aided detection (CAD), the second was cluster center detection by Shuffling Frog Leaching Genetic algorithm (SFLGA) and the third was brain tumor detection. Explanation of each module was done in this proposed methodology section of the paper.

Computer-Aided Detection

CAD is the most effective technique to diagnose the tumor in the Magnetic Resonance Image (MRI). Brain tumor images in the form of Dicom format has high noise as 3D object transforms in digital data while acquisition [14]. A number of different parts or chemical objects are sculpture, white matter, cerebrospinal fluid, tumor cell, etc. [15]. So some of the common CAD steps are involved in this module are: pre-processing, blurring, and skull removal.

Pre-Processing: Input image was converted into the grayscale format by involving so dependency of any format of the module was reduced. As almost all types of images were transformed in grayscale [16]. Some other text-based relevant information also detached from the input data as work does not need that information.

$$PI \leftarrow \text{Pre-Processing}(I) \text{---------Eq. 1}$$

In the above equation, the input image was I and PI (Pre-processed Image) was the output of this step where PI was two-dimension gray scale image has a pixel value range between 0 to 255.

Blurring: Its a noise removal technique in the spatial domain of the image. This work applies an order statics filter which preserves the edge portion of the image and works in non-linear way [17, 18].

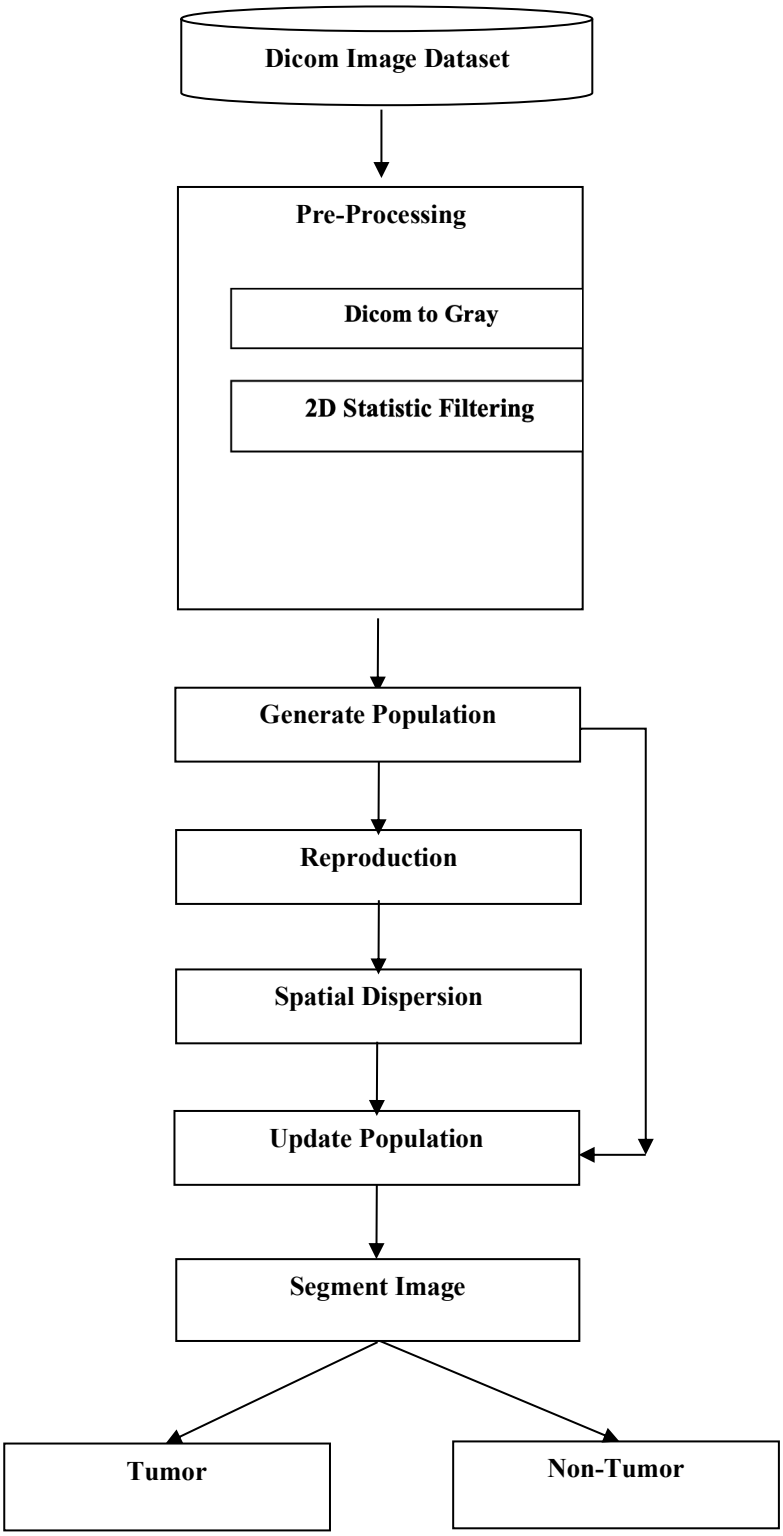


Fig. 1 Block diagram of proposed IWOTD model.

Hence smoothing of the image was performed by analyzing the filter area in the image and replaced the center pixel with ranked pixels in the area. This filter applied minimum value replacement where neighboring pixel values were observed this observation depends on filter size, hence non-linearity was performed by the filer. Finally paper remove noise by passing pre-processed image into 2D order statics filter.

Skull Removal: The filtered image was further process by removing the skull part of the brain MRI image. Hence detection of this skull was performed by finding the pattern of skull pixels in the image. As top angel input MRI image has a skull in an oval shape, so identifying the part of the skull was done in this paper by converting the FI in binary format and detect the white and black pixel patterns from left to right movement. This process was further repeated for the right to left movement with a pattern of the white and black pixels. Hence each type of movement identify the skull portion of the pixel in a row.

Binary image white pixel values were replaced by gray pixel value so the brain part of the image was passed further to get the cluster center of the image.

Invasive weed Optimization Algorithm

Generate Seeds

Each element in S_P act as seed element in the algorithm. Chromosomes in the population are seeds. Seed is a vector of pixel values randomly select as cluster center. Selection of random pixel value range from 0 to 255 is done by Gaussian distribution function. Population matrix is of CxS dimension where C is number of cluster center and S is number of seeds in the population.

$$S_P \leftarrow \text{Gaussian\_Distribution}(t, s) \text{ --------Eq. 1}$$

Reproduction

In this step fitness of the seed was checked by bowing in a area and check its production. Production of seed was test by fitness function. Chromosome having good fitness value are promote while other are replace or transform into other type of seed. Fitness value of each seed needs to be calculated by clustering the input brain Dicom image as per pixels in a set of the seed. Summation of difference

between the cluster center and image pixel is the final fitness value of a seed.

$$FV_s = \sum_1^M \sum_1^N \frac{1}{\max(\sqrt{FP_{s,c} - BI(m,n)})^2} \text{----------Eq. 2}$$

Spatial Dispersal

Fitness value of seed helps to find the better seed set. To improve the solution seed quality some changes need to be done randomly in low quality seeds. This operation act as crossover operation done in genetic algorithm. As solution need improvement in each iteration hence seed element get change from good seed pixel value. This can be understand let best fitness seed in a memeplex has {S1, S5} set and another seed in memeplex has {S2, S8} set than in crossover operation new child if randomly takes first position feature from best seed than child seed has {S1, S8} pixel set.

$S_p \leftarrow$ Dispersal(S_p, FV) ----------Eq. 5

Optimize Features

In this step, if the new seed fitness value is better than parent seed then parent seed was removed from the population otherwise childe seed is not taken in population. Finally, this has one final step of the genetic algorithm where number of iterations were checked if iteration reaches maximum counter than stop algorithm and best fitness in the population is the final solution, otherwise, iterate from the fitness function step.

Segment Image

In this module output of IWOTD is a cluster center set that can divide the image into the tumor and non-tumor region. Each grayscale pixel value of BI was compared with the cluster center and a highly matching cluster center occupies the pixel. So the whole image was cluster into two groups (tumor and non-tumor).

IV. Experiment and Result

Proposed model was developed on MATLAB and the experiment was performed on I3 processor have 4 GB RAM with windows operating system. A comparison of the proposed model was done with Rough Set Theory based tumor detection in MRI images.

Dataset: Dicom brain tumor dataset images were taken for the experimental part. Each image has 464x464 dimensions and top view brain tumor images were taken for the experimental evaluation. Each Dicom image has its own ground truth image as well for parameter evaluation.

Evaluation Parameters

$$\text{Pr}ecision = \frac{TruePositive}{TruePositive + FalsePositive}$$

$$\text{Re}call = \frac{TruePositive}{TruePositive + FalseNegative}$$

$$F\_Score = \frac{2 * \text{Pr}ecision * \text{Re}call}{\text{Pr}ecision + \text{Re}call}$$

$$Accuracy = \frac{Correct\_Classification}{Correct\_Classification + Incorrect\_Classification}$$

$$FPR = \frac{False\_Positive}{False\_Positive + True\_Negative}$$

Results:

Table 1. Experimental Image outcomes.

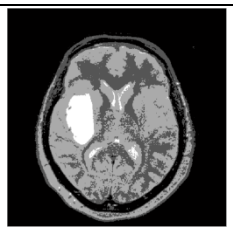
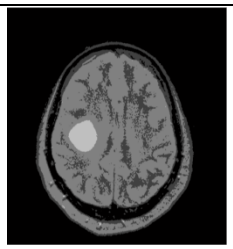
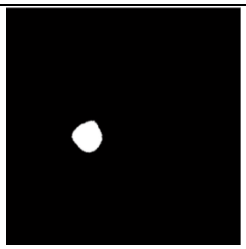
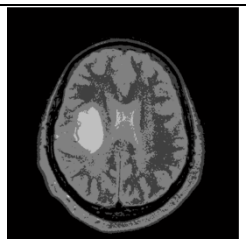
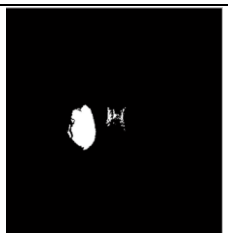
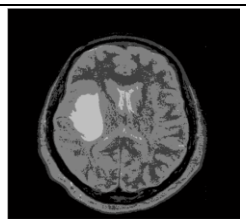
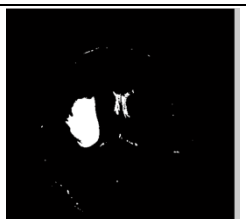
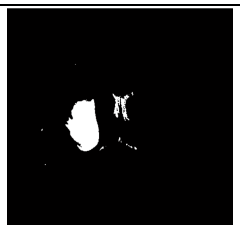
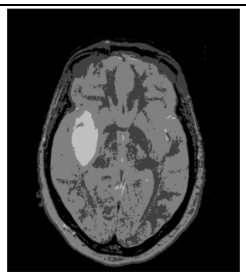
Dicom Image	RST [11]	IWOTD
		
		
		
		
		

Table 2 Precision values based comparison of tumor detection algorithms.

Dicom Image	RST [11]	IWOTD
DiconImg1	0.9759	0.9971
DiconImg2	0.9876	0.9998
DiconImg3	0.9815	0.9988
DiconImg4	0.9734	0.9989
DiconImg5	0.9838	1

Table 3 Recall values based comparison of tumor detection algorithms.

Dicom Image	RST [11]	IWOTD
DiconImg1	0.9973	0.9973
DiconImg2	0.9959	0.9959
DiconImg3	0.9951	0.9951
DiconImg4	0.9958	0.9938
DiconImg5	0.9933	0.9975

Table 1 shows that proposed model has increases the precision value parameter of tumor region pixel detection. Use of invasive weed optimization algorithm improve the cluster center selection work. Approach of order statics filter has increase the fitness of the work for optimizing the work cluster center detection. It was found in table 3 that recall value was enhanced by 0.04% as compared to previous approach of tumor detection proposed in [11]. Similarly precision value was improved by 1.84%.

Table 4 F-Measure values based comparison of tumor detection algorithms.

Dicom Image	RST [11]	IWOTD
DiconImg1	0.9865	0.9972
DiconImg2	0.9916	0.9978
DiconImg3	0.9882	0.9969
DiconImg4	0.9845	0.9963
DiconImg5	0.9886	0.9886

Table 5 Accuracy values based comparison of tumor detection algorithms.

Dicom Image	RST [11]	IWOTD
DiconImg1	97.3365	99.4499
DiconImg2	98.3601	99.5705
DiconImg3	97.6785	99.398
DiconImg4	96.9504	99.2882
DiconImg5	97.7420	97.7509

Table 4 shows that inverse average of precision and recall parameter values of different set of images were improved by the proposed IWOTD model. Use of filter and genetic algorithm has increases this work performance. Table 5 shows the accuracy parameter value of the work by 1.48% as compared to RST [11].

V. CONCLUSION

Medical images obtained from different resources is a great tool for diagnosis of various images. As number of patient increases day by day hence load on medical officers also increases. In order to this load technology take few responsibility for easiness of the work. This work takes brain computer aided diagnosis (CAD) images as input and identify the tumor region in the image. For reducing the false area detection proposed model apply some noise removal filter like Gaussian, median. This work use Invasive weed optimization genetic algorithm for the pixel classification as per filtered image. Dynamic adoption of genetic algorithm does not need any prior training or information. Experiment will be perform on real dataset images. Result shows that recall value was enhanced by 0.04% as compared to previous approach of tumor detection proposed in [11]. Similarly precision value was improved by 1.84%. accuracy parameter value of the work by 1.48% as compared to RST [11]. In future scholar can work on other format of images.

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