An Automated Method for MRI Based Brain Tumor Detection using Berkeley Wavelet Transformation and Support Vector Machine

V. Vinay Kumar, K. Sai Krishna, S. Kusumavathi

Abstract:-In this research work, a new automated system is developed for brain tumor detection by using Magnetic Resonance Imaging (MRI) on the basis of machine learning techniques. The major concerns in the brain tumor detection are time consuming, and the classification accuracy dependsonly on clinician's experience. To address these issues, a new supervised system is developed for brain tumor detection. In this research study, a new segmentation approach was used for improving the brain tumor detection performance and to diminish the complexity of the system. Initially, Anisotropic Diffusion Filter (ADF) was used as an image pre-processing technique for removing noise from the collected brain image. Then, Berkeley Wavelet Transformation (BWT) was utilized for converting the spatial form of pre-processed MRI image into temporal domain frequency. Besides, Support Vector Machine (SVM) was usedas a classification technique to classify the normal and abnormal regions. SVM classifier effectively diminishes the size of resulting dual issue by developing a relaxed classification error bound. In addition, the undertaken classification approach quickly speed up the training process by maintaining a competitive classification accuracy. From the experimental analysis, the proposed system improved dice coefficient >0.9 compared to the existing systems. The experimental investigation validated and evaluated that the proposed system showed good performance related to the existing systems in light of dice coefficient and accuracy.

Key-words:Support vector machine, Berkeley wavelet transformation, anisotropic diffusion filter, brain tumor detection MRI images.

I. INTRODUCTION

In present scenario, the growth of e-health care system and information technology in the medical field assists doctors to deliver significant health care to the patients. Most of the existing systems address the concerns related to segmentation of normal and abnormal brain cells such as cerebrospinal fluid, white matter, and gray matter from MRI utilizing dissimilar feature extraction techniques and classification techniques [1-2]. Commonly, the brain tumor tissues have uncontrolled growth, which is classified into two types (malignant and benign). The malignant tumor are heterogeneous (non-uniformity) in structure and contains active cells. Similarly, the benign tumors are uniform in nature that does not comprises of any active cells. The meningiomas and gliomas are the common examples of low grade tumors that are sub-divided into glioblastoma and benign tumors. Correspondingly, theastrocytoma is a high grade tumor class that is also called as malignant tumor. From the world health organization statement, the most common grading system utilizes a scale grade from I to IV for classifying the malignant and benign tumors [3]. In that scale, the grades I and II are specified as benign tumors and the grades III and IV are represented as malignant tumors. The grades III and IV are named as high grade tumors that possess a significant tumor growths. Correspondingly, the grades I and II are named as low grade tumors, which possess a slow growth. If the low-grade brain tumor is left untreated that developed as high grade brain tumor. Grade II gliomas patients' needs continues observations and monitoring.

For every six to eleven months, the computed tomography and MRI brain scans are composed. The brain tumor may influences at any age and the effect on the body may not be similar for every individuals. Benign tumors (low grade I and II gliomas) are deliberatedas restorative under surgical expedition. Similarly, the malignant tumors (high grade III and IV gliomas) are treated by chemotherapy, radiotherapy, and combination of both chemotherapy, radiotherapy. The malignant tumors (high grade III and IV gliomas) are also stated as plastic astrocytomas. The plastic astrocytomas is also refereed as mid-grade tumor that evaluates the bothabnormal and normal growth of blood cells by matching with other low grade tumors.Additionally, the malignant of astrocytoma have maximum grade gliomas that are named as glioblastoma. The presence of dead cells (necrosis) and the irregular growth of blood cells are differed from all other grades in the tumor class. Grade IV gliomas grows rapidly compared to other tumor grades.

In this research study, dissimilar MRI sequence images are utilized for brain tumor detection such as, T1weighted contrast enhanced MRI, T2 weighted contrast enhanced MRI,digital imaging and communications in medicine, BRATS, etc. The brain tumor detection at an early stage is a crucial problem to deliver an improved treatment. Usually, radiological valuation is essential for finding the tumor size, surrounding areas, and location, once the brain tumor is clinically suspected. Based on this evidence, best surgery, radiation, therapy or chemotherapy is decided[4].Early analysis of brain tumor detection effectively upsurges the survival rate. As an outcome, the research on brain tumor

Revised Manuscript Received on 14 August, 2019.

V.Vinay Kumar, Department of ECE, Anurag Group of Institutions, Venkatapur,Ghatkesar, Medchal (Dist), Telagana-500088, India.(Email: vemulavinay387@gmail.com)

K.Sai Krishna, Department of ECE, Anurag Group of Institutions, Venkatapur,Ghatkesar, Medchal (Dist), Telagana-500088, India.(Email: saikrishnaece@cvsr.ac.in)

S.Kusumavathi,Department of ECE, Anurag Group of Institutions, Venkatapur,Ghatkesar, Medchal (Dist), Telagana-500088, India.(Email: kusumakushi777@gmail.com)

detection utilizing neuro imaging technology has gained effective importance among the radiology departments.This research paper is arranged as follows. In section 2, numerous research papers on brain tumor detection are reviewed. Detailed explanation about the proposed system is given in section 3. In addition, section 4 describes about the quantitative and comparative analysis of the proposed system. Conclusion is made in section 5.

II. RELATED WORKS

In recent times, several techniques are developed for brain tumor segmentation and classification such as SVM, clustering based segmentation techniques, neural networks, deep learning techniques, expectation maximization approach, knowledge based techniques, etc. These are the some popular algorithms used for brain tumor detection.Many methodologies are developed by the researchers in brain tumor detection. In this literature section, a brief review of some important contributions to the existing literature is presented.

Brain tumor detection consists of two regions such as brain tumor region and normal region. J. Selvakumar, *et al* [5] used a hybrid system for brain tumor detection, which combines k-means clustering and fuzzy c means clustering algorithm. The developed system delivered better performance related to the existing systems by means ofJaccard coefficients. In the experimental outcome, the developed system achieved average segmentation S of 90% at the noise level 9%, and 3%. M. Sharma, and S. Mukharjee [6], M. Madheswaran, and D.A.S.Dhas, [7] presented extreme machine learning system for brain tumor detection on 3D MRI images. The developed system attained 97.8% of specificity, 93.2% of accuracy, and 91.6% of sensitivity.M. Jafari,*et al.* [8] developed a new system for brain tumor detection, which includes three major phases: segmentation, feature extraction, and classification. The present research work was evaluated on an online dataset with 428 MRI images. In this scenario, principal component analysis with artificial neural network was utilized as a classification approach, which attains 91% of classification accuracy.

From the literature survey, we analyzed the techniques used for segmentation, feature extraction and classification. In brain tumor detection, feature selection and optimization are essential to segment and classify the regions: CSF, infected tumor region, WM, and GM. In order to lessen the "curse of dimensionality" issue, only some features are essential to denote the brain tumor regions. In addition, the above mentioned literature papers does not calculate the overlapped dice coefficients that is considered as one of the vital parameters to investigate the efficiency of brain tumor detection.

In this research work, a new system (BWT-SVM) is proposed to enhance the accuracy of diagnosis. The main objective of this research study is to extract the feature information from the segmented region and then classify the region as normal or abnormal. Effectiveness of the proposed system is tested on an online dataset. The proposed system result is superior related to the existing systems. The proposed system assists doctors for the early diagnosis of brain diseases.

III. MATERIALS AND METHODS

In recent decades, several segmentation algorithms are implemented for detecting the brain tumors. Usually, an MRI brain image contains numerous regions or segments, which have same grayscale density with tumor area. In MRI brain tumor segmentation and classification, supervised systems includesseries of phases for detecting the tumors quickly and accurately. The proposed system includes four steps: data collection, pre-processing, transformation and classification. Detailed descriptions about the undertaken algorithms are listed below.

3.1 ADF for image denoising

In brain tumor detection, ADF is a widely utilized MRI image enhancement approach. Hence, ADF is non-optimal for the noise MRI images, intensity in homogeneity images, and the MRI images recreated from sensitivity encoded data. To address this problem, linear diffusion approach is combined with ADF. The linear diffusion technique effectively lessens the noise and improves the image contours, and the diffusion coefficients are locally adapted that significantly smooth's the image edges.

3.2 BWT

BWT is a 2D triadic wavelet transform, which performs data conversion that usually converts the spatial form of MRI image into temporal domain frequency. BWT is an effective image representation approach, which is completely orthonormal. In BWT, the mother wavelet transformation $\beta$is a piecewise constant function. Substitute of mother wavelet transformation function β is generated at several pixel positions in the 2D plane by insulation and scaling of mother wavelets that is mathematically denoted in equation (1).

$$\beta\,(\tau, s) \;=\; 1/s2\,\beta\varphi x\,(3s\,(x\;-\;i)\,,3s\,(y\;-\;j)) \quad (1)$$

Where, s is denoted as scaling parameter of the wavelet transformation and, τ is indicated as translation parameter of the wavelet transformation, and $\beta\varphi x$ is specified as transformation function that is also named as mother wavelet of BWT. In this transformation technique, a constant term is enough for representing the mean value of MRI image. The coefficient value is denoted in equation (2).

$$\beta 0 \;=\; 1/\sqrt{9}\,[u(x3\,,y3\,)] \qquad (2)$$

3.3 Classification using SVM

SVM is a binary classification methodology that classifies the training values into two classes based on the hyper-plane. In this research, hyper-plane is selected that has maximum margin (distance between the closest objects and hyper-plane in each and every class). Support vectors are also named as data a point, which lies close to the decision surface. These support vectors are difficult to classify and the graphical depiction of SVM classifier is stated in figure 1.

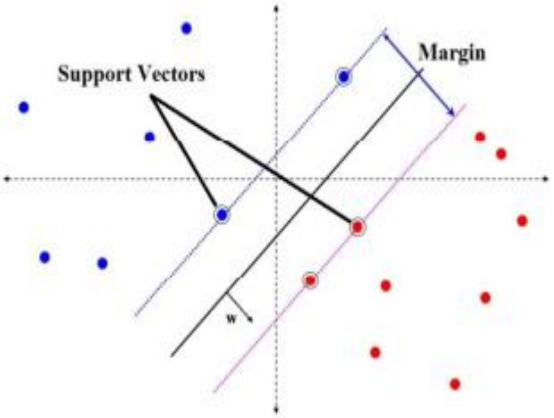

Figure 1. Graphical representation of SVM classifier

In MRI, the proposed system uses series of phases for brain tumor detection. Initially, ADF approach is used for smoothing the uniform regions with the help of image edges. Then, generate brain mask images that are given as the input for SVM classification approach that mainly depends on the symmetric characteristics of the brain images. At last, SVM classifier environs the tumor region precisely utilizing ground truth image. The work flow of proposed system is given in figure 2.

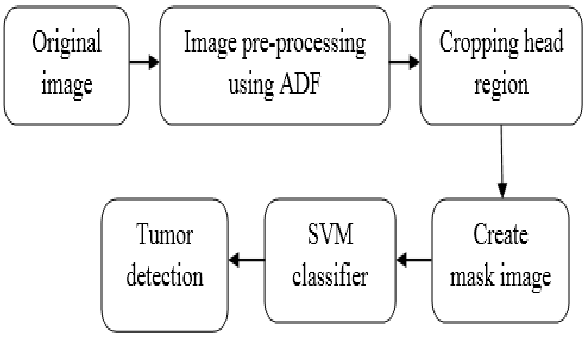

Figure 2.Work flow of proposed system

The proposed system is tested on several MRI images. SVM classifier utilizes mask image for detecting the brain tumor region precisely. To generate the ground truth image, bounding box is used to crop the head region without extra background in the labelled image. Then, convert the ground truth image into binary form, and figure 3 states the result of SVM algorithm.

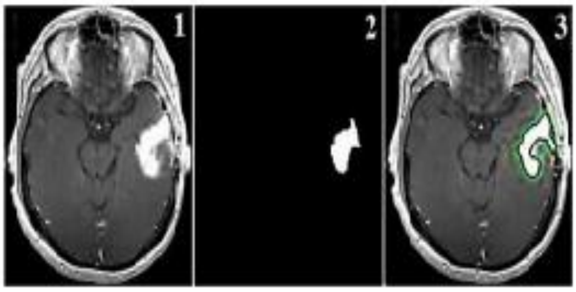

Figure 3. 1) Input image,2) ground truth image, 3) segmented image

The resulted image after applying threshold is depicted in the figures 4, 5, and 6 and table 1. In this scenario, a morphological operator is utilized to eliminate small objects from the brain images.

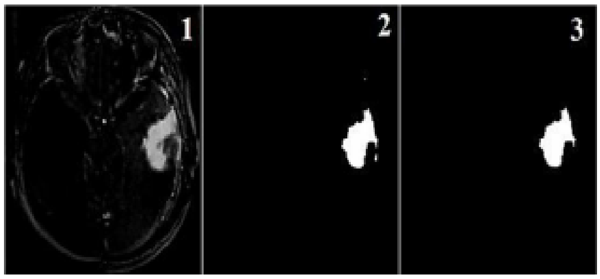

Figure 4. 1) Difference image, 2) Threshold image, 3) Removing small objects

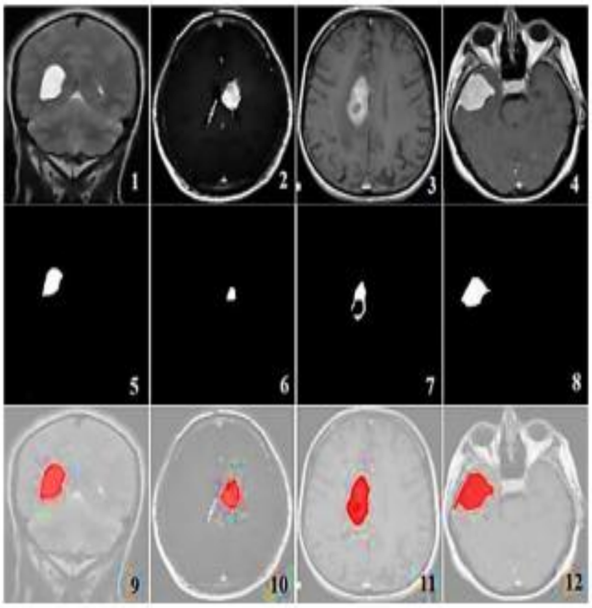

Figure 5. First row- input images,Second row- ground truth images,and Third row-segmented images

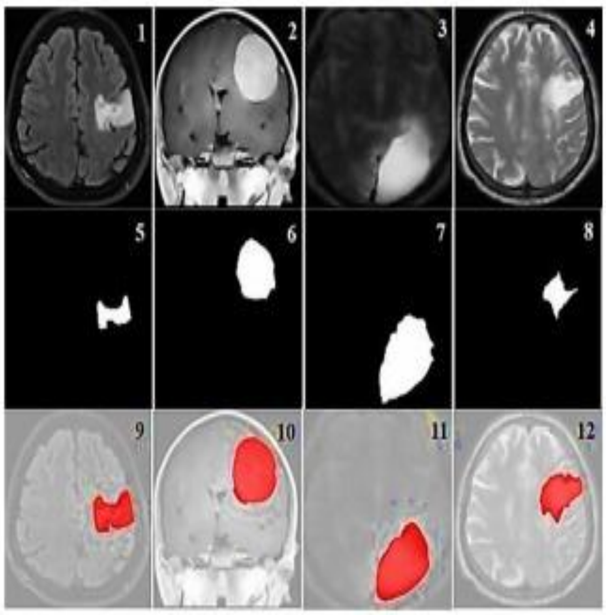

Figure 6.First row- input images,Second row- ground truth images,and Third row-segmented images

Table 1.Performance analysis in light of dice criteria

First set (%)		Second set (%)	
Image 1	91.2	**Image 5**	92.5
Image 2	91.5	**Image 6**	91.2
Image 3	91.6	**Image 7**	91.8
Image 4	94.7	**Image 8**	91.4

IV. RESULTS AND DISCUSSION

At first, compute the similarity between ground truth *A* (manually segmented image) and segmented image *B* using dice coefficient in order to investigate the performance of proposed system and existing systems. When dice coefficient>0.7, it is considered as good segmentation. In this research study, the proposed system is tested on two sets of MRI images with dissimilar types and sources that is represented in the figures 5, and 6. The effectiveness of the proposed tumor detection method is detailed in table 1.

4.1 Comparative analysis

In this section, the proposed system (BWT-SVM) attained good result compared to the existing classifiers like back propagation, ANFIS and KNN classifier in light of accuracy, specificity, and sensitivity. The detailed investigation about the performance metrics is shown in table 2. From the table 2, the performance of the proposed system effectively enhanced the brain tumor detection related to the existing classifiers:back propagation, ANFIS and KNN classifier.

Table 2. Comparative analysis of classifiers

Classifiers	**Accuracy (%) (without feature extraction)**	**Accuracy (%)(with feature extraction)**
ANFIS	80.12	91.25
Back propagation	82.34	87.21
k-NN	82.48	88.06
SVM(Proposed classifier)	**91.25**	**97.25**

VI. CONCLUSION

In this research paper, the proposed system includes many steps that are demonstrated with great potential, which is useful in MRI tumor segmentation. Here, ADF approach is used for smoothing the brain images. Then, generate mask imagebased on the symmetric features of the brain MRI images. At last, SVM classification approach is used for tumor detection accurately. The proposed segmentation approach detects the tumors precisely and achieved 97.25% of classification accuracy.

REFERENCES

1. C.A.Palma, F.A. Cappabianco, J.S.Ide, and P.A. Miranda, "Anisotropic diffusion filtering operation and limitations-magnetic resonance imaging evaluation",*IFAC Proceedings Volumes*, vol.47, no.3, pp.3887-3892, 2014.
2. P.S. Kumar, and P.G.Kumar, "Performance analysis of brain tumor diagnosis based on soft computing techniques",*American Journal of Applied Sciences*, vol.11, no.2, pp.329-336, 2014.
3. S.Tiwari, A.Bansal, and R.Sagar, "Identification of brain tumors in 2D MRI using automatic seeded region growing method",*Journal of Education*, vol.2, no.1, pp.41-47, 2012.
4. M.K. Kowar, and S. Yadav, "Brain tumor detection and segmentation using histogram thresholding",*International Journal of Engineering and Advanced Technology*, vol.1, no.4, pp.16-20, 2012.
5. J. Selvakumar, A.Lakshmi, and T. Arivoli, "Brain tumor segmentation and its area calculation in brain MR images using K-mean clustering and Fuzzy C-mean algorithm", In *IEEE-International Conference on Advances in Engineering, Science and Management (ICAESM-2012),IEEE*, pp.186-190, 2012.
6. M.Sharma, and S. Mukharjee, "Brain tumor segmentation using genetic algorithm and artificial neural network fuzzy inference system (ANFIS)", In *Advances in Computing and Information Technology,Springer, Berlin, Heidelberg*, pp.329-339, 2013.
7. M.Madheswaran, and D.A.S.Dhas, "Classification of brain MRI images using support vector machine with various Kernels",*Biomedical Research*, vol.26, no.3,2015.
8. M. Jafari, J.Mahmoodi, and R. Shafaghi, "A Neural Network-based Approach for Brain Tissues Classification Using GA",*Global journal of science, engineering and technology*, vol.7, pp.1-7,2013.

Retrieval Number: F11750986S319/2019©BEIESP
DOI: 10.35940/ijeat.F1175.0986S319

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication