International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-6, August 2019

An Automated Brain Tumour Boundary Detection using Region based Segmentation Technique along with SVM Classifier

Sunita Dharnia, Vikas Wasson

Abstract: ***We presents a fully automated method for an automated brain-tumour boundary detection using region based segmentation technique along with SVM Classifier of Magnetic Resonance Imaging (MRI).The procedure is based on artificial intelligence technique and classification of each super-pixel in MRI. A number of novel image features extraction approaches including intensity-based, texture based, fractal analysis and curvatures are calculated from each super-pixel within the entire brain area in MRI to ensure a robust classification. Brain tumor is the malignant types of cancer and their classification in earlier stage is biggest issue. While curable with early classification is useful, only extremely trained specialists are capable of accurately recognizing the cancer from skin MRI data. As expertise is in limited contribute, an automated systems capable of classifying cancer could save human lives, and also help to reduce unnecessary MRI, and reduce extra costs. On the way to achieve this goal, we proposed a Brain Tumour Detection and Classification System (BTDCS) that combines recent developments in machine learning with Support Vector Machine (SVM) structure, creating hybrid algorithm of threshold based segmentation with Maximally Stable External Regions (MSER) that are capable of segmenting accurate super-pixel region from MRI, as well as analyzing the detected area and surrounding tissue for malignant. Using threshold based segmentation technique, the foreground and background component is separated into two regions. To improve the segmentation results, MSER is used with the novel concept of region detection and feature extraction mechanism. The proposed system is evaluated using the largest publicly accessible standard BRATS 2015 dataset of MRI, containing benign and malignant images. When the evaluation parameters of proposed work is compared with a few other state-of-art methods, the proposed means attains the best performance of 98.2% concerning classification accuracy using only the MSER approach and SVM as classifier. The ultimate aim of this research is to devise an automated experimental approach that can segment the tumor boundary in a fast and efficient manner.***

Index Terms: ***Brain Tumour Segmentation, Brain Tumour Detection and Classification System (BTDCS), Pattern Recognition, Maximally Stable Extremal Regions (MSER) analysis on MRI, Support Vector Machine (SVM)***

I. INTRODUCTION

By the rising age population, brain tumour has become a worldwide health dilemma.

Revised Manuscript Received on August 30, 2019.

* Correspondence Author

Sunita Dharnia*, is a M.E. Research Scholar at Department of C.S.E., University Institute of Engineering, Chandigarh University (CU), Gharuan (Mohali), Punjab, India.

Er. Vikas Wasson, is working as an assistant professor in the Department of Computer Science and Engineering, Chandigarh University (CU), Gharuan (Mohali), Punjab, India.

In accordance to the modern data analysis of World Cancer Research Fund [1]-[3], the initial reason of death in world is brain tumour and the records are gradually increases with time. Nobody knows the accurate reason of brain tumors creation in human. Doctors can barely clarify about how somebody is overtaken by brain tumor and somebody else isn't. While a large amount of the natural cells are getting old or damaged, they fade away and new cells are replaced with them. Occasionally, this process goes erroneous; new cells are produced when body doesn't want them and the old and damaged cells don't fade away. Therefore, the ceaseless and incontrollable increase of cells causes the brain tumor creation in the human. In any human, if the brain tumors are not diagnosed immediately, they could either cause a serious brain injure or even death. In all of handling methods, any information regarding situation and dimension of the tumor for successful treatment is necessary. Consciousness of the tumor situation and dimension, especially changes about tumor dimension, can provide very imperative information to find the most effective regime for the patients during the treatment, including surgery, radiotherapy and chemotherapy. A brain-tumor is a mass or extension of irregular cells in the mind or near the mind. Brain-tumors are strange developments in the mind that can be either dangerous (threatening) or noncancerous (considerate) [4]. The consequences for the mind of harmful and benevolent brain-tumors are fundamentally the same as and can cause similar kinds of issues relying on the sort of tumor and where it is situated in the cerebrum. Various kinds of brain tumor exist in this world. Scarcely any cerebrum tumors are noncancerous (benevolent), and some brain tumor s are harmful (threatening). Brain tumor can start in your cerebrum (essential cerebrum tumors), or malignancy can start in different pieces of your body and spread to your mind (optional, or metastatic, cerebrum tumors) [5]. The locale of cerebrum tumor is given in the figure 1.

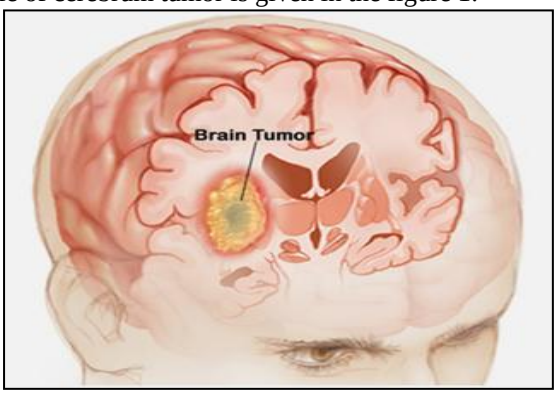

Figure 1: Brain Tumour

Above figure represents the tumour region in human brain that is a kind of malignant brain tumour and the proposed Brain Tumour Detection and Classification System (BTDCS) example is shown below figure 1.

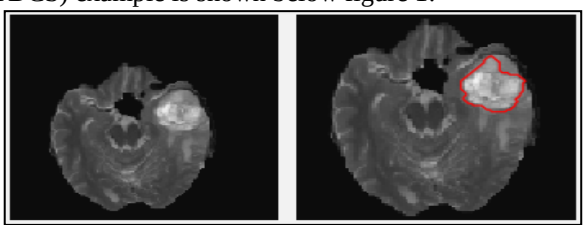

Figure 2: Tumour Region Boundary Detection

In the figure 2, red color boundary is denoting the tumour region which is different from the actual region and these are the super-pixel region. This paper develops BTDCS which classifies the benign and malignant types of tumour from the MRI using the Support Vector Machine (SVM)[7] as ML approach with combination of threshold based segmentation and MSER approach. The framework of proposed BTDCS is shown in the figure 3.

Figure 3: Framework of BTDCS

Above figure describe the block diagram of proposed BTDCS framework and the description of each blocks are given as:

A. ***MRI Data Uploading:*** It is the basic and primary step of any BTDCS. Data uploading is a nessential mechanism that is used to retrieving the MRI data [8] pixel value into software for further processing.

B. ***Pre-processing:*** Pre-processing is the utmost vital and basic stage for all digital image processing approach. In this paper, pre-processing is used to conversion of color level data into grey level data which helps in the background and foreground estimation process.

C. ***Segmentation:*** Image segmentation plays a major role in the area of image processing. Steps for image division:

- ❖ It begins with the whole image in single region and finds the group of different pixels in whole image and marks their positions.
- ❖ The boundary region is then split to form sub-regions of that's image which satisfy the essential segmentation decisive factor using an appropriate standardization predicate or standardization measure.

D. ***MSER Feature Extraction:*** Extract feature from the tumour region of MRI is called feature extraction algorithm and in this work we use MSER feature extraction technique. MSER is a means for blob detection in MRI. The MSER algorithm extracts feature from a region of MRI in terms of a number of co-variant regions, called MSER feature. An MSER feature is a steady connected component of some gray-level sets of the super-pixels [9].

E. ***Tumour Classification:*** It is a method to classify the types of tumour from extracted feature using MSER descriptor .MSER based SVM is used in the proposed BTDCS as a tumour classifier to classify the tumour as benign or malignant [10].

Motivation and contributions: Brain tumor segmentation and their classification is a standout amongst the most significant and troublesome assignments in numerous medicinal picture applications since it more often than not include an enormous measure of information. Ancient rarities because of patient's movement, restricted obtaining time, and delicate tissue limits are generally not all around characterized. There are huge class of tumor types which have assortment of shapes and sizes. They may seem detached sizes and types with various picture forces. Some of them may likewise influence the encompassing structures that change the picture powers around the tumor. From these types of challenging task we present an automated brain tumour boundary detection using region based segmentation technique along with SVM classifier [11]. In simple words, this paper makes thefollowing contributions.

- ❖ We present a new segmentation technique based on the MSER algorithm according to the white and gray matter present in MRI of brain using the concept of threshold based segmentation approach.
- ❖ For classification the benign and malignant tumour in MRI, SVM technique is used with segmented MSER feature.
- ❖ For the validation of proposed BTDCS, we evaluate performance parameters of proposed work like Sensitivity, Accuracy, Detection Time, Precision, Tumour Volume and compare with state-of-the-art approaches.

This paper presents an automated brain tumour boundary detection using region based segmentation technique along with SVM classifier and their comparison with existing trends. Specifically, in section 2, we submit the literate survey (background survey) of existing work for anomaly detection in surveillance videos. The architecture of proposed work is detailed in the section 3. The simulation result is cover in section 4 and we conclude with discussions on current challenges and future trends in section 5.

II. BACKGROUND SURVEY

In this section, we present the survey of existing work based on the segmentation of brain tumour region for cancer classification using different techniques. Hao Dong in 2017 [1] presents a programmed brain tumour identification and division utilizing u-net based completely convolutional systems. They proposed a completely programmed technique for brain tumor division, that is created utilizing U-Net based profound convolutional systems. Proposed strategy was assessed on BRATS 2015 datasets and cross approval has demonstrated that proposed technique can acquire promising division productively. The proposed work is only applicable for linear image during the classification process and need to improvement in the pre-processing steps for further usages of nonlinear images. M. J. Khan in 2014 [2] presents decoding of four movement directions by utilizing the hybrid NIRS-EEG brain-computer interface and they discussed about noninvasive hybrid brain computer interface methods for enhancing classification accuracy. In hybridization two techniques have been combined to modify the brain images and getting better results. Mainly the aim of hybridization is to enhance numerous control commands, get better classification accuracy and lessen the signal discovery time by using the only BCI technique,

the detection and segmentation result is not acceptable for medical science research point of view. Astina Minz in 2017 [3] proposed a brain tumour recognition system by using Magnetic resonance imaging (MRI) technique.

In this technique tumour has been analyzed by passing strong magnetic field into the brain of the patient body. Analyzing brain tumour by using MRI method is complex but it provides better accuracy. Author used Adaboost machine learning algorithm for improving the accuracy of the MRI image. Three processes comprises of three steps named as pre-processing phase, Feature extraction phase and classifications phase. Pre-processing phase has been used for removing the noise in the recorded data. Gray Level Co- occurrence Matrix (GLCM) has been used as feature extraction technique and for classification Adaboost technique has been used and the system complexity is increased by using the GLCM technique because GLCM returns more number of features. A Shereen in 2017 [4] presented a new method used for detecting brain tumor on the basis CSO-based algorithm by support vector machine for brain tumor's disease diagnosis. The classification accuracy is greatly enhanced by the use of the new feature optimization with PSO and SVM classifier. The used of RBF as a kernel function is affect the tumor volume and better option is to select polynomial kernel function

Based on the survey we conclude some important point which helps to short out existing problem. Our contributions in this paper to solve above mention problems are presented in two fold. Firstly, we introduce a completely automated hybrid method for tumour region segmentation by using threshold based segmentation with MSER technique. To the superlative of our awareness, our proposed work is among the first few attempts to use the concept of hybridization of MSER to tackle this challenging problem. Secondly, we design an appropriate feature extraction and classification system using MSER and SVM respectively. Our model can be easily generalized to other challenging medical image segmentation problems and also improve the accuracy of BTDCS for tumour detection and classification from MRI.

III. STRUCTURE OF PROPOSED METHODOLOGY

The proposed an automated brain tumour boundary detection using region based segmentation technique along with SVM classifier consists of three main steps. Firstly, various image pre-processing methods will be applied to enhance the image quality and suitable segmentation technique will be applied to separate out background from the image to extract exact Region of Tumour (ROT). Here, to enhance the segmentation accuracy, MSER is as a region based segmentation algorithm to minimize the unwanted background region from ROI using the fitness function. Then features will be extracted from the segmented ROT and feed as input to the SVM model. To extract the feature from ROT, MSER feature descriptor is used which helps to returns best key points from ROT. Finally, classification is performed using SVM as a classifier to produce desired output for the automatic tumour detection and classification. The challenge of this research work is to detect and classify the tumour using MRI and train the system using SVM on the basis of the features extracted from the ROT using MSER descriptor. The subsequent steps demonstrate the variety of phases that need to be accomplished.

Data Acquisition: Upload the MRI data of brain tumour database of different classes to train and test the system. In both section of model, training as well as testing MRI data is uploaded for processing. In training the number of images is more but in testing single test image is uploaded. The data uploading process is known as MRI Data Acquisition (MRIDA) and the algorithm of MRIDA is given as:

Algorithm 1: MRIDA Algorithm

Input: Num→Number of Images
Output: MRI Data
Define image browsing option for the image acquisition
Pathname = Browse (Image format (x.png), Title of uploading)
For i→ Num
    Full-path = (Pathname with Filename)
    Images (i) = Read (Full-path)
End
Return: Images (i) as an MRI Data
End

Pre-processing: Pre-Processing is done to remove various type of noise that are inherited in the MRI data to enhance the quality of MRI data in proposed BTDCS. The threshold based segmentation is used with the concept of hybridization with MSER technique and morphological operations. There are a lots of morphological operations are available but used operations are given in the below figure.

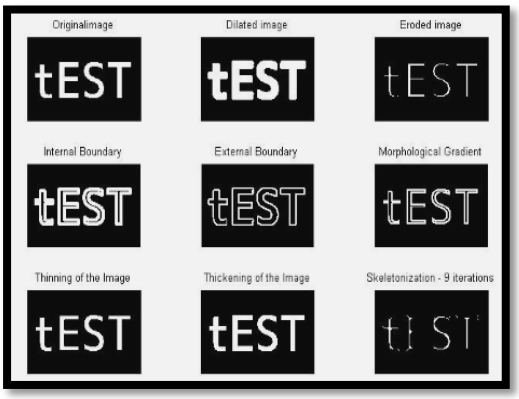

Figure 4: Morphological Operations

Above figure 4 represents the morphological operations which are used in the proposed BTDCS. In the proposed work, morphological operations help to find out the exact region of tumor and separate the extra region from images. The used pre-processing steps are:

1. ***Color Conversion:*** Color conversion is applied on the uploaded MRI to convert into single component(Gray Image) which helps in the feature extraction.

$$GrayImage = 0.299 \times R_b + 0.587 \times G_b + 0.114 \times B_b \quad \ldots\ldots (1)$$

Where, R_b: Red component of an image
G_b: Green component of an image
B_b: Blue component of an image

2. ***Binarization:*** The binarization process is carried out using the following equation with threshold value.

$$Bimg(i,j) = \begin{cases} 1 & if Fimg(i,j) \geq Threshold \\ 0 & else \end{cases} \ldots (2)$$

As shown in the equation (2), Bimg is binary image and Fimg is frame of video with row (i) and columns (j). The binarization algorithm of proposed work is given as:

Algorithm 2 :Binarization Algorithm
Input: Oimg→Original MRI
Output: Bimg→Binary Image

Define Row (R) and Columns (C) of Oimg
For I=1→R
For l=1→C
Using equation (2)
If Oimg(k, l) > Average (Oimg)
Bimg(k,l)= 1
Else if Oimg(k, l) < Average (Oimg)
Bimg(k,l)= 0
End
End
End
Return: Bimg as a binary image
End

Area Opening:The area opening is performed to remove the pixels from the boundary oftumour region in image so we can find out the well appropriate region of tumour. The opening is performed by using the given equation:

$$OpenImage = \begin{cases} 0, & Pixels < Threshold \\ 1, & Pixels \geq Threshold \end{cases} \quad \ldots (3)$$

Where, $Pixels$: Binary image pixels
$Threshold$: Threshold pixels value which helps to remove the boundary pixels
On the basis for morphological operations, Threshold based segmentation with MSER algorithm is designed and the algorithm of Threshold based segmentation with MSER algorithm (TBSMA) is given as:

Algorithm 3: TBSMA
Input: Bimg →Binary Image
Output: ROT→Region of Tumour from MRI data

[R, C, P] =size (Bimg)
Threshold$_{value}$= MSER(Bimg)
??????????????? = ?h????h????????
MaskImg=Morphological (Bimg, Threshold)
Boundaries = bwboundaries (MaskImg)
Segmented Region = Boundaries
Fork→1: P
Segmented Image = Bimg X Segmented Region
End
Return; Segmented Image as ROI of extracted frames
End

***Feature Extraction*:** Extract feature from the ROT of frames based on the MSER feature extraction algorithm. After the feature extraction algorithm, a set of feature is return by the MSER algorithm in terms of feature points. The MSER algorithm is given as:

Algorithm 4: MSER Algorithm
Input: ROT→Region of Tumour from MRI data
Output: MSER_Points→ Feature points

Load ROT data of MRI data
Calculate size of dataset [Row, Col.]
Fork→1 to all Row
Forl→1 to all Col
Local Intensity=intensity (ROI (k, l))
Connected Component=Component (Local Intensity (k, l), 8)
Threshold =Stable (Connected Components)
MSER_Points=Filtering (Threshold == True)
End
End
Return: MSER_Points as key feature of ROT
End

After the feature extraction algorithm applied on the ROT, we obtained below given results which are useful in training as well as classification process of proposed BTDCS. To extract feature from extracted ROT, MSER Descriptor is used and applied on the ROT. After the algorithm is applied on the ROT of MRI data, the marked image with MSER point is given in the figure 5.

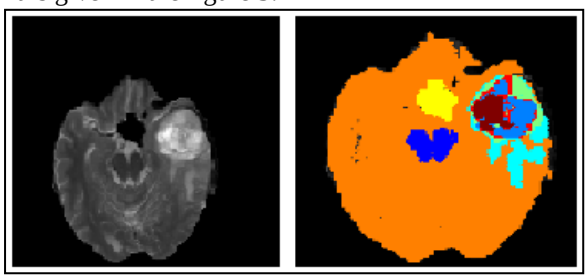

Figure 5: MSER Feature of Extracted ROT

Figure 5 represents the MSER region which count as MSER feature using the MSER descriptor. In the figure, (a) is the original image and (b) is represent the MSER region of original image which is considered as a set of MSER feature.

Training: Initialize SVM for classification purpose using two phases, namely, training and testing. After the training of system, we save the trained structure which is use in the classification section to classify the tumour types. In the testing phase, the test MRI data is uploaded and repeats the all steps. In the classification section, test MRI MSER feature is matched with trained SVM structure and return results type as benign and malignant and the used SVM algorithm is given as:

Algorithm5: SVMClassifiers
Input: MSER_Points→feature points as training data (T), Target (G) and kernel function (RBF)
Output: Type of tumour as benign and malignant

Initialize SVM with parameters
For each set of T
If Training Data ? Benign
Group(1)= Training data benign
Else if Training Data ? Malignant
Group(2)= Training data of malignant
Else
Group(3) = Extra
End
SVMStruct = svmtrain (Training data, Group, Kernel Function)
Classification Results = svmclassify (SVMStruct, Test Data Feature)
If Classification Results = True
Show classified results in terms of the benign and malignant
Compute the performance parameters
End
Return: Classified Results
End

BRATS 2015Dataset: Figure 6 represents the samples of used dataset in proposed BTDCS using a SVM along with threshold based MSER segmentation. In the database all MRI are with .png format and in the dataset MRI any type of compression is not applied. All MRIs are non-compressed and electronic noise free. In the dataset, mainly two types of categories of videos are presents, first is benign and another is malignant.

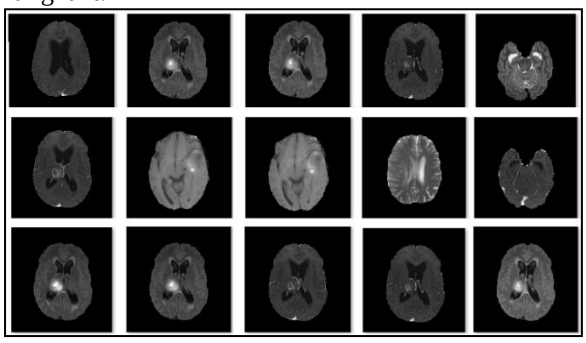

Figure 6: (a) Benign Sample ofBRATS 2015

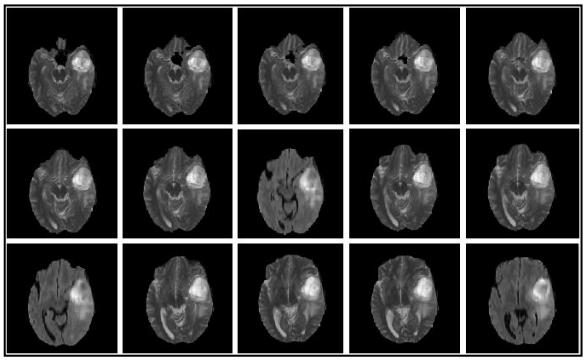

Figure 6: (b) Malignant Sample of BRATS 2015

After the simulation of proposed work the processing of each steps are shown in the figure 7 and their flowchart is given in the figure 9.

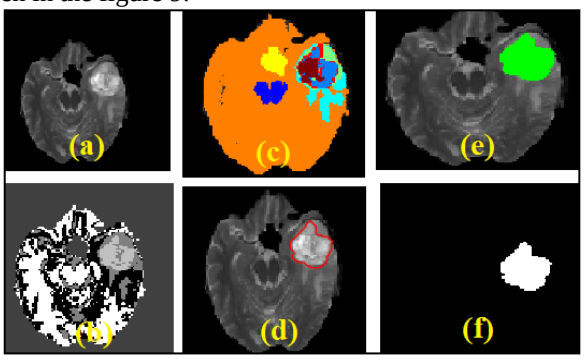

Figure 7: Processing of BTDCS

Above figure 7 represent the processing of the proposed BTDCS. In figure 7, (a) is the original MRI, (b) is the grey labeled image, (c) presents the segmented image using MSER algorithm, (d) is the ROT, (e) is the region of tumour in MRI and (f) is the segmented ROT using the hybridization of threshold based technique with MSER. Form the figure, the achievement of proposed hybrid segmentation technique is represented and it helps in the proposed automatic brain tumour detection and classification. After that the MSER is utilized as feature extraction procedure which returns the unique set of feature. The feature extraction process is shown in the figure 8.

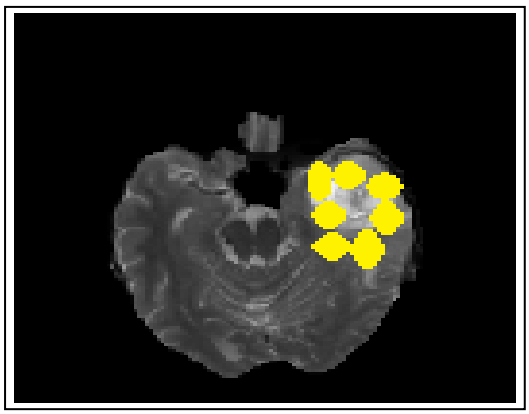

Figure 8: MSER Feature of MRI

Above figure 8 represents the MSER feature of the MRI data. In MSER feature extraction technique, each pixel below the given threshold are white and each of those above or equal are black and they considered as MSER feature set because they unique properties of an MRI. The flowchart of proposed BDTCS is shown in figure 9.

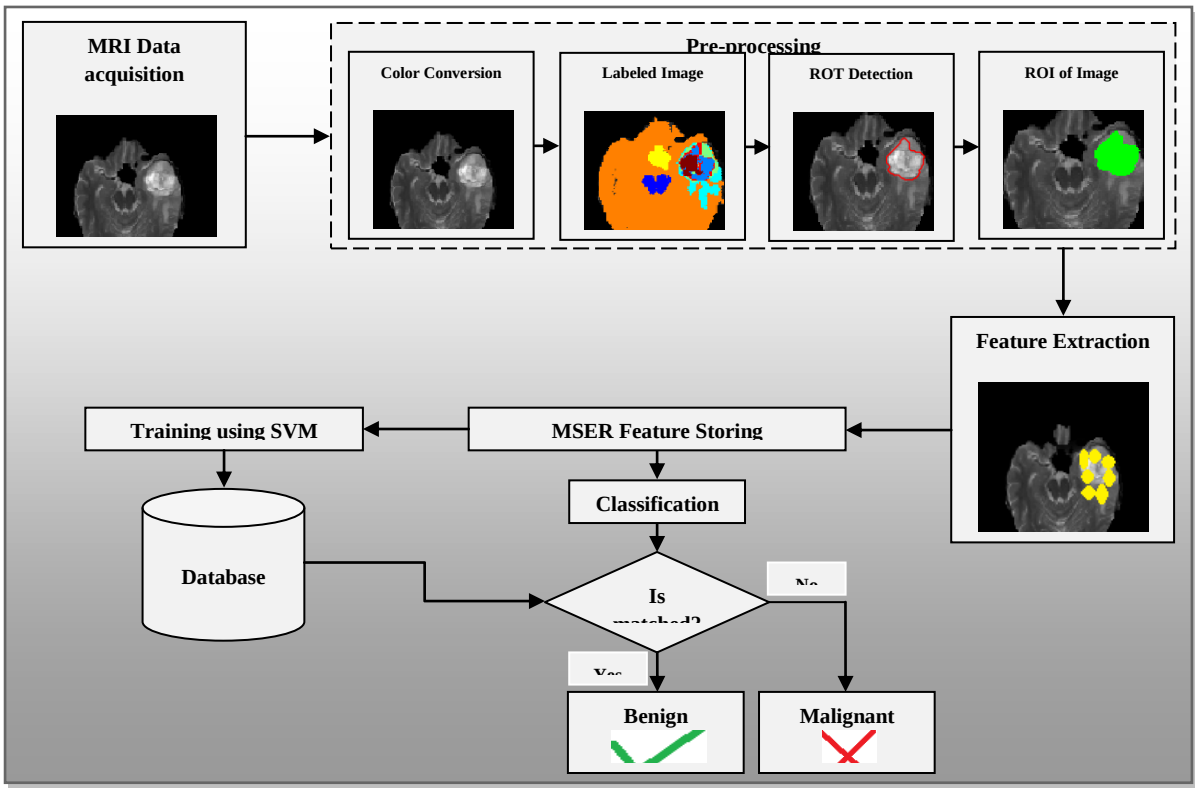

Figure 9: Flowchart of proposed work

IV.RESULTS AND DISCUSSION

In this unit, the simulation outcomes of proposed an automated brain tumour boundary detection using region based segmentation technique along with SVM classifier is discussed and the efficiency of proposed work is compared with existing work [1]. The training and testing of the proposed mechanism is evaluated by BRATS 2015 Dataset. By adapting the established proposed algorithms, below outcomes are computed with quality based parameters, such as Sensitivity, Detection Time, Precision, Tumour Volume and Accuracy.

TABLE I: Test results of proposed method

Types	Test Sample	Sensitivity	Detection Time (s)	Precision	Tumour Volume (ccm)	Accuracy (%)
Benign	Test Sample 1	0.985	1.1383	0.986	1.6	99.45
	Test Sample 2	0.993	1.4684	0.979	2.9	98.57
	Test Sample 3	0.981	1.2634	0.986	1.8	99.47
	Test Sample 4	0.968	2.0765	0.978	1.6	98.96
	Test Sample 5	0.988	1.9654	0.958	2.8	99.46
Malignant	Test Sample 1	0.948	1.3459	0.937	4.7	99.05
	Test Sample 2	0.983	1.3986	0.963	3.8	99.29
	Test Sample 3	0.985	2.0265	0.982	5.8	99.46
	Test Sample 4	0.998	1.8965	0.978	4.7	98.58
	Test Sample 5	0.968	1.9665	0.994	3.9	99.09

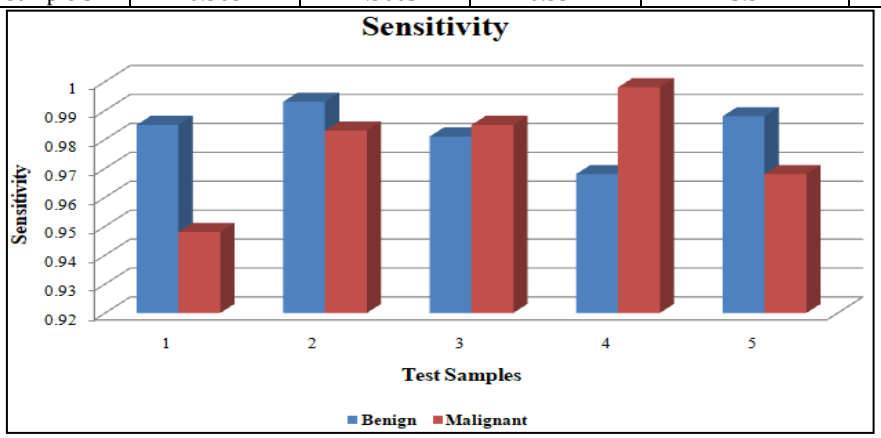

Figure 10: Comparison of evaluation parameters based on Sensitivity

The comparison of evaluation parameters based on the sensitivity for proposed is depicted in figure 10. Sensitivity is the probability of accurately enrollment of features which are included in the matching process. For the proposed work the average sensitivity is more than 0.979.

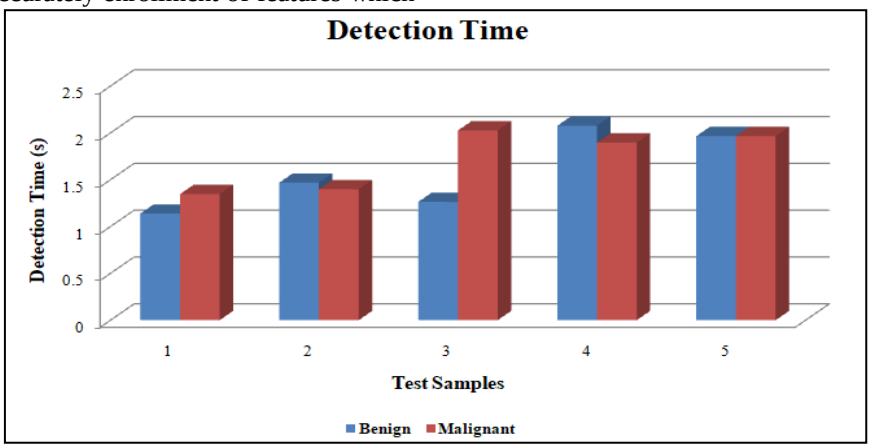

Figure 11: Comparison of evaluation parameters based on Detection Time

The comparison of evaluation parameters based on the detection time for proposed is depicted in figure 11. The detection time is the summation of total time taken by system to classify the tumour types. For the proposed work the average detection timeis less than 1.65 second.

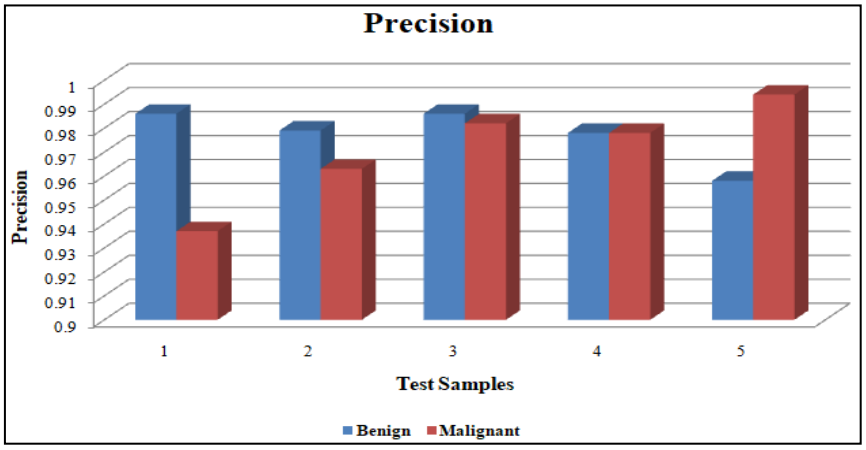

Figure 12: Comparison of evaluation parameters based on Precision

The comparison of evaluation parameters based on the precision for proposed is depicted in figure 12. Precision is the rate of TP and summation of TP and FP which represents the accuracy participating feature of classified category of tumour. For the proposed work the average precision is more than 0.975.

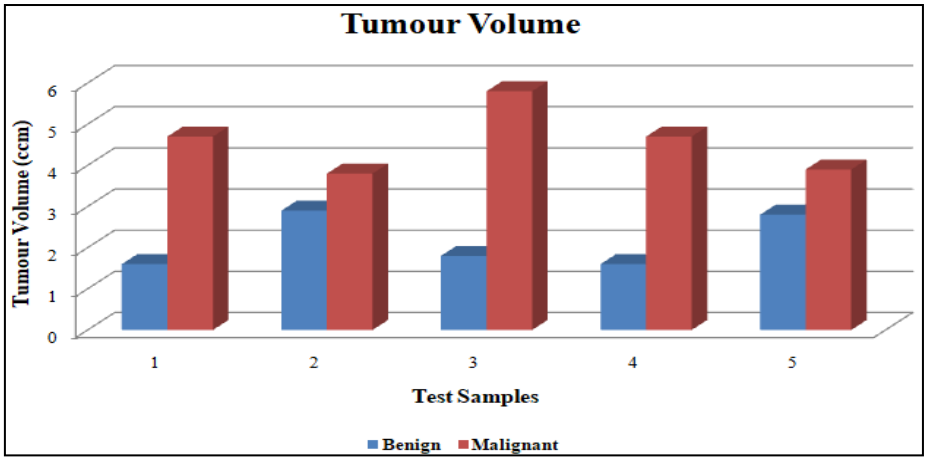

Figure 13: Comparison of evaluation parameters based on Tumour Volume (ccm)

The comparison of evaluation parameters based on the tumour volume for proposed is depicted in figure 13. Tumour volume is the important parameters of proposed BTDCS and based on the tumour volume the estimation of brain tumour stage could be identify. From the figure 13, it is clear that the tumour volume of benign and malignant tumour is correctly classified.

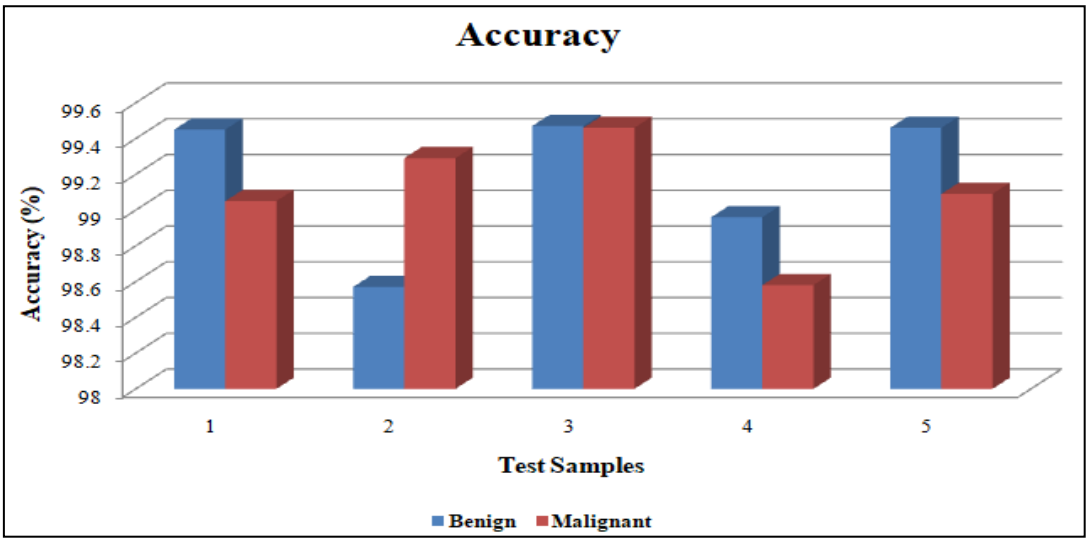

Figure 14: Comparison of evaluation parameters based on Accuracy

The comparison of evaluation parameters based on the accuracy for proposed is depicted in figure 12.

The accuracy of proposed BTDCS is the rate of truly classified tumour types using the SVM as a classifier. For the proposed work the average accuracy is more than 99.13%. From the above observation, we concluded the accuracy of proposed work is better and the comparison of proposed work with some other existing work, which is considered in survey of proposed work, is described in below table.

Table II: Comparison of accuracy of proposed work with existing works

Authors	Accuracy (%)
Hao Dong [1]	90.00
M. J. Khan [2]	89.30
Astina Minz [3]	87.40
A Shereen [4]	86.11
Proposed Work	99.13

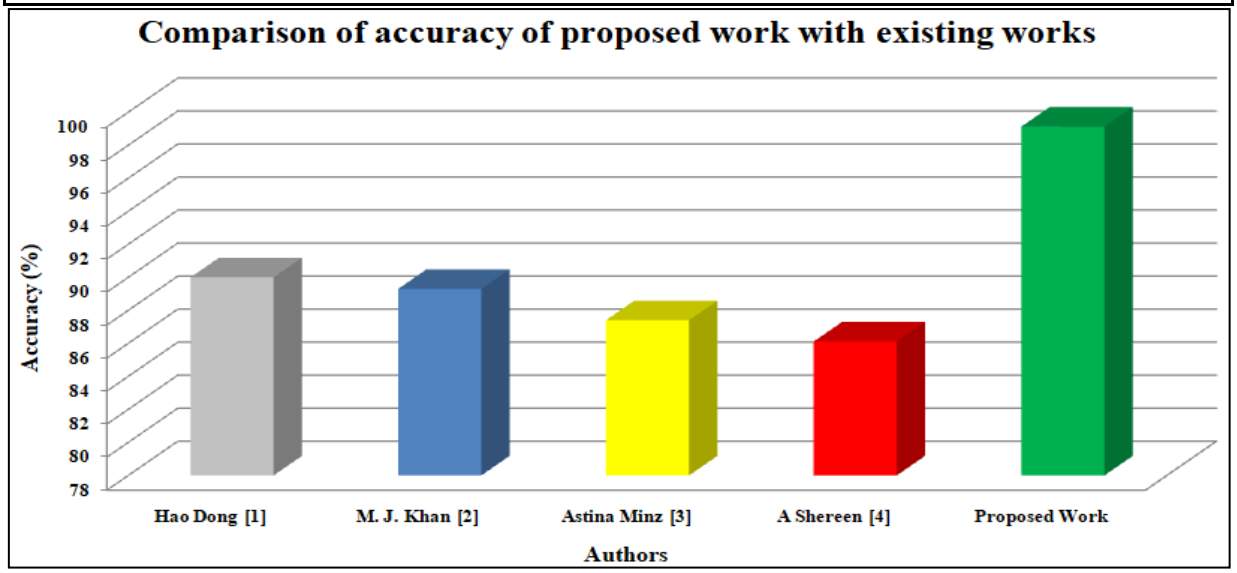

Figure 15: Comparison of accuracy of proposed work with existing works

Figure 15 represents the comparative analysis of existing work based on the classification accuracy. From the figure we observe that the accuracy achieve by proposed work is better than other authors by using the hybrid segmentation with the concept of threshold based segmentation using MSER technique and MSER feature extraction technique used with SVM as a classifier.

V. CONCLUSION AND FUTURE WORK

In this paper, an automated brain tumour boundary detection using region based segmentation technique along with SVM classifier is proposed. It provides a detailed view of the different applications and potential challenges of segmentation and classification of tumour from MRI which a difficult task in medical science. For the finding and classification of brain tumour, segmentation of tumour region is major task and it is performed by hybridization of threshold based segmentation with MSER. After that, in this paper we present a SVM with MSER descriptor for the classification of benign and malignant tumour and BRATS 2015 dataset is used for validation of proposed model. Utmost classification accuracy is reported when proposed work is simulated on dataset using the concept of SVM. With proposed method, the accuracy is 99.13% whereas with the existing work, the accuracy is less.

In future work, CNN is used as a classifier to train system based on hybridization of MSER descriptor with soft computing based feature selection algorithm cloud be used to reduce the time complexity of system.

REFERENCES

1. Dong, Hao, et al. "Automatic brain tumor detection and segmentation using U-Net based fully convolutional networks." annual conference on medical image understanding and analysis. Springer, Cham, 2017.
2. Khan, M. Jawad, Melissa Jiyoun Hong, and Keum-Shik Hong. "Decoding of four movement directions using hybrid NIRS-EEG brain-computer interface." Frontiers in human neuroscience 8 (2014): 244.
3. Minz, Astina, and Chandrakant Mahobiya. "MR Image classification using adaboost for brain tumor type." Advance Computing Conference (IACC), 2017 IEEE 7th International. IEEE, 2017.
4. M. J. Khan, A. Zafar and K. S. Hong, "Comparison of brain areas for executed and imagined movements after motor training: An fNIRS study," 2017 10th International Conference on Human System Interactions (HSI), Ulsan, South Korea, 2017, pp. 125-130.
5. S. A. Taie and W. Ghonaim, "Title CSO-based algorithm with support vector machine for brain tumor's disease diagnosis," 2017 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops), Kona, HI, 2017, pp. 183-187.
6. M. J. Khan, A. Zafar and K. S. Hong, "Comparison of brain areas for executed and imagined movements after motor training: An fNIRS study," 2017 10th International Conference on Human System Interactions (HSI), Ulsan, South Korea, 2017, pp. 125-130.
7. Jasmine, R. Anita, and P. Arockia Jansi Rani. "A two phase segmentation algorithm for MRI brain tumor extraction." Control, Instrumentation, Communication and Computational Technologies (ICCICCT), 2016 International Conference on. IEEE, 2016.
8. R. Majid Mehmood, R. Du and H. J. Lee, "Optimal Feature Selection and Deep Learning Ensembles Method for Emotion Recognition from Human Brain EEG Sensors," in IEEE Access, vol. 5, no. , pp. 14797-14806, 2017.

9. Singh, Garima, and M. A. Ansari. "Efficient detection of brain tumor from MRIs using K-means segmentation and normalized histogram." Information Processing (IICIP), 2016 1st India International Conference on. IEEE, 2016.
10. Taie, Shereen A., and Wafaa Ghonaim. "CSO-based algorithm with support vector machine for brain tumor's disease diagnosis." Pervasive Computing and Communications Workshops (PerCom Workshops), 2017 IEEE International Conference on. IEEE, 2017.
11. C. H. Rao, P. V. Naganjaneyulu and K. S. Prasad, "Brain Tumor Detection and Segmentation Using Conditional Random Field," 2017 IEEE 7th International Advance Computing Conference (IACC), Hyderabad, 2017, pp. 807-810.
12. M. Gupta, B. V. V. S. N. P. Rao and V. Rajagopalan, "Brain Tumor Detection in Conventional MR Images Based on Statistical Texture and Morphological Features," 2016 International Conference on Information Technology (ICIT), Bhubaneswar, 2016, pp. 129-133.
13. L. Farhi and A. Yusuf, "Comparison of brain tumor MRI classification methods using probabilistic features," 2017 13th IASTED International Conference on Biomedical Engineering (BioMed), Innsbruck, Austria, 2017, pp. 55-62.
14. K. D. Kharat, V. J. Pawar and S. R. Pardeshi, "Feature extraction and selection from MRI images for the brain tumor classification," 2016 International Conference on Communication and Electronics Systems (ICCES), Coimbatore, 2016, pp. 1-5.
15. B. Beddad and K. Hachemi, "Brain tumor detection by using a modified FCM and Level set algorithms," 2016 4th International Conference on Control Engineering & Information Technology (CEIT), Hammamet, 2016, pp. 1-5.
16. Logeswari, T., and M. Karnan, "An improved implementation of brain tumor detection using segmentation based on soft computing," Journal of Cancer
17. Mustaqeem, Anam, Ali Javed, and Tehseen Fatima, "An efficient brain tumor detection algorithm using watershed & thresholding based segmentation," International Journal of Image, Graphics and Signal Processing vol.4, 2012, pp. 34-43.
18. M. N. Wu, C. C. Lin and C. C. Chang, "Brain Tumor Detection Using Color-Based K-Means Clustering Segmentation," Third International Conference on Intelligent Information Hiding and Multimedia Signal Processing (IIH-MSP 2007), Kaohsiung, 2007, pp. 245-250.

AUTHORS PROFILE

Sunita Dharnia is a M.E. Research Scholar at Department of C.S.E., University Institute of Engineering, Chandigarh University (CU), Gharuan (Mohali), Punjab, India. Her specialization is in Software Engineering field. She received her B.Tech Degree in Computer Science Engineering from Guru Jambheshwar University of Science & Technology, Hisar (Haryana) in the year of 2016;And pursuing her M.E. in CU in Present. She is doing her project in the field of Image Processing, titled as, An Automated Brain Tumor Boundary Detection using Region Based Segmentation Technique along with SVM Classifier. Besides Image Processing, her other research interests include computer networking, network simulation, Big Data Analytics. She has research publication in IEEE.

Er. Vikas Wasson is working as an assistant professor in the Department of Computer Science and Engineering, Chandigarh University (CU), Gharuan (Mohali), Punjab, India. Currently he is taking care of first year students of CSE department being a Head of Department (HOD). He has 12 years teaching experience in engineering field. His field of specialization is soft computing and Digital Image Processing. He has guided more than 15 ME students for their research projects and thesis work. Author has many research publications in reputed national and international journals and conferences.