An Extensive Survey on Brain Tumor Detection (Segmentation, Feature Enhancement and Classification) on MRI Scans

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Abstract- Brain tumor detection and segmentation is one of the most challenging and time consuming task in the domain of medical image processing. MRI (Magnetic Resonance Imaging) is a medical technique, mostly adopted by the radiologist for visualization of internal structure of the human body without any surgery. MRI provides plentiful information about the human soft tissue, which helps in the diagnosis of brain tumor. Accurate segmentation of MRI image is essential for the diagnosis of brain tumor by computer aided clinical tool. After appropriate segmentation of brain MRI images, tumor is classified to be either malignant or benign, which is a complicated task since complexity varies in proportion to the tumor tissue traits like its shape, size, gray level intensities and location. Taking into account the aforesaid challenges, this research is focussed towards highlighting the strength and limitations of earlier proposed brain tumor detection and classification schemes as discussed in the contemporary literature. Besides summarizing the literature, the paper also offers a critical evaluation of the surveyed literature review which reveals new research facets. Finally the paper gives the future research scope to overcome the addressed research gap.

Keywords – Brain MRI, SVM, K-Means Segmentation, SVM-KNN, Neuro-fuzzy classifier, PCA & LDA features extraction, Brain Tumor Detection

I. INTRODUCTION

In human body a variety of types of tumors with different characteristics are often observed. Human brain is considered as the most essential part of the body which controls and supervises all the activities done by other body parts. This communication is done with the help of neural system. Every section of the brain has some specific function in driving human body in a healthy way. But, when a brain part grows to an unnatural size then the functions done by the brain get hampered and sometime brain may stop its normal behaviour. This abnormal growth of the brain is termed as 'brain tumor' in medical science. A tumor can be defined as a cluster of abnormal cells growing inside the brain. The exact reasons behind brain tumors are still at the darkest side of medical science but the serious effects of brain tumors are observed, sometimes it leads to abnormal human behaviour, internal cavity paralysis and sometimes it may threaten the human life [1]. A research has depicted more than 120 types of distinguished brain tumors among which a many are malignant in nature, i.e. which can threat life. Hence, to combat with this life-threatening issue an accurate diagnosis must be the primary step.

In last few couple of decades we have experienced a few advanced methods, among which computer based imaging is the most preferred one, of diagnosis of brain tumors are appreciated and accepted in surgical planning and further treatment. In neuroscience and neurosurgery, the brain MRI is widely accepted imaging technique. The MRI is the most commonly used modality for imaging brain tumors and detection of the locality of that. The traditional method for CT and MRI brain images classification and tumor detection is still mostly based on a direct human inspection of those images, although a number of other different methods have already been proposed[2,3]. MRI is a non-destructive, non-invasive and non-ionising method in nature. MRI provides high resolution images which are commonly used in brain imaging purpose. MRI is taken, using three techniques which are Tl- weighted, T2-weighted and Proton Density (PD) images. MRI of human head scan is taken in three orientations, axial (top to bottom of the head), sagittal (left to right of the head), and coronal (back to front of the head). There are several image processing technique such as histogram equalisation, image segmentation, image enhancement, morphological operation, feature selection and extraction and classification.

The remaining part of the paper is organized as follows. Section II, discusses about the extensive review of existing research towards the brain tumor detection and its classification. Section III, deals with a comparative analysis of various discussed techniques is provided. In section IV and V the research gaps and statistics of publications are discussed and section VI summarizes and concludes the paper.

II. LITERATURE SURVEY

Over the time, various researchers worldwide have already worked in the domain of brain tumor detection and classification and they have utilized and conceived a heap calculation that assesses the execution of their proposed approaches and plans. In this segment, we have advanced a few survey of such existing research along with their corresponding accuracy of computational executions.

Classification of Tumors and it stages in Brain MRI using Support Vector Machine and Artificial Neural Network[4]

Researchers Rasel Ahmmed et al. [4] have proposed a methodology that achieves tumor stage classification employing Artificial Neural Network (ANN) which comprises stages like image pre-processing, segmentation, feature extraction followed by SVM classification. In the pre-processing stage, three different contrast enhancement schemes have been applied; i) adjusted ii) adaptive threshold and iii) histogram imaging adopting both weiner2 and median2 filter techniques. The TKFCM algorithm which is essentially a merged approach of the K-means and Fuzzy c-means schemes has been adopted with certain modifications for implementing the segmentation stage. However, the feature extraction phase is performed in two orders. In the First order, statistic features and in Second order region property based statistic features have been derived. Finally the SVM scheme classifies the brain MRI image either into the normal or having tumor categories. The Brain Tumor stage is classified using the ANN classifier. The data set for each MRI image of normal brain, malignant tumor, and benign tumor have been extracted from 39 images out of which 3 normal, 9 benign, 17 malignant I, 6 malignant II, 3 malignant II, and 1 malignant IV stage tumor brain MRI images have been successfully identified. The accuracy of proposed method was assumed around 97.44%.

Segmentation and Classification of MRI Brain Tumor [5]

Researchers P. S. Mukambika et al. [5] have advocated an image processing scheme that essentially consists of i) Pre-processing, ii) Segmentation, iii) Feature extraction and iv) Classification phases. In pre-processing stage, the morphology scheme is adopted where double thresholding approach is implemented to detach the skull image from the MRI brain images. This current work has put forth a comparative study between two techniques that have been devised for tumor detection purpose. Both the schemes have been briefly described here: first is based on the Level set approach that exploit advantages of the non-parametric distorted models having active contours that are used to segment brain tumors from the MRI brain scans; the second approach uses the K-means segmentation algorithm. Once the segmentation stage terminates, decision making is adopted in two stages: i) Feature extraction adopting DWT (Discrete Wavelet Transform) and Gray Level Co-occurrence Matrix, and ii) Classification using the Support Vector Machine (SVM). Here the dataset consisted of MRI brain tumor cans that included T2 weighted 17 benign and 24 malignant tumor images of multiple patients. The achieved results were as follows: SVM having Level Set approach and K-Means segmentation scheme had classified brain scans into normal, benign or malignant tumor categories with 94.12% and 82.35% accuracy respectively. Obviously as evident, the Level Set methodology gave better results as compared to its k-means segmentation counterpart.

MR Image classification using Adaboost for brain tumor type [6]

Researchers Astina minz et al. [6] have proposed an efficient and effective automated classification scheme for detection of brain tumor from MRI scans using the Adaboost machine learning algorithm. The devised approach comprises three phases namely i) Pre-processing, ii) Feature Extraction and iii) Classification. During the pre-processing stage, firstly the noise from the raw data is separated; next it is transformed from the standard RGB image into grayscale form and eventually followed by applying median filter and thresholding segmentation schemes. As for the feature extraction stage, GLCM technique was adopted by which 22 myriad features were extracted from MRI scan. For classification purpose, the Adaboost boosting technique was employed which gave 89.90% accuracy. As far as their future work scope is concerned, they propose to work with quadratic and polynomial kernel functions since they believe that better accuracy might be achieved in future by increasing the training of their collected dataset MRI scans. Additionally the proposed system in this work is believed to be applicable for other critical scenarios like Glioma and Meningioma.

Tumor Detection in Brain using Genetic Algorithm [7]

Researchers G Rajesh Chandra et al. [7] have advised the adoption of an effective brain tumor detection scheme where the MRI brain scan is de-noised applying the DWT approach by using the wavelet co-efficient thresholding method. Here essentially the Genetic algorithm is adopted to detect the tumor pixels. This algorithm determines the best combination of information that can be extracted applying the relevant selection criterions. The current approach has integrated the K-Means clustering scheme into Genetic Algorithms for devising this last Evolutionary Algorithm that efficiently computes the optimal or sub-optimal data partitions. The devised detection method has been reported to improve segmentation accuracy from 82 % to 97 % based on ground truth. However, the limitation of this work lies in large storage and incurring of high computational cost for having adopted the wavelet transform scheme.

Efficient Detection of Brain Tumor from MRIs Using K-Means Segmentation and Normalized Histogram [8]

Researchers Garima Singh et al. [8] have devised a novel technique for brain tumor detection that encompasses Histogram Normalization and adoption of K-means Segmentation schemes. In this present work under investigation, at first, the input image is pre-processed to de-noise unwanted signals from MRI scans using varied filters like Median filter, Adaptive filter, Averaging filter, Un-sharp masking filter and Gaussian filters. The histogram of the pre-processed image is then normalized and classification of MRI scan is facilitated. Eventually, the image is segmented adopting the K-means algorithm in order to detach the tumor from the scan. MRIs can be efficiently classified by either adopting the Naive Bayes (NB) Classifier or the SVM so as to offer accurate prediction and classification. NB and SVM classifiers reportedly gave accuracy of 87.23% and 91.49% respectively. As clearly evident, the SVM approach offered higher accuracy. The implementation was executed on the MATLAB platform. However, this work too suffers from some limitation like its inability to locate precisely the accurate boundary of the tumor region under investigation. In the future, improvements can be incorporated in the proposed algorithm by addressing the limitation and the quality of the output images can be enhanced by adopting better morphological operations.

MRI Brain Cancer Classification using Hybrid Classifier (SVM-KNN) [9]

Researchers Ketan Machhale et al. [9] have adopted an intellectual classification system to categorize normal and abnormal MRI brain scans where the scan undergoes three phases namely; i) image pre-processing, ii) feature extraction and subsequent iii) classification. During the pre-processing stage, first the RGB components of the brain scans are transformed into grey scale format. Next, the Median Filter is applied to de-noise the MRI scans. Finally Skull Masking approach is used to separate non-brain tissues from MRT brain images. Dilation and Erosion are two fundamental morphological operations that are used for implementing the skull masking technique. In the second stage of feature extraction the texture features of the scan like symmetrical, gray scale components are extracted. Finally in the classification phase, varied machine learning techniques like Support Vector Machine (SVM), K-Nearest Neighbor (KNN) and Hybrid Classifier (SVM-KNN) have been adopted and a comparative study among them is facilitated. The dataset comprised 50 images and it was concluded that the Hybrid classifier SVM-KNN scheme offered the highest accuracy rate of 98% as compared to its counterparts.

Detection of Brain Tumor in MRI Images, using Combination of Fuzzy c-means and SVM [10]

Researchers Parveen et al. [10] have devised an algorithm that is an integration of SVM and fuzzy c-means, a hybrid scheme for detection of brain tumor from MRI scans. Here, firstly the image quality is improved using the contrast improvement and mid-range stretch techniques. Moreover, morphological operations like the Double thresholding scheme have been adopted for skull striping. For the purpose of image segmentation and feature extraction, Fuzzy c-means (FCM) clustering and Grey level run length matrix (GLRLM) is implemented respectively. Eventually, classification schemes like Linear, Quadratic and Polynomial SVM have been adopted to categorize the brain scans. The data set consisted of 120 MRI brain scans of patients; out of which 96 was adopted to train the SVM classifier and the remaining 24 scans were utilized to test the trained SVM. SVM classifier operating under the Linear, Quadratic and Polynomial kernel function modes reported accuracy level of 91.66%, 83.33% and 87.50% respectively and was assured to offer 100% specificity.

Intelligent Brain Tumor Lesion Classification and Identification from MRI Images Using k-NN Technique [11]

Researchers K. Sudharani et al. [11] have advocated brain tumor detection methodology that comprised schemes like Histogram, Re-sampling, K-NN Algorithm and use of Distance Matrix. At the beginning, histogram computes the total quantity of specified pixel values distributed in a particular image. The Re-sampling scheme, re-sizes the scan to 629 X 839 model for proper geometrical image representation. Finally the Classification and identification stages are facilitated using k-NN which is based on training of k value. Interestingly in this work the Manhattan metric has also been incorporated to estimate the distance of the classifier. The algorithm was tested on 48 images and implemented using the Lab View platform where the overall accuracy rate for all images were around 95%.

An Automated Detection and segmentation of Tumor in Brain using Artificial Intelligence [12]

M.Y. Bhanumurthy et al.[12] discusses a fully automated technique which uses AI to detect and segment abnormal tissue cells like tumor by analyzing MRI images accurately. This method deals with entropy, energy homogeneity and contrast extracted from the MRI image are applied as input to an AI system which uses nuerofuzzy classifier which differentiates an abnormal image from a normal one. The unusual tissues like tumor are then depicted by using region growing method. This method has achieved an accuracy of 95.65% in categorizing the images to normal and abnormal ones.

Robust algorithm for Brain Magnetic Resonance Image Classification based on GARCH variances Series[13]

Hashem Kalbhani et al [13] in their paper have introduced a novel classification method for categorizing MRI scans into normal and abnormal categories. Two dimensional discrete wavelet transform (2D DWT) of input image is computed in the first two levels. Adopting the Generalized Auto Regressive Conditional Hetroscedasticity (GARCH) statistical model, the wavelet coefficients of details sub band are modelled. Once the feature vector normalization is executed, the schemes: principal component analysis (PCA) and Linear Discriminant Analysis (LDA) are exploited to deduce proper feature and minimize the redundant traits from the primary feature vectors. Eventually the extracted feature are separately subjected to both the K nearest neighbor (KNN) and support vector machine (SVM) classifiers to determine detect and classify normal/aberrant brain scans. Results reveal that the devised scheme achieves high classification rate and requires only minimal features for classification purpose. The attained classification accuracy in the first scenario for KNN and SVM classifier were about 97.62% and 98.21% respectively and under the second investigated scenario both classifier achieved 100% accuracy.

Brain tumor Detection and Classification of MRI Using Texture Feature and Fuzzy SVM Classifiers[14]

Researchers Jayachandran et al. in this paper [14] have proposed brain tumor detection in magnetic resonance imaging (MRI) scans based on a hybrid algorithm that employs statistical and support vector machine classifiers. The devised approach includes 4 stages namely; i) noise minimization, ii) feature extraction, iii) feature reduction and iv) classification. An anisotropic filter was employed for de-noise mechanism and to enhance image quality for feature extraction. Using gray level co-occurrence matrix, the texture features were extracted followed by reduction of extracted features adopting the principal component analysis (PCA) scheme. Finally the FSVM classifier was adopted in classification stage where attained accuracy was about 95.80%. However, one principal limitation of the aforesaid approach is usage of PCA scheme that minimizes the lower dimensionality of the image texture features.

Brain Tumor Classification using Back Propagation Neural Network [15]

Researchers Sumitra et al. [15] in this work have presented a neural network technique for the classification of MRI brain images. The proposed scheme encompasses 3 stages namely: i) feature extraction, ii) dimensionality reduction and iii) classification. The feature extraction was implemented using PCA from MRI scans and essential traits such as mean, median, variance, correlation values of maximum and minimum intensity were extracted. The classifier in the classification stage was based on back propagation and neural networks have been developed. This classifier classified the scan as either normal, benign and malignant. The result reveals that the BPN classifier gave fast and accurate classification as compared to any other neural network counterparts. The classification accuracy was 73%. Its future work might improve the performance of devised scheme by expanding the data set.

Extraction and Application of Deformation Based Feature in Medical Images[16]

Researchers Xiao et al [6] have devised an approach to determine features using the correlation between brain lateral ventricular (LaV) distortion and tumor. The for tumor segmentation of MRI scans are facilitated by applying the extracted features. The advocated scheme comprises four stages: i) pre-processing, ii) feature extraction, iii) segmentation and iv) classification. In the pre-processing stage, issues like non-standardization of intensity, geometric non uniformity and redundant data in the brain scans and skull are primarily addressed. Lateral ventricular distortion is essentially used for feature extraction. In the segmentation phase, evaluation of LaV distortion feature on the brain tumor segmentation is executed having adopted unsupervised segmentation methods. In this work, K nearest neighbors (KNN) and conventional Fuzzy connected C-mean (FCM) are some of the most frequently used methods. The experiment reveals the relevancy between LaV distortion and tumor location. Comparative experimental studies on tumor segmentation suggest that, its accuracy improves when the extracted features are more accurate. The proposed design yields specificity and sensitivity of 100%. However, it suffers from a limitation; the brain tissue segmentation scheme wrongly assigns a non CSF pixel to the cluster CSF and to separate this undesired pixel, a global mask is employed. Potential future scope of this work might include incorporation of the LaV distortion as an additional feature that can be obtained for pattern recognition segmentation, thereby improving the accuracy of brain tissue segmentation procedure.

Wavelet statistical feature based wavelet statistical feature based segmentation and classification of brain computed tomography images [17]

Researchers Nandagopal et al. [17], in their work have presented a combined approach of wavelet statistical features (WST) and wavelet co-occurrence texture feature (WCT) that has been attained from two level discrete wavelet transform which is eventually used for classification of abnormal brain scans into benign and malignant categories. The designed scheme encompasses four phases: i) segmentation of region under investigation, ii) discrete wavelet decomposition, iii) feature extraction and feature selection and iv) classification and evaluation. The support vector machine (SVM) approach is exploited for conducting brain tumor segmentation. For feature extraction of tumor zone, a merged approach of WST and WCT is employed that has been primarily extracted from two level discrete wavelet transform. Genetic algorithm was utilized to select set of optimal texture features from among extracted feature set. The probabilistic neural network (PNN) was adopted for classifying aberrant brain tissues into benign and malignant variants and finally the performance evaluation was facilitated by conducting a comparative study between the PNN with its other variants. The attained accuracy was 97.5%.However one fundamental limitation of this scheme lies with the requirement of new training for Gaussian SVM classifier whenever a change is encountered in image data set and this method can only be applied to CT images. Future work scope of this devised methodology might be extended to other types of imaging such as liver CT imaging, MRI imaging, ultrasound imaging etc.

Feature and model selection with discriminatory visualization for diagnostic classification of brain tumor [18]

Researchers Navarro et al.[18], in their work have proposed a novel scheme for feature selection of dimensionality reduction and numerous unconventional classifiers on various HMRS modalities i.e, long and short echo times and its combined ad hoc operation mode. Entropy selection algorithm, which was essentially a swift method to generate relevant subsets of spectral frequency was adopted in feature selection scheme. This selection procedure was independently implemented in the classifier among the boot strap samples. A set of classifiers was eventually designed on the boot strap samples utilizing the previously selected features set and the desired outcome was the selection of a specific classifier for each data type. The final model was devised employing the boot strap sample using an iterative approach. The attained accuracy was approx 95%.The future research scope of this work might extend the adoption of the proposed scheme and apply the same to other relevant brain tumor classification problems that involves varied pathologies and pathological grouping.

Spectral clustering independent component analysis for tissue classification from brain MRI [19]

Researchers Sindhu mol et al. [19] have devised a methodology to improve the classification of brain tumor from MRI scans based on spectral angle feature extraction and spectral clustering independent component analysis (SCICA). Firstly the MRI image is segregated into different clusters by spectral distance based clustering. Independent component analysis (ICA) is executed on the clustered data along with support vector machine (SVM). Here T1weighted, T2 weighted and proton density fluid inversion recovery images were primarily adopted for evaluation purpose. Comparative analysis was facilitated with ICA based SVM and other conventional classifiers to reinforce the stability and efficiency of SCICA based classification. The accuracy achieved by the analysis of ICA based SVM resulted in 98% and 96.1% for reproduced lesion. Future scope of this work might include refined and adaptive threshold selection scheme followed by the expansion of multi spectral data with more informative MRI sequence. The experimental result revealed that the system performance varies based on selected threshold values.

The next section offers a comparative analysis among the aforesaid schemes on the basis of parameters like: adopted methods, corresponding limitations and accuracy level of each devised approach.

III. COMPARATIVE STUDY OF DIFFERENT BRAIN TUMOR DETECTION AND CLASSIFICATION TECHNIQUES USING MRI

A contrast investigation of various brain tumor Detection and Classification strategies are abridged in the following comparison table (Table 1) with focal points and hindrances. The table depicts different methods used by researchers, accuracy of their approaches and their drawbacks.

Table – 1 Comparative Analysis of Brain tumor detection and classification

No	Author	Year	Adopted Method	Limitation	Accuracy
1.	R. Ahmmed, A.S. Swakshar and Md. F.Hossain, Md.A. Rafiq [4]	2017	TKFCM Segmentation , SVM Classification and ANN classification	Trouble in choosing ideal features to recognize distinctive classes is time consuming.	97.44%.
2.	P.S. Mukambika and K Uma Rani [5]	2017	Level set method , k-Means Segmentation and SVM classifier	Potential of misidentification of what should be classified.	94.12% & 82.35%
3.	A. Minz and C. Mahobiya [6]	2017	Adaboost & Neural Algorithms	It can maximize the margin with respect to features that have already been selected.	89.90% & 74.00%
4.	G.S Chandra and K.R. H Rao [7]	2016	DWT Filtering and Genetic Algorithm	Wavelet transform require large storage and its computational cost is high.	90.00%

5.	G. Singh and M.A. Ansari [8]	2016	K-Means Segmentation and SVM &Naïve Bayes classification	It doesn't function admirably with clusters (in the original input data) of various size and Different density.	91.49 & 87.23%
6.	K. Machhale, H.B.Nandpuru ,V. Kapur and L. Kosta [9]	2015	SVM & SVM-KNN classification	At the point when there is an adjustment in the dataset, a fresh preparing dataset is required.	98.00%
7.	Parveen and A.Singh [10]	2015	FCM Segmentation and SVM classification	Brain tumor type can’t be classified and Difficult to select SVM kernel function.	91.66%
8.	K. Sudharani, T.C. Sarma and K.S. Rasad [11]	2015	SVM & SVM-KNN classification	Large search problem to discover nearest neighbour and Storage of data.	95.00 %
9.	M.Y. Bhanumurthy and K. Anne [12]	2014	Neuro-fuzzy classifier, Region growing method	Region growing method is very costly in terms of calculation of time and memory.	95.65%
10.	H. Kalbkhani, M.G. Shayesteh and B. Zali-Vargahan [13]	2013	PCA & LDA features extraction and KNN & SVM classifier for classification.	They cannot model asymmetric with respect to the indication of past qualities.	97.62% and 98.21%
11.	A. Jayachandran and D. Raghavan[14]	2013	Based on hybrid algorithm for detection of brain tumor by using statistical and SVM classifier.	Principal component analysis, diminishes the lower dimensionality of the texture feature.	95.3%
12.	N. Sumitra and R. Saxena [15]	2013	Uses a neural network technique for the classification of MRI images. The feature extract ion is done by using PCA	Over discriminant accuracy is less. Assurance of Unique feature vector is not possible	73%
13.	K. Xiao, A. L. Liang, H.B. Guan and A.E.Hassanien [16]	2013	K nearest neighbours (KNN) and conventional Fuzzy connected C-mean (FCM).	They wrongly dole out a non-CSF pixel to the group. Undesired pixel is evacuated by putting a global mask, in this way leaving the region as removed one.	100%
14.	G.S Chandra and K.R. H Rao[17]	2013	SVM is used for segmentation. A combination of WST and WCT is used for feature extraction. Genetic algorithm is used to select the optimal texture feature. PNN is used for classification.	Whenever there is any change in the image data set, It requires a new training set for Gaussian SVM classifier .This strategy is applied only to CT images.	97.5%
15.	Navarro and D. Hackney[18]	2013	It introduce a new method for feature selection and dimensionality reduction by using off the shelf classifiers on various HMRS modalities.	There are numerous issues including various pathologies and neurotic gathering.	95%

16.	S. Sindhumol and A. Kumar,K. Balakrishnan[19]	2013	It is based on spectral angle based feature extraction and spectral clustering independent component analysis (SC-ICA)	A low threshold value can prompt over clustering. Cost of Feature extraction due to clustering is high.	98% & 96.1%

The following section provides details of current research gap.

IV. CURRENT RESEARCH GAP

From the above mentioned reviews we find a number of further research areas in brain tumor detection and analysis. Most of the current analysts are concentrated on brain images which are having high image quality yielded from MRI, but they are not bothered about poor MRI images which contain noise and poor brightness. Almost all of researchers have talked about MRI based imaging but there could be better imaging techniques which can be used for this purpose. Basic segmentation process of MRI is in focus but object based segmentation process has never been appreciated. Existing neural network based analysis takes enough time while training and testing phases, hence, time complexity is the key point to be noted. Here, methods with poor images, object based segmentation and less time complexities can be approached for further research studies. The next section puts forth the statistics of publications pertaining to the existent brain tumor detection scenarios.

V. STATISTICS OF BRIAN TUMOR DETECTION PUBLICATIONS

This section discusses the statistics of existing publications. The search for the statistics is carried out with desired keywords like brain MRI enhancement, segmentation and classification. The search statistics (Table 2 and 3) are considered for conference publications, journals and magazines, early access articles, books, e-books, chapter publications and bar chart representation (Figure 1 & 2) of the above said tables.

Table – 2 IEEE Publication Statistics

Type	Brain MRI + Segmentation	Brain MRI + Enhancement	Brain MRI + Tumor Detection Classification
Conference Publications	5	7457	1027
Journals Publications	2	2291	162
Early Access Articles	0	33	8
Books & eBooks	0	5	0

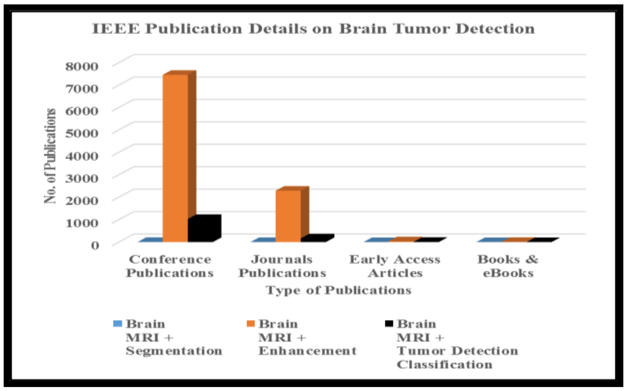

Figure 1. Graphical Representation of IEEE Publication

Table – 3 Springer Publication Statistics

Type	Brain MRI + Segmentation	Brain MRI + Enhancement	Brain MRI + Tumor Detection Classification
Conference Publications	2559	471	414
Journals Publications	5857	161	130
Chapters Publications	2828	598	516

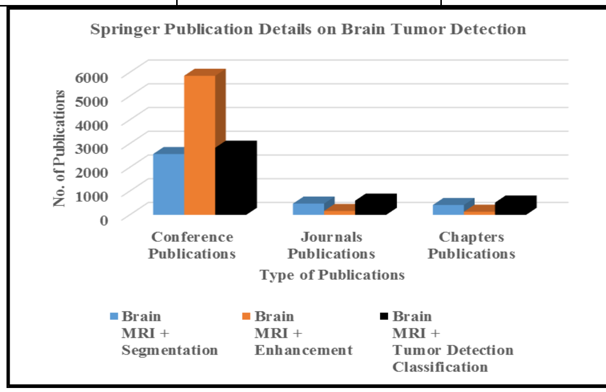

Figure 2. Graphical Representation of Springer Publication

VI. CONCLUSION

In this paper we have accomplished an extensive survey of various detection and classification techniques for MRI brain scans and a comparative study is also furnished among the discussed techniques. This work can be extended in devising more sophisticated brain tumor detection algorithms in the near future that can offer more promising results than the existent schemes. As diagnosing brain tumor is a highly critical, complicated and a sensitive task, obviously higher accuracy and reliability in diagnosis methodologies are preferable. Hence delving into the details of such schemes can highlight new vistas for developing more robust image segmentation and detection techniques in the near future.

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