CHAPTER 2
BACKGROUND AND LITERATURE REVIEW

2.1 INTRODUCTION

Abnormality detection (segmentation of brain region) in Magnetic Resonance (MR) brain images is a challenging task. The detection procedure of any irregularities in the brain images is a step by step procedure. Initially, the MR brain images are categorized into different groups (image classification) according to its nature, because the treatment planning varies with different instances abnormalities. Further, the abnormal portion is extracted (image segmentation) to perform volumetric analysis, which mainly verifies the success rate of the treatment given to the patient [20]. The involution in abnormality detection processes is that lack of detection techniques with high precision within expeditious convergence time. Numerous automated techniques are evolved to overcome this drawback. Among the automated techniques, there are massive quantities of study which has been borne out in the task of image segmentation.

Medical image segmentation has also had a notable attention, due to the importance of an application of the segmented result. Remarkably a large quantity of scientific research has been paying attention to specific regions of the human body and different types of imaging modalities used for that. Nevertheless, this segment will make available, a survey of many proposed approaches for brain tumour segmentation (abnormality detection) in MR images. Here significantly expresses the state of creative production in the field of medical image segmentation. Among the diverse methodologies for imaging technique, the most commonly practiced technique in radiology to visualize the brain soft tissue is Magnetic Resonance Imaging (MRI).

All the works specified in the survey associated with this task are concentrated in computer aided MR image segmentation based on machine learning and put into practice the identification process. Manual segmentation of tumour or abnormality detection is largely held away due to its subjective variability in results. The event of automatic segmentation (using computers) primarily depends on its feature selection and screening. The following prose scrutinizes the pros and cons of the different
methods adopted so far in the field of abnormality detection based on image segmentation.

The Literature survey described here in two different aspects,

1. Literature survey based on the chronological order of work carried out in the same field.

2. A Categorical literature survey of the work done in each step, which are involved in tumour segmentation.

2.2 LITERATURE SURVEY

Tina Kapur, W. Eric L. Grimson et al [21]: Segmentation of brain tissues is performed with the assist of a combined method, which are individually exploit grey level values of each pixel with its topological and spatial information associated with it. After performing an intensity based correction, brain tissues are classified by Expectation Maximization algorithm (EM). Connectivity among the pixels and binary morphology is used for extracting the relative topological information. In summation of all these, balloon based contour deformable model designed for the spatial information for the division process.

Conclusion: Expectation maximization provides reliable intensity-based categorisation of the data into various tissue classes. But further processing is needed because brain structures are not specified by unique intensity values. The precision of the obtained result is subsists as an open issue

Wei-Ying Ma, B. S. Manjunath et al [22]: A region growing based segmentation with a novel boundary detection scheme based on edge flow is projected in this work. Conventionally edges are to be found in an image at the local maxima of the gradient in the intensity image feature space. In the first step, formulate an edge vector, by using the edge energies and the corresponding probabilities obtained from different image properties. To shape a single edge flow field for boundary detection, the attributes like intensity, texture, phase and weighting coefficients associated with image intensity attributes are used. Combined information about the vividness and texture is used for the boundary detection. Separate edge flow of colour and texture is calculated and aggregated with the direction information to an edge vector. Boundary detection can be run away by moving the edge flow vector along the image and identifying the locations where two
opposite direction of flow happen upon each other. A predictive coding method is used to identify the focal point of alteration in colour and texture (grain). To end with boundary detection, disjoint boundaries are related to form closed counter and results in a bit of the image area. Region merging algorithm is employed to merge similar regions. Colour histogram and Gabor texture features are computed for measuring the region similarity.

**Conclusion:** A single scale parameter has been employed for the entire image segmentation. Still, this might not be appropriate for images which contain multiple scale information. Proposed approach requires very less parameter tuning. Referable to the lack of ground truth, no quantitative performance evaluations are held out for this overture. Visual inspection shows that the segmentation has acceptable accuracy.

**Weiber DOU, Su RUAN et al** [23]: Fuzzy information fusion method for segmentation of brain tissue is suggested here. Fuzzy information fusion is implemented in following steps. First step registers the data received firm multi-spectral image, is known as data matching. During the second phase of fusion, knowledge based modelling methods are used to characterize the correlation data. The fuzzy membership function corresponding to fuzzy set is modelled from this information modelling. During information fusion, with the fuzzy relation fuse the fuzzy information represented in membership function in each and every multi-spectral image. Tumour area under investigation is considered as fuzzy, because it is a mixture of disturbances, the partial volume effects, etc., In accordance with the different characteristic, fuzzy set can also be patterned with different membership function. The membership degree determines whether the pixel classified as normal or not.s

**Conclusion:** It automatically classifies abnormal tissue in human brain in three dimensional spaces from a fused image such as T1-weighted, T2-weighted and proton density image. It consists of data matching, data modelling, data fusion and fuzzy classification. Data fusion is a central step in the method. Fuzzy classification successfully applied in this algorithm, only after a registration procedure. It do not mention about the time of convergence or execution.
Jianxun Zhang, Quanli Liu, Zhuang Chen [24]: This paper discusses an unsupervised method of image classification based on Kohenen Self Organizing Map Neural Network (KSOMNN). Self organizing algorithms come under the category of neural network. Neural network map the signals from higher dimensional space to lower dimensional space in terms of neuron units and its associated weights. It organizes data into groups according to the similarity criterion. To enhance the operation, two dimensional images are decomposed into smaller size sub images and de-noise the image by a 2 dimensional discrete wavelet transform. This de-noised sub image is presented as input in the preparation process of image segmentation.

Conclusion: The chief problem of Self Organizing Map (SOM) proposed by Kohenen network is that grooming time is very large and the result is greatly determined by the noise content present in the image. These two disadvantages are eliminated with the help of 2D DWT algorithm incorporated along with this SOM. The result shows encouraging level of improvement in segmentation. Execution time and level of complexity is very high.

Phooi Yee Lau, Frank C. T. Voon [25]: Projected an analytical method for the detection of brain tumour from MR images. The proposed technology evolved with a conceptually simple supervised block and image-based techniques to analyze MRI brain images. Conversion of image into blocks it relatively reduces the computational requirements. The main objective of block based analysis is that to detect a block under suspicion. This algorithm implemented into two sections like feature block section, and the multi-parameter section. In the first section divide the image into blocks. In the second phase analyze the image using three different parameters like, edge, energy and contrast. The feature blocks are compared with standard parameters to detect the irregularity in the image. Edge parameter is always used to determine the boundary of the object. Energy parameter defined as the intensity of pixels in the limited area. Contrast parameter often used to characterize the variation of pixel intensities.

Conclusion: This type of algorithm is applicable to T2- weighted image only. This clearly indicates the abnormalities in the brain area. The execution of this depends upon the size of the cube under consideration. Even though the computation
time and complexity of this algorithm is considerably less, it can not used for all types of images.

Nahla Ibraheem Jabbar et al [26] : The main trouble coupled with the segmentation for the abnormality detection in MR image is that, there is no distinct hard boundary between dissimilar regions of the image. Human brain consists of dissimilar types of tissue, which are correlated to one another in terms of its function and visual aspects. At the point of fact, in that respect is a blending of dissimilar cases of tissue in the brain which is not comfortable to differentiate with the help of straightforward computerized technology. Here is a method projected to expose this criterion of intermixing of normal and abnormal tissues. Fuzzy C-means Clustering (FCM) and Kohonen Neural Network (KNN) is utilized for setting apart the different tissues into single modules. This new family of algorithm is called Fuzzy Kohonen Clustering Network (FKCN). This proposal utilized different techniques such as fuzzy membership, parameter optimization and learning the rules of Kohonen network for getting better outcomes.

Conclusion: This new algorithm takes an automatic control on distribution of reading rate. The fuzzy parameter “m” (learning parameter) greatly affected the result of the Fuzzy Kohonen neural network. The parameter “m” is not a static parameter; it moves on changing during each iteration process and the outcome will be worsened if the value of “m” is big.

D. Jude Hemanth, C. Kezi Selva Vijila et al [27]: In the case of biological computation application Artificial Neural Network (ANN) and Fuzzy based systems is widely used. This paper proposed a comparative survey of these two techniques in Magnetic Resonance (MR) brain image segmentation. Real time images with abnormalities are used in this revision. The feature extraction is a method of data reduction to fix out a subset of informative variable based on image data. Nine textural features rooted in the probability matrices are studied and applied for the partition. The features are angular second moment, sum, mean, sum variance, sum entropy, difference variance, difference entropy, correlation coefficient, mean and standard deviation. All-inclusive features that are elicited from the image may not be having great meaning, merely more or less of the inconsequential features drive into inferior performance. Optimization technique is done on these characteristics to
select significant features. These chosen features are utilised for training Neural Network. Linear Vector Quantization (LVQ) neural net is integrated in this work and Fuzzy C-means clustering algorithm.

**Conclusion:** Performance is assessed along the basis of segmentation accuracy and convergence time. Accuracy of the LVQ is found higher than the fuzzy segmentation because segmentation efficiency depends on the initial membership value and cluster size in the case of fuzzy algorithms. Calculation time is less in the case of LVQ compared to fuzzy classifier.

**H.B. Kekre and Saylee Gharge et al** [28]: Presented a new method for image segmentation for MRI image. Here probability and entropy are the measures used for grouping pixels into different regions. At first formulate a probability image, based on the chance of each picture element in the input image. Probability image contains very low values, which are the probability rather than grey level values. Normalize these values and segment the image using a threshold. Randomness is a feature used for the partition of the image. Entropy is a measure of uncertainty, if the value is high more information is associated with the source. During the second phase, probability image is applied as an input to construct an entropy image. Entropy is analyzed by an appropriate window size, to select the neighbourhood of each picture element in the input image. A window size of 3x3 window provides better outcomes. By moving window over the image and calculate the entropy for each window to make a new image based on entropy by replacing the value of center pixel. Image segmentation is done after histogram equalization. The value of the threshold for the segmentation is the value at the mid point of minimum and maximum grey level of normalized images of probability and entropy.

**Conclusion:** Proposed method provides a better solution compared to GLCM based segmentation. This algorithm performed much faster compared to the co-occurrence matrix method. It does not provide a clarification about the time of execution and accuracy.

**Safer Iscan, Zümray Dakar et al** [29]: Here a novel method is offered for the detection of abnormality (tumour) in MRI images. The execution of this technique is investigated on phantom and on original brain images. 2D (2 dimensional)
continuous wavelet transform is applied to retrieve texture characteristic of tumour from magnetic resonance image. The perception of symmetric property is implied for the segmentation of tumour, because the human brain is basically symmetric across the mid sagittal plane. Incremental supervised neural network (ISNN) and wavy stripes are utilized for the segmentation of brain image into seven categories. From these seven class brain area (consists of six divisions) is extracted using background elimination. Symmetric property of the head is resolved with the help of moment properties. If any asymmetric differences are found between left and right vectors, that is identified as tumour. This asymmetric difference is further investigated using the space between the two vectors.

**Conclusion:** The advantage of CWT is that, it does not need extra or maximum computational load to be ready. Noise added to the phantom image is not perceived as asymmetry. Small asymmetric differences according to the symmetry axis in seven classes increase the Normalized Distance (ND) which might cause the proposed algorithm to make an erroneous conclusion.

**T. Logeswari and M. Karnan** [30]: Presented a two phase clustering based approach using Self Organizing Map for MR image segmentation. During the first phase image is undergoing a preprocessing technique. A weighted average filter for a wide class of nonlinear filtering is used for preprocessing. The weighted median filter has the robustness and edge preserving capability compared to other filtering techniques. Aside from other clustering techniques, here recommend an efficient vector quantization model for clustering. Vector quantization is a process of portioning to optimize the standard function, convert a n-dimensional vector space into M different regions. There are two processes involved in the vector quantization; the first course is that according to the probability, determine a code book. This beginning phase is also known to be as the training operation. Second step is the encoding process which assigns input vectors to the code book vectors. This clustering process (vector quantization) implemented with the help of competitive learning neural network (CLNN). In addition to the competitive learning process in SOM a hierarchical SOM (HSOM) that combines the idea of data abstraction is also included to segmentation. Fuzzy clustering and SOM together project he data to lower dimensions. An efficient image segmentation was used fuzzy C-means and HSOM are implemented here.
**Conclusion:** Selection of the initial cluster is performed with the help of HSOM technique. But the convergence of cluster centre is needed just after several iterations. The operation of this algorithm depends on the weight vector, execution time and tomorrow pixels will detect.

**Dr. Samir Kumar Bandyopadhyay [31]:** Brain image obtained from the scanner for the detection of tumour may contain noise and other artefacts. Then, pre-processing is necessary to thin out the artefacts contained in it. Here a three stage system is employed for noise reduction. The proposed three tier system is histogram equalization, median filter and an application of un-sharp mask on the image. During detection and classification of tumour (abnormal) region, the image is considered as pixel data. Calculate the maximum difference in threshold from the image and compare this value with the entire pixel in the image. If the value of difference is larger than the maximum difference in threshold, then the area under exploration will splits the image into two parts. Otherwise the mode value of the subset will be propagated to the entire portion of the image. This procedure is continued securely the image vertically from top to tail end, followed by uniform colour quantization technique in colour space.

**Conclusion:** The primary drawback of this approach is that, the classification accuracy is different for different dataset images.

**P. Tamije Selvy, V. Palanisamy et al [32]:** Clustering is an important means of information mining for separating information into different categories by similar feature. The main difference of clustering from classification is that first one is an unsupervised technique. An important query is how to decide what comprise good clustering; there is no absolute ‘best’ criterion which would be independent of the final design of the bundling. Clustering algorithms are used for the isolation of tumour objects from the brain image. This paper had analyzed the efficiency of the various cluttering techniques to key out the tumour region in MR brain Image. The algorithms employed for comparison are K-means, Self organizing Map (SOM), and Hierarchical Clustering and Fuzzy C-means algorithm. Public presentation is assessed based on parameters like segmentation accuracy and implementation time.
Conclusion: When the number of tumour pixels identified is concerned, K-means and Hierarchical clustering give better resolution than other clustering techniques. Implementation time of K-means and Self organizing map is lesser than any other organization. While 100 images are used for testing, 95% of accuracy is obtained from K-means and Hierarchical clustering. Overall Result shows that K-means clustering had outperformed all other clustering in the case of tumour detection and recognition. No algorithm can work better than the other in all phases.

Rashid Hussain*, Abdul Rehman Memon et al [33]: Early detection of malignant tumour had an important role in the event of patient endurance. Conventional method has major limitations, especially when the image is corrupted with burst noises. Here a new approach on fuzzy clustering that is based on wavelet de-noising is proposed to get rid of the adverse consequence of noise presented in the image. To get image results at various stages of decomposition, work out a multi resolution wavelet decomposition of the icon. Compute threshold for a sort of statistical distributions of the disturbance. Apply soft thresholding rules on the noisy coefficients finally, perform inverse wavelet decomposition to reconstruct the image. Different sizes of tumour and diverse forms of noise burst are considered for the evaluation of the operation.

Conclusions: It is found out that the proposed technique provides an efficient detection of brain tumour in the noisy, magnetic resonant image where benign and malignant areas are hard to identify. Computational complexity of the fuzzy clustering is also taken under different scenarios.

S. Javeed Hussain, C. Venkatesh et al [34]: Presented a precise segmentation of normal and pathological tissue in brain MR image. Beginning of all input images is classified by two by a dual feed forward, back-propagation neural network classifier (FFBNN). And so, the segmentation process is executed on the classified images. In the case of normal image, image is categorized as white matter, grey matter and cerebro-spinal fluid. In the event of abnormal image, it is categorized into edema and tumour tissue. Non-cortical tissues in the grey scale image are transferred by region based binary mask extraction process during pre-processing. To segment GM and WM, find out the edge through the binarization process of using gradient image. Orthogonal polynomial transformation applied to skull stripped
image to find-out the CSF region within the image. Edema pixels are categorized with regard to a threshold value of the chosen area. Tumour region segmented using a region growing algorithm.

**Conclusion:** Features used for classification are two dynamic statistical features and three 2D wavelet decomposition features. A dual feed forward, back-propagation neural network classifier is applied in the initial stage of the identification process of the algorithm. The solution of this algorithm tested using defined set of images. Performance measured in terms of specificity, accuracy and sensitivity. Performance standards are having a dual level dependency.

**R.Rajeswari, P. Anandhakumar et al [35]:** Image is a two dimensional signal. The signal is nothing but a aggregation of numbers. Analysis of these numbers gives insight into the details and nature of the signal. In the case of digital image processing applications, the frequency content of the signal is very significant. The Fourier transform is the most popular transform used to hold the frequency spectrum of the signal. Analysis of frequency content in the MR image is so because it has the capability of showing the irregularities of the brain like a tumour, stroke etc., and Fast Fourier Transform (FFT) is applied here to analyze non stationary signal. Those are having good frequency and time location. For the inspection of the spectral leakage, the sign is multiplied with window function and zero padding is also given to the signal to increase the distance. The algorithm works with enhancement of the tumour region by eliminating background and threading process. Go through the FFT with window and zero padding and plot the magnitude versus frequency for a given image window. Zero padded FFT provides both correct amplitude and minimal spectral leakage. Spectral leakage is less for normal tissue and more for the infected tissue. It is observed that usually more leakage found in the frequency region of 50 Hz to 400 Hz with intensity value more than 255. Then that country having this specified characteristic is assumed as tumour region.

**Conclusion:** Boundary between the tumour region and normal tissue region are differentiated using pixel intensity values. To examine the spectral leakage zero padded FFT is applied. This method of algorithm efficiently detects the tumour region using its frequency domain analysis.
Dr. H. B. Kekre, Dr. Tanuja Sarode et al [36]: Presented a comparison of the carrying out of texture based segmentation algorithms. The GLCM based segmentation algorithm provides proper tumour location, merely it calls for high computational time to compute the statistical attributes. Kekre’s Median Codebook Generation (KMCG) works with the help of code generation based on the median of the stored value. Initially size of the code book is set to one. After the every iteration, code book is size increased by a factor of 2. Repeat he process up to a specified size. Each vector finds the corresponding picture element in the original picture and the tag with the code vector number. In the code book kept all the pixels having an intensity equal to 255 as such and define all other pixel value to 0. Restore the image by putting back the code vector corresponding to each indicator. Post-processing operations like dilation and erosion are applied to reconstructed image to segment exact tumour. KFCG (Kekre’s Fast Codebook Generation) reduce code-script generation time. Initially begin with a single cluster with entire training vector and code vector. In the subsequent steps this cluster is split into two in second steps and again into two and so on up to the code book size reached to the size stipulated by the user.

Conclusion: GLCM gives a more honest result, but computational complexity is really high. Watershed segmentation is computationally less complex, but result into over segmentation. KMCG and KFCG show the proper tumour demarcation. KMCG provides better results than watershed segmentation and GLCM. Computational complexity of KFCG algorithm is very less and the result is also better in the case of KFCG.

Anjum Sheikh, R.K. Krishna, Subroto Dutt [37]: Proposed an Ant colony optimization is employed for the detection of tumours. Ant colony optimization is a co-operative search algorithm, inspired by the behaviour of real ant. This is a population based approach. This case of segmentation is done in 2 phases, namely Pheromone Initialization (PI) and local Pheromone updating. During initialisation, for an ant, select a random pixel from the icon, one which has not been taken previously. Selected pixel is updated with a flag value 1. For each ant separate column for pheromone and flag value are allocated in the solution matrix. Local pheromone updating is performed by all ants after each construction step. The
number of ant and number of steps to be taken by the ant is equal to the number of rows and number of columns of the solution matrix

**Conclusion:** This met heuristic based image segmentation method shows that Ant Colony Optimization (ACO) method can only be successfully segment a tumour provided the parameters are taken properly. But its energy efficient concept is extensive because execution time is comparably less compared to other technique.

Dina Aboul Dahab, Samy S. A. Ghoniemy et al [38]: Presented a modified image segmentation technique that is applied in MRI to detect brain tumor. A modified Probabilistic Neural network (PNN) model based on Linear Vector Quantization (LVQ) is used here. PNN has an inherent statistical foundation based on Bayesian statistical theory that makes it suitable for solving segmentation problems. Learning vector quantization is a supervised competitive learning technique that takes decision boundaries based on training sets in input space. It reduces the size of the hidden layer of the network. PNN classifier performance is assessed in terms of training, performance, classification accuracies and computational time. Adjustment is performed along the basis of automatic use of specific areas of involvement. From each ROI, features like tumour shape, and intensity are extracted and normalized. Each ROI is then given a weight to estimate the Probability Distribution Function (PDF) of each brain tumour. These weights are applied as a modelling process or alter the conventional PNN.

**Conclusion:** The major disadvantage of the conventional probabilistic neural network is that the calculation time is very large. In a conventional probabilistic neural network the entire training set has to be stored and must be undergo during testing. And so the measure of computation necessary to categorize an unknown pixel is proportional to the size of the training set. Merely in the modified PNN, second layer of the classifier contains one neuron for each year of the training data set. This change leads to much less computational time for sorting. The LVQ-based PNN system decreased the processing time considerably compared with the conventional PNN.

Method: Tuhin Utsab Paul et al [39]: Proposed a two step segmentation process. The image enhancement is performed by applying an unsharp filter, which
are created from a negative of Laplacian filter with alpha value equal to 0.2. Image sharpening is performed by taking off a blurred version of the image of itself. A two dimensional array is produced as the filter. Pixels in the output image are computed using double precision floating point. Output pixel elements that go past the orbit of the integer while compared with input image are truncated and fractional values are filled out. With a skull mask skull can be transferred from the original image. Segmentation process is a footstep by step refined process, got going with simple K-Means algorithm. K-Means algorithm never reaches into an optimum solution, there for optimization called local standard deviation guided grid based coarse grain localization performed thereafter. Segmentation boundaries are reevaluated to generate more optimal solutions by mapping image pixels in a large grid. Grounded along the local standard deviation, calculated the histogram in each grid from that generate new boundary. To obtain most optimum segmentation, the same process like grid mapping done on a little power system. By this local standard deviation guided grid based fine grain localization, able to restore the sharp details of the tumour boundary and can have better-quality analysis on overlapped region.

**Conclusion:** This method overcomes the conventional K-means algorithm. Qualitative and quantitative measures of the brain tumour segmentation process increased. During guided grid based coarse grain localization selection of large grid dimension may reduce the effect of noise in segmenting the grid. Simply, the large grid dimension pays no attention to the finer anatomic details like twists and turns tumour boundary and overlapping region of in the brain. The real time execution time of the tumour detection is also getting reduced.

**Shaikh Afroz Fatima** [40]: Employed an efficient arrangement for the detection of cancer region in an MR image. Division is prepared with the help of histogram equalization and thresholding. Histogram equalization employs a monotonic, nonlinear function, which set the intensity values of pixels in the input image such that the output image includes uniform distribution of strength. Threading is done in such a way that the grim and white pixels correspond to background and foreground respectively. To better the contrast between tumour region and non tumour region, an image enhancement is performed by means of average filter and morphological operation. Texture features in conjunction with its correlation coefficient are selected as features for the identification procedure. If the
correlation-coefficient is greater than 0.9, they are assumed to a single feature. Finally, classification is furnished by Neuro-fuzzy classifier. Input layer of the classifier encloses neurons equal to the number of features. Single layer in the output is to ascertain whether the tissue is a tumour or not. Hidden layer is updated according to prescribed regulations.

**Conclusion:** The arrangement results in better classification during the identification operation. The accuracy level is set up to be approximately 50-60% improved in recognition compared to the existing Neuro-classifier. It requires a considerable amount of iteration time for the calculation of yield.

Aditi P. Killedar Veena P. Patil Megha S. Bose [41]: Content Based Image Retrieval (CBIR) is specified as a set of methods applied to index an image based on the features of its visual content, and to retrieve the images based on the passed criteria. CBIR can also be applied for the detection of brain tumour. The suggested method is done in three stages; feature extraction stage by means of GLCM (Gray Level Co-occurrence Matrix), feature reduction stage, via PCA (Principal Components Analysis) and classification stage by SVM (Support Vector Machine). Main features based on GLCM matrix value, discrete wavelet based image and direct variance are used. Accuracy and performance of the result are primarily depending upon the selection of features. In parliamentary law to cut the redundancy, principal component analysis is executed over the extracted feature. Support vector classification is utilized for the classification of tumours, because of its ability to generate nonlinear decision boundaries using methods designed for linear classifiers.

**Conclusion:** The medical decision making system has been planned by the grey level co-occurrence matrices, principal component analysis and support vector machine as a supervised learning method which will help to get very hopeful results in separating the normal images, images with a tumour and image of multiple sclerosis.

Nitish Zulpe and Vrushsen Pawar [42]: This work primarily payed attention to the classification of four different classes of tumours such as Astrocytoma, Meningioma, Metastatic bronchogenic carcinoma, and the Sarcoma. Pre-processing is performed to improve the quality of the image by Gaussian filtering, noise
suppression, contrast enhancement, intensity equalization and outlier elimination. GLCM features like autocorrelation, contrast, correlation, energy, entropy, homogeneity, sum, average, sum entropy etc., is used for classification. Two layer feed forward neural net, namely Levenberg-Marquardt (LM) algorithm based classifier is applied for sorting. Confusion matrix gives the accuracy of the classification and its diagonal elements shows classified groups. A contour plot is a graphical technique for representing a 3-dimensional surface by plotting constant z slices, called contours, on a 2-dimensional format. Target contour plot represents desired output vector and output contour plot represents actual output.

**Conclusion:** After preprocessing, the GLCM textural features used to train the feed forward neural network with 80 MR images of 4 different classes are classified with 97.5% accuracy with Levenberg-Marquardt algorithm. Levenberg Marquart (LM) is a nonlinear optimization algorithm which gives the better recognition rate of 97.5%. Computational complexity is not clearly mentioned in the algorithm.

**S. Javeed Hussain, T. Satya Savithriet al** [43] : An effective technique is anticipated for the precise partitioning of the normal and pathological tissues in the MR brain images. The proposed segmentation technique initially performs classification process by using Fuzzy Inference System (FIS) and Fuzzy Based Neural Network (FBNN). Five characteristics are extracted from the MR images: they are two dynamic statistical features and three 2D (2 dimensional) wavelet decomposition features. Block based features extracted from whole image are used for classification in this algorithm. Brain imaging is divided into N number of stoppages, even though just a few numbers of blocks (not all the blockages) are considered for feature selection. For this, chosen one block and checked its neighbour blocks. If the value in the neighbour blocks is 0, then these blocks are not weighed in the feature extraction procedure. Only if it's not so, and so the distance between the selected block and neighbour blocks is found out by exploiting Euclidian distance. In Segmentation, the normal tissues such as WM (White Matter), GM (Gray Matter) and CSF (Cerebro-spinal Fluid) are sectioned from the normal MR images and pathological tissues such as edema and tumour are segmented from the abnormal images.
**Conclusion:** The implementation result shows the efficiency of proposed tissue segmentation technique in segmenting the tissues accurately from the MR images. The carrying out of the partitioning technique is judged by the performance measures such as accuracy, specificity and sensitivity.

**M. Rakesh, T. Ravi** [44]: Three textural features, namely contrast, correlation and entropy based on the grey level co-occurrence have been used for image segmentation in this work. Basically, feature space selection is a key issue in cluster based segmentation. While the MR brain image is turned into a grey-level image, that is not enough to support fine features. To get more useful feature and enhance the visual density, the proposed method applies pseudo-colour transformation by a lookup table with a predefined colour map. Segmentation performed using Fuzzy C-means (FCM) clustering allows one pixel to belong to two or more clusters. The constraint associated with FCM can be done away with by means of a modified FCM algorithm, which is founded on the concept of condensation where the dimensionality of the input is highly concentrated. The data compression is removed in two steps quantization and aggregation. The FCM algorithm attempts the partition of a finite collection of pixels into a assembling of "C" fuzzy clusters with respect to the given criterion. The quantization of the feature space is performed by masking the lower 'm' bits of the feature value. The quantized output will affect the common intensity values for more than one feature vector. Aggregation involves the grouping of feature vectors which share common intensity values. A representative feature vector is chosen from each group and they are presented as input for the conventional FCM

**Conclusion:** The comparison concludes that, the performance metric of both methods are same, while the mean speed of the modified FCM algorithm is found 80 times improved than conventional techniques.

**Ganesh Vilas Madhikar, S. S. Lokhande** [45]: Tried to address the drawback like the over segmentation occurred in normal region growing. Over segmentation resulted because of the presence of noise and volume variation. The input image must be subjected to a set of pre-processing steps so that the image gets transformed suitably for further processing. Gaussian filter and RGB(Red,Blue,Green) to grey image converter were used in the preprocessing phase. Afterward, the pre-processed
image is segmented using the modified and the normal region growing techniques. Region growing approach to segmentation is to match the neighbouring pixels of initial "seed points" and to determine whether the pixel neighbours should be summed to the region or not, based only on intensity constrain. For this, a threshold degree of intensity value is going down and those neighbour pixels that satisfy this threshold is selected for region growing. The normal region grower has the drawback that the noise or variation of strength may result in holes or over segmentation. Region growing is not able to discriminate the shading in the picture. Modified region growing is effectively tackling above the drawback by incorporating the orientation constraints in addition to the normal intensity. The part is grown, but if, and only if both constraints are satisfied.

**Conclusion:** While adding additional parameter, “Orientation” is tailored in the modified region growing. The performance of the proposed technique has considerably improved. Form the investigation of the result in terms of specificity, accuracy and selectivity, the performance of the proposed technique has noticeably enhanced the tumor detection compared with the region growing algorithm based MRI segmentation.

**Amarjot Singh, Shivesh Bajpai et al [46]:** Proposed a segmentation methodology called Gradient Vector Field (GVF), which founded on the energy feature to segment the tumor with the aid of a standard object detection algorithm. Gradient Vector Field works on the principle of energy minimization. The features of interest in this algorithm are mainly lines, boundaries or limits. This algorithm firstly interacts with its features, gradually forming into patterns. Active contour also called snake is used to find out the region boundary. Smart snake achieved by initializing the snake in the nearby proximity or region. Initialized snake converges to the border and subsequently acquire the configuration. Overlap of these two is a state that defined balance between internal energy function and external energy function, at this stage both energies are equal and opposite. Internal energy defined as the combination of elasticity and strain energy. It is used to control the snake tension and rigidity. The external energy is one which pulls the snake towards the border. The operation of the algorithm tests with synthetic image database as easily as with real MRI image.
**Conclusion:** The initialization of the snake is a difficult task. It is difficult to automatically generate the set of parameters for the objects of interest. Hence, these constants are determined by the user. Parameters of the GVF are controlled manually, which is time consuming and may lead to wrongdoing. Another disadvantage is that edge operator identified the object boundary with the help of intensity variation between the target and setting. If these are no substantial variation exists between the normal tissue and the tumour region result in error during edge detection.

**Sonali Patil, Dr. V. R. Udupi** [47]: Preprocessing is an important task because the performance of the subsequent sections like segmentation, feature extraction and classification etc are depending upon this. Pre-processing is starting with elimination of film artefacts by median filter. Morphological operations performed on the image to remove the skull region. The primary advantage of the pre-processing is that it cuts down the chance of over segmentation problems during image segmentation. Film artefacts removed by replacing each entry with the median of the neighbour pixels. There are dissimilar cases of windows used to process the artefacts, among them are simple box window is applied here for the removal artefacts. A mathematical morphological operation like dilation and erosion is used to take away the skull region.

**Conclusion:** The result of pre-processing both algorithms shows that artefacts from the image were satisfactorily removed. The skull is also found to be transferred successfully. A successful removal unwanted portion of the image significantly reducing the hazard of over segmentation. Only the performance measure of pre-processing is highlighted in this work.

**Dipak Kumar Kole, Amiya Halder** [48]: Proposed an automatic brain tumour detection and isolation from MRI image using a genetic algorithm based clustering, intensity based asymmetric map and along with region growing technique. This algorithm implemented in four different phases. First point, split up the area into different region, according to the difference in volume. In stage2 identify the tumour with respect to highest intensity value. Phase 3 is linked with the formation of the seed point with the help of asymmetric map. The final point is that, with this selected seed point, segments the tumour using a region growing algorithm. Genetic
algorithm (GA) is employed as an optimisation technique to refine the obtained solution. GA is a population-based stochastic method for optimization and search problems. The choice of traditional optimization techniques by using directed random searches to place optimal solutions in multimodal landscapes. The heading of the GA is to optimize the given objective or fitness function using the main operators like crossover and sport. It begins with an encoding mechanism to represent the solution to chromosome. The fitness function evaluates the ability of chromosome for the production of optimum solution. Crossover randomly chooses a point and swaps the content of the two chromosomes, it will effect if and only if these chromosomes satisfy the crossover probability. Sport is a randomizing the search, involves in altering the capacity of the chromosomes after satisfying the mutation probability. Searching probability of the GA is used in K-means algorithm to label un-labelled pixels. Roulette Wheel (RW) selection is utilized for selecting random pixels for crossover. Use single-point crossover with a fixed crossover probability during crossover operation and for the mutation use uniform distribution with a specified probability.

**Conclusion:** This algorithm proposes a really simple technique for the isolation of the tumour from the MR image. But effective implementation depends on many parameters of genetic algorithms like specification of stopping criterion. It is also indirectly depends upon the efficiency of K-means clustering.

**CYN Dwith, Vivek Angoth, Amarjot Singh** [49]: The main features taken into account for the detection of brain tumour are location and size of tumour. The report plots the detection of tumour by creating a combined image of Computer Tomography (CT) and MRI. CT images are applied more frequently to detect out the differences in tissue density depending upon their power to block X-rays. MRI makes available good contrast between the different soft tissues of the physical structure. Fused images can be made by blending data from multiple modalities, such as magnetic resonance imaging and CT. Both cases of images play specific important roles in medical image processing. The merged image from multiple images from an image which included combined complementary and redundant data, thus resulting into better visibility of tumour. Preprocessing techniques are also performed to increase the contrast and brightness of the image. Image fusion is performed by removing the absolute extreme of the coefficients as the larger
coefficients corresponding to sharp brightness changes. The wavelet transform technique of image fusion allows to effectively take out the salient characteristics of the input images because it preserves the directional information. This method may add or remove pixels from the boundaries of the objects in the image depending on the size and structuring element, thereby facilitating better detection of tumour with minimum error.

**Conclusion:** The output of the proposed image fusion algorithm is dependent on the wavelet used for the image decomposition. The approximation or detail coefficients obtained can be fused with different attacks, which require taking the maximum, the minimum or the mean of the coefficients from the two input images and the full number of decomposition of the image using the wavelet analysis. But the disadvantage is that as number of decomposition increases, it may result in the loss of a few minute details of image, as these small regions can be of significant importance in the medical analysis.

**N. Sumitra, Rakesh Kumar Saxena** [50]: Proposed a hybrid approach to classify malignant and benign tumours via some prior knowledge about the intensity of pixels and some anatomical features. Principal Component Analysis is an orthogonal transformation tool, used to convert a lot of observations of possible correlated variables into a set of values of linear uncorrelated variables. In the case of an image, the number of main elements is less than or equal to the number of original variables. The first principal component has the largest possible variance to account for as much of the unevenness in the data as possible. Each succeeding component is orthogonal to the first, having the highest division. Features extracted using principal component analysis was utilized to form more essential features such as mean, median, variance, correlation, values of maximum and minimum intensity for training and testing. Back propagation algorithm was applied for categorization of the neoplasm.

**Conclusion:** Back propagation algorithm provided fast speed in training and sample testing. The BPNN (Back Propagation Neural Network classifier presented good accuracy, very small training time, robustness to weight changes. Results show that the features extracted can give satisfactory result in analysis and classification of brain tumours.
Pratik P. Singhai, Siddharth A. Ladhake [51]: Presented a modified approach for detection of brain tumor from the MRI image. Pre-processing like image resize, grey scale conversion are performed to formulate the image for segmentation. The basically watershed algorithm worked on the gradient image. The disadvantage with the basic watershed algorithm is that it results in over-segmentation. It makes a large turn of clusters in and around local minima. To defeat this issue, change the basic watershed to be a marker based watershed algorithm. This modified algorithm worked to help of internal markers and external markers. Internal markers are marked from grey scale image, image, external markers which are shaped from the distance transform of the internal markers. A division of the gradient image is initiated from the markers instead of local minima. Finally connected component analysis is applied for the calculation of the tumour area.

**Conclusion:** Watershed segmentation depends on the marker instead of local minima, which, depending on the threshold selection. The operation of this algorithm greatly depends upon the selection threshold.

### 2.3 SIGNIFICANCE OF VARIOUS STEPS IN TUMOUR DETECTION IN NUTSHELL

Apart from the analysis upon on the basis of works done on image segmentation for the detection of abnormality, this section explains the various aspects of the main steps involved in image segmentation. Literature survey narrated in section 2.2 considers the performance only on the basis of the work carried out by individuals. Conventional image segmentation primarily consists of four important steps, here describe the various aspects of these steps researched so far.

#### 2.3.1 Over View of Image Pre-Processing based on Literature Survey

Image pre-processing is a groundwork which is necessary to ensure the exactness of the succeeding steps in the image processing. The MR images acquired from the scanner in general contain many artefacts such as intensity inhomogeneities, motion artefacts, labels, unwanted cranial tissues etc., which affects the overall accuracy of the process. Mainly filters are used for the correction or removal of artefacts from the image under investigation.
Gabor filters is a linear filter used for edge detection. The important characteristic of gabor filter adopted in pre-processing is that, its frequency and orientation representations are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination. It effectively reduces the noise, blur, but it gets rid of the details of the structure presented in the image.

Diffusion filtering combined with simple, non-adaptive intensity thresholding is used by to enhance the region of interest. Diffusion filters soften images during the process. Basically, a diffusion filter diffuses strong light without affecting the sharpness and the contrast of the image. The main drawback of this technique is the non-adaptive nature of the threshold value.

Pre-processing of image is also consists of fuzzy connectedness based intensity non-uniformity correction. It is implemented by the sequential approaches with fuzzy connectedness, atlas registration and bias field correction, but it methodology can be used only if the intensity variations in images within a limited range.

In the case of minimizing the effects of inter-slice intensity variation a weighted least squares estimation method implemented. The Major disadvantage of this approach is that the selection process of the weights.

Wavelets, curvelets and hybrid approaches involving Variance Stabilizing Transform (VST) are also used. However, this technique is only suitable for images with Poisson noise.

Tracking algorithm based de-noising technique is also adopted for pre-processing. But its performance depends on the selection of seed point, therefore the efficiency of this technique is found low.

Model based contrast enhancement is also implemented for noise removal and pre-processing. This improves the contrast of the image, but it does not provide the differentiation in the case of the unwanted tissues.

Expectation Maximization Segmentation (EMS) algorithm is another technique for image pre-processing. The main advantage of this technique is that it is a fully automatic technique.
In some cases, combinations of these methodologies also take into consideration. All the above pointed out techniques for the pre-processing is only for specific artefacts which are not sufficient for high classification accuracy and segmentation efficiency. Apart from eliminating the noises, techniques for the removal of unwanted tissues such as the skull tissues in MR images are highly essential for accurate identification of the diseases.

**2.3.2 Over View of Feature Extraction based on Literature Survey**

The extremely important and significant step in the tumour detection is feature extraction. Features are the measures or attribute of an object (normal and abnormal region in the image) under study. Feature extraction is the procedure of pull out specific features of the pre-processed images of different categories. The selected features should be able to guarantee that within - class similarity is maximum and between - class similarity is minimized. Earlier research works report many feature extraction techniques employed for medical image processing.

2-Dimensional and 3-dimensional wavelet transform based textural features, might be used for classification. However need to use different wavelets in different situations makes it more complications. A combination of 2D and 3D features provides better results than they performed individually.

Performance of feature extraction technique improved using the complimentary wavelet transformed image. A complimentary wavelet extract feature from all the four sub-bands are more efficient than the features from the approximation sub-band alone. Discrete Wavelet Transform (DWT) never yields superior results

Another set of features are the first and second order statistical features like histogram based statistical features and intensity based features, etc., The moment based features are also used for segmentation. Moment based features having the improvement, but the lack of generalization of these features is the main drawback. In order to reduce the execution time and complexity, block based feature also taken in the segmentation process

By analysis based on the efficiency of each texture feature, it is revealed that the entropy is the most dependable feature among the textural features.
2.3.3 Over View of Brain Image Classification Techniques based on Literature Survey

Objective of image classification is to differentiate the different brain image regions based on the optimal feature set. Several conventional classifiers are available for categorization, but Artificial Intelligence (AI) techniques which yield extremely accurate results. Usage of Artificial Neural Networks (ANN) improves the accuracy of the classifiers. Linear discriminant is another type classifier having the superior nature of neural networks.

From the analysis of various ANN for image classification it is found that, conventional neural networks lacks in faster convergence rate. This emphasises the requirement of a modified neural network having superior convergence rates for image classification applications.

Support Vector Machine based classification performed better than rule based systems, but the accuracy is noticeably low. The support vector machine does not have penalization property, it works only better in the case of glioma images.

Kohonen neural networks for image classification are much superior to the conventional neural networks. A hybrid approach for the classification such as combination of wavelets and Support Vector Machine (SVM) for classifying the abnormal and the normal images works better than the Kohonen neural networks. But the drawback of this system is that it efficiently worked on the small size of the dataset. A modification of conventional SVM such as Least Square SVM (LS-SVM) suggested only for multiclass classification techniques than bi-level classification. Abnormal images such as metastasis, glioma and meningioma are differentiated using the least square feature transformation based Probabilistic Neural Network (PNN). The comparative analysis shows that PNN is superior to the SVM in terms of classification accuracy.

Some other classifiers like Adaptive Resonance Theory (ART) neural network for classifiers are working on Magnetic resonance spectroscopy images rather than magnetic resonance image.

Classification based on fuzzy approach with pattern discovery algorithm provides good results when compared with the other classifiers.
2.3.4 Over View of Brain Image Segmentation Techniques based on Literature Survey

Classification is a pathology identification process is performed on the image to categorize the normal region and abnormalities present in the MR image. If there is any abnormality found in the image, treatment started for curing it. During and after treatment, it is extremely necessary to estimate the response. Need to carry out a volumetric analysis of MR brain tumour images; this can be furnished by image segmentation. It extracts the abnormal portion of the image which is useful for analysing the size and shape of the abnormal region. Several research works have been going on in the area of medical image segmentation. Generally, all these research works can be classified into two broad categories called: (a) Non-AI techniques and (b) AI techniques.

2.3.4.1 Image segmentation based on Non-AI techniques

Maximum Likelihood (ML) approach is used to segment the pathological tissues from the normal tissues. The negative aspect of this is that the proposed system is dependent on class probabilities and threshold values. A Modified Expectation Maximization (EM) algorithm, a model based tumour segmentation technique implemented for accurate segmentation. But lack of quantitative analysis on the extracted tumour region is the next drawback prompted by this algorithm. Another approach developed for segmentation is a level set method which involves the method of boundary detection with the seed point. The main problem with this method and watershed algorithm is the selection of seed point. Inaccurate and random selection of seed point may lead to unsuitable segmentation result.

On the analysis of various types of brain tumours and the effect on MR image segmentation techniques results as follows, statistical based image segmentation techniques fail in the case of large deformations. Segmentation based on symmetry analysis reported that efficiency is very low. Symmetric study also concluded that the proposed approach is a failure in case of symmetrical tumour across the mid-sagittal plane and its limited to the tumours which are densely packed. Mathematical morphology based segmentation is an approach which involves the initialization of several parameters which is one of the demerits of this approach. The hybrid
approach of statistical techniques with image registration is suitable for noisy images. But computational time is the major drawback.

Bayesian model based tissue segmentation technique has computational efficiency and having improved results over the conventional techniques. K-Nearest Neighbour technique based MR brain image segmentation.

2.3.4.2 Image segmentation based on Artificial Neural Networks

ANN and Fuzzy theory are the primarily used methodologies for segmentation. ANN is preferable because of its adaptive nature, accuracy, and it is faster compared to LVQ and Back Propagation Algorithm, etc. Self Organizing Map based segmentation employs unsupervised techniques, so even if the proposed system is faster, the efficiency of segmentation is low.

Automated brain image segmentation by a combined Radial Basis Function neural network (RBF) and contour model based MR image segmentation technique is also proposed. The contour model is used to develop a clear boundary and then RBF performed to segment the various brain tissues into different classes. A hybrid approach with SOM with Markov random field add extra spatial constraints for weight adjustment for faster convergence, but this method is highly prone to noise.

There are so many other works associated with tumour segmentation are modified bidirectional associative memory for gray level pattern classification with self-convergent iterative learning is adopted with a non-linear function. This approach suffers from the drawback of handling non linear separable problems. The convergence time can be reduced by the analytical method of weight updating instead of iterative method.

In the analysis in terms of segmentation efficiency and the time period for convergence a hybrid system based on SOM is proposed for interpretation of MR brain images. This system found to be much superior than the individual ANN in terms of its accuracy. The lack of availability of an expert knowledge database for all the applications is the major drawback of this system.

Kohonen neural network having an inferior segmentation efficiency and low Signal-to-Noise Ratio (SNR) comparable to other techniques.
2.3.4.3 Image segmentation based on fuzzy techniques

Introduction of fuzzy logic theory into the segmentation algorithm significantly improve overall performance of the system and the usage of fused fuzzy features improves the accuracy of the techniques. Modified Fuzzy C-Means (FCM) algorithm for brain image segmentation provides significant time saving compared to a conventional FCM algorithm. Lack of quantitative analysis on segmentation efficiency is the drawback of this approach.

A mixing of GA with the fuzzy theory is adopted to achieve more efficient results. GA is used for cluster centre selection in the FCM algorithm. This methodology increased the accuracy, but it only applicable to noise free images.

2.3.4.4 Image segmentation based on hybrid techniques

Several hybrid Neuro-fuzzy approaches for image analysis are also analyzed. A hybrid Neuro-fuzzy approach like conventional fuzzy clustering algorithm combined with the Multi Layer Perception (MLP) neural network is also implemented for tumour segmentation. The negative aspects of these algorithms are the selection of appropriate convergence criterion. The slow convergence rate of these approaches is due to the fact that many complex steps are involved. This is the main disadvantage of this algorithm. The drawback of the fuzzy Kohonen neural network is that it completely dependents on the input features.

2.4 CONCLUSION

This literature survey has analyzed the qualities and limitations of various techniques adopted in each unit of the abnormality detection (segmentation) in brain MRI.