CHAPTER 2
LITERATURE SURVEY

2.1 INTRODUCTION

Automated brain disorder diagnosis with MR images is becoming increasingly important in the medical field. The automated diagnosis involves two major steps: (a) Image classification and (b) Image segmentation. Image classification is the technique of categorizing the abnormal images into different groups based on some similarity measure. The accuracy of this abnormality detection technique must be significantly high since the treatment planning is based on this identification. The second step is image segmentation which is used to extract the abnormal portion necessary for volumetric analysis. This volumetric analysis determines the effect of the treatment on the patient which can be judged from the extracted size and shape of the abnormal portion. Many research papers with different approaches for image classification and segmentation are reported in the literature. This chapter provides an extensive survey of existing methods for abnormality detection in brain images. The outline of the methods used for image classification and segmentation are shown in Figure 2.1.

The drawbacks of the existing methods are twofold: (a) lack of high accuracy and (b) slow convergence rate. Since wrong identification leads to fatal results, accuracy must be exceedingly high in classification and segmentation techniques. Also, these techniques must possess a faster convergence rate which will make them practically feasible for real-time applications. These problems can be overcome by using artificial intelligence techniques and by performing suitable modifications on the existing conventional algorithms. This report provides the detailed survey of classification and segmentation techniques for abnormality detection in MR brain images. The rest of the report is organized as follows: Section 2 and 3 deals with the literature survey of the pre-processing and feature extraction techniques, Section 4 deals with the literature survey of the
classification methodologies and Section 5 deals with the literature survey of the segmentation techniques.

2.2 LITERATURE SURVEY ON IMAGE PRE-PROCESSING

Image pre-processing is one of the preliminary steps which are highly required to ensure the high accuracy of the subsequent steps. The raw MR images normally consist of many artifacts such as intensity inhomogenities, extra cranial tissues, etc. which reduces the overall accuracy. Several researches are reported in the
literature to minimize the effects of artifacts in the MR images. An analysis on filtering techniques with Gabor filters for noise reduction is performed by Nicu et al (2000). These primitive methods along with reducing the noise blur the important and detailed structures necessary for subsequent steps. Chunyan et al (2004) have implemented the colour ray casting method to differentiate the region of interest from the background. But this technique is image dependent and not applicable for gray level images. Expectation Maximization Segmentation (EMS) software package is used by Hayit et al (2006) for image pre-processing. The main advantage of this technique is that it is a fully automatic technique. Diffusion filtering combined with simple non-adaptive intensity thresholding is used by Yong et al (2006) to enhance the region of interest. The main drawback of this technique is the non-adaptive nature of the threshold value. Fuzzy connectedness based intensity non uniformity correction has been implemented by Yongxin et al (2006).

A sequential approach with fuzzy connectedness, atlas registration and bias field correction is used in this approach. The conclusions revealed that the proposed technique can be used only if the intensity variations between the images are of a limited range. Marianne et al (2006) have minimized the effects of inter-slice intensity variation with the weighted least square estimation method. The selection of weights for the least square method is the major disadvantage of this approach. Bo et al (2008) have proposed the noise removal technique using wavelets and curvelets. Hybrid approaches involving Variance Stabilizing Transform (VST) are also used in this work. But this technique is applicable for images with Poisson noise. Tracking algorithm based de-noising technique is performed by Jaya et al (2009). Since the seed point for tracking is random in nature, the efficiency of this technique is low. A contrast agent accumulation model based contrast enhancement is implemented by Marcel et al (2009). This improves only the contrast of the image and the unwanted tissues are not eliminated. Rajeev et al (2009) have used the wiener filtering methodologies for noise removal in abnormal MR brain images. Apart from noise removal, several
other pre-processing steps are also reported in the literature. This includes image format conversion, image type conversion etc. Rajeev et al (2009a) also have used the combination of three modalities of MR images for further processing. All the above mentioned techniques remove only specific artifacts which is 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 LITERATURE SURVEY ON FEATURE EXTRACTION

The next step in the automated diagnosis process is feature extraction. Feature extraction is the technique of extracting specific features from the pre-processed images of different abnormal categories in such a way that the within-class similarity is maximized and between-class similarity is minimized. Earlier research works report many feature extraction techniques employed for medical image processing. Arivazhagan et al (2003) have used 2-Dimensional (2D) wavelet transform based textural features for classification. In this report, basic statistical features are used and then co-occurrence based textural features are used to improve the accuracy. But the effects of usage of different wavelets are not dealt in the report.

A comparison of 2D wavelet transform based textural features and 3-Dimensional (3D) wavelet transform based textural features is performed by Kourosh et al (2004). This work concluded that the combination of 2D and 3D wavelet based textural features yield better results than the 2D wavelet features. Hiremath et al (2006) have presented a feature extraction technique using the complimentary wavelet transformed image. The report claimed that the features extracted from all the four sub-bands are more efficient than the features from the only the approximation sub-band. All these techniques used the basic Discrete Wavelet Transform (DWT) which does not yield superior results. An improved version based on wavelet packet decomposition is implemented by Hiremath et al (2006a).
The results revealed that the packet decomposition technique is more efficient than the DWT technique. Apart from extracting the features from the whole image, features are also extracted from local regions which are used for image segmentation applications. One such work is reported by Ryszard (2007). Pantelis et al (2007) have described a novel feature set which comprises the features such as short run emphasis, run length non-uniformity, etc. which are based on run length matrices. The drawback of this work is the low classification accuracy which shows that these features do not guarantee superior results. Ke et al (2008) have explored the merits of wavelet features for image classification. The technique of dimensionality reduction based on sub band grouping and selection have also been implemented in this work. A comparative analysis with the conventional algorithms is presented in this report.

First and second order statistical features are also extracted from each training points and used for segmentation applications. These types of features are used by Jesus et al (2009). This report suggested that the combination of histogram based statistical features is more effective than the intensity based features. The effects of usage of moment based features are analyzed by Taras et al (2009). Though this approach yields considerable improvement in the accuracy, the lack of generalization capability of these features is a drawback of this methodology. Feature extraction based on block processing technique is reported by Nandita et al (2009). Several other researchers analyzed the efficiency of each texture features individually. Kekre et al (2009) have revealed that the entropy is the most dependable feature among the textural features. These earlier works clearly lay an emphasis on optimal feature extraction methodologies for successful image classification and segmentation techniques.

2.4 LITERATURE SURVEY ON BRAIN IMAGE CLASSIFICATION TECHNIQUES

The important process in the automated system is brain image classification. The main objective of this step is to differentiate the different abnormal brain images based on the optimal feature set. Several conventional classifiers are available for
categorization but most of the earlier works depend on Artificial Intelligence (AI) techniques which yield highly accurate results than the conventional classifiers. Ronald et al (2000) have clearly illustrated usage of Artificial Neural Networks (ANN) to improve the accuracy of the classifiers. This report was based on head and neck carcinoma detection and a comparative analysis was performed with the Linear Discriminant Classifier to show the superior nature of neural networks. Michael et al (2001) have proposed an interactive tool to classify the healthy and the tumorous MR brain images. But the accuracy proposed in this system is very low compared to the AI techniques. Though this approach claimed a faster convergence rate, it may not be much useful because of its low accuracy. This report mainly concentrated on improving the convergence rate only.

The application of various ANN for image classification is analyzed by Egmont et al (2001). The lack of faster convergence rate of the conventional neural networks is also explained in the report. This lay an emphasis on the requirement of modified neural networks with superior convergence rate for image classification applications. Carles et al (2004) have classified four different types of tumor using LDA technique. But the classification accuracy reported in the paper is in the order of 80% which is relatively low. This work also suggested the various reasons for misclassifications.

Support Vector Machine based classification of various levels of MR glioma images is performed by Guo-Zheng et al (2006). This method claimed to be better than rule based systems but the accuracy reported in the paper is low. This work dealt with only glioma images and thus the lack of generalizing capability of this work is another drawback of this system. Willem et al (2006) have used the Kohonen neural networks for image classification. Some modifications of the conventional Kohonen neural network are also implemented in this work which proved to be much superior to the conventional neural networks. Sandeep et al (2006) have used a hybrid approach such as combination of wavelets and Support Vector Machine (SVM) for classifying the abnormal and the normal images. This report revealed that the hybrid SVM is better than the Kohonen neural networks
in terms of performance measures. But the major drawback of this system is the small size of the dataset used for implementation. The classification accuracy results may reduce when the size of the dataset is increased. A modification of conventional SVM such as Least Square SVM (LS-SVM) for brain tumor recognition is proposed by Jan et al (2007). Both bi-level classification and multiclass classification are performed in this work to show the superior nature of the proposed method over the conventional classifiers. This report also specified an important note that the differences between various algorithms increase when the number of classes increase. Thus, this work suggested the necessity for multiclass classification techniques than bi-level classification techniques.

Another version of LS-SVM is proposed and successfully implemented by Selvaraj et al (2007). An extensive comparative analysis is performed between the SVM, neural classifier and the statistical classifiers. Results suggested the advantages of SVM in terms of classification accuracy. Only bi-level classification is performed in this work which is inadequate for judging the nature of the automated system. Pantelis et al (2008) have used the modified Probabilistic Neural Network for tumor image classification. Abnormal images such as metastasis, glioma and meningioma are differentiated using the least square feature transformation based Probabilistic Neural Network (PNN). A comparative analysis is also performed with SVM. This work inferred that the transform based PNN is superior to the SVM in terms of classification accuracy. Yamashita et al (2007) have categorized the different grades of abnormal images using artificial neural networks. This report suggested a practical method for selection of database. The training of ANN is dependent on input data and hence a wide variety of pattern is desirable for high accuracy. This report also highlighted the difficulty in collecting a large dataset of different uncommon patterns and hence concluded that the automated system can be tested with the images of common abnormalities.

A time efficient neural network such as PNN is used by Ibrahiem et al (2008) for pattern classification problems. Emphasis was given for convergence
time than the classification accuracy. The results concluded that the PNN is superior over conventional neural networks in terms of training time period. Pantelis et al (2008a) have developed a computer aided system for discriminating the primary and secondary tumors. Probabilistic Neural classifier is used in this work. Though the report records high classification accuracy, the size of the dataset is significantly small. Statistical classifiers are used for classifying different tumor types and one such work is reported by Felix et al (2008).

This classification is performed on proton Magnetic Resonance Spectroscopy images. A comparative analysis with neural classifier is also reported in this work. This report concluded that a combined statistical and neural classifier increased the accuracy to higher extent. Ramaswamy et al (2009) have implemented an enhanced Adaptive Resonance Theory (ART) neural network for classification applications. This employed the Genetic Algorithm (GA) approach to select the order of training patterns to enhance the classification performance. This experiment is conducted on various datasets. But the classification accuracy results are different for different datasets which is one of the drawbacks of this approach. Merinsky et al (2009) have implemented a self organizing neural network based automated system for glioma detection. The main disadvantages of this system are the low classification accuracy and the lack of multiclass analysis. Satish et al (2009) have used the RBF kernel based SVM for brain tumor detection. The results of SVM are compared with AdaBoost, a machine learning algorithm. Experimental results illustrated the superior nature of SVM over the other classifiers.

Andrew et al (2006) has demonstrated image classification based on fuzzy approach using the pattern discovery algorithm. Experiments are conducted on various real-world datasets and the results concluded that the proposed algorithm yield good results when compared with the other classifiers. A hybrid approach for pattern classification is reported by Chin-Teng et al (2006). The combination of SVM and fuzzy rules is experimented in this work. The results revealed that the proposed hybrid approach is accurate, fast and robust. Kadam et al (2011)
have framed an overall system for ANN based brain image classification. The concept of differentiating the normal image and the abnormal image is discussed in this work. Zhang et al (2011) have proposed a hybrid method based on Forward Neural Network (FNN) to classify the normal and the abnormal images.

BPN based pattern recognition of brain tumor images has been successfully implemented by Jafari et al (2011). The usage of PCA in this approach has increased the computational complexity to high extent. Another BPN based bi-level classification of tumor images is reported by El-Dahshan et al (2010). Feed forward neural networks based binary classification has been reported by Maitra et al (2006) and Zhang et al (2010). But, these works have either the drawback of inferior accuracy (or) increased convergence rate. Zhang et al (2011a) have used the Back Propagation Network (BPN) for abnormality detection in brain images. But, the number of images used in this work is very less which affects the robustness of the system.

2.5 LITERATURE SURVEY ON BRAIN IMAGE SEGMENTATION TECHNIQUES

Pathology identification is performed by the image classification technique and then the treatment is planned based on the nature of abnormality. After treatment, it is highly essential to estimate the response of the patient to the treatment. In case of brain tumor abnormalities, the size of the tumor may decrease which indicates a positive effect and sometimes it may increase which shows a negative effect. In any case, it is important to perform a volumetric analysis on MR brain tumor images. Image segmentation covers this objective by extracting the abnormal portion from the image which is useful for analyzing the size and shape of the abnormal region. This method is also called as “pixel based classification” since the individual pixels are clustered unlike the classification techniques which categorizes the whole image. Several research works are reported in the area of medical image segmentation. All the research works performed on image segmentation can be classified into two broad categories: (a) Non-AI techniques
and (b) AI techniques. Initially, a survey is performed on Non-AI techniques followed by the report on AI techniques.

2.5.1 Image segmentation based on Non-AI techniques

Zavaljevski et al (2000) have used the Maximum Likelihood (ML) approach to segment the pathological tissues from the normal tissues. The drawback of this approach is that the proposed system is dependent on class probabilities and threshold values. A model based tumor segmentation technique was implemented by Nathan et al (2002). Modified Expectation Maximization (EM) algorithm is used in this work to differentiate the healthy and the timorous tissues. A set of tumor characteristics are presented in this paper which is highly essential for accurate segmentation. But the drawback of this work is the lack of quantitative analysis on the extracted tumor region. Fuping et al (2003) have developed a level set method based tumor segmentation technique. This method involves the method of boundary detection with the seed point. Watershed algorithm is also used to capture the weak edges. The main problem of this approach is the selection of seed point. Random selection of seed point may lead to inappropriate results and also consumes large convergence time period.

A complete analysis of various types of brain tumors and the effect of MR image segmentation techniques on the treatment is studied by Sundeep et al (2006). The report concluded that the enhanced MR image segmentation techniques play a major role for brain tumor treatment. This study shows the requirement for an accurate and quick image segmentation technique. Habib et al (2006) have elaborated the merits and demerits of various statistical segmentation techniques. This work analyzed the performance measures of histogram based method, EM technique and the Statistical Parameter Mapping (SPM2) package in detail. This report aimed at differentiating four different types of brain tissues. Experiments are carried out on simulated brain images. But the statistical techniques fail in the case of large deformations. An enhanced version of symmetry analysis which also incorporates the deformable models is reported by Hassan et al (2007). The segmentation efficiencies reported in this approach is
very low and the report also concluded that the proposed approach is a failure in case of symmetrical tumor across the mid-sagittal plane. Mathematical morphology based segmentation is implemented by Abdelouahab et al (2007).

The experimental results suggested the usage of Skeleton by Influence Zones detection (SKIZ) for brain image segmentation. This technique involves the initialization of several parameters which is one of the demerits of this approach. Withey et al (2007) have revealed the various softwares available for medical image segmentation. This work also suggested appropriate techniques for various types of segmentation methods. An analysis on evaluation procedure for segmented images is performed by Ranjith et al (2007). Few conventional algorithms such as EM algorithm mean shift filtering algorithm, etc. are experimented in this work. But the comparative analysis between various performance measures is not reported in this work.

Pierre et al (2007) have implemented a topology preserving tissue classification on MR brain images. The advantages of statistical techniques and image registration are combined in this technique which is also suitable for noisy images. But the requirement for high computational time period is the major drawback of this approach. Symmetry based brain tumor extraction is performed by Nilanjan et al (2008). The ability of this approach is limited since it can detect only the densely packed tumor tissues. Chi-Hoon et al (2008) have demonstrated the application of pseudo-conditional random fields for brain tumor segmentation. This technique is implemented on images of different tumor size. This system also claimed to be highly accurate and much faster than other conventional techniques. The mode of training used in this approach is patient - specific training which is one of the limitations of this technique.

Jason et al (2008) have implemented a Bayesian model based tissue segmentation technique for tumor detection. This method proved to be computationally efficient besides yielding improved results over the conventional techniques. K-Nearest Neighbour technique based MR brain image classification is performed by Petronella et al (2008). An extensive comparative analysis is
performed with other techniques. The dependency on threshold values for accurate output is the drawback of this approach. A volumetric image analysis based on mesh and level set method is illustrated by Aloui et al (2009). This work concentrated on 3D image processing and employed on different tumor types. But the results yielded by this approach are inferior and not comparable to the other pixel based classifiers. Zhen et al (2009) have performed a survey on various medical image segmentation algorithms and analyzed the merits and demerits of these techniques. The drawbacks of several techniques are clearly illustrated in this report and also suggested suitable techniques for tumor segmentation.

2.5.2 Image segmentation based on Artificial Neural Networks

Another group of researchers depend on AI techniques for brain image segmentation. Among the AI techniques, ANN and Fuzzy theory are the predominantly used methodologies for segmentation. ANN is preferred by the researchers because of its adaptive nature, accuracy, etc. Javad et al (1997) have demonstrated the application of Learning Vector Quantization (LVQ) for brain image segmentation. A comparative analysis is performed with the Back Propagation Network (BPN) and the experimental results proved the superior nature of LVQ. The report also concluded that the ANN is faster than the conventional classifiers. Constantino et al (2000) have implemented Self Organizing Map based segmentation technique on MR brain images. Though the proposed system is faster, the segmentation efficiency is comparatively low since it employs unsupervised mode of training.

Automated brain image segmentation using conventional LVQ is proposed by Carlos et al (2003). The convergence rate of this approach is high but this system failed to distinguish the outer layers of brain which is normally seen in MR brain images. Also the results are not quantitatively analyzed in this report. Raquel et al (2004) have developed a combined Radial Basis Function neural network (RBF) and contour model based MR image segmentation technique. The contour model is used as a pre-segmentation step by developing the clear boundaries between the different tissues. RBF neural network is then used to segment the various brain
tissues into different groups. A modified version of SOM with Markov random field model is suggested by Yan et al (2005). Extra spatial constraints are added in this algorithm for weight adjustment between the input layer and the output layer. But this method is highly prone to noise and applicable for only noise-free images. Back propagation neural network based tumor segmentation is performed by Martin et al (2006). A comparative analysis is done with the Inverse Laplace Transform based technique.

Sylvian et al (2006) have developed a modified Bidirectional associative memory for gray level pattern classification. A self-convergent iterative learning is performed in this approach with a non-linear function. This technique is more applicable for noisy images. But this approach suffers from the drawback of handling non linear separable problems. A fast neural network suitable for real time applications is implemented by Guang-Bin et al (2006). An iterative-free training approach is followed in this network using the Huang’s neural network. The convergence time period is considerably reduced since the weights are determined analytically rather than through conventional weight adjustment procedure. Lange et al (2006) have presented a comparative study between the neural classifiers and another AI technique such as fuzzy classifier. SOM is used as a neural representative and fuzzy n-means algorithm is used as the fuzzy representative. Experimental results revealed the inability of SOM to detect small tumor areas.

A modified neural network with neighbourhood information is proposed by Siddhartha et al (2008). This work aimed at minimizing the false classifications of the images. The efficiency of this approach is revealed through experimental results and the report also revealed the applicability of this method for binary, multilevel and colour intensity images. Wei et al (2008) analyzed the functional MRI (fMRI) data using the SOM architecture. Hierarchical clustering technique has been incorporated in this approach to yield better results. An enhanced version of LVQ neural network is implemented by Jinn-Yi et al (2008). The concept of GA is incorporated in this technique to improve the performance of
conventional LVQ. An analysis in terms of segmentation efficiency and convergence time period is provided in the report. Inan et al (2009) have developed a hybrid expert system based SOM for interpretation of MR brain images. This system proved to be much superior than the individual ANN since the accuracy is increased to a higher extent. This work also highlighted the application of neuro-fuzzy approach for high quality results. But the lack of availability of an expert knowledge database for all the applications is the major drawback of this system. A novel neural network such as Incremental Supervised Neural Network (ISNN) is proposed by Zafer et al (2010). This method depends on Continuous Wavelet Transform (CWT) and Zernike moments for the analysis of six different types of brain tissues. Experimental results suggested the applicability of this network for noisy environment.

Jaya et al (2011) have used the pixel similarity based technique for tumor segmentation in abnormal MR brain images. Kohonen neural network has been used for tumor segmentation by Riad et al (2011). But, the level of misclassification rate reported in this work is significantly high. SOM based brain image segmentation methodologies are also reported by Shi et al (2010) and Valarmathi et al (2011). An improved version of SOM based brain image segmentation is implemented by Logeswari et al (2010). Another modified approach such as Echo State Neural Newtork (ESNN) is used for brain image segmentation is reported by Suganthi et al (2011). The major drawback of these works is the inferior segmentation efficiency and low Signal-to-Noise Ratio (SNR). Another SOM based segmentation application is described by Iftehkaruddin et al (2008). BPN based tumor segmentation is implemented by Pradhan et al (2011). The size of the input dataset used in this work is very less and the error rate reported in this work is also high.

2.5.3 Image segmentation based on fuzzy techniques

Several earlier works based on fuzzy logic theory are also reported in the literature. Tai et al (1998) have implemented a modified Fuzzy C-Means (FCM) algorithm for brain image segmentation. This method is shown to provide
significant time saving when compared with the conventional FCM algorithm. Lack of quantitative analysis on segmentation efficiency is the drawback of this approach. A more accurate FCM algorithm is proposed by Dzung et al (1999). The outlined approach in this paper is applicable for MR images with intensity inhomogeneities. But the execution time of this approach is directly proportional to the amount of inhomogeneities present in the images. This leads to slower convergence rate which makes the system practically non-feasible. A complete survey of various segmentation algorithms is presented by Dzung et al (2000). The merits and the demerits of various techniques are analyzed in detail. Appropriate techniques for different applications are also suggested in this review paper.

The applicability of conventional FCM algorithm for 3-D image processing is reported by Lynn et al (2001). This work highlighted the methodology for the selection of number of clusters in FCM algorithm. Expert knowledge is also required for this automated approach. Lack of availability of accurate expert knowledge is the drawback of this approach. Hisao et al (2001) have revealed the significance of weights for fuzzy rules in image processing applications. The necessity of weights for fuzzy rules is proven through computer simulations on real time data sets. The report also has provided an efficient method for framing fuzzy IF-THEN rules. A robust fuzzy clustering algorithms proposed by Rajesh et al (2002). This approach has eliminated the dependency of FCM algorithm on similarity measures such as distance measures. The proposed approach is highly generalized in terms of the parameters used in the algorithm.

John et al (2002) have proposed a time efficient FCM for real time applications. The requirement of two updates equations have reduced to a single update equation in this approach. This approach has solved the high memory requirement problem of conventional FCM. A descriptive fuzzy classifier is implemented by Javier et al (2002). In this approach the approximate rules derived from the inputs are converted into descriptive rules. The report has concluded that the proposed translation yield high accuracy at a comparable time
period. Mohammad et al (2002) have developed a modified FCM algorithm based on spatial model. Qualitative results highlighted the improvement in the segmentation efficiency of the spatial model based FCM over the conventional FCM. The lack of volumetric analysis of the segmented tissues is the major drawback of this system. A linguistic FCM algorithm is proposed by Sansanee et al (2002). This technique is based on extension principle and the results are compared with the conventional FCM. The computational complexity of conventional FCM is also tackled in this technique.

Steven et al (2003) have implemented a fast and accurate FCM algorithm for image segmentation applications. A data reduction method based on quantization is involved in this approach for high speed clustering. A comparative analysis with the conventional FCM algorithm is also provided in this report. An adaptive spatial clustering algorithm is implemented by Alan et al (2003). The usage of this approach for nonuniform intensity MR images is demonstrated in this work. Suitable modifications are performed in the FCM algorithm to incorporate the spatial constraints and to eliminate the artifacts. A comparative analysis with other techniques is also presented in the paper. Iterative watersheds based fuzzy tumor segmentation is reported by Matei et al (2003). This approach claimed to be fast and accurate but the segmentation efficiency is comparatively low. The report also suggested the usage of prior knowledge to improve the efficiency.

Yuanjie et al (2004) have proposed an image segmentation technique using fuzzy connectedness. The requirement for initialization of several initial parameters including the seed pixel is one of the disadvantages of this system. Kannan (2005) has modified the FCM algorithm to achieve high accuracy for MR brain images. Several methods for initializing the cluster centres such as Silhouette method are highlighted in this work. Only qualitative analysis is reported in the paper which is not sufficient for judging the effectiveness of the system. A possiblistic fuzzy clustering approach is reported by Francesco et al (2005). This approach is experimented on brain image segmentation and promising results are
obtained by this technique. An improved FCM algorithm is also proposed by Murugavalli et al (2006). This technique is based on block processing where each block is processed by a parallel processor. Though this approach is faster, the requirement for additional hardware is the major drawback of this system. Alan et al (2006) have conducted an extensive survey on tissue segmentation algorithms for MR brain images. A technique to minimize the intensity nonuniformity artifact is also proposed in this paper. Several suggestions on pixel based approaches, region based approaches, model based approaches are provided in this work.

Weibei et al (2007) have illustrated the merits of incorporating the fuzzy information in MR brain image segmentation techniques. Several fuzzy models are created and the fuzzy features are extracted from these models. Experimental results have suggested the usage of fused fuzzy features for improving the accuracy of the techniques. Even though performance measures are specified, an extensive analysis in terms of the measures is not done in this work. Diffusion model based segmentation technique is reported by Masroor et al (2008). K-means clustering is used in this work for tumor extraction. Lack of the fuzzy knowledge is clearly visible in the segmented results which are of low quality. No quantitative analysis is performed in this work which is another drawback of this method.

Sriparna et al (2007) have mixed the GA concept with the fuzzy theory to achieve more efficient results. The experimental results are compared with the EM algorithm. Results have revealed the applicability of GA for cluster centre selection in the FCM algorithm. This methodology has significantly increased the accuracy. The report also suggested that the proposed work is more appropriate for noise free MR images. Kannan et al (2008) have explained a modified FCM algorithm for MR brain image segmentation. The method of initial selection of membership values are highlighted in this report. This work has not conducted significant experiments which is evident from the lack of quantitative analysis. Benoit et al (2009) have included the fuzzy localization map for structure
identification in MR brain images. The experiments conducted on MR images revealed the efficiency and the robust nature of the proposed system. An adaptive Mean-Shift clustering based tissue segmentation is performed by Arnaldo et al (2009). Spatial information is also incorporated in this approach to minimize the effect of artifacts. In this work, experiments are conducted to cluster the normal brain images. This technique can be extended to extract abnormal tissues.

A new kernelised weighted C-means algorithm is developed by Pawel (2009). High quality results are reported in this work but the experiments are conducted on a small size dataset which is highly insufficient to estimate the quality of the proposed system. Lack of generalization is another drawback of the approach since the analysis is performed only on glioma tumor images. Kai et al (2010) have implemented a Gaussian smoothing based FCM algorithm to achieve improved performance measures. This approach has incorporated a feature selection algorithm for improved accuracy. Experimental analysis has revealed the suitability of this approach for noisy MR images. But the computational complexity of this approach is significantly high due to the bootstrap based feature selection techniques.

A fast and robust FCM based brain image segmentation is implemented by Cai et al (2007). The spatial and the gray information are combined together to develop this modified approach. Beevi et al (2010) have used the spatial probability of the neighbouring pixels to enhance the performance of the FCM algorithm. This work is highly inclined towards noisy environment. Modified approaches of FCM algorithm is also achieved by changing the membership adjustment equations. Such works are reported by Vasuda et al (2010) and Wang et al (2008). But, these works suffer either from inferior accuracy or increased computational complexity. A novel approach such as Suppressed-FCM (SFCM) is implemented by Hung et al (2006). The focus of this work is on the selection of various parameters for the training procedure. FCM technique for intensity inhomogeneity correction is proposed by Siyal et al (2005). An optimized FCM
technique is implemented by Soesanti et al (2011). The inclusion of optimization has increased the computational complexity of the proposed approach.

2.5.4 Image segmentation based on hybrid techniques

Several hybrid neuro-fuzzy approaches for image analysis are also reported in the literature. Jyh-Shing (1993) has explained the theory behind Adaptive Neuro Fuzzy Inference System (ANFIS) and also suggested several applications for this hybrid approach. The report also illustrated the effects of various membership functions on the ANFIS training and testing process. The foundation for the ANFIS based research is provided in this work. A hybrid neuro-fuzzy approach is used for image segmentation by Victor et al (2002). The conventional fuzzy clustering algorithm combined with the Multi Layer Perceptron (MLP) neural network is used for segmentation. Selection of appropriate convergence criterion is the major drawback of this approach. An optimal neuro-fuzzy possibilistic C-means algorithm is proposed by Abdelouahab (2006). A comparative analysis between the conventional techniques is also performed in this work. This work mainly aimed at improving the segmentation efficiency of noisy MR images. The drawback is the slow convergence rate due to the fact that many complex steps are involved in this algorithm.

A combinational approach of SOM, SVM and fuzzy theory is implemented by Chia-Feng et al (2007). An extensive analysis is performed with the other segmentation techniques to show the superior nature of the proposed approach. Nandedkar et al (2007) have proposed a reflex fuzzy min-max neural network for clustering techniques. The reflex mechanism of brain together with fuzzy rules has been used to reduce the misclassification rate. The results are also compared with the conventional techniques and found to be useful for improving the segmentation efficiency. No specific application is reported in this work. Wavelet based neuro fuzzy segmentation is proposed by Mausumi et al (2007). A neural architecture with fuzzy rules is used for implementation in this work. This work is not experimented on brain images. Murugavalli et al (2007) mixed the combination of SOM and FCM algorithm for brain image segmentation. But the
drawback of this technique is that it is not suitable for tumors of varying size. The convergence rate reported in this work is also very low which another drawback of this technique is. A fuzzy kohonen neural network is implemented by Nahla et al (2008). This technique is completely dependent on the input features which are the drawback of this system. The qualitative and quantitative analysis results are inadequate when compared with the other techniques. Thus, the literature survey has highlighted the merits and demerits of the various techniques available for each module of the proposed automated system.

In this research work, several methods are proposed for each module with an objective to overcome the drawbacks of the earlier works. In image pre-processing, methods are being framed to eliminate the extra cranial tissues which often interfere with the tumorous tissues that ultimately degrade the accuracy. Both qualitative and quantitative analysis of the results is shown to prove the necessity of artifacts removal in MR brain images. An extensive set of textural features are also extracted from the input images. Two different types of features are to be extracted for the classification and the segmentation techniques. These textural features are extracted from the entire image for the classification techniques. For segmentation, block based features are to be carried out in this research.

All the existing research works on ANN for brain image classification aimed only at improving the classification accuracy but failed to determine the effect of the convergence time period. Most of the conventional neural networks require large time period for convergence which makes the system practically non-feasible. Also, the research work on application of fuzzy theory for abnormality identification is relatively low. In this work, modifications of the existing neural networks are to be performed to improve the performance measures such as convergence rate and classification accuracy. Some of the conventional neural networks are also used in this work. An extensive analysis is to be performed between these techniques to highlight the optimal technique for further applications.
The main objective of the above mentioned works are improving the segmentation efficiency which alone is not sufficient for real time applications. In this work, tumor segmentation is to be performed with modified neural networks and modified conventional fuzzy algorithms to achieve high accuracy at a quicker time period. A detailed comparative analysis between the various techniques in terms of the performance measures is to be presented in this work.