CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

In Medical diagnosis, through Magnetic Resonance Images, Robustness and accuracy of the Prediction algorithms are very important, because the result is crucial for treatment of Patients. There are many popular classification and clustering algorithms used for predicting the diseases from Images. The goal of clustering a medical image is to simplify the representation of an image into a meaningful image and make it easier to analyze. Several Clustering and Classification algorithms are aimed at enhancing the Prediction accuracy of diagnosis Process in detecting abnormalities such as Cancer and white matter lesions from MR Images.

The first section of this chapter presents different clustering approaches to Medical diagnosis from Images. Survey on Classification algorithms in diagnosis is given in the second section. The next three sections reviews about different Brain Tumor, White matter lesion and Breast lesion detection algorithms. Finally a survey on several Optimization approaches for Clustering and Classification algorithms has been presented followed by the summary of this chapter.

2.2 IMAGE MINING ALGORITHMS

Zhang et al (2002) proposed the developments in the area of image acquisition and storage technique. A Synthetic image set (Ordonez and

Omiecinski, 1999) containing geometric shapes was taken as the dataset. The images which are available in Synthetic image databases, if examined, can provide valuable information to the human users. Image mining facilitates the extraction of hidden information, image data association, or other patterns not clearly accumulated in the images. Image mining is an interdisciplinary effort that provides significant application in the domain of machine learning, image processing, image retrieval, data mining, database, computer vision, and artificial intelligence. Even though there exists growth of several applications and techniques in the individual research domain mentioned above, research in image mining has to be explored and investigated their existing research problems in image mining, modern growth in image mining, predominantly, image mining frameworks, modern techniques and systems.

Content based tissue image mining was proposed by Abhi Gholap et al (2005). Biological data management and mining are the areas of recent biology research. High throughput and huge information content are two significant features of any Tissue Microarray Analysis (TMA) system. Tissue image mining is resourceful and faster if the tissue images are indexed, stored and mined on content. A four-level system to exploit the knowledge of a pathologist with image examination, pattern identification, and artificial intelligence, was proposed in this approach. At Image Processing and Information Level, information such as disparity or color is utilized. At Object Level, pathological objects, comprising cell constituents, are recognized. At Semantic Level, arrangement and configuration of individual cells into sheets in a tissue image are examined. At the uppermost level, Knowledge Level, supposition of the expert is specified.

Sanjay et al (2007) put forth an image mining technique using wavelet transform. An image mining approach has been proposed using wavelet transform. It uses common pattern identical, pattern identification and data mining models with the intention that a real life scene/image can be associated to a particular category, assisting in different prediction and forecasting mechanisms. It is a three-step procedure i.e. image gathering, learning and classification. Since wavelet transform uses time frequency association, it can be utilized for image mining as a substitute of Fourier transform. Wavelet transform is utilized to decompose an image into dissimilar frequency sub bands and a small frequency sub band is used for Principal Component Analysis (PCA). Classification assists in recognizing the category to which an image relates with. They have constructed a prototype system for identification using DWT + PCA system. The conception of image mining as a consequence can be competently used for weather forecasting so that one can know the natural disasters that may occur in advance.

Image mining approach using clustering and data compression techniques was projected by Sabyasachi et al (2008). Satellite images of clouds play a substantial role in forecasting weather conditions. Frequency of image acquired ranges from one image per minute to another image per hour based on the climatic environment. These occurrences results in huge collection and creation of image data warehouse. Permanent storage and transmission of images is a demanding task. In their approach, data mining clustering method together with Vector Quantization (VQ) is implemented to cluster and compact static color image. Results are shown to demonstrate the findings both subjectively and visually.

Perner (2002) discussed about image mining framework as a standard tool and its application to medical-image analysis. A tool and a technique for data mining in picture-archiving systems are provided. It is expected to determine the suitable knowledge for picture examination and identification from the data base of image descriptions. Knowledgeengineering methods are used to acquire a list of attributes for symbolic image descriptions. An expert describes images based on this list and accumulates descriptions in the database.

Digital-image processing can be implemented to obtain better imaging of specific image characteristics, or to obtain expert-independent characteristic evaluation. Decision-tree induction is utilized to discover the expert knowledge, provided in the form of image descriptions in the database. This assembled decision tree provides efficient models of decision-making, which can be investigated to maintain image categorization by the expert. A tool for data mining and image processing is developed and its application to image mining is revealed on the task of Hep-2 cell-image categorization. On the other hand, this tool and the technique are standard and can be utilized for other image-mining tasks. They implemented this method in additional medical tasks, for instance, in lung-nodule analysis in X-ray images, lymph-node analysis in MRI and examination of breast MRI.

Decision tree based image processing and image mining technique was projected by Lu Kun-Che and Yang (2003). Important information can be hidden in images, conversely, few research talks about data mining on them. In their approach, they developed a common framework depending on the decision tree for mining and processing image data. Pixel-wised image characteristics were extracted and changed into a database-like table which permits a variety of data mining algorithms to make explorations on it. Each tuple of the changed table has a feature descriptor produced by a collection of characteristics in conjunction with the target label of a particular pixel. With the label feature, they adopted the decision tree induction in order to comprehend associations among features and the target label from image pixels, and to build up a model for pixel-wised image processing based on a specified training image dataset.

Both experimental and theoretical analyses were performed in their study. Their results confirmed that this model can be extremely capable and effectual for image processing and image mining. It is estimated that by using this model, various existing data mining and image processing methods could be worked on together in different ways. Their model can also be used to generate new image processing techniques, enhance existing image processing methods, or act as a powerful image filter.

Jaba Sheela and Shanthi (2007) described the image mining approaches for categorization and segmentation of brain MRI data. Image segmentation plays a vital role in several medical imaging applications by computerizing or assisting the description of anatomical arrangements and additional regions of interest. Automatic recognition of tumors in several medical images is encouraged by the requirement of better accuracy when handling with a human life. Also, the computer assistance is demanded in medical institutions owing to the reality that it possibly will progress the results of humans in such a domain where the false negative cases must be at a very low rate. It has been confirmed that double reading of medical images possibly will show the way for enhanced tumor detection. But the cost implied in double reading is extremely huge, that’s why better software to assist humans in medical institutions is of interest at the present time. In their approach they developed a system which uses image mining approaches to categorize the images either as normal or abnormal and then divide the tissues of the anomalous Brain MRI to recognize brain related diseases.

Content based image mining approach was explained by Aura Conci et al (2002). Image mining presents unique distinctiveness suitable to the richness of the data that an image can show. Successful assessment of the results of image mining by content requires that the user point of view (of likeness) is used on the performance parameters. Comparison among different mining by resemblance systems is particularly challenging owing to the great variety of methods implemented to represent resemblance and the dependence that the results present of the used image set. Other obstacle is the lack of parameters for comparing experimental performance. In their work they described an evaluation framework for comparing the influence of the distance function on image mining by color.

Experiments with color similarity mining by quantization on color space and measures of likeness between a sample and the image results have been carried out to illustrate the proposed scheme. Important aspects of this type of mining are also described. A new image mining approach was described by Hui Jiang and Chong-Wah Ngo (2003). Given several images, initially they use Attributed Relational Graph (ARG) to characterize them.

Ashok N. Srivastava et al (2004) proposed a knowledge driven image mining technique. The issue of automatically mining the multispectral images using Mercer Kernels with the hope of identifying a technique to automatically construct tags for images that denote the percentage of cloud cover, the percentage of presence of other geophysical processes such as snow, ice, melting regions, drought regions, and fire hazard has been proposed. A kernel function is defined as the inner product of the mapped data in the feature space. A new technique has been proposed for automatic knowledge driven image mining based on the theory of Mercer Kernels, which are extremely nonlinear symmetric positive definite mappings from the original image space to a very high, probably infinite dimensional feature space.

In that high dimensional feature space, linear clustering, prediction, and classification techniques can be used and the results can be mapped back down to the original image space. Therefore, highly nonlinear structure in the image can be obtained with the use of popular linear mathematics in the feature space. The theory of Mercer Kernels, illustrated its use in image mining, discussed a new technique to construct Mercer Kernels directly from data, and compared the results with conventional techniques on data from the MODIS (Moderate Resolution Spectral Radiometer) instrument taken over the Arctic region.

An image mining approach for clustering shoe prints was proposed by Wei Sun et al (2008). The main objectives of their work are (i) to cluster shoe prints, (ii) to analyze the results of each clustering algorithm, (iii) to use a visualization tool to see how the clusters are affected by changes of input variables, and (iv) to examine the differences in the distributions of variables from cluster to cluster. The experiments have been conducted to cluster a sequence of shoe prints through clustering techniques in WEKA. In order to make the experiment more convincible, the RGB values of images chosen are relatively close, so that the images are not that much identifiable. The partitioning-based clustering techniques are used, namely k-means and expectation maximization (EM) in their proposed work. It has been confirmed that no single machine learning scheme is appropriate for all image mining problems.

Rajendran and Madheswaran (2009) discussed about an improved image mining technique. An enhanced image mining technique for brain tumor classification using pruned association rule is presented. This method proposed makes use of association rule mining technique to classify the CT scan brain images into three categories namely normal, benign and malign. It combines the low-level features extracted from images and high level knowledge from specialists. The developed algorithm can lend a hand to the physicians for well-organized classification with multiple keywords per image to get better the accuracy. The method proposed in this work classifies the brain CT scan images into three categories: normal, benign and malignant.

In association with the above mentioned research works Kun Qin et al (2003) explained the methods of remote sensing image mining based on concept lattice. The theory of concept lattice has been described and the techniques of association rule mining depending on concept lattice, established the techniques into remote sensing image mining, examined and illustrated the spectrum characteristics mining, texture characteristics mining, shape characteristics mining and spatial distributing laws mining and finally analyzed the application of remote sensing image mining, such as the automation classification, intelligent retrieval of remote sensing image.

Hsu et al (2000) illustrated image mining in IRIS. There is an increasing requirement for systems that can frequently examine images and obtain semantically significant information. IRIS and an Integrated Retinal Information system, has been designed to give medical experts simple access to the screening, trend and progression of diabetic related eye diseases in a diabetic patient database. The mining approaches which can be used to exactly obtain features in the retinal images have been proposed. Especially, classification techniques have been applied to decide the conditions for tortuosity in retinal blood vessels.

Keiji Yanai (2003) describes a common image classification method with an automatic knowledge acquisition scheme from the Web. This approach used three phases for the processing. Initial phase is the gathering period i.e. it collects images related to specified class keywords from the Web. Second phase is the learning period where it extracts image attributes from collected images and relates them with each class. Third phase is the classification period which categorizes an unknown image into dissimilar classes in proportion to class keywords by using the association among the image attributes and the classes.

Figueiredo et al (2007) proved several new results which strongly support the claim that the SI does not compromise the usefulness of this class of algorithms. Standard formulations of image/signal deconvolution under wavelet-based priors/regularizers lead to very high dimensional optimization problems involving the following difficulties: the non-Gaussian (heavy-tailed) wavelet priors lead to objective functions which are non-quadratic, usually non-differentiable and sometimes even non-convex; the presence of the convolution operator destroys the separability which underlies the simplicity of wavelet-based denoising. This work presents a unified view of several recently proposed algorithms for handling this class of optimization problems, placing them in a common majorization-minimization (MM) framework. One of the classes of algorithms considered (when using quadratic bounds on non-differentiable log-priors) shares the infamous “singularity issue”(SI) of “iteratively reweighted least squares” (IRLS) algorithms: the possibility of having to handle infinite weights, which may cause both numerical and convergence issues. Exploiting the unified MM perspective, a new algorithm is introduced, resulting from using l1 bounds for non-convex regularizers; the experiments confirm the superior performance of this method, when compared to the one based on quadratic majorization. Finally, an experimental comparison of the several algorithms, reveals their relative merits for different standard types of scenarios.

Esser et al (2010) generalize the Primal-Dual Hybrid Gradient (PDHG) algorithm proposed by Zhu and Chan (2008). An Efficient Primal-Dual Hybrid Gradient Algorithm for Total Variation Image Restoration, CAM Report 08-34, UCLA, Los Angeles, CA, 2008 to a broader class of convex optimization problems. In addition, survey on several closely related methods with connection to primal-dual hybrid gradient **(**PDHG) has been done. Convergence results for a modified version of PDHG shows similarly good empirical convergence rate for Total Variation (TV) minimization problems.

They also prove a convergence result for PDHG applied to TV denoising with some restrictions on the PDHG step size parameters. They show how to interpret this special case as a projected averaged gradient method applied to the dual functional. They discuss the range of parameters for which these methods can be shown to converge. They also present some numerical comparisons of these algorithms applied to TV denoising.

Yue and Mathews (2012) introduced novel image regularization penalties to overcome the practical problems associated with the classical total variation (TV) scheme. Motivated by novel reinterpretations of the classical TV regularizer, two families of functionals involving higher degree partial image derivatives have been derived. These families are termed as isotropic and anisotropic higher degree TV (HDTV) penalties, respectively. The isotropic penalty is the mixed norm of the directional image derivatives, while the anisotropic penalty is the separable norm of directional derivatives. These functionals inherit the desirable properties of standard TV schemes such as invariance to rotations and translations, preservation of discontinuities, and convexity. The use of mixed norms in isotropic penalties encourages the joint sparsity of the directional derivatives at each pixel, thus encouraging isotropic smoothing. In contrast, the fully separable norm in the anisotropic penalty ensures the preservation of discontinuities, while continuing to smoothen along the line like features; this scheme thus enhances the linen like image characteristics analogous to standard TV. Efficient majorize-minimize algorithms have been introduced to solve the resulting optimization problems. The numerical comparison of the proposed scheme with classical TV penalty, current second-degree methods, and wavelet algorithms clearly demonstrate the improved performance. Specifically, the proposed algorithms minimize the staircase and ringing artifacts that are common with TV and wavelet schemes, while better preserving the singularities.

Chambolle et al (2011) proposed the finite-difference approximations to the variational problem using the Bounded Variation (BV) smoothness penalty that was introduced in an image smoothing context. A dual formulation for an upwind finite-difference approximation for the BV seminorm has been given; this formulation is in the same spirit as one popularized for a simpler, less isotropic, finite-difference approximation to the (isotropic) BV seminorm. A multiscale method has been introduced for speeding up the approximation of both Chambolle's original method and of the new formulation of the upwind scheme. They demonstrated numerically that the multiscale method is effective, and they provide numerical examples that illustrate both the qualitative and quantitative behavior of the solutions of the numerical formulations.

2.3 CLUSTERING ALGORITHMS IN MEDICAL DIAGNOSIS

Alan Wee-Chung Lieu et al (2006) discussed an Adaptive Spatial Fuzzy Clustering Algorithm for 3-D MR Image Segmentation. An adaptive spatial fuzzy c-means clustering algorithm is presented in this work for the segmentation of three-dimensional (3-D) magnetic resonance (MR) images. The input images may be corrupted by noise and intensity non uniformity (INU) artefact. The proposed algorithm takes into account, the spatial continuity constraints by using a dissimilarity index that allows spatial interactions between image voxels. The local spatial continuity constraint reduces the noise effect and the classification ambiguity. The INU artefact is formulated as a multiplicative bias field affecting the true MR imaging signal. By modelling the log bias field as a stack of smoothing spline surfaces, with continuity enforced across slices, the computation of the 3-D bias field reduces to that of finding the spline coefficients, which can be obtained using a computationally efficient two-stage algorithm.

The system uses a shot boundary detection method based on SVM optimized by GA. The method utilizes GA to optimize the RBF parameters of SVM, then classifies the video frames and ascertains the shot boundaries by using the model trained by the approximately optimal parameters obtained by GA.

Dempster et al (1977) proposed a general approach to iterative computation of maximum-likelihood estimates when the observations can be viewed as incomplete data. Since each iteration of the algorithm consists of an expectation step followed by a maximization step, it is called the EM algorithm. The EM process is remarkable in part because of the simplicity and generality of the associated theory, and in part because of the wide range of examples which fall under its umbrella. When the underlying complete data come from an exponential family whose maximum-likelihood estimates are easily computed, then each maximization step of an EM algorithm is likewise easily computed.

Algorithm for computing maximum likelihood estimates from incomplete data is presented at various levels of generality. Theory showing the monotone behavior of the likelihood and convergence of the algorithm is derived. Many examples are sketched, including missing value situations, applications to grouped, censored or truncated data, finite mixture models, variance component estimation, hyper parameter estimation, iteratively reweighted least squares and factor analysis.

The EM algorithm is directed at finding a value that maximizes g(y I+) given an observed y, but it does so by making essential use of the associated family f(xl+). Notice that given the incomplete-data specification g(y1 +), there are many possible complete-data specifications f(xI+) that will generate g(y I+). Sometimes a natural choice will be obvious, at other times there may be several different ways of defining the associated f(xl+). Each iteration of the EM algorithm involves two steps which are called as the expectation step (E-step) and the maximization step (M-step).

Lue Vincent and Pierre Soille (1991) proposed a concept of watershed. Watersheds are one of the classics in the field of topography. Everybody has heard for example about the great divide, this particular line which separates the U.S.A. into two regions. A drop of water falling on one side of this line flows down until it reaches the Atlantic Ocean, whereas a drop falling on the other side flows down to the Pacific Ocean. The two regions it separates are called the catchment basins of the Atlantic and the Pacific Oceans, respectively. The two Oceans are the minima associated with these catchment basins. Now, in the field of image processing and more particularly in Mathematical Morphology (MM) grayscale pictures are often considered as topographic reliefs.

In the topographic representation of a given image I, the numerical value (i.e., the gray tone) of each pixel stands for the elevation at this point. Such a representation is extremely useful, since it first allows one to better appreciate the effect of a given transformation on the image under study. It is known for example that an opening removes some peaks and crest lines, whereas a closing tends to fill in basins and valleys. Furthermore, this representation, such notions as minima, catchment basins and watersheds can be well defined for grayscale images. Naturally, the first algorithms for computing watersheds are found in the field of topography. Topographic surfaces are numerically handled through Digital Elevation Models (DEM's). These are arrays of numbers that represent the spatial distribution of terrain altitudes.

The most commonly used data structure for DEM's is the regular square grid in which available elevations are equally spaced in two orthogonal directions. Automated watershed extraction from DEM's has received increasing attention in the past few years. The first step of most published algorithms is a parallel procedure performing local operations defined on a 3×3 window. This allows one to extract potential dividing pixels. In a second step, the extracted pixels are connected into geomorphological networks. However, the very local approach of the first step and the lack of objective rules to perform the second one usually lead to poor results. Meanwhile and apart from these researches in digital topography, the above notions were studied in the field of image processing.

Shyi-Ching et al (2011) proposed the extension that modifies the algorithm design to incorporate parallel processing. The goal of data mining is to extract knowledge from data. The discovered knowledge plays an important role in decision making. Accordingly, the comprehensibility of the discovered knowledge is very critical. If the discovered knowledge is not comprehensible, it will not be useful for decision making, even leads to an incorrect decision. Data mining is an interdisciplinary research topic. There are various data mining tasks. This work focuses on the solving for classification rule problem. Classification rule is the most common representation of the rule in data mining. It belongs to the supervised learning process which generates rules from training data set. The goal of the classification rule mining is the prediction of the predefined class. Considering the classification task of data mining, discovered knowledge is often expressed in the form of IF-THEN rules.

2.4 CLASSIFICATION ALGORITHMS IN MEDICAL DIAGNOSIS

Selim and Gokberk (2009) proposed a new image mining technique using directional spatial constraints. The significant contributions in their approach include expanding the association model to numerous reference objects, integrating the spatial information into the Bayesian decision rule as spatial priors for background classification, and facilitating dynamic queries by using directional associations as spatial parameters with support for the visibility of image areas that are incompletely enclosed by reference objects. They also demonstrated the efficiency of this technique using quantitative and qualitative results on contextual classification and retrieval of elevated spatial resolution satellite imagery. Retrieval performance was evaluated using precision (percentage of the correctly detected objects among all detections in the result set) and recall (percentage of the accurately identified objects between all objects in the ground truth) using a ground truth that was constructed by manually identifying the objects satisfying each query.

Yuan jiang et al (2003) proposed a method for segmenting images based on SOM neural network is proposed. At first, the pixels are clustered based on their color and spatial features, where the clustering process is accomplished with a SOM network. Then, the clustered blocks are merged to a specific number of regions. Experiments show that these regions could be regarded as segmentation results reserving some semantic means. This approach thus provides a feasible new solution for image segmentation which may be helpful in image retrieval.

Yan and Zheru (2005) proposed a new unsupervised MR image segmentation method based on self-organizing feature map (SOFM) network. The magnetic resonance imaging (MRI) is an advanced medical imaging technique providing rich information about the human soft tissue anatomy. The goal of magnetic resonance (MR) image segmentation is to accurately identify the principal tissue structures in these image volumes. The algorithm includes spatial constraints by using a Markov Random Field (MRF) model. The MRF term introduces the prior distribution with clique potentials and thus improves the segmentation results without having extra data samples in the training set or a complicated network structure. The simulation results demonstrate that the proposed algorithm is promising.

Lei Jiang and Wenhui Yang (2003) proposed a new approach for robust segmentation of Magnetic Resonance images that have been corrupted by intensity in homogeneities and noise. The algorithm is formulated by modifying the objective function of the standard Fuzzy C-Means (FCM) method to compensate for intensity in homogeneities. An additional term is injected into the objective function to constrain the behavior of membership functions with the neighborhood effect. An adaptive K-means clustering algorithm that initializes the centroids is described. The efficacy of the algorithm is demonstrated on both simulated and real Magnetic Resonance Images.

Outlier voxels are those that are far from the normal range of voxel values in controls. The lesion is then identified by searching for outlier voxels in Grey Matter (GM) and White Matter (WM) segments. This ensures that they identify lesions that are specific to brain tissue (i.e., GM and WM) using fuzzy clustering with fixed-prototypes (FCP), for outlier detection in second-level functional MRI. The approach is illustrated using both simulated and real patient data.

Shasidhar et al (2011) proposed modified FCM algorithm. Clustering approach is widely used in biomedical applications particularly for brain tumor detection in abnormal magnetic resonance (MRI) images. Fuzzy clustering using fuzzy C-means (FCM) algorithm proved to be superior over the other clustering approaches in terms of segmentation efficiency. But the major drawback of the FCM algorithm is the huge computational time required for convergence. The effectiveness of the FCM algorithm in terms of computational rate is improved by modifying the cluster center and membership value updating criterion. In this work, the application of modified FCM algorithm for MR brain tumor detection is explored. A comprehensive feature vector space is used for the segmentation technique.

Comparative analysis in terms of segmentation efficiency and convergence rate is performed between the conventional FCM and the modified FCM. Experimental results show superior results for the modified FCM algorithm in terms of the performance measures.

Yanyan He et al (2012) used fast discrete cosine transform to solve the TV-regularized optimization problem. The objective function of the original (fuzzy) C-mean method is modified by a regularizing function in the form of total variation (TV) with regard to gradient sparsity, and a regularization parameter is used to balance clustering and smoothing. The new algorithm is tested on both synthetic and real data, and is demonstrated to be effective and robust in treating images with noise and missing data (incomplete data).

Zhu et al (2008) proposed a simple yet efficient algorithm for total variation (TV) minimizations with applications in the image processing realm. This descent-type algorithm alternates between the primal and dual formulations and exploit the information from both the primal and dual variables. It converges significantly faster than some popular existing methods as demonstrated in our experiments. This approach is to some extent related to projection type methods for solving variational inequalities. It can be applied to solve other TV model and L1 minimization problem.

Joshi et al (2009) proposed a novel method for resolution enhancement for volumetric images based on a variational-based reconstruction approach. The reconstruction problem is posed using a deconvolution model that seeks to minimize the total variation norm of the image. Additionally, a new edge-preserving operator is proposed that emphasizes and even enhances edges during the up-sampling and decimation of the image. The edge enhanced reconstruction is shown to yield significant improvement in resolution, especially preserving important edges containing anatomical information. This method is demonstrated as an enhancement tool for low-resolution, anisotropic, 3D brain MRI images, as well as a pre-processing step to improve skull-stripping segmentation of brain images.

Liew et al (2000) presented a spatial fuzzy clustering algorithm that exploits the spatial contextual information in image data. The objective functional of their method utilizes a new dissimilarity index that takes into account the influence of the neighboring pixels on the center pixel in a 3*3 window. The algorithm is adaptive to image content in the sense that its influence from the neighboring pixels is suppressed in nonhomogenous regions in the image. The cluster merging scheme that merges two clusters based on the closeness and the degree of overlap is presented. Through this merging scheme, an 'optimal' number of clusters can be determined automatically as iteration proceeds. Experimental results with synthetic and real images indicate that the proposed algorithm is more tolerant to noise, better at resolving classification ambiguity.

Liew et al (2003) proposed an adaptive spatial fuzzy c-means clustering algorithm for the segmentation of three dimensional (3-D) magnetic resonance (MR) images. The input images may be corrupted by noise and intensity non uniformity (INU) artifact. The proposed algorithm takes into account the spatial continuity constraints by using a dissimilarity index that allows spatial interactions between image voxels. The local spatial continuity constraint reduces the noise effect and the classification ambiguity. The INU artifact is formulated as a multiplicative bias field affecting the true MR imaging signal. By modeling the log bias field as a stack of smoothing spline surfaces, with continuity enforced across slices, the computation of the 3-D bias field reduces to that of finding the spline coefficients, which can be obtained using a computationally efficient two stage algorithm. The efficacy of the proposed algorithm is demonstrated by extensive segmentation experiments using both simulated and real MR images and by comparison with other published algorithms.

Laszlo Szilagyi et al (2007) presented a modified FCM-based method that targets accurate and fast segmentation in case of mixed noises. Automated brain MR image segmentation is a challenging pattern recognition problem that received significant attention lately. The most popular solutions involve fuzzy c-means (FCM) or similar clustering mechanisms. Several improvements have been made to the standard FCM algorithm, in order to reduce its sensitivity to Gaussian, impulse, and intensity non-uniformity noises. This method extracts a scalar feature value from the neighborhood of each pixel, using a context dependent filtering technique that deals with both spatial and gray level distances. These features are clustered afterwards by the histogram-based approach of the enhanced FCM algorithm. Results were evaluated based on synthetic phantoms and real MR images. Test experiments revealed that this method provides better results compared to other reported FCM-based techniques. The achieved segmentation and the obtained fuzzy membership values represent excellent support for deformable contour model based cortical surface reconstruction methods.

2.5 BRAIN TUMOUR DETECTION ALGORITHMS

Glotsos et al (2003) proposes the uses of support vector machines (SVMs) and decision tree (DT) classification as a possible methodology for the characterization of the degree of malignancy of brain tumours astrocytomas (ASTs). A two-level hierarchical DT model was constructed for the discrimination of 87 ASTs in accordance to the WHO grading system. The first level concerned the detection of low versus high-grade tumours and the second level, the detection of less aggressive as opposed to highly aggressive tumours. The decision rule at each level was based on SVM classification methodology comprising three steps: i) From each biopsy, images were digitized and segmented to isolate nuclei from surrounding tissue. ii) Descriptive quantitative variables related to chromatin distribution and DNA content was generated to encode the degree of tumour malignancy. iii) Exhaustive search was performed to determine best feature combination that led to the smallest classification error. SVM classifier training was based on the leave-one-out method. Finally, SVMs were comparatively evaluated with the Bayesian classifier and the probabilistic neural network.

Othman and Basri (2011) uses Probabilistic Neural Network with image and data processing techniques to implement an automated brain tumor classification. The conventional method for medical resonance brain images classification and tumors detection is by human inspection. Operator-assisted classification methods are impractical for large amounts of data and are also non-reproducible. Medical Resonance images contain a noise caused by operator performance which can lead to serious inaccuracies in classification. The use of artificial intelligent techniques like neural networks, and fuzzy logic shows great potential in this field. In this work the Probabilistic Neural Network was applied for the purposes. Decision making was performed in two stages: feature extraction using the principal component analysis and the Probabilistic Neural Network (PNN). The performance of the PNN classifier was evaluated in terms of training the performance and classification accuracies. Probabilistic Neural Network gives fast and accurate classification and is a promising tool for classification of the tumors.

Jing Huo et al (2009) proposed the novel methods novel methods using diffusion weighted (DW) MR images as a biomarker to detect early GBM brain tumor response to treatment. Apparent Diffusion Coefficient (ADC) map, calculated from DW-MR images, can provide unique information of tumour response at cellular level. In this study, they investigate whether changes in ADC histograms between two scans, taken 5-7 weeks apart before and after treatment, could predict treatment effectiveness before lesion size changes are observed on later scans. The contribution of the work is to exploit quantitative pattern classification techniques for the prediction. For both pre and post treatment scans, the histogram was computed from the ADC values covered within the tumour. Then supervised learning was applied on features extracted from the histogram for classification. Then evaluated the approach with pool data of 86 patients with GBM under chemotherapy while 40 responded and 46 did not respond based on tumour size reduction. It was compared with Fisher's linear discriminate analysis, AdaBoost and random forests classifier using leave one out cross validation (LOOCV), resulting in the best accuracy of 67.44%.

Singh et al (2009) proposed a method to characterize a brain tumor. A tumor characterization technique has been developed using Marker Controlled Watershed Segmentation method and region property functions using image processing toolbox. The parameters extracted are area, major and minor axis length, eccentricity, orientation, equivdiameter, solidity and perimeter. This method is quite versatile, fast and simple to use. This can be applied to all types of 2D MR Images representing all tumors irrespective of their location in human body and their size. This technique was simulated on Matlab and results were compared with experimental data obtained from diagnostic centre.

Karnan and Logheshwari (2010) proposed a hybrid with Fuzzy segmentation. Ant Colony Optimization (ACO) metaheuristic is a recent population-based approach inspired by the observation of real ants colony and based upon their collective foraging behavior. In the first step, the MRI brain image is Segmented ACO Hybrid with Fuzzy method to extract the suspicious region. The second step deals with similarity between proposed segmented algorithms and Radiologist report. The tumor position and pixel similarity of the Aco Hybrid with Fuzz techniques are measured with Radiologist report.

Wang and Ma (2011) proposed a new general method for segmenting brain tumors in 3D magnetic resonance images. This method is applicable to different types of tumors. First, the brain is segmented using a new approach, robust to the presence of tumors. Then tumor detection is performed, based on improved fuzzy classification. Its result constitutes the initialization of a segmentation method based on a deformable model, leading to a precise segmentation of the tumors. Imprecision and variability are taken into account at all levels, using appropriate fuzzy models. The result obtained on different types of tumors has been evaluated by comparison with manual segmentations.

Kharrat et al (2009) introduced an efficient detection of brain tumor from cerebral MRI images. The methodology consists of three steps: enhancement, segmentation and classification. To improve the quality of images and limit the risk of distinct regions fusion in the segmentation phase an enhancement process is applied. Mathematical morphology was adapted to increase the contrast in MRI images. Then Wavelet Transform was applied in the segmentation process to decompose MRI images. At last, the k-means algorithm is implemented to extract the suspicious regions or tumors. Some of experimental results on brain images show the feasibility and the performance of the proposed approach.

Akram and Usman (2011) proposed a method for automatic brain tumor diagnostic system from MR images. The system consists of three stages to detect and segment a brain tumor. In the first stage, MR image of brain is acquired and preprocessing is done to remove the noise and to sharpen the image. In the second stage, global threshold segmentation is done on the sharpened image to segment the brain tumor. In the third stage, the segmented image is post processed by morphological operations and tumor masking in order to remove the false segmented pixels. Results and experiments show that this technique accurately identifies and segments the brain tumor in MR images.

Vrji and Jayakumari (2011) investigates the potential use of MRI data for improving brain tumor shape approximation and 2D & 3D visualization for surgical planning and assessing tumor. In medical image processing, Segmentation of anatomical regions of the brain is the fundamental problem. Here, a brain tumor segmentation method has been developed and validated using MRI Data. In Preprocessing and Enhancement stage, medical image is converted into standard formatted image. Segmentation subdivides an image into its constituent regions or objects. This method can segment a tumor provided that the desired parameters are set properly.

Ming-Ni Wu et al (2007) proposed a color-based segmentation method that uses the K-means clustering technique to track tumor objects in magnetic resonance (MR) brain images. The key concept in this color-based segmentation algorithm with K-means is to convert a given gray-level MR image into a color space image and then separate the position of tumor objects from other items of an MR image by using K-means clustering and histogram-clustering. Experiments demonstrate that the method can successfully achieve segmentation for MR brain images to help pathologists distinguish exactly lesion size and region.

Iftekharuddin et al (2006) proposed the classification of the tumor regions from non-tumor regions. Two novel fractal-based texture features are exploited for pediatric brain tumor segmentation and classification in MRI. One of the two texture features uses Piecewise-Triangular-Prism-Surface-Area (PTPSA) algorithm for fractal feature extraction. The other texture feature exploits novel Fractional Brownian Motion (FBM) framework that combines both fractal and wavelet analyses for fractal wavelet feature extraction. Three MRI modalities such as Tl (gadolinium-enhanced), T2 and fluid-attenuated inversion-recovery (FLAIR) are exploited in this work. The self-organizing map (SOM) algorithm is used for tumor segmentation. For a total of 204 Tl contrast-enhanced, T2 and FLAIR MR Images obtained from nine different pediatric patients; the successful tumor segmentation rate is 100%.

Two classification methods, multi-layer feedforward neural network and support vector machine (SVM), are used to classify the tumor regions from non-tumor regions. For neural network classifier, at a threshold value of 0.7, the True Positive Fraction (TPF) values range from 75% to 100% for different patients, with the average value of 90%. For SVM classifier, the average accuracy rate is 95% and 92% for using 1/3 and 1/2 of data for testing respectively.

Leung et al (2003) proposed a new approach to detect the boundary of brain tumor based on the Generalized Fuzzy Operator (GFO). Boundary detection in MR image with brain tumor is an important image processing technique applied in radiology for 3D reconstruction. The non homogeneities in density tissue of the brain with tumor can result in achieving the inaccurate location in any boundary detection algorithms. Some studies using the contour deformable model with regional base technique, show that the performance is insufficient to obtain the fine edge in the tumor, and the considerable error in accuracy exist. Moreover, even in some of the normal tissue region, edge created by this method has also been encompassed. One typical example is used for evaluating this method with the contour deformable model.

Koley and Majumder (2011) presents the segmentation of brain MRI for the purpose of determining the exact location of brain tumor using CSM based partitional K means clustering algorithm. CSM has attracted much attention as it gives efficient result as a self merging algorithm compared to other merging processes and the effect of noise is also less and the probability of obtaining the exact location of tumor is more. This approach is much simpler and computationally less complex and computation time is very less.

Badran et al (2010) proposed a computer-based method for defining tumor region in the brain using MRI images. A classification of brain into healthy brain or a brain having a tumor is first done which is then followed by further classification into benign or malignant tumor. The algorithm incorporates steps for preprocessing, image segmentation, feature extraction and image classification using neural network techniques. Finally the tumor area is specified by region of interest technique as confirmation step. A user friendly Matlab GUI program has been constructed to test the proposed algorithm.

Shasidhar et al (2011) presented the application of modified FCM algorithm for MR brain tumor detection. A comprehensive feature vector space is used for the segmentation technique. Comparative analysis in terms of segmentation efficiency and convergence rate is performed between the conventional FCM and the modified FCM. The effectiveness of the FCM algorithm in terms of computational rate is improved by modifying the cluster center and membership value updating criterion.

Phooi and Ozawa (2005) presented an analytical method to detect lesions or tumors in digitized medical images for 3D visualization. A tumor detection method has been developed using three parameters; edge (E), gray (G), and contrast (H) values. The method proposed here studied the EGH parameters in a supervised block of input images. These feature blocks were compared with standardized parameters (derived from normal template block) to detect abnormal occurrences, e.g. image block which contain lesions or tumor cells. The abnormal blocks were transformed into three-dimension space for visualization and studies of robustness. Experiments were performed on different brain disease based on single and multiple slices of the MRI dataset. The experiments results have illustrated that this conceptually simple technique is able to effectively detect tumor blocks while being computationally efficient.

Dubey et al (2011) proposed that an accurate segmentation is critical, especially when the tumor morphological changes remain subtle, irregular and difficult to assess by clinical examination. A automated tumor segmentation in MRI brain tumor poses many challenges with regard to characteristics of an image. A comparison of three different semi-automated methods, viz., Modified Gradient Magnitude Region Growing Technique (MGRRGT), level set and a marker controlled watershed method is undertaken here for evaluating their relative performance in the segmentation of tumor. A study on 9 samples using MGRRGT reveals that all the errors are within 6 to 23% in comparison to other two methods.

2.6 WHITE MATTER LESION DETECTION METHODOLOGIES

Murugavalli and Rajamani (2007) proposed the implementation of a neuro-fuzzy segmentation process of the MRI data, to detect various tissues like white matter, gray matter, Cerebrospinal Fluid (CSF) and tumor. The advantage of hierarchical self organizing map and fuzzy C means algorithms are used to classify the image layer by layer. The lowest level weight vector is achieved by the abstraction level. A higher value of tumor pixels was also achieved by this neuro-fuzzy approach. The computation speed of the proposed method is also studied. The multilayer segmentation results of the neuro fuzzy are shown to have interesting consequences from the viewpoint of clinical diagnosis. Neuro fuzzy technique shows that MRI brain tumor segmentation using HSOM-FCM also with better accuracy.

Kannan (2005) presented various clustering techniques for Magnetic Resonance Imaging (MRI) with recent programming language. It presents many results using Fuzzy C mean (FCM) and silhouette value. Mainly this work develops a new effective Clustering Algorithm Method to explore easily the MRI using FCM, Silhouette method, and programming language. The new clustering algorithm is employed to tissue segmentation, to differentiate CSF from White and Grey matter and to track the brain tumor. The clustering program with FCM was designed to be robust and to accept dissimilarity data as objects. To compare the images, the clustering programming and Image programming provide visual display. The important sides of program in, a new task introduces that the image converts into data matrices, FCM program analyze the data of image, and then the samples of data matrices have been separated according to the cluster after using clustering algorithm.

Seghier et al (2008) proposed a new procedure to identify any type of brain damage given a single anatomical image is proposed. Procedure is based on the assumption that the lesion comprises atypical voxels that disclose themselves as outliers in gray and white matter segments. Atypical voxels are those that do not correspond to the expected tissue types; i.e., are neither Grey Matter (GM), White Matter (WM), nor Cerebrospinal Fluid (CSF). To avoid misclassification, a modified version of the unified segmentation scheme has been proposed to segment healthy and damaged brain tissue.

De Boer et al (2009) proposed fully automated method for CSF, GM and WM segmentation based on multimodal MRI data which is optimized and extended with WML segmentation.

The three steps proposed are:

1. Evaluate different atlas registration methods for a brain tissue segmentation method where atlas registration is used to automatically train a k-nearest neighbor classifier.
2. The method is extended with an automatic WML segmentation. This segmentation method uses the GM classification to determine a white matter lesion intensity threshold value in the FLAIR scan.
3. The method is qualitatively validated on a large dataset of 209 elderly subjects. The different brain tissues, CSF, GM and WM, are segmented by an automatically trained kNN classifier using atlas registration.

Tokunaga et al (2010) proposed a method which consists of extraction of a brain parenchymal region based on a brain model matching. The segmentation of the brain parenchyma into cerebral cortical and white matter regions was based on a fuzzy c-means (FCM) algorithm. It would be very important to estimate the degree of cerebral atrophy based on cortical regions for diagnosis of Alzheimer's Disease. However, it would be still challenging to segment brain parenchymal regions with Alzheimer's Disease into cerebral cortex and white matter when the boundary between them is unclear due to the presence of Alzheimer's Disease showing in magnetic resonance (MR) images. The purpose of this study was to develop an automated segmentation of the brain parenchyma into cerebral cortical and white matter regions with Alzheimer's Disease in three-dimensional (3D) T1-weighted MR images. The method was applied to MR images of the whole brain obtained from 9 cases, including 4 Alzheimer's Disease cases and 5 control cases. The mean volume percentages of the brain parenchymal region in the respective Alzheimer's Disease patients and controls were 41.7%

and 45.2% for cortical cortex region and 58.3% and 54.8% for white matter region, respectively.

Udupa et al (1997) proposed a novel methodology and a system that can be routinely used for segmenting and estimating the volume of MS lesions using dual-echo fast spin echo MR imagery. An operator indicates a few points in the images by pointing to the white matter, the grey matter, and the cerebrospinal fluid (CSF). Each of these objects is then detected as a fuzzy connected set. Fuzzy connected objects are presented to the operator who indicates acceptance/rejection through the click of a mouse button. The number and volume of accepted lesions is then computed and output. This methodology is highly reliable and consistent, with a coefficient of variation of 0.9% for volume and a mean false-negative volume fraction of 1.3%, with a 95% confidence interval of 0% –2.8%.

Kobashi et al (2006) suggested an automated method that locally classifies the brain tissues by adapting a fuzzy model that represents transit of MR signals on a line that draws from the gray matter to the white matter. Classification of brain tissues assists for detecting brain tumors and for quantifying the cerebral atrophy. Almost all conventional methods assign the same class to voxels that have same MR signal independent of their locations. So, their methods are unsuitable for MR images with intensity nonuniformity (INU) artifact.

2.7 CEREBROSPINAL FLUID DETECTION TECHNIQUES

Barnabas Wilsona et al (2001) proposed a study and treatment on alzheimer's disease. Alzheimer's disease is a progressive and fatal neurodegenerative disorder manifested by cognitive and memory deterioration, progressive impairment of activities of daily living, and a variety of neuropsychiatric symptoms and behavioral disturbances.

Alzheimer's disease affects 15 million people worldwide and it has been estimated that Alzheimer's disease affects 4.5 million Americans. Rivastigmine is a reversible cholinesterase inhibitor used for the treatment of Alzheimer's disease. Central nervous system drug efficacy depends upon the ability of a drug to cross the blood–brain barrier and reach therapeutic concentrations in brain following systemic administration. The clinical failures of most of the potentially effective therapeutics to treat the central nervous system disorders are often not due to a lack of drug potency but rather shortcomings in the method by which the drug is delivered. Hence, considering the importance of treating Alzheimer's disease, an attempt has been made to target the anti-Alzheimer's drug rivastigmine in the brain by using poly(n-butylcyanoacrylate) nanoparticles. The drug was administered as a free drug, bound to nanoparticles and also bound to nanoparticles coated with polysorbate 80. In the brain, a significant increase in rivastigmine uptake was observed in the case of poly(n-butylcyanoacrylate) nanoparticles coated with 1% polysorbate 80 compared to the free drug. The study demonstrates that the brain concentration of intravenously injected rivastigmine can be enhanced over 3.82 fold by binding to poly(n-butylcyanoacrylate) nanoparticles coated with 1% nonionic surfactant polysorbate 80.

Maria et al (2009) investigated Alzheimer's disease. Currently, drugs approved for AD address symptoms which are generally manifest after the disease is already well-established. But, there is a growing pipeline of drugs that may alter the underlying pathology and therefore slow or halt progression of the disease. As these drugs become available, it will become increasingly imperative that those at risk for AD be detected and possibly treated early, especially given recent indications that the disease process may start decades before the first clinical symptoms are recognized. Early detection must go hand-in-hand with qualified tools to determine the efficacy of drugs in people who may be asymptomatic or who have only very mild symptoms of the disease. Devising strategies and screening tools to identify and monitor those at risk in order to perform prevention trials is seen by many as a top public-health priority, made all the more urgent by an impending growth in the elderly population worldwide.

John and Breitner (2003) investigated on the Alzheimer's disease and its prevention. Epidemiologic evidence suggests that nonsteroidal anti-inflammatory drugs (NSAIDs) delay onset of Alzheimer's dementia, but randomized trials show no benefit from NSAIDs in patients with symptomatic Alzheimer's dementia. The Alzheimer's Disease Anti-inflammatory Prevention Trial (ADAPT) randomized 2528 elderly persons to naproxen or celecoxib versus placebo for 2 years (standard deviation = 11 months) before treatments were terminated. During the treatment interval, 32 cases of AD revealed increased rates in both NSAID-assigned groups.

The double-masked ADAPT protocol for 2 additional years to investigate incidence of Alzheimer's dementia (primary outcome). Then they collected cerebrospinal fluid (CSF) from 117 volunteer participants to assess their ratio of CSF. Including 40 new events observed during follow-up of 2071 randomized individuals (92% of participants at treatment cessation), there were 72 Alzheimer's dementia cases. Overall, NSAID-related harm was no longer evident, but secondary analyses showed that increased risk remained notable in the first 2.5 years of observations, especially in 54 persons enrolled with cognitive dementia (CIND). These same analyses showed later reduction in Alzheimer's dementia incidence among asymptomatic enrollees who were given naproxen. CSF biomarker assays suggested that the latter result reflected reduced Alzheimer-type neurodegeneration.

Formichi et al (2006) found that the diagnosis of Alzheimer's dementia is still largely based on exclusion criteria of secondary causes and other forms of dementia with similar clinical pictures. The diagnostic accuracy of Alzheimer’s dementia is low. Improved methods of early diagnosis are needed, particularly because drugs treatment is more effective in the early stages of the disease. Recent research focused the attention to biochemical diagnostic markers (biomarkers) and according to the proposal of a consensus group on biomarkers, three candidate CSF markers reflecting the pathological Alzheimer’s dementia processes, have recently been identified: total tau protein (t-tau), amyloid beta(1-42) protein (A beta42), and tau protein phosphorylated at Alzheimer’s dementia -specific epitopes (p-tau). Several articles report reduced CSF levels of A beta42 and increased CSF levels of t-tau and p-tau in Alzheimer’s dementia; the sensitivity and specificity of these data are able for discrimination of Alzheimer’s dementia patients from controls. However, the specificity for other dementias is low.

Boudraa et al (2000) proposed a method for fully automated detection of Multiple Sclerosis (MS) lesions in multispectral magnetic resonance (MR) imaging. Based on the Fuzzy C-Means (FCM) algorithm, the method starts with a segmentation of an MR image to extract an external CSF/lesions mask, preceded by a local image contrast enhancement procedure. This binary mask is then superimposed on the corresponding data set yielding an image containing only CSF structures and lesions. The FCM is then reapplied to this masked image to obtain a mask of lesions and some undesired substructures which are removed using anatomical knowledge. Any lesion size found to be less than an input bound is eliminated from consideration. Results are presented for test runs of the method on 10 patients. Finally, the potential of the method as well as its limitations are discussed.

The geometric data consists of polyhedral objects representing anatomically important structures such as cortical gyri and deep gray matter nuclei. The method consists of iteratively registering the data set to be segmented to the Volumetric Brain Structure Model (VBSM) using deformations based on local image correlation. This segmentation process is performed hierarchically in scale-space. Each step in decreasing levels of scale refines the fit of the previous step and provides input to the next. Results from phantom and real MR data are presented.

Christopher Lisanti et al (2001) presents an article to review the normal appearance of CSF, flow physics in relation to CSF flow dynamics, and commonly encountered appearances and arti-facts of CSF due to superimposed flow effects.

Alperin et al (2005) proposed a work based on Cerebrospinal Fluid (CSF). The diagnosis of Chiari Malformation (CM) is based on the degree of tonsilar herniation, although this finding does not necessarily correlate with the presence or absence of symptoms. Intracranial compliance (ICC) and local craniocervical hydrodynamic parameters derived using magnetic resonance (MR) imaging flow measurements were assessed in symptomatic patients and control volunteers to evaluate the role of these factors in the associated pathophysiology.

Seventeen healthy volunteers and 34 symptomatic patients with CM were studied using a 1.5-tesla MR imager. Cine phase-contrast images of blood and Cerebrospinal Fluid (CSF) flow to and from the cranium were used to quantify local hydrodynamic parameters (for example, cord displacement and systolic CSF velocity and flow rates) and ICC. The ICC was derived using a previously described method that measures the small, natural changes in intracranial volume and pressure with each cardiac cycle. Differences in the average cord displacement and systolic CSF velocity and flow, comparing healthy volunteers and patients with CM were not statistically significant. Note, however, that a statistically significant lower ICC (20%) was observed in patients compared with controls.

Previous investigators have focused on CSF flow velocities and cord displacement to explain the pathogenesis of CM. Analysis of results have indicated that ICC is more sensitive than local hydrodynamic parameters to changes in the craniospinal biomechanical properties in symptomatic patients. It has been concluded that decreased ICC better explains CM pathophysiology than local hydrodynamic parameters such as cervical CSF velocities and cord displacement. Low ICC also better explains the onset of symptoms in adulthood given the decline in ICC with aging.

Riemenschneider et al (2002) investigated CSF tau and Aβ42 concentrations in 34 patients with FTD, 74 patients with Alzheimer's dementia, and 40 cognitively healthy control subjects. CSF levels of tau and Aβ42 were measured by ELISA. With use of receiver operating characteristic–derived cutoff points and linear discrimination lines, the diagnostic sensitivity and specificity of both markers were determined. CSF tau concentrations were significantly higher in FTD than in control subjects but were significantly lower than in Alzheimer's dementia. CSF Aβ42 levels were significantly lower in FTD than in control subjects but were significantly higher than in Alzheimer's dementia. In subjects with FTD, neither tau nor Aβ42 levels correlated with the severity of dementia. The best discrimination between the diagnostic groups was obtained by simultaneous measurement of tau and Aβ42, yielding a sensitivity of 90% at a specificity of 77% (FTD vs controls) and a sensitivity of 85% at a specificity of 85% (FTD vs Alzheimer's dementia).

In FTD, CSF levels of tau are elevated and Aβ42 levels are decreased. With use of these markers, subjects with FTD can be distinguished from control subjects and from patients with Alzheimer's dementia with reasonable accuracy.

Blennow et al (2001) reviewed the performance of cerebrospinal fluid (CSF) protein biomarkers for Alzheimer's dementia. The introduction of acetylcholine esterase (AChE) inhibitors as a symptomatic treatment of Alzheimer's disease has made patients seek medical advice at an earlier stage of the disease. This has highlighted the importance of diagnostic markers for early Alzheimer's disease. However, there is no clinical method to determine which of the patients with Mild Cognitive Impairment (MCI) will progress to Alzheimer's disease with dementia, and which have a benign form of MCI without progression. The diagnostic performance of the three biomarkers, total tau, phospho-tau, and the 42 amino acid form of β-amyloid have been evaluated in numerous studies and their ability to identify incipient AD in MCI cases has also been studied. Some candidate Alzheimer's disease biomarkers including ubiquitin, neurofilament proteins, growth-associated protein 43 (neuromodulin), and neuronal thread protein (AD7c) show interesting results but have been less extensively studied. It is concluded that CSF biomarkers may have clinical utility in the differentiation between Alzheimer's disease and several important differential diagnoses, including normal aging, depression, alcohol dementia, and Parkinson's disease, and also in the identification of Creutzfeldt-Jakob disease in cases with rapidly progressive dementia. Early diagnosis of Alzheimer's disease is not only of importance to be able to initiate symptomatic treatment with AChE inhibitors, but will be the basis for initiation of treatment with drugs aimed at slowing down or arresting the degenerative process, such as γ-secretase inhibitors, if these prove to affect Alzheimer's disease pathology and to have a clinical effect.

2.8 BREAST LESION DETECTION METHODOLOGIES

Cheng (2010) investigates performance evaluation of CAD system. Ultrasound imaging is one of the most frequently used diagnosis tools to detect and classify abnormalities of the breast. In order to eliminate the operator dependency and improve the diagnostic accuracy, Computer-Aided Diagnosis (CAD) system is a valuable and beneficial means for breast cancer detection and classification. Generally, a CAD system consists of four stages: preprocessing, segmentation, feature extraction and selection, and classification.

Dijia Wu et al (2009) proposed a Min-Max Framework of Cascaded Classifier with Multiple Instance Learning for Computer Aided Diagnosis. It is a novel learning formulation to combine cascade classification and multiple instance learning (MIL) in a unified min-max framework, leading to a joint optimization problem which can be converted to a tractable quadratic constrained and efficiently solved by block-coordinate optimization algorithms. Although this method predicts abnormality from the images correctly, False positive rates are high.

Cheng et al (2006) suggested methods for mass detection and classification in breast cancer. Mammography has been one of the most reliable methods for early detection of breast carcinomas. However, it is difficult for radiologists to provide both accurate and uniform evaluation for the enormous mammograms generated in widespread screening. The estimated sensitivity of radiologists in breast cancer screening is only about 75%, but the performance would be improved if they were prompted with the possible locations of abnormalities. Breast cancer CAD systems can provide such help and they are important and necessary for breast cancer control. Microcalcifications and masses are the two most important indicators of malignancy, and their automated detection is very valuable for early breast cancer diagnosis. Since masses are often indistinguishable from the surrounding parenchymal, automated mass detection and classification is even more challenging.

Cheng et al (2003) present the enhancement and segmentation algorithms, mammographic features, classifiers and their performances. Breast cancer continues to be a significant public health problem in the world. Approximately, 182,000 new cases of breast cancer are diagnosed and 46,000 women die of breast cancer each year in the United States. Even more disturbing is the fact that one out of eight women in US will develop breast cancer at some point during her lifetime. Primary prevention seems impossible since the causes of this disease still remain unknown. Early detection is the key to improving breast cancer prognosis. Mammography is one of the reliable methods for early detection of breast carcinomas. There are some limitations of human observers, and it is difficult for radiologists to provide both accurate and uniform evaluation for the enormous number of mammograms generated in widespread screening. The presence of microcalcification clusters (MCCs) is an important sign for the detection of early breast carcinoma. An early sign of 30–50% of breast cancer detected mammographically is the appearance of clusters of fine, granular microcalcification, and 60–80% of breast carcinomas reveal MCCs upon histological examinations. The high correlation between the appearance of the microcalcification clusters and the diseases show that the Computer Aided Diagnosis (CAD) systems for automated detection/classification of MCCs will be very useful and helpful for breast cancer control. In this survey paper, they summarize and compare the methods used in various stages of the computer-aided detection systems (CAD).

Mostert et al (2011) investigated circulating tumor cells. The enumeration of circulating tumor cells has long been regarded as an attractive diagnostic tool, as circulating tumor cells are thought to reflect aggressiveness of the tumor and may assist in therapeutic decisions in patients with solid malignancies.

However, implementation in clinical routine has been cumbersome, as a validated test was not available until recently. Circulating tumor cells are rare events which can be detected specifically only by using a combination of surface and intracellular markers, and only recently a number of technical advances have made their reliable detection possible. Most of these new techniques rely on a combination of enrichment and a detection step.

Xingwei Wand et al (2012) studied the performance of the three neural networks CMAC, ANFIS and MLP. Mammography is regarded as the most reliable detection method of breast tumor and with the increase of cases, computer-aided diagnosis/detection (CAD) has been widely studied and applied to assist the radiologists. In order to choose an effective classifier, three neural networks are used to identify the focuses respectively, and their performance is compared and then discussed.

Adaptive Neuro Fuzzy Inference System (ANFIS) only performs well when the dimensionality of the features of the samples is comparatively low, while MLP is the most stable classifier, especially when the dimensionality of the features increases and the number of the samples is limited. The final classification precision of the focuses is: for 120 mammograms of 60 cases, the true positive rate of the masses and the MCs are respectively 93.6% and 96.9%, and the false positive per image of them are 0.63 and 0.2.

Fitzgibbons et al (2000) proposed that the tumor size is one of the most powerful predictors of tumor behavior in breast cancer. The frequency of nodal metastases in patients with tumors smaller than 1.0 cm is 10% to 20% node-negative patients with tumors smaller than 1.0 cm have a 10-year disease-free survival rate of about 90%.Precise assessment of tumor size is necessary to properly stratify patients, particularly since screening mammography has resulted in a steadily increasing proportion of pT1 cancers.

Abbosh et al (2011) investigated the use of neural networks to detect and locate early breast cancer using a simple feed-forward back-propagation neural network. In order to test the proposed algorithm, an electromagnetic simulator is used to build a three-dimensional breast model. Spherical tumors of radii 1 mm, 2 mm, 4 mm, and 5 mm are assumed to be at different locations in the breast model. An ultra-wideband pulse is transmitted towards the breast model and four probes are located around the breast to capture the scattered signals. The collected signals are then analyzed using the neural networks to get useful information concerning the presence or otherwise of the tumor and its location if it does exist. The obtained results from using the proposed method are promising with 100% success in the detection and 95% success in the localization.

Arabi et al (2010) proposed a method of external irradiation by a suitable source for the breasts is proposed to increase the contrast between the thermal images of normal breast cells and the cancer cells. The experiment conducted with the phantom models showed that the temperature difference between the normal and cancerous breast cells is elevated by external irradiation. A normal breast thermogram is used to simulate the thermographic images of normal and cancerous breast cells based on these results. There is a definite possibility of early detection of breast carcinoma by the proposed method since the contrast in image between the normal and cancerous breast cells is enhanced considerably by this method.

Bandyopadhyay et al (2010) proposed a method to identify cancer parts just using simple technique of isolation of insignificant portion of slide by color polarization. The simplicity of algorithm leads to less computational time. This also understands the type of human breast cancer and it attempts to analyze the histopathological slides. In the era of computer and telecommunications, pathologist's still mount tissue slices on glass slides, treat them with appropriate stains and examine them through a microscope. Despite advances in staining techniques, it's a process that has changed little over the last twenty years. Interpreting what they see is a time-consuming process and requires a great deal of skill and experience. Imaging techniques can play an important role in helping perform breast biopsies, especially of abnormal areas.

Bahreini et al (2010) used the Gradient Vector Flow (GVF) snake segmentation method for the purpose of obtaining accurate results. The development of computer-aided diagnosis (CAD) for breast magnetic resonance (MR) images has encountered some big challenges. One of these challenges is related to breast lesion segmentation. Accurate segmentation of breast lesions has a vital role in other consequent applications such as feature extraction. Since malignant breast lesions typically appear with irregular borders and shapes in MR images whereas benign masses appear with more regular shapes, and smooth and lobulated borders, it seems that the accurate segmentation of breast lesion borders in MR images are important. This study included 52 (33 malignant and 19 benign) histopathologically proven breast lesions and the stages of the proposed method are as follows: selecting the Region of Interest (ROI), segmentation using GVF, and evaluation of GVF snake segmentation method. The results of GVF segmentation method in this study were satisfactory compared to the radiologist's manual segmentation. The results showed the GVF snake segmentation method correctly segmented 97% of malignant lesion borders and 89.5% of benign lesion borders at the overlap threshold of 0.6. This indicates GVF snake segmentation method could provide us with a powerful method that can make an accurate segmentation in breast lesion borders.

Sharkas et al (2011) proposed a new CAD system for the detection of MCs in mammograms. Clusters of Micro Calcifications (MC) in the mammograms are an important early sign of breast cancer. Mammography is currently the most sensitive method to detect early breast cancer. Manual readings of mammograms may result in misdiagnosis due to human errors caused by visual fatigue. Computer aided detection systems (CAD) serve as a second opinion for radiologists. The Discrete Wavelet Transforms (DWT), the contour let transform, and the Principal Component Analysis (PCA) are used for feature extraction, while the support vector machine (SVM) is used for classification. The best classification rate was achieved using the DWT features. The system classifies normal and tumor tissues in addition to benign and malignant tumors. The classification rate was 100%.

Dheeba and Selvi (2011) proposed Clustered Microcalcification (MC) in mammograms. It is the major indication for early detection of breast cancer.MC is quiet tiny bits of calcium, and may show up in clusters or in patterns and is associated with extra cell activity in breast tissue. Usually, the extra cell growth is not cancerous, but sometimes tight clusters of microcalcification can indicate early breast cancer. Individual clusters are difficult to detect, hence an intelligent Computer Aided Detection (CAD) will help the radiologists in detecting the MC clusters in an easy and efficient way. This work, presented a new classification approach using Support Vector Machines (SVM) for detection of microcalcification clusters in digital mammograms. Classifying data is a common task in machine learning. SVM is a linear classifier which constructs a hyperplane or set of hyperplanes in an infinite dimensional space. The MC detection is formulated as a supervised learning problem and apply SVM is applied as a classifier to determine at each pixel location in the mammogram whether MC is present or not. To improve the classification rate, Law's texture energy measures are taken from the image Region of interest (ROI). Once the features are computed for each

ROI, they can be used as input to the SVM classifier. The method was applied to 322 digitized mammographic images from the MIAS database.

The work proposed by Ling et al (2011) is a novel automatic method for Breast Ultrasound (BUS) image tumor detection. By using the fuzzy logic theory image is transformed into fuzzy domain. An iterative method is used to find threshold. Ultrasound is one of the most often used methods for breast cancer detection. The experimental results demonstrate that the proposed approach can automatically detect the tumor in BUS image with high accuracy. It can process low quality ultrasound image very well.

Abdaheer et al (2011) proposed a simple and automatic method for classification of breast malignancy in digital mammogram images. The method is based on circular approximation of the contour extracted from the mammogram image. Then it matches the overlapping area between the tumor's contour and its circular approximation. The fitting circle is obtained by considering the centroid of tumor as its centre and the arithmetic mean of maximum and minimum radial distances of contour points from the centroid, as its radius. The similarity between the fitted circle and tumor is measured in terms of area matching as a feature for classification of tumor as malignant or benign. The simulation results show that for a set of 150 tumor contours, the performance obtained in terms of the receiver operating characteristic (ROC) parameters like accuracy (Ac), sensitivity (Se), specificity (Sp), and Positive Predictive Values (PPV) and Negative Predictive Values (NPV) are 94%, 0.9494, 0.9296, 0.9375 and 0.9429 respectively.

Chowdhury et al (2005) proposed a method for detecting colorectal polyps based on curvature analysis for standard and low-dose CT Data. Due to the technical advances in CT system design, the volume of data required to be processed by radiologists has increased significantly, and as a consequence the manual analysis of this information has become increasingly time consuming process whose results can be affected by inter and intra user variability. Integrated CAD-CTC system is proposed that is able to robustly identify the clinically significant polyps in the CT data

Chowdhury et al (2008) proposed the development of a computationally efficient CAD algorithm based on the statistical features derived from the local colonic surface that are used for the detection of colonic polyps in CTC. The candidate surface voxels were detected and clustered using the surface normal intersection, convexity test, region growing and Hough transform. The main objective of this proposed system is to provide a high discrimination between local surfaces defined by polyps and folds.

Dijia Wu et al (2009) proposed approach to the CAD problems. The computer aided diagnosis (CAD) problems of detecting potentially diseased structures from medical images are typically distinguished by the following challenging characteristics: extremely unbalanced data between negative and positive classes; stringent real-time requirement of online execution; multiple positive candidates generated for the same malignant structure that are highly correlated and spatially close to each other. To address all these problems, a novel learning formulation to combine cascade classification and multiple instance learning (MIL) in a unified min-max framework has been proposed, leading to a joint optimization problem which can be converted to a tractable quadratically constrained quadratic program and efficiently solved by block-coordinate optimization algorithms. Then applied proposed approach to the CAD problems of detecting pulmonary embolism and colon cancer from computed tomography images. Experimental results show that the approach significantly reduces the computational cost while yielding comparable detection accuracy to the current state-of-the-art MIL or cascaded classifiers. Although not specifically designed for balanced MIL problems, the proposed method achieves superior performance on balanced MIL benchmark data such as musk and image data sets.

Papp et al (2011) proposed a novel detection and classification method to process Single-Photon Emission Computed Tomography Computed Tomography (SPECT-CT) images representing breast and prostate lymph nodes. Lymph nodes are those nodes that are near the primer tumor and may become cancerous in time, hence their early detection is a key factor for the successful treatment of the patient. Prior methods focus on the visual aid to manually detect the lymph nodes which still makes the process time-consuming. Other solutions segment the lymph nodes only on CT, where the small lymph nodes may not be located accurately. Our solution processed both SPECT and CT data to provide an accurate classification of all SPECT hot spots. The method has been validated on a huge amount of medical data. Results show that our method is a very effective tool to support physicians working with related images in the field of nuclear medicine.

Zhaohui et al (2008) proposed an efficient algorithm based on Principal Component Analysis (PCA) and fuzzy Support Vector Machine (SVM) for the diagnosis of breast cancer tumor. First, PCA algorithm is implemented to project high-dimensional breast tumor data into much lower dimensional space, and then the processed data are classified by a fuzzy SVM classifier. Experimental and analytical results show that in the diagnosis of breast cancer tumor, the proposed method can greatly speed up the training and testing of the classifier, get high testing correct rate and pick out untypical cases to be reexamined by experienced doctors, superior to the traditional rigid margin SVM classifier.

Kiyuna et al (2008) had a study to investigate a new technique for image-based cancer cell classification and provide a more quantitative and objective characterization method for a diagnosis, which currently relies on qualitative and empirical judgment of pathologists. For this, a new method for chromatin texture characterization employing a new feature, contour complexity, is proposed and evaluated using nuclear images obtained from paraffin-wax embedded sections of human breast cancer on slides. The proposed feature is calculated on the basis of a contour length of nucleus obtained by setting different threshold values of intensity for a grayscale image, and it is a quantitative measure of chromatin texture. An expectation-maximization (EM) algorithm-based segmentation and an effective initial parameter search method for EM are used for the automatic calculation of the feature. The results for breast cancer cell detection showed that the average contour complexity value for malignant cells (19.6plusmn4.1) is found to be significantly greater ($p < 10-6$, Kolmogorov-Smirnov test) than that of benign cells (0.35plusmn0.17). By the comparison with the conventional fractal dimension approach, it is shown that the proposed feature is much more sensitive feature than the fractal dimension for the individual cancer cell detection.

Osareh and Shadgar (2010) in their paper intelligence that employs a variety of statistical, probabilistic and optimization techniques that allows computers to “learn” from past examples and to detect hard-to-discern patterns from large, noisy or complex data sets. As a result, machine learning is frequently used in cancer diagnosis and detection. In this paper, support vector machines, K-nearest neighbours and probabilistic neural networks classifiers are combined with signal-to-noise ratio feature ranking, sequential forward selection-based feature selection and principal component analysis feature extraction to distinguish between the benign and malignant tumours of breast. The best overall accuracy for breast cancer diagnosis is achieved equal to 98.80% and 96.33% respectively using support vector machines classifier models against two widely used breast cancer benchmark datasets.

Zhuang Miao et al (2011) proposed improved Fuzzy C-Means (FCM) algorithm, taking both the local and non-local information into the standard FCM clustering algorithm. In medical images, exist often a lot of noise; the noise will seriously affect the accuracy of the segmentation results. The traditional standard FCM algorithm in image segmentation does not take into account the relationship of the adjacent pixels. This leads to the standard FCM algorithm very sensitive to noise in the image. The experiment results can show that the improved algorithm can achieve better effect than other methods of brain tissue segmentation.

2.9 OPTIMIZATION ALGORITHMS

Xuemei Sun et al (2011) proposed a Novel Shot Boundary Detection Method Based on Genetic Algorithm (GA) and Support Vector Machine (SVM). The system uses a shot boundary detection method based on SVM optimized by GA. The method utilizes GA to optimize the RBF parameters of SVM, then classifies the video frames and ascertains the shot boundaries by using the model trained by the optimal parameters obtained by GA.

Hezam Izakian and Ajith Abraham (2011) discusses FCM algorithm integrated with FPSO algorithm to form a hybrid clustering algorithm called FCM–FPSO which maintains the merits of both FCM and PSO algorithms. Fuzzy c-means clustering is an effective algorithm, but the random selection in centre points makes iterative process falling into the local optimal solution easily. In order to overcome the shortcomings of Fuzzy Clustering, a hybrid fuzzy clustering algorithm based on FCM and FPSO called FCM–FPSO has been propsed. The FCM algorithm is faster than the FPSO algorithm because it requires fewer function evaluations, but it usually falls into local optima.

FCM–FPSO algorithm applies FCM to the particles in the swarm every number of iterations/generations such that the fitness value of each particle is improved. In order to optimize the performance of the FPSO and FCM–FPSO, fine tuning has been performed and best values for their parameters are selected.

Saeed Vaneshani et al (2011) uses from a control strategy based on the combination of fuzzy logic and particle swarm optimization techniques. The purpose is to control the concentration of the Continuous Stirred Tank Reactor System (CSTR) in the presence of the set point changes. The PSO optimization technique is a stochastic search through an n-dimensional problem space aiming the minimization of the objective function. The purpose is to control the concentration of the CSTR in the presence of the set point charges.

It has been proved that the optimized FLC has better performance when compared with a conventional controller in the presence of additive random noise. According to the results of the computer simulation, the FLC with PSO algorithm is better than the conventional FLC without PSO algorithm. The major disadvantage of the fuzzy controller is lack of analytical technique design. Therefore, the PSO-FLC controller gives robustness and very good results when compared with the conventional FLC controller.

Chandra et al (2009) proposed a clustering algorithm based on Particle Swarm Optimization (PSO). The algorithm finds the centroids of number of clusters, where each cluster groups together brain tumor patterns, obtained from MR Images. The results obtained for three performance measures are compared with those obtained from Support Vector Machine (SVM) and Ada Boost. The performance analysis shows that qualitative results obtained from the proposed model are comparable with those obtained by SVM. However, to obtain better results from the proposed algorithm, careful selection of the different values of PSO control parameters, are needed.

Gopal and Karnan (2010) designed an intelligent system to diagnose brain tumor through MRI using image processing clustering algorithms such as Fuzzy C Means along with intelligent optimization tools, such as Genetic Algorithm (GA), and Particle Swarm Optimization (PSO). The detection of tumor is performed in two phases: Preprocessing and Enhancement in the first phase and segmentation and classification in the second phase.

Jiaxin Wu et al (2011) proposed the combined use of gene expression profiles and protein-protein interaction networks that have shown remarkable successes in the prediction of breast cancer metastases. Nevertheless, as a primary step of network-based methods, the problem of effectively identifying predictive subnetwork markers remains a great challenge. Typically, existing methods use greedy search algorithms to search for subnetworks. This strategy, though efficient in time complexity, may fail in finding the optimal subnetwork markers and accordingly impair the performance of the successive learning machines. In this paper, a genetic algorithm is proposed to improve the subnetwork markers that have been identified by an existing greedy search method. It is demonstrated that the discriminative power of the optimized subnetwork markers are significantly higher than the original subnetwork markers, and higher classification performance can be achieved when using the optimized subnetworks as predictive features with the help of six popular machine learning approaches (logistic regression, support vector machine, decision tree, Adaboost, random forest and Logitboost). According to the comparison between different classification approaches, Logitboost with the optimized subnetwork markers shows the highest classification performance and optimal reproducibility for identifying breast cancer metastases.

Krishnamoorthy et al (1998) compare the two techniques when locating fuzzy clusters embedded in noisy data. The partitioning of data into clusters is an important problem with many applications. Typically, one locates partitions using an iterative fuzzy c-means algorithm in one form or another. Unfortunately, the results of these techniques depend on the cluster center initialization because their search is based on hill climbing methods. Recently, there has been much investigation into the use of genetic algorithms to partition data into fuzzy clusters. Genetic algorithms are less sensitive to initial conditions due to the stochastic nature of their search.

Sasikala and Kumaravel (2005) present and compare feature selection algorithms for the detection of glioblastom a multiforme in brain images. Texture features are extracted from normal and tumor regions (ROI) using spatial gray level dependence method and wavelet transform. An artificial neural network has been used for classification. A very difficult problem in classification. techniques is the choice of features to distinguish between classes. The feature optimization problem is addressed using a genetic algorithm (GA) as a search method. Principal component analysis, classical sequential methods and floating search algorithm are compared against the genetic approach in terms of the best recognition rate achieved and the optimal number of features. The classification performance of 97.3% is achieved in GA with optimal features compared to sequential methods and Principal component analysis.

2.10 SUMMARY

In summary, in this chapter different Image Mining schemes were reviewed. A detailed survey on Clustering algorithms in Medical diagnosis schemes were discussed. It was observed that the algorithms either lack in prediction accuracy or in Robustness, and hence they are not suitable for the Medical Image Mining applications where the prediction results are crucial.

Survey on Classification algorithms in diagnosis is given in the second section. The next three sections review about different Brain Tumour, White matter lesion and Breast lesion detection algorithms. Finally a survey on several Optimization approaches for Clustering and Classification were done.

Based on the above survey, this thesis has four major contributions for Prediction of Diseases from Magnetic Resonance Images.

- A Hybrid approach in diagnosis of Brain Tumor from Medical Images using K-means, Fuzzy C-Means, Self Organizing Maps (SOM) and Hierarchical Clustering Algorithms.
- A Robust Brain Image Segmentation for Cerebrospinal Fluid level detection using Fuzzy C Means (FCM) with an Anisotropic Diffusion Regularization. This is based on new objective function, which is well adapted and efficient for functional MRI data segmentation.
- An Optimized Clustering approach for detection of white matter lesions in MR Images using Fuzzy and Possiblistic approach.
- An Efficient method for diagnosis of breast lesions from stain images using Genetic algorithm driven Support Vector Machine.