CHAPTER 2

LITERATURE SURVEY

2.1 MEDICAL IMAGE ANALYSIS DIAGNOSING DISEASE

A hybrid Neural-Digital Computer-Aided Diagnosis (N.CADx) system has been proposed and developed by Lin et al (1994). This system aims for the early detection and classification of cancerous lung nodules of 3-15 mm. Digital image processing techniques were employed for noise reduction, image enhancement, and suspect search and localization. The authors developed multi-label output encoding procedures using fuzzy linguistic concepts for neural training and interpretation of the activity distributions in the output neurons. The activity distribution is interpreted as the Normalized Disease Index (NDI), or as a Nodule Detection Probability (NDP), associated with a confidence level factor. The authors concluded that the N.CADx system has a great future potential in several medical applications.

Goldbaum et al (1996) have presented the Structured Analysis of the Retina (STARE) system which is an advanced image management system that can automatically diagnose images, compare them, measure the key features of images, as well as annotate the contents and also search for images similar in content. The inference was made from Bayesian Networks, which learn from image examples of each disease. The authors anticipate that ophthalmologists and physicians would depend on systems like STARE to reduce on repetitive work and help in the diagnosis of rare diseases and in the image management of large databases.
Allan & Kinsner (2001) wanted to prove that the competitive neural networks would automate or semi-automate medical image analysis to improve the accuracy of diagnosis. For this purpose, the authors made use of competitive neural networks for extracting general features from images obtained through a microscope of four types of human breast disease, two of which were benign and two malignant. The features were found to be extracted while no distinctions between benign and malignant was found in visual inspection.

Myoung et al (2004) have presented a system that allows visualization of anatomical shapes and measurement of medical image parameters. Cardiac-Station gives heart motions and also extracts clinical parameters from the ventricular MR images, both of which would help in the diagnosis of heart disease. The differences in the hippocampus between patients and normal individuals can be found through Brain-Reg, which displays the abnormal regions of the brain by registering multi-modal images.

Phooi & Ozawa (2004) proposed a method for classifying input images in association to their disease as well as diagnosis. The authors found this necessary to allow these images to support diagnosis and treatment. The relationship between disease and its tumor image properties were studied in the perspective of binary, intensity and selected-pixel intensity image. The binary and intensity image profiling were based on texture and shape-based classification. The selected-pixel intensity image slice profiling was based on content-based classification. The authors aimed at finding out whether gender and age were of significance during the profiling of both healthy and cancer patients. The results revealed that the algorithms developed by the authors were suitable for classifying the input images using the pixel-based approach for multimodal datasets.
Stoitsis et al (2006) have presented and explained analysis modular software system to help in the interpretation of medical images. The texture and motion of selected Regions of Interest (ROI) could be done. Analysis software also made on-line tele-collaboration possible between health care professions. The authors applied B-mode ultrasound images of the carotid artery to identify the usefulness of ‘Analysis’ to clinical practice. The authors concluded that ‘Analysis’ was a useful platform for computerized analysis of medical images and support of diagnosis.

Tobin et al (2007) have devised a method of automatic detecting the optic nerve and localization of the macula using digital red-free fundus photography. The method accurately segmented the vasculature of the retina before determining the spatial features of density, average thickness, average orientation of vasculature and optic nerve’s position. Out of 345 images of the 269 patients with 18 different conditions associated with Diabetic Retinopathy (DR) and other retinal diseases like as age-related macular degeneration, 90.4% detection of optic nerve performance have been reported by the authors using their automatic detection method.

De Siqueira et al (2008) have presented a method that provides automatic localization of cardiac structures in fetal echocardiography images. The four cardiac cavities are most pivotal. A hierarchical search based on windowing technique with mold matching was used to find the cardiac cavities. For calculating the mold, a probability density function that receives the gray level of a representative image as parameter and makes use spatial features of the images were used. The image was first covered to locate the heart and desired heart structure was then found based on the position of the heart. The mold and the candidate image was compared using the Euclidean Distance.
Jirawanitcharoen et al. (2009) have presented a method to detect tonsillitis based on medical knowledge and Neural Network (NN). The authors considered three important factors of swelling that can be indicated in the pictures, namely, ratio of tonsil grand dimension, average of tonsil grand color and the surface of tonsil grand (whether purulent or not) using Two Dimensional Fast Fourier Transform (2D FFT). The three factors mentioned were input into the Neural Network and samples of 30 pictures were used for training into the Neural Networks. The experimental results revealed 90% approximation of the technique with doctor's oral diagnosis.

Hai et al. (2009) proposed a Pulmonary Disease Census Aiding System (PDCAS) that was based on medical image grid. The aim of the researchers was to improve the efficiency of occupational pulmonary disease using the grid technology. PDCAS integrated the medical information of hospitals into an area of Medical Information Centre. The census records were classified through cross clustering model based on risk rate. The main processing algorithms of PDCAS were subdivided and made into detachable Web services that would support the grid workflow composition corresponding to various pulmonary diseases. The prototype of PDCAS is revealed improvement of grid technology for intensive medical applications.

Kupryjanow et al. 2010 have proposed a partial automation of the process of advancement of the Parkinson's disease which was done by specialist through medical observation. A multimodal interface called Virtual-Touch Pad (VTP) could be used to support the medical diagnosis. As VTP was based on processing the image of hand, a patient did not feel constrained by any equipment. The authors have also given two types of tests that can be supported by VTP. They are Finger Taps test, were the patient taps his thumb with the index finger in quick succession and the Rapid Alternating Movement of Hands test that consisted of pronation and supination.
movements of the hands. VTP can capture the image of the patient's hand during the test. Based on this image the hand gesture is assigned to the given class. The hand movement velocity can also be measured and used in the diagnosis.

As diagnosis of the lung cancer with perfect accuracy is difficult Paulus & Gaol (2010) have conducted a study to investigate gray color for image indexing and its retrieval. The statistical distribution of Harralick feature from image sample provided the base for the study. The authors concluded that the retrieval results were more reliable.

Suapang et al (2010) provided facilities for the image processing and analysis. The facilities include a DICOM viewer that could display different digital image formats on single frame, multi frame and cine loop, on Image processing with zoom in/out and contrast/color map, image analysis to determine pixel values in a Region of Interest that can be set as a rectangle, ellipse, line or polygon and Nuclear medicine diagnosis for the calculation of Glomerular Filtration Rate (GFR), Effective Renal Plasma Flow (ERPF), or Renogram. When the DICOM 3.0 standard image and APEX-XPERT Program were tested, the authors could not find any significant difference.

Medical images are often corrupted by noise arising in the image acquisition process. Accurate diagnosis of the disease requires the medical images to be sharp, clear and free of noise. Thus, image denoising is one of the fundamental tasks required by medical image analysis. Several denoising techniques like Median, Wavelet, Wiener, Average and Independent Component Analysis (ICA) filters exist for the medical images. The ICA is a statistical and computational technique for revealing the hidden factors that underlie sets of random variables, measurements, or signals. Arakeri & Reddy (2011) used ICA to separate noise from the image and provide important diagnostic information to the physician. Its usefulness was demonstrated by
comparing its performance with other noise filtering methods. The performance of the ICA and other techniques were evaluated using the metrics like Peak Signal-to-Noise Ratio (PSNR), Mean Absolute Error (MAE) and Mean Structural Similarity Index (MSSIM). The authors found that the ICA based noise filtering technique gives 25.8245 dB of PSNR, 0.7312 of MAE and 0.9120 of SSIM. ICA was found to be effective in eliminating noise from the medical image.

Vere et al (2011) aimed to overcome the lack of diagnostic procedure to identify Alzheimer’s Disease (AD), which has projected a major challenge to the society. The authors identified a panel of AD biomarkers. These biomarkers have incorporated proteins which possess diagnostic power due its interrelated patterns. The authors have confidently concluded that their approach would ensure effective utilization state-of-the-art imaging technologies.

The model for different parts of human body for biomechanical analysis is obtained through scanned images. Zhang et al (2011) has implemented the contour detection and extraction for medical CT images of knee joint through Visual Basic (VB) 6.0 program. Roberts Cross operator and Sobel operator were the first order differential operators used in the contour detective algorithm. It also included the second-order differential operator of Laplacian and Canny operators. Contour extraction was done by the authors using chain code method. The authors have thus provided the foundation for the development of independent medical image processing program and for building a geometric model of the human body from the medical images.

Expert physicians are able to attain good Alzheimer's Diseases (AD) diagnostic accuracy, relying only on visual inspection of Positron Emission Tomography (PET) images. Nevertheless, computerized
methods have been implemented with similar or even better performance. Bicacro et al (2012) investigated the potential of the physician's experienced visual inspection to guide feature selection, in an automatic classification procedure. Eye tracking methodology was employed to obtain a model of the physician's visual behavior, which allowed for the sampling of voxel intensity features that were then fed to an SVM classifier. This approach was compared with the commonly used automatic feature selection alternatives. Image data were taken from the Alzheimer's disease Neuro imaging Initiative database. The results showed that the approach proposed by them improved accuracy marginally in AD vs. CN classification, but for MCI vs. CN and AD vs. MCI it presented a lower performance.

Maity & Sil (2012) aimed to develop a parameterization technique that could efficiently extract biomedical bone image features from poor resolution images. They used elastix, an open source software to select the appropriate image registration method for a specific application. The authors intended to remove uncertainties from the images of bone scintigraphy to arrive at a clear idea of the unconventional shape of specific human bones. The authors thought that this could be the basis for identifying the affected bones, which would help diagnosis.

Mizotin et al (2012) have considered the application of the feature-based approach to brain MRI scans to enable for early diagnosis of Alzheimer's Disease. The authors proposed the use the Laguerre Circular Harmonic Functions coefficients as feature vectors. They also believe that an additional pre-classification step based on Alzheimer's Disease early image abnormalities would enhance the overall precision.

Shamsul et al (2012) have developed an automatic diagnostic system. This diagnostic system replaces human arbitration with machine intervention for diagnosis of skin anomalies. The automatic diagnostic system
works in two steps. Both the steps are dependent. The first step detects skin anomalies and the second step identifies the disease. The system operates on visual input. Color image processing techniques, k-means clustering and color gradient techniques are used for identifying the diseased skin. Feed forward back propagation Artificial Neural Network (ANN) is used for classifying the diseases. The authors have recorded a diseased skin detection accuracy of 95.99% and a disease identification accuracy of 94.016%.

With the aim of overcoming the problem of bright reflection spots present in the medical images taken from camera based devices such as laparoscope, colposcope and retinoscope, Gupta et al (2013) have developed a solution by incorporating a multi-LED lighting. This solution could switch on and off the LED's in a pattern that would dynamically and geometrically shifts/shuffles the glare spots back and forward. In this way each glare-affected area of a single image frame could be reconstructed from a few adjacent time-frame images. The prototype developed by the authors demonstrated the solution for the glare problem in medical video/image. A reduction 65-95% in specularity on phantom model was achieved by the authors.

Mertz (2013) discusses about the increasingly significant role of medical imaging. The author is of the opinion that medical imaging has already improved care in the areas of Optical Tomography, Molecular Imaging, Computerized Tomography and Ultrasound. Further he expects medical imaging to help in the early diagnosis and formulation custom made treatment plans for the patients and knowledge of intricacies of disease initiation and progression.
2.2 CHRONIC OBSTRUCTIVE PULMONARY DISEASE

Amaral et al (2010) aimed to develop an automatic classifier based on Artificial Neural Network (ANN) that would help in the diagnosis of COPD using Forced Oscillation Measurements (FOT). The parameters provided by FOT were classifier inputs and the output is whether COPD is indicated or not. A dataset with seven possible input features of 90 measurements from 30 volunteers was used. Linear correlation analysis and forward search were used to identify a reduced set of the most relevant parameters. Two training strategies for ANNs were used. The performance of the resulting network was evaluated through accuracy, sensitivity, specificity and AUC. The ANN classifiers showed presented high accuracy in the complete as well as the reduced set of FOT parameters, thereby indicating the usefulness of ANNs classifiers in the diagnosis of COPD.

A telehealth system and integration of specific clinical measurement parameters with a Decision Support System (DSS) was presented by Basilakis et al (2010). To analyze the acquired telehealth data, an enterprise application-server framework combined with a rules engine and statistical analysis tools was used. The DSS would reduce data overload and allow appropriate targeting of clinical resources to best health management of the patient.

As chronic diseases have become a major cause of health care expenditure among the developed countries, the presently used models of health services are found to be inadequate. To overcome this lacunae, Lovell et al (2010) have provided business models, clinical services, bio signal processing and knowledge management for streamlining healthcare delivery to suit the needs of modern society.
Rosso et al (2010) have presented the main objectives of CHRONIOUS, which is an innovative Information and Communication Technologies (ICT) research to monitor the lifestyle. The project has been undertaken by 17 European organizations from February 2008 to open a platform to monitor elderly patients with chronic diseases with problems in reaching hospitals. The testing of Chronic Obstructive Pulmonary Disease (COPD) patients and of the Chronic Kidney Disease (CKD) patients would be done at Italy and Spain. Wearable technologies and sensors would be used to record the health condition. The CHRONIOUS platform data analysis and Decision Support System (DSS) would help in patient care.

As the use of mechanical ventilator in patients with COPD during episodes of Acute Respiratory Failure (ARF) is difficult, Serna et al (2010) have developed an interactive tool based on mathematical models that would easily study the interaction between a mechanical ventilator and patient. This tool allows the study of most of the widely used ventilator modes. The variables and parameters were displayed in graphical interface just like the last generation mechanical ventilators. The authors concluded that the newly developed interactive tool holds hope.

To evaluate the respiratory muscular effort and efficiency, Torres et al (2010) evaluated the MMG signal of the diaphragm muscle to assess the respiratory muscular function in COPD patients. Two capacitive accelerometers placed on both left and right sides of the costal walls of the patient was used to get the MMG signals from left and right hemi diaphragm. The MMG signals and the inspiratory pressure signal were collected when the COPD patients performed the inspiratory load respiratory test. Based on the results obtained, the authors concluded that the information provided by MMG signals could be used in the evaluation of the respiratory effort and the muscular efficiency in COPD patients.
Dinesen et al (2011) reported the qualitative perspectives of rehabilitation of COPD patients. The case study method was used as the research strategy. The authors conducted a randomized study among 111 individuals. The authors have concluded that telerehabilitation is a learning process. Learning happens due to the interaction of the healthcare professionals, COPD patients and their families.

Sarlabous et al (2011) report a study that was undertaken to evaluate the efficiency of respiratory muscles efficiency during a progressive Incremental Flow (IF) respiratory test among healthy as well as COPD subjects. The relationship between mouth Inspiratory Pressure (IP) increment (measure of the force produced by respiratory muscles) and respiratory muscular activity increment was analyzed. Mechanomyografic (MMG) signals of the diaphragm muscle were used to measure the increment in respiratory muscular activity. Two groups, one consisting of four female subjects (two healthy, two moderate COPD) and another group of ten men (six severe and four very severe COPD patients). All the subjects were put through an easy IF respiratory test. The authors found that there was an increase in the amplitude and a displacement towards low frequencies in the MMG signals when the IP increased. Also, the efficiency of the respiratory muscles was found to be lower in patients with severe COPD, and lower in women than in men. The authors have concluded that the information from MMG signals can be effectively used to analyze muscular efficiency in people.

Bellos et al (2012) have explained the modalities of using CHRONIOUS wearable platform to successfully manage and treat COPD patients. Various signals and patient data can be stored by using an ergonomic jacket and patient’s platform interface. The patient’s health was analyzed using Hybrid techniques based on supervised and unsupervised
methodologies. Messages or advice denoting the patient’s health status appeared on the patient's and clinician's devices.

To achieve effective and timely management of patients with COPD the mobile and internet technologies assisted home care model (M-COPD) was developed by Ding et al (2012) have discussed the setup and technical aspect of M-COPD and its usage to monitor and manage remotely.

Heart Rate Variability (HRV) analysis of polysomnograms of COPD patients are monitored in a clinical centre. However as COPD is related to cardiovascular risk and sudden death, Lado et al (2012) developed an ambulatory electrocardiography technique to monitor COPD patients at home. Here, the patient’s Electrocardiogram (ECGs) are studied at distinct time period to find out the difference previous to the exacerbation and during acute episodes. Based on the results of the study, the authors concluded that there important differences between the ECG taken during an exacerbation episode and that taken a few months earlier.

As exercise is an important aspect of pulmonary rehabilitation of patients with COPD, Ming-Feng et al (2013) developed an approach based on Fuzzy Logic Control and sensor networking. The approach with Calibration, Rehabilitation, Artifact/Safety monitoring and Endpoint decision (CRASE) could perform adaptive subject exercise training and monitoring. The authors investigated an exercise training model with overload principle and safety concern. The results revealed CRASE scheme to be capable of efficiently putting exercise training into practice for home-based rehabilitation.

O’ Clock et al (2012) studied the impact of high and low Frequency Chest Compression on lung water secretion, mucus transport, heart rate and blood pressure by using a Trapezoidal Source Pressure Waveform. The secretion of water from the epithelial tissue and passage of mucus through
lung airways was found to increase with use of trapezoidal High-Frequency Chest Compression (HFCC) source pressure waveform among patients with CF and COPD. Low-Frequency Chest Compression (LFCC) was found to have an effect on the cardiovascular system at frequencies as low as 3 Hz. A trapezoidal source pressure waveform of 1 Hz frequency, LFCC produces variations in the intensity of the components of electrocardiogram time-domain waveform. The authors have concluded that LFCC appears to give additional cardiovascular benefits by reducing peak and average systolic and diastolic blood pressure for patients with hypertension.

Sorensen et al (2012) have developed an approach for texture based quantitative analysis of COPD in pulmonary computerized tomography (CT) images. This approach is based on supervised learning. The classes were labeled based on measured lung function. COPD was quantitatively measured by fusing the COPD probabilities computed in ROIs within the lung fields where the individual ROI probabilities were computed using a k nearest neighbor (kNN) classifier. The distance between two ROIs in the kNN classifier was computed as the textural dissimilarity between the ROIs. The ROI texture was described by histograms of filter responses from a multi-scale, rotation invariant Gaussian filter bank. When applied to 400 images, the authors found that the texture-based method discriminated better between the subjects with and without COPD than the common quantitative measures. The authors concluded that the method proposed by them correlated better with lung function and was less influenced by inspiration level.

Souad et al (2012) have developed a decision making support system based on Case-Based Reasoning (CBR) for use in the diagnosis of COPD. This system intends to reproduce physician’s behavior by estimating the similarity on attributes with the missing data in the most important stage of CBR process. The authors implemented and tested three ideas to find the
real diagnosis of cases with the missing data. The preliminary experimentations of these ideas showed promising results.

As a strong association has been indicated between physiological homeostasis and the onset of COPD exacerbation, Yang et al. (2013) have attempted to develop a method for predicting COPD exacerbation. The method developed by the authors was regression-based machine learning technique. In this method, trend-pattern variables from COPD patients records were used to classify them into low-risk and high-risk. The experimental results revealed that the model developed had an average accuracy of 79.27%.

2.3 DIAGNOSING DISEASE USING FILTERING AND CLASSIFIER

Lima et al. (2002) proposed an alternative strategy to develop fuzzy systems with the help of Neuro Fuzzy Networks, because it is capable of learning and provides IF-THEN fuzzy rules in linguistic or explicit form. Out of the given models, ANFIS is recognized as a reference framework, mainly for its flexible and adaptive character. The authors extend the ANFIS theory by experimenting with a multi-net approach wherein two or more differently structured ANFIS instances are coupled to play together. The authors observed that Ensembles of ANFIS (E-ANFIS) has given a better performance than the Neurofuzzy Networks.

Mueen et al (2007) proposed a new image classification method using multi-level image features and Support Vector Machine (SVM). The authors extracted and combined three levels of features global, local and pixel and the combined feature vector achieved a recognition rate of 89%. The authors concluded that the result of accuracy with SVM was 89% than that of KNNearest neighbor which was 82%.
Selvaraj et al (2007) have applied the advanced classification technique to brain MRI image slices based on Least Squares Support Vector Machines (LS-SVM). They have also compared LS-SVM classifier using a linear as well as nonlinear Radial Basis Function (RBF) kernel with other classifiers like SVM, RBF classifier, Multi Layer Perceptron (MLP) classifier and K-NN classifier. The authors observed that the LS-SVM classifier outperformed all the other classifiers.

As it is very important to have automatic defects detection in MR images of brain, AmirEhsan Lashkari (2010) have proposed a Novel automatic brain tumor detection method using Gabor wavelets. The neural network had been trained using back propagation algorithm and training process was continued until the Mean Square Error (MSE) became constant with accuracy of 98.15%. The authors concluded that their method was effective to classify the brain tissues to normal and abnormal classes automatically.

Joshi et al (2010) have developed and designed a Brain Cancer Detection and Classification System using conceptually simple classification method using the Neuro Fuzzy logic. Texture features were used in the Training of the Artificial Neural Network. Co-occurrence matrices at different directions were calculated and Grey Level Co-occurrence Matrix (GLCM) features were extracted from the matrices. The authors have concluded that the results of the system provided precision detection and classification of Astrocytoma type of cancer.

Though Alzheimer’s Disease (AD) among the aging population has become common, lack of standardized and conclusive diagnostic procedures make early diagnosis difficult. Polikar et al (2010) provide a comprehensive data fusion analysis of all the non-invasive biomarkers now available to diagnose AD. The authors have combined the EEG, MRI and PET data using
classifier based on decision fusion approach. The authors conclude that by the approach of data fusion analysis the diagnostic accuracy improved by 10-20 %, than when each individual source of data was used.

Wu et al (2010) have developed an automatic liver cirrhosis diagnosis system using adaptive ultrasound image matching. When an input image was given, noise was filtered and the extremely stable edge pattern was detected. The authors constructed a template to facilitate the detection of region of interests and classify liver cirrhosis. The authors report that the experimental results showed system to be effective.

Smitha et al (2011) have discussed the medical image classifications namely, texture classification, neural network classification and data mining classification. The authors have described the manipulation, processing and handling of data of medical images that were used in patient’s health record. They concluded that the development of the medical image classification were associated with decision support system to decide the diagnosis.

As extraction of retinal vessels is important for the diagnosis of several retinal diseases, You et al (2011) have provided a framework to accurately segment the retinal vessels for feature extraction of the vessels. The authors first used isotropic Gaussian kernel Frangi filter to enhance the retinal vessels before measuring their diameters. The principal curve projection and tracing algorithm was then proposed to identify the centerlines of the vessels in the output image. The estimated vessel radius was used as the bandwidth in the principal curve projection and tracing. The vessel features towards diagnosing the diseases as well as analyzing them could be extracted from the segmentation results.
Abdel-Motaleb et al (2012) developed an artificial intelligence system using Artificial Neural Networks (ANN) to diagnose heart disease from Phonocardiogram (PCG) signals. The characteristics of signals like activity, complexity, mobility and spectral peaks from the power spectral density plots were used as input to the neural network. The authors used 94 PCG signals from three heart diseases to test the accuracy of the neural networks. The signals were first filtered, feature characteristics extracted and classification done using Radial Basis Function (RBF) network and Back Propagation Network (BPN) techniques. The authors found that RBF provided 98% accuracy in disease prediction while BPN had an accuracy of 90.8% for the same.

The performance of conventional ANFIS network and extreme-ANFIS on regression problems were compared and explained by Jagtap & Pillai (2014). ANFIS networks include the knowledge of the fuzzy systems and learning capabilities of Neural networks. The authors suggested that this learning technique overcomes the slow learning speed of the conventional learning techniques like neural networks and SVM without giving up the generalization capability. The structure of extreme-ANFIS network is similar to the conventional ANFIS which combines the fuzzy logic's qualitative approach and neural network's adaptive capability. As in the case of ELM, the first layer parameters of the proposed learning machine are not tuned. The authors conclude that performance on two regression problems shows that extreme-ANFIS provides enhanced generalization capability and quicker learning speed.