Chapter 2

Literature survey
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References
2.1 Introduction

This chapter deals with the literature survey of digital image processing and applications of the image processing using different techniques. This chapter also describes the literature survey on MATLAB based image processing medical applications, literature survey on ANN based Image processing applications, literature Survey for the detection of tuberculosis using medical and technical methods. From the elaborated literature survey the motivations for the present work is presented. References are provided at the end of the chapter.

2.2 Literature survey on image processing and its applications

Many of the techniques of digital image processing, or digital picture processing as it often was called, were developed in the 1960s at the Jet Propulsion Laboratory, Massachusetts Institute of Technology, Bell Laboratories, University of Maryland. A few researches such as application to satellite images, wire-photo standards conversion, medical imaging, videophone, character recognition, and photograph enhancement were also carried out[1].

SuezouNakadate et al [2] discussed the use of digital image processing techniques for electronic speckle pattern interferometry. A digital TV-image processing system with a large frame memory allows them to perform precise and flexible operations such as subtraction, summation, and level slicing. Digital image processing techniques made it easy compared with analog techniques to generate high contrast fringes.

Satoshi Kawata et al [3] discussed the characteristics of the iterative image-restoration method modified by the reblurring procedure through an analysis in frequency space. An iterative method for solving simultaneous linear equations for image restoration has an inherent problem of convergence. The introduction of the procedure called “reblur” solved this convergence problem. This reblurring procedure also served to suppress noise amplification. Two-dimensional simulations using this method indicated that a noisy image degraded by linear motion can be well restored without noticeable noise amplification.
William H [4] highlighted the progress in the image processing and analysis of digital images during the past ten years. The topics included digitization and coding, filtering, enhancement, and restoration, reconstruction from projections, hardware and software, feature detection, matching, segmentation, texture and shape analysis, and pattern recognition and scene analysis.

David W. Robinson [5] presented the application of a general-purpose image-processing computer system to automatic fringe analysis. Three areas of application were examined where the use of a system based on a random access frame store has enabled a processing algorithm to be developed to suit a specific problem. Furthermore, it enabled automatic analysis to be performed with complex and noisy data. The applications considered were strain measurement by speckle interferometry, position location in three axes, and fault detection in holographic nondestructive testing. A brief description of each problem is presented, followed by a description of the processing algorithm, results, and timings.

S V Ahmed [6] discussed the work prepared by concentrating upon the simulation and image processing aspects in the transmission of data over the subscriber lines for the development of an image processing system for eye statistics from eye.

P K Sahoo et al [7] presented a survey of thresholding techniques and updated the earlier survey work. An attempt was made to evaluate the performance of some automatic global thresholding methods using the criterion functions such as uniformity and shape measures. The evaluation was based on some real world images.

Marc Antonini et al [8] proposed a new scheme for image compression taking psycho-visual features into account both in the space and frequency domains. This new method involved two steps. First, a wavelet transform in order to obtain a set of bi orthogonal subclasses of images; the original image is decomposed at different scales using a pyramidal algorithm architecture. Second, according to Shannon's rate distortion theory, the wavelet coefficients are vector quantized using a multi resolution codebook. Furthermore, to encode the wavelet coefficients, a noise shaping bit allocation procedure was proposed which assumes that details at high resolution are less visible to the human eye. Finally, in order to allow the receiver to recognize a picture as quickly as possible at minimum cost, a progressive transmission scheme was presented. It is showed that the wavelet transform is particularly well adapted to progressive transmission.
Harpren MD [9] presented a wavelet theory geared specifically for the radiological physicist. As a result, the radiological physicist can expect to be confronted with elements of wavelet theory as diagnostic radiology advances into teleradiology, PACS, and computer aided feature extraction and diagnosis.

Salem Saleh Al-amri et al [10] attempted to undertake the study of segmentation image techniques by using five threshold methods as Mean method, P-tile method, Histogram Dependent Technique (HDT), Edge Maximization Technique (EMT) and visual Technique and they are compared with one another so as to choose the best technique for threshold segmentation techniques image. These techniques are applied on three satellite images to choose base guesses for threshold segmentation image.

Wiecek B.et al [11] proposed a new image processing tools for conversion thermal and visual images, mainly for application in medicine and biology. A novel method for area and distance evaluation based on statistical differencing was discussed. In order to increase the measurements accuracy, the interpolation and sub pixel bitmap processing were chosen.

Patnaik et al [12] presented an image compression method using auto-associative neural network and embeddedzero-treecoding. The role of the neural network (NN) is to decompose the image stage by stage, which enabled analysis similar to wavelet decomposition. This works on the principle of principal component extraction (PCE). Network training is achieved through a recursive least squares (RLS) algorithm. The coefficients are arranged in a four-quadrant sub-band structure. The zero-treecoding algorithm is employed to quantize the coefficients. The system outperformed the embeddedzero-tree wavelet scheme in a rate-distortion sense, with best perceptual quality for a given compression ratio.

Shanhui Sun Christian Bauer et al [13] presented a fully automated approach for segmentation of lungs in CT datasets. The method was specifically designed to robustly segment lungs with cancer masses and consists of three processing steps. First, a ribcage detection algorithm is utilized to initialize the model-based segmentation method. Second, a robust active shape model matching approach is applied to roughly segment the outline of the lungs. Third, the outline of the matched model is further adapted to the image data by means of an optimal surface finding approach. The method was evaluated on the
LOLA11 test set, consisting of 55 chest CT scans with a variety of different lung diseases and scan protocols. Compared to a reference standard, mean average and median volumetric overlap scores of 0.949 and 0.990 were achieved respectively. Several examples demonstrated the ability of our method to successfully segment lungs with cancer masses.

Sonalet et al [14] presented various types of image compression techniques. There are basically two types of compression techniques. One is Lossless Compression and other is Lossy Compression Technique. Comparing the performance of compression technique is difficult unless identical data sets and performance measures are used. Some of these techniques are obtained good for certain applications like security technologies. Some techniques perform well for certain classes of data and poorly for others.

Suzuki K et al [15] developed an image-processing technique for suppressing the contrast of ribs and clavicles in chest radiographs by means of a multiresolution massive training artificial neural network (MTANN). An MTANN is a highly nonlinear filter that can be trained by use of input chest radiographs and the corresponding "teaching" images. "bone" images obtained by use of a dual-energy subtraction technique as the teaching images were employed. A validation test database consisting of 118 chest radiographs with pulmonary nodules and an independent test database consisting of 136 digitized screen-film chest radiographs with 136 solitary pulmonary nodules collected from 14 medical institutions are used in this study.

Weixingwang et al [16] presented the newly developed ridge detection algorithm to diagnose indeterminate nodules correctly, allowing curative resection of early-stage malignant nodules and avoiding the morbidity and mortality of surgery for benign nodules. The algorithm was compared to some traditional image segmentation algorithms. All the results are satisfactory for diagnosis.

Md. FoisalHossain et al [17] presented an enhancement technique based upon a new application of contrast limited adaptive histograms on transform domain coefficients called logarithmic transform coefficient adaptive histogram equalization (LTAHE). The method is based on the properties of logarithmic transform domain histogram and contrast limited adaptive histogram equalization. A measure of enhancement based on contrast measure with respect to transform was used as a tool for evaluating the performance of
the proposed enhancement technique and for finding optimal values for variables contained in the enhancement. The algorithm's performance was compared quantitatively to classical histogram equalization using the aforementioned measure of enhancement. Experimental results were presented to show the performance of the proposed algorithm alongside classical histogram equalization.

Wenhong Li. Collet al [18] presented the paper on currency classification system using image processing techniques. The processing effect and recognition accuracy of RMB is an important part in the paper currency classification system. According to the characteristics of RMB images, the paper uses the theory of digital image processing and pattern recognition to put forward the method of RMB image processing based on the processing and recognition of the part of the RMB serial numbers, the arithmetic of linear perception based on rewards and punishment method and the extraction method of serial numbers character. Through the experiment on the paper currency classification system which uses the CIS sensor as the image acquisition, it testifies that this method of recognition has a high feasibility and recognition accuracy.

Li Minxiaet al [19] designed defect extraction by image segmentation. Firstly, on the basis of wavelet analysis, a new wavelet adaptive threshold denoising method based on genetic algorithm optimization was proposed. Secondly, an algorithm of multi-scale morphological to local contrast enhancement was designed. Finally, background is simulated, and the defect regions were extracted using algorithm of digital subtraction. The experimental results indicated that the methods can achieve automatic extraction of defect region, which is always a good foundation for flaw feature parameter extraction and choice.

Kanwal, N.et al [20] deals with contrast enhancement of X-Ray images and presents here a new approach for contrast enhancement based upon Adaptive Neighborhood technique. A hybrid methodology for enhancement has been presented. Comparative analysis of proposed technique against the existing major contrast enhancement techniques has been performed and results of proposed technique are promising.

Noorhayati Mohamed Noor et al [21] presented the enhancement capability of adaptive histogram equalization (AHE) on the soft tissue lateral neck radiograph for suspected fish bone ingestion. Embedded fish bone lodge in the throat is not easily visible in
unprocessed plain radiograph. Serious complication may cause perforation of the lodged and inflammation that can progress to abscess. Due to the high resolution, the images were cropped before being processed using adaptive histogram equalization. The quality of the image was assessed and evaluated during pre and post processing by the radiologists. The result showed AHE as a promising contrast enhancement for detection of fish bone in soft tissue at the lateral neck radiographs.

Lu Zhang et al [22] described about Diffraction-enhanced imaging (DEI) and the capability of DEI to observe different types of tissues was investigated. It is a synchrotron based imaging technique, which generates high spatial resolution and contrast of both calcified and soft tissues. This technique not only provided the visualization of absorption information like conventional X-ray imaging, but also refraction and scattering properties. In this study the MIR is used to extract information from a series of DEI images.

Md. FoisalHossainet al [23] proposed a method of medical image enhancement based upon non-linear technique and the logarithmic transform coefficient histogram equalization using EME as a measure of performance. The performance of this algorithm was compared to a classical histogram equalization enhancement technique. This method improves visual quality of images that contain dark shadows due to limited dynamic range of imaging like X-ray images. Experimental results ascertained that the proposed technique outperform commonly used enhancement technique like the histogram equalization qualitatively and quantitatively.

HasanDEMIREL[24] introduced a new face recognition technique based on the gray-level co-occurrence matrix(GLCM). GLCM represents the distributions of the intensities and the information about relative positions of neighboring pixels of an image. Two methods were being proposed to extract feature vectors using GLCM for facelcassification. The first method extracts the well-known Haralick features from the GLCM, and the second method directly uses GLCM by converting the matrix into a vector that can be used in the classification process. The results demonstrated that the second method, which uses GLCM directly, is superior to the first method that uses the feature vector containing the statistical haralick features in both nearest neighbour and neural networks classifiers. The proposed GLCM based face recognition system not only outperforms well-known techniques such as principal component analysis and linear
discriminant analysis, but also has comparable performance with local binary patterns and Gabor wavelets.

Pu J et al [25] presented a shape “break-and-repair” strategy for medical image segmentation and applied it to the segmentation of human lung and pulmonary nodules in this study. In this approach, the regions that may cause any problems in segmentation were removed and then estimated using implicit surface fitting based on RBFs. Its most important characteristic is the capability of segmenting anatomical structures depicted on medical images in a unified framework within a single pass. The preliminary assessment results are encouraging and demonstrated the feasibility, generality, and robustness of this strategy in segmentation.

Hongsheng Li et al [26] proposed a novel predictive model, active volume model (AVM), for object boundary extraction. It is a dynamic “object” model whose manifestation includes a deformable curve or surface representing a shape, a volumetric interior carrying appearance statistics, and an embedded classifier that separates object from background based on current feature information. The model focused on an accurate representation of the foreground object’s attributes, and does not explicitly represent the background. They showed, however, the model is capable of reasoning about the background statistics which can detect when change is sufficient to invoke a boundary decision.

Sadeer G. Al-Kindiet al [27] proposed a novel hybrid and repetitive smoothing-sharpening (HRSST) technique and its impacts are assessed to beneficially enhance sonogram and mammogram images. The technique aimed to gain and combine the advantages of both the sharpening process that aims to highlight sudden changes in the image intensity, with the advantages of iterative image smoothing, which is usually applied to remove random noise from digital images. Nevertheless the developed technique also eliminated the drawbacks of each of the two sharpening and smoothing techniques resulting from their individual application in image processing field. The proposed technique was tested on both breast ultra-sound (BUS) as well as breast X-ray mammograms. Results showed that the proposed methodology has high potential to advantageously enhance the image contrast hence giving extra aid to radiologists to detect and classify sonograms and mammograms.
Sandeep Kumar et al [28] provided a framework for denoising the enhanced image based on prior knowledge on the Histogram Equalization. Many image enhancement schemes like Contrast limited Adaptive Histogram Equalization (CLAHE), Equal area dualistic sub-image histogram equalization (DSIHE), Dynamic Histogram equalization (DHE) Algorithm were implemented and compared after the denoising using the wavelet thresholding. The Performance of all these Methods with the denoising has been analyzed and a number of Practical experiments of real time images have been presented. From the experimental results, it is found that all the three techniques with the denoising yields Different aspects for different parameters.

Xiaoyan Xu [29] implemented the embedded zero tree wavelet algorithm (EZW), which is a simple, yet remarkably effective, image compression algorithm. The experiment was done on a set of standard images and the results show the good performance of this algorithm compared to some other compression scheme. EZW has proved to be a very effective image compression method based on the mean-square error (MSE) distortion measure. Coding results shown in this paper illustrates the performance of this improvement.

Arpita Mittal et al [30] reported that as till date there is no proven cure for the disease i.e. Rheumatoid Arthritis (RA), hence close monitoring of the disease is important in the medical treatment of this disease. An application of image processing techniques for identification of most common disease (RA) is opted. In this paper Fingers and Knee images of the patient having RA have been analyzed through Morphological Image processing techniques. The processed images find their application in the field of Medical Science and can be beneficial for doctors in identification of disease stages from monitoring point of view.

Jagadeesh et al [31] presented the preprocessing methods of the leukemic blast cells image in order to generate the features well characterizing different types of cells. The solved problems include: the segmentation of the bone marrow aspirate by applying the watershed transformation, selection of individual cells, and feature generation on the basis of texture, statistical and geometrical analysis of the cells.

KimmiVerma et al [32] did a research which made the use of software with edgedetection and segmentation methods, which gave the edge pattern and segment of brain and the
brain tumor itself. In this research, it has provided a foundation of segmentation and edges reviewed with an emphasis placed on revealing the advantages and disadvantages of these methods for medical imaging applications. The use of image segmentation in different imaging modalities is also described along with the difficulties encountered in each modality.

Ashraf Anwar et al [33] introduced an inexpensive, user friendly general-purpose image processing tool and visualization program specifically designed in MATLAB to detect much of the brain disorders as early as possible. The application provided clinical and quantitative analysis of medical images. Minute structural difference of brain gradually results in major disorders such as schizophrenia, Epilepsy, inherited speech and language disorder, Alzheimer's dementia etc. Here the main focusing is given to diagnose the disease related to the brain and its psychic nature (Alzheimer’s disease). Medical imaging is expensive and very much sophisticated because of proprietary software and expert personalities.

Pallavi T. Suradkar [34] reviewed image analysis studies aimed at automated diagnosis or screening of malaria infection in microscope images of thin blood film smears.

Md. Amran Hossen Bhuiyan et al [35] reported that in order to achieve an effective way to identify skin cancer at an early stage without performing any unnecessary skin biopsies, digital images of melanoma skin lesions were investigated. To achieve this goal, feature extraction was considered as an essential weapon to analyze an image appropriately. In this paper, different digital images have been analyzed based on unsupervised segmentation techniques. Feature extraction techniques are then applied on these segmented images. After this, a comprehensive discussion has been explored based on the obtained results. Signal and imaging investigations are currently a basic step of the diagnostic, prognostic and follow-up processes of heart diseases.

R K Samantaray et al [36] has presented an effective way to achieve a high-level integration of signal and image processing methods in the general process of care, by means of a clinical decision support system (CDSS), and has discussed the advantages of such an approach. In particular, significant and suitably designed image and signal processing algorithms are introduced to objectively and reliably evaluate important features that, in collaboration with the CDSS, could facilitate decisional problems in the
heart failure domain. Further-more, additional signal and image processing tools enrich the model base of the CDSS.

S.Kannadhasan et al [37] described a method which is not only effectively detecting the presence of cancer cells but also it is reducing the overall time taken for diagnosis by carrying the whole process under biotelemetry. On the other hand, biotelemetry is mostly used for one dimensional signals thus in this project it extended for transferring two dimensional signals i.e., image if it happen so then complex or time consuming diagnosis process completes in short duration. The telemetry link was provided by Zigbee transceivers and diagnosis was carried with the help of digital image processing technique.

HardikPandit [38] discussed an application of digital image processing and analysis techniques, which can be useful in healthcare domain to predict some major diseases of human beings. The application is an image processing system, which works on the basis of medical palmistry. The images of human palm form input to the system. Then, system applies digital image processing and analysis techniques on input images to identify certain features in the image. By using knowledge base of medical palmistry it analyzes certain features in image and predicts probable disease.

2.3 Literature survey on MATLAB based image processing medical applications

M Bister [39] illustrated some of the important points with fast implementations of bilinear interpolation, watershed segmentation and volume rendering with MATLAB, as MATLAB has often been considered an excellent environment for fast algorithm development but is generally perceived as slow and hence not fit for routine medical image processing, where large data sets are now available e.g., high resolution CT image sets with typically hundreds of 512x512 slices. Yet, with proper programming practices – vectorization, pre-allocation and specialization – applications in MATLAB could run as fast as in C language.

JiříBlahuta [40] presented a processing of medical ultrasound images with MATLAB. This processing is useful to potential diagnosis of Parkinson’s disease in brain-stem area. Furthermore introduced DICOM standard for medical imaging and modern 3D/4D scanning for high level and accuracy of diagnoses that was higher than traditionally 2D scanning.
Joaquim Jose Furtado et al [41] aimed to realize the image classification using MATLAB software. The image was classified using three and five classes, with a population size of 20 and time of 30, 50 and 100. The gotten results showed that the time seems to affect the classification more than the number of classes.

S. AllinChristeet al [42] presented an efficient architecture for various image filtering algorithms and tumour characterization using Xilinx System Generator (XSG). This architecture offered an alternative through a graphical user interface that combines MATLAB, Simulink and XSG and explored important aspects concerned to hardware implementation. Performance of this architecture implemented in SPARTAN-3E Starter kit (XC3S500E-FG320) exceeds those of similar or greater resources architectures. The proposed architecture reduced the resources available on target device by 50%.

NasrulHumaimiMahmoodet al [43] reported a survey of image processing algorithms that have been developed for detection of masses and segmentation techniques. 35 students from university campus participated in the Development of Biomedical Image Processing Software Package for New Learners Survey investigating the use of software package for processing and editing image. Composed of 19 questions, the survey built a comprehensive picture of the software package, programming language, workflow of the tool and captured the attitudes of the respondents. The result of this study showed that MATLAB is among the famous software package and its result is expected to be beneficial and able to assist users on effective image processing and analysis in a newly developed software package.

Ching Yee Yong et al [44] made a survey of image processing algorithms that were developed for detection of masses and segmentation techniques. The result of this study showed that MATLAB is among the famous software package; more than 60% of the respondents prefer to use MATLAB for their image processing work. The Microsoft Photo Editor is the second popular software for images editing process. More than 30% of respondents are very likely to use a ready-to-use package for processing image rather than given source code. The result is expected to be beneficial and is able to assist users on effective image processing and analysis in a newly developed software package. A preliminary image processing tool prototype that was developed is also being presented in the paper.
Deepak Kumar Garget al [45] discussed a method that involves processing of ECG paper records by an efficient and iterative set of digital image processing techniques for the conversion of ECG paper image data to time series digitized signal form, resulting in convenient storage and retrieval of ECG information. The method involved are calculation of Heart rate, QRS Width and Stability (variation in R-R peaks) from the extracted signal. Comparison of the above calculated parameters with the manually calculated parameters showed an accuracy of 96.4%, thus proving the effectiveness of the process. The author also proposed the development of fuzzy based ECG diagnosis system that assists the doctors in diagnosis.

Shirui Gao [46] emphasized the MATLAB based medical image processing tools. It includes the theoretical background and examples. Through MATLAB this paper made the introduction of the post-imaging quality in medical technology and medical imaging. It also introduces the medical image processing technology and describes the image processing and processing technologies, including the organ contours, interpolation, filtering, and segmentation techniques. In medicine, the DICOM image data processing using MATLAB is also widely used in this type of image processing.

Bhausaheb Shinde [47] proposed a method to improve the accuracy of MRI, Cancer, X-ray and Brain images for easy diagnosis. For this experimental work they took different medical images like MRI, Cancer, X-ray, and Brain and calculated standard derivations and mean of all these medical images after finding Gaussian noise and then applied median filtering technique for removal of noise. After removing noise by using median filtering techniques, again standard derivations and mean are evaluated. The results, achieved were more useful and they proved to be helpful for general medical practitioners to analyze the symptoms of the patients with ease.

2.4 Literature survey on ANN based Image processing applications

Artificial Neural Network is a branch of Artificial intelligence and has been accepted as a new technology in computer science. Neural Networks are currently a 'hot' research area in medicine, particularly in the fields of radiology, urology, cardiology, oncology and etc. It has a huge application in many areas such as education, business; medical, engineering and manufacturing. Artificial neural networks are finding many uses in the medical
diagnosis application. Neural Network plays an important role in a decision support system.

HeryPURNOMO et al. [48] explored the performance testing for PCNN method compared to the classical standard method for tuberculosis detection. There was significant improvement in processing time and Diagnosis percentage, which the image is processed first with Adaptive White Gaussian noise (AWGN) for reliability testing of the method.

Juan A et al. [49] described some important aspects of recent visual cortex-based ANN models and finally discussed about the conclusions reached throughout the process.

N Ganesan et al. [50] made an attempt to make use of neural networks in the medical field (carcinogenesis (pre-clinical study)). In carcinogenesis, artificial neural networks have been successfully applied to the problems in both pre-clinical and post-clinical diagnosis. The main aim of research in medical diagnostics is to develop more cost-effective and easy-to-use systems, procedures and methods for supporting clinicians. It has been used to analyze demographic data from lung cancer patients with a view to developing diagnostic algorithms that might improve triage practices in the emergency department. For the lung cancer diagnosis problem, the concise rules extracted from the network achieve a high accuracy rate of on the training data set and on the test data set.

Dilip Roy Chowdhury et al. [51] reported the use of artificial neural networks in predicting neonatal disease diagnosis. The proposed technique involves training a Multi Layer Perceptron with a BP learning algorithm to recognize a pattern for the diagnosing and prediction of neonatal diseases. A comparative study of using different training algorithm of MLP, Quick Propagation, Conjugate Gradient Descent, shows the higher prediction accuracy. The Back propagation algorithm was used to train the ANN architecture and the same has been tested for the various categories of neonatal disease. About 94 cases of different sign and symptoms parameter have been tested in this model. This study exhibits ANN based prediction of neonatal disease and improved the diagnosis accuracy of 75% with higher stability.

Qeethara Kadhim et al. [52] presented a method to evaluate artificial neural network in disease diagnosis. Two cases were studied. The first one is acute nephritis disease; data is the disease symptoms. The second is the heart disease; data is on cardiac Single Proton
Emission Computed Tomography (SPECT) images. Each patient classified into two categories: infected and non-infected. Classification is an important tool in medical diagnosis decision support. Feed-forward back propagation neural network is used as a classifier to distinguish between infected or non-infected person in both cases. The results of applying the artificial neural networks methodology to acute nephritis diagnosis based upon selected symptoms showed abilities of the network to learn the patterns corresponding to symptoms of the person.

Hasan et al [53] introduced a new face recognition technique based on the gray-level co-occurrence matrix (GLCM). GLCM represents the distributions of the intensities and the information about relative positions of neighboring pixels of an image. Two methods were proposed to extract feature vectors using GLCM for face classification. The first method extracts the well-known Haralick features from the GLCM, and the second method directly uses GLCM by converting the matrix into a vector that can be used in the classification process. The results demonstrated that the second method, which uses GLCM directly, is superior to the first method that uses the feature vector containing the statistical Haralick features in both nearest neighbor and neural networks classifiers. The proposed GLCM based face recognition system not only outperforms well-known techniques such as principal component analysis and linear discriminate analysis, but also has comparable performance with local binary patterns and Gabor wavelets.

MussaratYasminet al [54] summarized overview of research and development held in recent past highlighting the role of Neural Networks in advancement of Medical Imaging.

Zhenghao Shi [55] reviewed the application of artificial neural networks in medical image preprocessing, in medical image object detection and recognition. Main advantages and drawbacks of artificial neural networks were discussed. By this survey, the paper tried to answer what the major strengths and weaknesses of applying neural networks for medical image processing would be.
2.5 Literature Survey for the Detection of Tuberculosis

2.5.1 Clinical methods

Tuberculosis is diagnosed by finding Mycobacterium tuberculosis bacteria in a clinical specimen taken from the patient. While other investigations may strongly suggest tuberculosis as the diagnosis, they cannot confirm it.

A complete medical evaluation for tuberculosis (TB) must include a medical history, a physical examination, a chest X-ray and microbiological examination (of sputum or some other appropriate sample). It may also include a tuberculin skin test, other scans and X-ray, surgical biopsy.

A definitive diagnosis of tuberculosis can only be made by culturing Mycobacterium tuberculosis organisms from a specimen taken from the patient (most often sputum, but may also include pus, CSF, biopsied tissue, etc.). A diagnosis made other than by culture may only be classified as "probable" or "presumed". For a diagnosis negating the possibility of tuberculosis infection, most protocols require that two separate cultures both test negative.[56]

2.5.1.1 Sputum

Sputum smears and cultures are done for acid-fast bacilli if the patient is producing sputum.[57] The preferred method for this is fluorescence microscopy (auramine-rhodamine staining), which is more sensitive than conventional Ziehl-Neelsen staining.[58] In cases where there is no spontaneous sputum production, a sample can be induced, usually by nebulized inhalation of a saline or saline with bronchodilator solution. A comparative study found that inducing three sputum samples is more sensitive than three gastric washings.[59]

2.5.1.2 Abreugraphy

A variant of the chest X-Ray, abreugraphy (from the name of its inventor, Dr. Manuel Dias de Abreu) was a small radiographic image, also called miniature mass radiography (MMR) or miniature chest radiograph. Though its resolution is limited (it doesn't allow the diagnosis of lung cancer, for example) it is sufficiently accurate for diagnosis of tuberculosis [60].
Much less expensive than traditional X-Ray, MMR was quickly adopted and extensively utilized in some countries, in the 1950s. For example, in Brazil and in Japan, tuberculosis prevention laws went into effect and about 60% of the population to undergo MMR screening.

The procedure went out of favor, as the incidence of tuberculosis dramatically decreased, but is still used in certain situations, such as the screening of prisoners and immigration applicants.

2.5.1.3 Immunological test

ALS Assay

Antibodies from Lymphocyte Secretion or Antibody in Lymphocyte Supernatant or ALS Assay is an immunological assay to detect active diseases like tuberculosis, cholera, typhoid etc. Recently, ALS assay nods the scientific community as it is rapidly used for diagnosis of Tuberculosis. The principal is based on the secretion of antibody from in vivo activated plasma B cells found in blood circulation for a short period of time in response to TB-antigens during active TB infection rather than latent TB infection [61].

2.5.1.4 Nucleic acid amplification tests (NAAT)

This is a heterogeneous group of tests that use the polymerase chain reaction (PCR) technique to detect mycobacterial nucleic acid. These test vary in which nucleic acid sequence they detect and vary in their accuracy. The two most common commercially available tests are the amplified mycobacterium tuberculosis direct test (MTD, Gen-Probe) and Amplicor (Roche Diagnostics) [62]. In 2007, a systematic review of NAAT by the NHS Health Technology Assessment Program concluded that "NAAT test accuracy to be far superior when applied to respiratory samples as opposed to other specimens. Although the results were not statistically significant, the AMTD test appears to perform better than other currently available commercial tests."[63].

As the sputum test is the universally accepted medical test for the detection of TB, so, we have chosen the test as the clinical result.
2.5.2 Technical Methods

Plikaytis BD et al [64] presented a computerized pattern recognition model used to speciation mycobacterium based on their restriction fragment length polymorphism (RFLP) banding patterns. Thirty-nine independent strains of known origin, not included in the probability matrix, were used to test the accuracy of the method in classifying unknowns: 37 of 39 (94.9%) were classified correctly. An additional set of 16 strains of known origin representing species not included in the model were tested to gauge the robustness of the probability matrix. Every sample was correctly identified as an outlier, i.e. a member of a species not included in the original matrix.

S APatil [65] presented a computer algorithm for texture analysis of TB chest radiograph. Algorithm included important steps, like image acquisition, image pre-processing, lung field segmentation, and features extraction. Total 49 images were used during experiment to estimate 1st and 2nd order texture features. Gray Level Co-occurrence Matrix (GLCM) technique is used to estimate texture features.

K. Veropoulos et al [66] presented a method of developing an automated method for the detection of tubercle bacilli in clinical specimens, principally sputum smears to improve the diagnostic process. A preliminary investigation is presented here, which makes use of image processing techniques and neural network classifiers for the automatic identification of TB bacilli on Auramine stained sputum specimens. The developed system showed a sensitivity of 93.5% for the identification of individual bacilli. As there are usually fairly numerous TB bacilli in the sputum of patients with active pulmonary TB. The overall diagnostic accuracy for sputum smear positive patients was expected to be very high. Potential benefits of automated screening for TB are rapid and accurate diagnosis, increased screening of the population, and reduced health risk to staff processing slides.

Rachna H. B et al [67] proposed an algorithm based on image processing technique for identification of TB bacteria in sputum, as the availability of expertise, time and cost are the constraints of the human intervention based examinations. The method is based on Otsu thresholding and k-means clustering approach. The performance of clustering and thresholding algorithms for segmenting TB bacilli in tissue sections is compared. The developed automated technique showed good accuracy and efficiency.
P. Sadaphal et al [68] demonstrated the proof of principle of an innovative computational algorithm that successfully recognized Ziehl-Neelsen (ZN) stained acid-fast bacilli (AFB) in digital images. Automated, multi-stage, color-based Bayesian segmentation identified possible ‘TB objects’, removed artifacts by shape comparison and color-labeled objects as ‘definite’, ‘possible’ or ‘non-TB’, bypassing photo micrographic calibration. Superimposed AFB clusters, extreme stain variation and low depth of field were challenges. This novel method facilitated electronic diagnosis of TB, permitting wider application in developing countries where fluorescent microscopy is currently inaccessible and unaffordable. [49]

Stefan Jaeger et al [69] described the medical background of TB detection in chest X-rays and presented a survey of the recent approaches using computer-aided detection. After a thorough research of the computer science literature for such systems or related methods, 16 papers were identified, including our own, written between 1996 and early 2013. These papers showed that TB screening is a challenging task and an open research problem. They reported on the progress to date and described experimental screening systems that have been developed.

Manuel G forero et al [70] developed a new autofocus algorithm and a new bacilli detection technique with the aim to attain a high specificity rate and reduce the time consumed to analyze sputum samples. This technique is based on the combined use of some invariant shape features together with a simple thresholding operation on the chromatic channels. Some feature descriptors were extracted from bacilli shape using an edited dataset of samples. A k-means clustering technique was applied for classification purposes and the sensitivity vs specificity results were evaluated using a standard ROC analysis procedure.

Ajay Divekar [71] developed a stepwise classification (SWC) algorithm to remove different types of false positives, one type at a time, and to increase the detection of TB bacilli at different concentrations. Based on the Shannon cofactor expansion on Boolean function for classification, Both bacilli and non-bacilli objects are first analyzed and classified into several different categories including scanty positive, high concentration positive, and several non-bacilli categories: small bright objects, beaded, dim elongated objects, etc. The morphological and contrast features were extracted based on a prior clinical knowledge. The SWC is composed of several individual classifiers. Individual
classifier to increase the bacilli counts utilizes an adaptive algorithm based on a microbiologist’s statistical heuristic decision process. Individual classifier to reduce false positive is developed through minimization from a binary decision tree to classify different types of true and false positive based on feature vectors. Finally, the detection algorithm was tested on 102 independent confirmed negative and 74 positive cases. A multi-class task analysis showed high accordance rate for negative, scanty, and high-concentration as 88.24%, 56.00%, and 97.96%, respectively.

Jeannette Chang [72] presented an algorithm for automated TB detection in smear images taken by digital microscopes such as Cell Scope, a novel low-cost, portable device capable of bright field and fluorescence microscopy. Automated processing on such platforms could save lives by bringing healthcare to rural areas with limited access to laboratory-based diagnostics. Though the focus of the study was the application of automated algorithm to Cell Scope images, the method may be readily generalized for use with images from other digital fluorescence microscopes. The algorithm applies morphological operations and template matching with a Gaussian kernel to identify TB-object candidates. Then moment, geometric, photometric, and oriented gradient features were used to characterize these objects and perform discriminative, support vector machine classification. Then the algorithm was tested on a large set of CellScope fluorescence images from sputum smears collected at clinics in Uganda (594 images corresponding to 290 patients). The object-level classification is highly accurate, with Average Precision of 89.2% ± 2.1%. For slide-level classification, the algorithm performed at the level of human readers, demonstrating the potential for making a significant impact on global healthcare.

The main drawback with these methods are that the work is trying to replace a clinical test. They are working on the detection of bacilli using different techniques such as neural network, which is bit complicated as for further classification we need to use another neural network which becomes the usage of multiple neural network. To use this method we need a high resolution image which is a bit expensive.

The main problem in the texture analysis of chest radiographs is the complex “background” of superimposed normal anatomical structures to which the analysis must be somehow insensitive.
The enhancement method [14] is quite sufficient in diagnosing the fish bone quickly. However the enhanced images not only enhance the fish bone but also enhance the noise that is present in the radiographs images. Hence, all these factors motivated the author to design and develop a novel technique for TB detection.

2.6 Motivation for the Present Research Work

Tuberculosis (TB) is one of the most important public health problems worldwide. There are 9 million new TB cases and nearly 2 million TB deaths each year. Case-finding and the management of pulmonary tuberculosis is an essential target of tuberculosis control programs. However, pulmonary tuberculosis (PTB) is becoming more and more of a serious problem, particularly in countries affected by epidemics of human immunodeficiency virus (HIV)-TB co-infection. The diagnosis of PTB using prompt and accurate methods is a crucial step in the control of the occurrence and prevalence of TB. However, the diagnosis of PTB is quite complex, so there is no unified standard at present. Frequently, there is over diagnosis and missed diagnosis and it is a thorny question in the field of TB control. That is why TB as the parameter is chosen. If it is not diagnosed in the early stage it may lead to death. The image processing techniques along with the usage of Artificial Neural Network in instrumentation is used in this work for the design of diagnosing system and hence provides better way for the further treatment.

After elaborate literature survey we found that most of the studies on TB diagnosis reported were on conventional clinical test based or technical methods separately for identifying the TB. These tests involve identification of presence/absence of bacillus which is a cause for TB. Besides, no studies reported on the severity (percentage) of TB in a patient.

In addition, the manual screening for the bacillus identification involves a labour intensive task with a high false negative rate. Automatic screening will entail several advantages, like a substantial reduction in the labour workload of clinicians, improving the sensitivity of the test and a better accuracy in diagnosis by increasing the number of images that can be analyzed by the computer.

Though the disease seems to be simple but it is very much infectious and has to be cured in time or in other words in early stage. So, as far as the treatment is concerned, diagnosis becomes the primary and crucial stage of the disease. There are many ways of diagnosing
the TB. One of them is the sputum examination. This test is accepted worldwide. X-ray analysis is another technique of diagnosing TB. In this method, the radiologist or a consultant physician has to take the print of X-ray and analyze the presence of the disease (TB). The second method is quite expensive, tedious and may not yield precise results. This has motivated the author to design a system which can diagnose the presence of TB without taking the X-ray film print. And also according to the survey made with senior doctors, it is learnt that the diagnosis of TB for inexperienced doctors is very difficult. The cost level can also be reduced as the X-ray print need not be taken. At the same time according to the survey made, people have used either X-ray of chest or the sputum result or the image of the smear to find out the bacilli. But, in the proposed system sputum as well as X-ray image which has led to more accuracy in identifying and predicting the percentage of TB has been used.

As the present system will diagnosis of Pulmonary Tuberculosis with the help of X-ray & sputum results which are mandatory for a specialist to detect TB, So, the system is not very expensive. At the same time the junior doctor who is not experienced can use the system for the diagnosis pulmonary TB.

Over all, the aim is to design a system which helps the patient through the doctor. Also, as the X-ray system is already digitized it has been made very convenient for taking the softcopy of the images in diagnosing the TB along with the sputum examination result. These have motivated to carry out this research work. Hence, the proposed design is a novel approach combining the conventional (sputum analysis) and modern (X-ray analysis) methods to diagnose and thus better treat the fatal TB in human beings.
2.7 Objectives for the Present Research Work

✓ To collect the lung X-ray images of PTB and normal patients.
✓ To preprocess the X-ray images.
✓ To extract the features from the X-ray images.
✓ To design an ANN for further investigation.
✓ To train the ANN with the extracted features.
✓ To design a GUI for user.
✓ To test unknown X-ray images for the detection of PTB.
✓ To check the severity of PTB.

Detailed study on the methodology i.e., design and development of overall system is dealt in the next chapter.
References


[50] Dr. N. Ganesan, Dr. K. Venkatesh, Dr. M. A. Rama, ”Application of Neural Networks in Diagnosing Cancer Disease Using Demographic Data”, International Journal of Computer Applications, Volume. 1, No. 26, pp. 76-85.


