Chapter 6

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6.1 Introduction

This chapter presents the important conclusions drawn from the present work and future scope of the present work.

6.2 Conclusions

In the present work, Image processing techniques along with ANN has been used for the detection of PTB. The ANN is derived with three stages is a multi-level multilayered approach with the first stage includes six shape features and 2 hidden layers to suitably achieve an accuracy of 70% with segmentation technique. This accuracy value will not fulfill the need. To improve the accuracy, we ensured to combine the enhancement technique which combines the colour and DWT enhancement. The other way round we combined the Gabor features to get 128 texture-40 hidden layers. Then the ANN when combined with shape and texture features will form totally 134-40-6-2 neurons. Using this we could obtain an accuracy of 86%. However based on the doctor's advice, we added sputum examination result. With all these combined features we got an accuracy of 94.65% in the detection PTB.

The study presented here indicates that machine-assisted diagnosis of tuberculosis is certainly feasible. A study of the potential market indicates that the proposed technique should be cost effective in several middle-income countries (e.g. South Africa and China). As an example, technicians at the SAIMR (South African Institute of Medical Research) screen about 100,000 slides per annum at a cost of 12.8ZAR (approx. 2USD) per slide. Assuming a machine cost of 20,000USD this would certainly be cost effective [1]. The cost of the process could be further reduced by combination with other diagnostic techniques that use automated microscopy, such as cervical smear screening [2].

From the above discussions it is clear that the diagnosis of TB using the equipments and technicians is costlier when compared to computer aided diagnosis. This is because the reduction in the manpower with the expensive equipment can be reduced in the above explained system. So, we conclude that our diagnosis system is better than the other systems. [Publication 2].
Due to the complexity of TB diagnosis, there continues to be no unified standard for it. Over diagnosis and missed diagnosis are formidable problems in the process for TB control. The cost of new diagnostic methods, such as nucleic acid amplification tests is very high and the effectiveness of these tests has not been confirmed in developing countries. To aim directly at uncertainty information and artifacts in clinical diagnosis, the limitation of regression modeling can be overcome by the use of ANNs. Reasonable judgment, satisfactory predictions and ideal forecasts can be achieved by ANN based on existing knowledge and experiences in solving problems. It was confirmed that the sensitivity, specificity of TB diagnosis were appreciable. These results indicate that the validity of diagnosis was good and the (135-40-10-2)-BP network could be further extended to new patient data. The results indicate that this could be used as a new diagnosis method for this complex problem [Publication 1].

Earlier reported accuracy is of 93.5% [3], which is effectively increased to 94.5% by our designed system. Hence we can conclude that our system is better in terms of accuracy. As the severity check is made, the system has become more effective for the PTB diagnosis.

The wavelet transform based and subtraction algorithm that has been used in the present work incorporates newer imaging and diagnostic methods to facilitate the evaluation and management of solitary pulmonary tuberculosis. Management of tuberculosis cavities that are clearly benign or malignant is straightforward. The difficulty is in the evaluation and management of the indeterminate nodule and the goal is to correctly diagnose indeterminate tuberculosis cavities, allowing curative resection of early-stage malignant tuberculosis cavities and avoiding the morbidity and mortality of surgery for benign tuberculosis cavities. From the test results, the proposed technique was successful in detecting tiny spots on lung X-ray image. This is found to have many advantages over the exiting methods.[Publication 3]

It is found that the accuracy of TB diagnosis is 94.5% by the (135-40-10-2)-BP network. These results indicate that the validity of diagnosis was good and the (135-40-10-2)-BP network could be further extended to new patient data. The results indicate that this could be used as a new diagnosis method for the diagnosis of PTB. [Publication 4]
We used the DB 9/7 wavelet compression coupled with the EZW coding and found that this algorithm gives better results than the other compression techniques. EZW has many advantages, such as good image quality, high PSNR (Peak Signal to Noise Ratio) and good progressive image transmission. Hence, it also has wider application in the compression of images. [Publication 5]

In the present work, a user-friendly system has been designed. With the GUI, designed in MATLAB, the user has to only select the X-ray image and put it for processing. The results or findings of the test image are displayed on the same window. As all the information is available on the GUI window, the user need not have to search for any applications. As a result, the system becomes a powerful medical instrument for PTB diagnosis.

The designed system is very helpful for doctors/physicians in diagnosing PTB. The developed system assists the young doctors (amateurs/ beginners in the field concerned) to study the patients’ history and results of the image under investigation readily and directly on the user screen. In addition, the system helps a lot as the results of even intermediate stages are displayed along with the final result as the case is TB or NON-TB.

Indirectly the system helps patients as the diagnosis is easy and accurate. In the society, rather diagnosis is very important than treatment. Because the misdiagnosis affects the patient with fatal condition. This is how the developed system also helps the patients.

Comparatively the method is less expensive as the X-ray film print is not taken for diagnosis. The soft image from X-ray machine can be directly sent to our system with the need for print of hardcopy which definitely reduces the cost.

The system is tested and verified by various doctors and the system has been certified and work is found to be satisfactorily. The respective certificates are presented in appendix-I for your kind reference.
6.3 Future Scope

Future scope for the present work is as follows,

- Image registration can be conducted in the early stage of the enhancement to avoid masking of the TB cavities.
- We use binarization method for segmentation. Other methods can also be tested to improve the performance.
- As for as the ANN is considered the BP network is used. This network is found to be universal network in ANN. Multiple networks can be used i.e hybrid networks can be used to improve the performance. Over all the training performance can be further increased so that detection accuracy increases.
References
