Abstract

X-ray images are used for the diagnosis of several diseases throughout the world and is one of the most important tools used in clinical practice. Computer aided analysis and interpretation of x-ray images can provide several useful clues for diagnosis, treatment planning and medical research. One of the aims of this research is to develop suitable computer aided techniques for classification of chest x-ray images of tuberculosis and dental x-ray images of dental caries for their use in diagnosis and treatment planning. The following paragraphs are the summaries of the contributions made by the author on different aspects of computer aided diagnostic tools namely, enhancement, segmentation and classification techniques.

In the present investigation enhancement techniques are used for obtaining better visibility, clinical information such as changes in the anatomical structures, lung nodules, shape of thoracic cage etc. Both fuzzy based techniques and crisp enhancement techniques have been used for pre-processing the chest x-ray images. Fuzzy based enhancement techniques have provided better-enhanced output than the crisp enhancement techniques. The parameters can be varied easily and the methods are more users friendly also.

Image segmentation, specifically tuned for segmenting the lung region in the chest radiographs has been used. Fuzzy based techniques are found to give better segmentation of the chest x-ray images than the non-fuzzy segmentation techniques. The segmentation can be performed based on users requirement. Parameters for segmentation can be varied, and the number of regions to be segmented can also be varied.

After the enhancement, classifications of chest x-ray images of tuberculosis and dental x-ray images of dental caries have been performed. Useful information can be made available for the diagnosis of the disease from these classified images. There is constant endeavor for obtaining more and more accurate results of classification owing to a large number of processes and variables involved in gathering of such medical data.

As the boundaries and properties of the regions in the chest x-ray images are essentially vague and imprecise, the logic of uncertainty and imprecision is necessary to process such data. Taking into consideration this inexactitude and associated uncertainties into the x-ray imaging frame work; we need to apply fuzzy logic for obtaining better results. Back propagation algorithm and neuro-fuzzy algorithms are used for classification and it is found that neuro-fuzzy techniques are better than the crisp backpropagation technique. For classification, extent of tuberculosis lesions present in the chest radiograph, namely, minimal, moderately advanced and far advanced TB has been adopted.

Texture analysis techniques provide promising results in the classification of x-ray images. The concept of fuzzy texture spectrum have been developed and used for the classification of tuberculosis. After extracting the texture features from the

fuzzy texture spectrum, a statistical classifier is used to classify the TB infected x-ray images. This statistical classifier depends very much on the strength of the features and otherwise its implementation is very trivial. One main advantage of this classifier is that it does not require a large number of samples as the initial input for creation of the database. The neural network classifiers require a lot of training samples and may not be a useful choice if the total number of samples is low. Another classification tree method based on texture feature value has also been developed for a finite set of images. Histogram analysis of the three sets of images has been done. Fuzzy histogram, which is a continuous one, can provide the characteristics of the image, under situations defined imprecisely and uncertainly.

Dental x-ray images are widely used for the diagnosis and treatment planning of diseases in dentistry. Texture based x-ray image analysis techniques such as Central pixel oriented matrix method, Texture feature method etc have been developed. Gray level imprecision has been incorporated which is then used for classification of dental caries. Comparisons of the crisp central pixel oriented matrix method and the texture feature method have been made with those of the fuzzy texture based methods. It is found that the fuzzy methods outperform the crisp texture analysis techniques. Among the texture analysis algorithms, co-occurrence matrix method is considered as one of the most accurate one. A modification of this has been done for obtaining better accuracy. Subsequently, the method has been fuzzified and then used for the classification of dental caries into enamel caries, dentinal caries and pulpal caries. The gray level run length method is found to be less accurate than other texture algorithms. Here fuzzification of the run length method has been carried out in a theoretical framework with the help of three different membership functions. The neighbouring gray level dependent matrix method has been used for classification of dental caries. The method has been fuzzified and then used for classification. It is observed that fuzzy neighbouring gray level dependent matrix method provides the best classification result.

To sum up, in this work, pre-processing of chest x-ray images of tuberculosis has been performed by crisp and fuzzy based enhancement techniques. Segmentation of lung field has been performed by crisp and fuzzy cluster based segmentation strategies. Fuzzy based segmentation techniques are found to be better than the non-fuzzy segmentation techniques. They are faster, easy to implement; user friendly and the parameters can be varied. Classification of chest x-ray images has been carried out by using neural networks, fuzzy texture spectrum, histogram analysis and decision tree method. Fuzzy texture based strategies are better than crisp texture analysis techniques. Dental x-ray images have also been classified with fuzzy texture based strategies and crisp texture analysis algorithms. The fuzzy texture based approaches are found to be more accurate and faster than the conventional image analysis techniques.