ABSTRACT

Liver cancer is one of the most common intestinal malignancies worldwide and its early detection provides a better chance of proper treatment. Examination of liver tumours is performed with various medical imaging modalities such as ultrasonography, computed tomography and magnetic resonance imaging. Computed tomography has been identified as an accurate and robust imaging modality in the diagnosis of the liver tumours. Although the quality of computed tomography images has improved significantly, in some cases even experienced radiologists resort to invasive procedures to confirm their diagnosis. The complications and contraindications of invasive procedures are severe.

Computer-assisted liver tumour classification based on medical image analysis can be employed in the diagnosis and hence reduce the number of invasive procedures that would otherwise have been necessary. The evolution in medical image processing and artificial intelligence techniques has given researchers the opportunity to investigate the potential of computer-aided diagnostic systems for classifying liver tumours. Studies of computer-aided diagnosis systems show that they can improve the diagnostic accuracy, reduce cancer detection missed due to fatigue and minimize the diagnostic errors caused by inter and intra-reader variability. Moreover,
computer-aided diagnosis systems can help to reduce the number of required biopsies.

The objective of this research is the development of a fully automated computer-aided diagnosis system to differentiate between malignant and benign liver tumours from computer tomography images. The computer-aided diagnosis system developed comprises segmentation, feature extraction and classification stages. The system automatically segments tumour region of interest from pre-processed abdominal computed tomography images using a two step process. The algorithm applies prior knowledge, intensity analysis, the confidence-connected region-growing, pre and post processing steps for segmentation of the liver and alternative fuzzy c means clustering algorithm for segmentation of the tumour region.

A novel co-occurrence texture feature extraction method based on multiresolution and multidirectional Contourlet Transform, called, the contourlet coefficient co-occurrence matrix is employed. It extracts discriminating information from the directional contourlet coefficients of the tumour region and hence characterizes a tumour texture more effectively. Contourlet coefficient first-order statistics features are also extracted from the contourlet coefficients for comparison. The two sets of feature descriptors extracted from contourlet coefficients are also extracted from the original gray level tumour region as well as from the wavelet transformed detail
coefficients of tumour regions for evaluation. The dimensionality of the extracted feature sets is reduced by principal component analysis and is used in discriminating malignant from benign tissues employing a probabilistic neural network classifier.

The performance of the computer-aided diagnosis system for different texture extraction methods are evaluated using performance measures like accuracy, sensitivity, specificity, positive predictive value, negative predictive value, F_score, Youden’s Index, discriminant power, error odds ratio, diagnostic odds ratio and by receiver operating characteristic curve analysis. The accuracy of classifying the tumours into benign (hemangioma) and malignant (hepatocellular carcinoma) using contourlet coefficient co-occurrence texture feature is 96.7 %, which is higher than those obtained by other methods. The experimental results suggest that the developed computer-aided diagnosis system has a great potential and promise in the automatic diagnosis of both benign and malignant tumours of the liver. The proposed system can be extended for diagnosis of other types of liver diseases also.