ABSTRACT

Tumour detection is a process of crucial importance in oncology. Image enhancement, segmentation and classification are general problems in computer vision and are of dominant importance in medical imaging. Particularly, Computed Tomography (CT) is one of the most commonly used imaging modalities for tumour detection and diagnosis, by reason of its high spatial resolution, fast imaging speed and wide availability. Additionally, CT is the most frequently used imaging technique in the diagnosis of lung tumour. Nodules and pathological residues with varied diameter can be comfortably viewed by computed tomography. Nodules on the lung are categorized as benign or malignant. During diagnosis, nodules that are solid and atypical can be measured as malignant in some cases. However, in most cases, a solid nodule with calcification is usually categorized as benign. It is essential to diagnose nodules at early stages in order to accelerate the treatment process. Therefore, lung tumour detection and classification are challenging and difficult tasks of computed tomography in medical image processing. Furthermore, image enhancement algorithm may improve the accuracy of the tumour detection and classification processes. A number of studies applied various techniques in an endeavour to deal with enhancement issues and tumour detection in CT images. Analyzing existing literature, image enhancement system and tumour identification are well suited for lung cancer diagnosis. The primary intention of this study is to develop an efficient methodology for an automated lung tumour diagnosis.

The aim of this study is three-fold: (i) to investigate the strength and drawbacks of current medical image enhancement and tumour detection schemes, (ii) to develop and design a new approach to overcome the limitations, and (iii) to evaluate the new schemes using application scenarios
for enhancement and tumour detection of lung CT images. This thesis focuses on a complete intelligent system for medical related application. Overall, the complete intelligent system is composed of three major phases.

As an initial attempt in this direction, an image enhancement problem is formulated through Wavelet Shrinkage Adaptive Histogram Equalization (WSAHE) in order to correct the contrast and to increase the accuracy of lung tumour segmentation. This phase solves the drawbacks of adaptive histogram equalization and histogram equalization. Particularly, wavelet transform performs an important role in this phase, which helps to extract multi-resolution information. This phase totally eliminates the need of the image enhancement process in tumour detection, which is an especially desirable achievement that can hardly be found in the existing systems. A comparative analysis has been performed with some existing image enhancement researches by means of peak-signal to noise-ratio, entropy and computation time.

In the second phase, a segmentation scheme is proposed to extract the tumour region from CT images efficiently using hybridization of Cellular Automata (CA) and level set that removes the drawbacks of cellular automata. The hybridization of tumour segmentation scheme comprises the following important steps: 1) seed point selection, 2) adapting transition rule, 3) Cellular Automata (CA) operation on tumour probability map and 4) smoothing via level set operation. Initially, the tumour seeds and the background seeds are determined by using the line already drawn by the user to measure the longest diameter of the solid tumour. Subsequently, an efficient transient rule is derived to enhance tumour transition borders. After that, tumour probability map is constructed using the foreground and background strength maps with Cellular Automata (CA). Finally, the smoothing operation is performed using level set operation to extract tumour region. The performance of the
segmentation is evaluated through segmentation accuracy, spatial overlap and jaccard coefficient.

In the final phase, a tumour classification scheme is presented using Multi-Kernel Support Vector Machine (MKSVM). After the process of tumour segmentation, wavelet-based second order statistical features are extracted from the segmented benign or malignant tumour region for classification purpose. Once the feature extraction is completed, the tumour classification is done to decide whether the lung image is benign or malignant. For classification phase, an efficient classification scheme is designed using Multi-Kernel Support Vector Machine (MKSVM) that improves the performance of the Support Vector Machine (SVM). The kernel hybridization is done in support vector machine to improve the individual kernel performance. This classification system overcomes the limitation of the existing classification systems. The experimental results have demonstrated the efficacy of the proposed tumour classification approach. A comparative analysis has been performed with some existing tumour classification methods by means of accuracy, sensitivity and specificity. This algorithm was then tested on a real time data set of CT lung images, which were collected from hospitals. Experimental result shows that the proposed medical image enhancement, tumour detection and classification system achieves better performance than the existing systems. This thesis fulfilled the medical image enhancement, tumour detection and classification objectives which prove the framework to be suitable for tumour detection and classification from the clinical point of view.