

Abstract

Histological examination of biopsy slides is the gold standard for the diagnosis of skin cancer such as cutaneous melanoma. However, visual evaluations performed by pathologists are prone to inter- and intra-observer variations. In addition, it is very labor-intensive to manually analyze a whole biopsy slide due to the large amount of data involved. With recent advances in digital scanners and computational powers, automatic biopsy image analysis has been desired to assist pathologists in their clinical diagnosis. In this dissertation, several computerized algorithms that can aid towards building a computer-aided diagnosis (CAD) system for digitized skin biopsy slides are developed.

The main contributions of this dissertation are five fold. First, automated techniques are proposed to segment skin epidermis and dermis regions in skin whole slide images (WSIs). The proposed techniques segment the skin epidermis using a coarse-to-fine procedure based on thickness measurement and k-means clustering, and segment skin dermis based on a predefined depth of interest value. Second, two automated techniques are proposed to detect nuclei seeds in skin histopathological images. The first technique detects nuclei seeds based on ellipse descriptor analysis and an improved voting algorithm, while the second technique detects nuclei seeds by using generalized Laplacian of Gaussian (gLoG) kernels. Third, an automated technique is proposed to delineate nuclei boundaries in skin histopathological images. The technique segments nuclei boundaries by a multi-scale radial line scanning (mRLS) method, which incorporates image gradient, intensity variance and shape prior together for nuclei boundary determination. Fourth, a comput-

erized technique for melanocytic tumor classification in skin WSIs is developed. The technique analyzes both epidermis and dermis areas, and performs skin tissue classification by using a multi-class support vector machine (mSVM) with a set of cytological and textural features. These four set of techniques have been developed primarily for H&E stained images, which are widely used for clinical diagnosis. The nuclei detection and segmentation techniques work for both H&E and Ki-67 stained skin images. Finally, an automated technique is proposed for measuring the melanoma depth of invasion (DoI) in MART-1 stained skin histopathological images. Note that MART-1 is a melanoma specific stain typically used for melanoma grading. The proposed technique identifies the skin granular layer based on a Bayesian classifier, and computes the melanoma DoI using a multi-resolution framework with the Hausdorff distance measure.

Evaluations of proposed techniques have been thoroughly performed on a set of skin biopsy images provided by pathologists, which mainly includes 66 H&E stained skin WSIs, 40 Ki-67 stained and 30 MART-1 stained skin histopathological images. Experimental results indicate that the proposed techniques can provide superior performances compared to closely related methods in the literature. Due to the promising performance and relatively low complexity, the proposed techniques have the potential to be used for assisting pathologists in skin biopsy image analysis and disease diagnosis.