Chapter 38
An Analysis in Tissue Classification for Colorectal Cancer Histology Using Convolution Neural Network and Colour Models

Shamik Tiwari
UPES University, India

ABSTRACT

Computer vision-based identification of different tissue categories in histological images is a critical application of the computer-assisted diagnosis (CAD). Computer-assisted diagnosis systems support to reduce the cost and increase the efficiency of this process. Traditional image classification approaches depend on feature extraction methods designed for a specific problem based on domain information. Deep learning approaches are becoming important alternatives with advance of machine learning technologies to overcome the numerous difficulties of the feature-based approaches. A method for the classification of histological images of human colorectal cancer containing seven different types of tissue using convolutional neural network (CNN) is proposed in this article. The method is evaluated using four different colour models in absence and presence of Gaussian noise. The highest classification accuracies are achieved with HVI colour model, which is 95.8% in nonexistence and 78.5% in existence of noise respectively.

1. INTRODUCTION

Image processing techniques are extensively designed for assisting specialists in analysis of histological images acquired from biopsies for diagnoses and prognoses purpose. Several types of cancer can be diagnosed using CAD systems depends on image processing. Colorectal cancer is commonly found cancer, which is increasing cancer-related deaths day-by-day in the world (Aaltonen et al., 1993). Various cancers form masses of tissue referred as solid tumors. Cancers of the blood, like leukemias, usually do

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not create solid tumors. These solid tumours consist of several types of tissues with complex structures. These multiples types of tissues can be identified by histopathological evaluation of tissue samples. In histology, samples of tissue are taken from patients and then prepared using appropriate staining protocols to detect and diagnose the disease including cancer. Hematoxylin and Eosin (H&E) staining is the standard protocol applied in histology as it provides a decent summary of the tissue, the cellular constituents and moreover it noticeably displays different types of structures (Rowatt et al., 2018).

Even though manual assessment of histological slides is still crucial in clinical practices, computer vision can deliver quantitative and high-throughput analysis of the tumour tissue (Li et al., 2004). This paper investigates the performance of four colour models in convolution neural network based classification framework for the categorization of cancerous tissues. The rest of the paper is divided into six sections. Section 2 presents literature review and research gaps in the area. A summary of colour models is provided in Section 3, Section 4 presents noise model and Section 5 gives an overview of convolution neural network. Section 6 discusses experiment details including dataset, model architecture, performance metrics and results. Finally, Section 7 concludes the paper.

2. LITERATURE REVIEW

Morphological Cell Image Analysis is an area, which has received much attention with the leading requirements in both bioinformatics and biomedical uses. Morphological cell analysis used to find the cell shape, statistics, cell regularity, classification and diagnosis (Chen et al., 2012).

Another approach for tissue classification is based on texture features. Various texture-based features have been successfully utilized during last decade such as Gray-Level Co-Occurrence Matrix (GLCM) (Bergmeir et al., 2012), Haralick's textures features (Mouelhi et al., 2013), Histogram of Oriented Gradients (HOG) features (Song et al., 2013) and Colour Component Based Statistical Moments (CCSM) (Rathore et al., 2016). The wavelets are useful in multi-resolution analysis of microscopic biopsy images because they compute compact features and yields better compression than other transforms. The mean, entropy, energy, contrast homogeneity, and sum of wavelet coefficients are considered for tissue classification (Madabhushi, 2009).

Various supervised and unsupervised machine-learning methods are also used for automatic separation of tissue types in histological images by researchers. Some machine learning based frameworks for segmentation and classification of histology images utilized Support Vector Machine (SVM) (Mukhopadhyay et al., 2018), K-Nearest Neighbour (KNN) (Ye et al., 2004) and Neural Networks (Damodharan & Raghavan, 2015).

Recently, due to availability of computing power and large dataset sizes allowed the application of Convolutional Neural Networks (CNNs) which delivers state of the art performance in a broad range of image classification problems. CNNs learn useful features directly from the training image by the optimization of the classification loss function in comparison to the traditional classification models, which require handcrafted features for learning. These deep learning models have attained outstanding performance in image classification problems of different areas including medical image analysis, and specifically in histopathology image analysis (Ker et al., 2018).

The choice of the best performing colour space has been an open problem during the last years as using one space instead of another, can deliver significant improvements in certain applications of image processing. Few researchers have addressed this issue for different applications. Sural et al. have ana-