Chapter 1

Bag-of-Features in Microscopic Images Classification

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ABSTRACT

Microscopic image analysis plays a foremost role for understanding biological processes, diagnosis of diseases and cells/ tissues identification. Microscopic image classification is one of the challenging tasks that have a leading role in the medical domain. In this chapter, an overview on different classification techniques elaborated with microscopic images is presented to guide the reader through the advanced knowledge of major quantitative image classification approaches. Applied examples are conducted to classify different Albino rats' samples captured using light microscope for three different organs, namely hippocampus, renal and pancreas. The Bag-of-Features (BoF) technique was employed for features extraction and selection. The BoF selected features were used as input to the multiclass linear support vector machine classifier. The proposed classifier achieved 94.33% average classification accuracy for the three classes. Additionally, for binary classification the achieved average accuracy was 100% for hippocampus and pancreas sets classification.

INTRODUCTION

Medical and biological image analysis/ processing provide a forum for the dissemination of extensive research results. Medical imaging advances so promptly to develop more techniques and algorithms that facilities accurate analysis. Image enhancement, restoration, registration, segmentation and classification are considered the main digital image processing requirements for medical applications. Various medical imaging modalities and acquisition systems are used to capture medical images. Such modalities are the X-ray, Magnetic resonance imaging (MRI), Computed tomography (CT), Endoscopy, Ultrasound and Positron emission tomography (PET).

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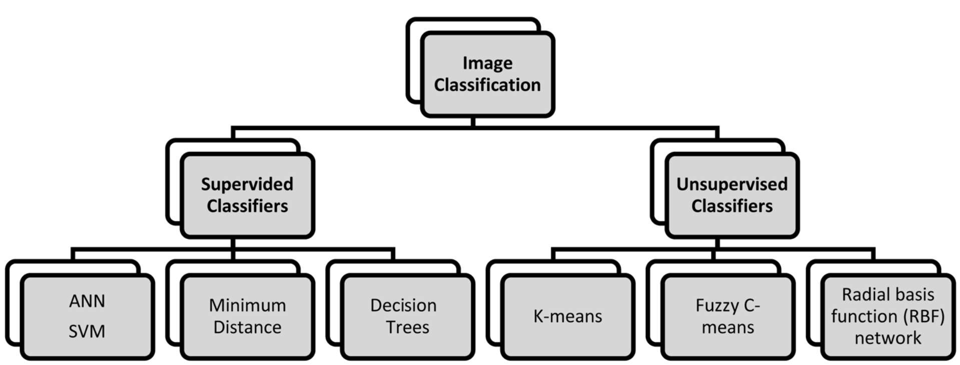
Recently, microscopic imaging technology becomes one of the utmost extensively used research tools to assist physicians in diagnosis/ prognoses of the patient conditions as well as the biologists in understanding the complex processes of cells (Mohapatra *et al*., 2010). Histology is concerned with the study of microscopic structure of cells and tissues. Cells and tissues analysis assists the diagnosis of a vast number of diseases. Manual analysis has numerous evaluation drawbacks such as time consuming, less accuracy and dependency on the operator skills. Otherwise, the automated analysis performed quickly and provided precise results.

Image analysis elaborates complex algorithms to count, identify and characterize cellular shape, color, and tissue samples' quantity using image pattern recognition schemes. Tissue image analysis can be employed to ensure/ measure the presence of cancer cells in a biopsy of a malignant tumor and determine the recurrence prediction rate of cancer. Conventional image analysis and processing tools are involved in histology image analysis. It includes preprocessing, image segmentation, feature extraction and classification. Since, texture characterizes any geometric structure of the image gray levels. Thus, texture is imperative in many application of computer image analysis for the classification of segmented images based on local spatial variations of intensity of color (Smitha *et al*., 2011). Texture analysis provides significant information on the spatial character of the gray levels and the relationship with their neighborhood.

Classification is the most imperative aspect of texture analysis that interests with the search for a specific texture among different predefined texture categories. It is performed using statistical methods and algorithms that describe the texture descriptors and then perform the classification process. Medical and microscopic image databases contain images of different modalities taken under varied conditions with variable accuracy of annotation that can be used for image classification. There is an exponential increase in medical images classification using different classifiers and algorithms. Several classifiers are engaged for the classification process such as: Support Vector Machine (SVM), artificial neural network (ANN), Probabilistic Neural Network, nearest neighbor classifier, and K-means.

Generally, image classification techniques can be categorized into two main groups, namely supervised classification and unsupervised classification. Supervised classifier (parametric method), which requires an exhaustive training phase of the classifier parameters. It involves the act of obtaining the information class of data sets, and classifying the test data by identifying training data's best possible match (Supardi *et al*., 2012). In contrast, unsupervised classifier does not require training and relies directly on the data to execute the classification process (Oren *et al*., 2008). Figure 1 illustrates these two main classification categories.

Figure 1. Various medical image classification techniques



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