Abstract. In the Automatic recognition of blood cell images, the color blood cell images are usually transformed into grayscale images for feature extraction, which result in losing plenty of useful color information. Although the sparse coding based linear spatial pyramid matching (ScSPM) is popular in grayscale image classification, the sparse coding methods in ScSPM fail to extract color information. In this paper, we proposed a novel joint sparse coding SPM (JScSPM) method by using the joint trained joint codebook. The joint codebook is able to represent the inner color correlation among different color components, and the individual color information of each color channel as well. JScSPM method was then applied to classify color blood cell images. The experimental results showed that the proposed method achieved mean 3.1% and 6.6% improvements on classification accuracy, compared with the majority voting based ScSPM the original ScSPM, respectively.

1 Introduction

The analysis of blood cells in microscope images is one of the most important steps in clinical hematological procedures. Consequently, the image-based automatic counting and classification of blood cells have attracted lots of attention.

In current classification system, the colored blood cell images are usually transformed into grayscale images for further feature extraction, in order to simplify algorithms and reduce the computational complexity. However, plenty of useful color information will be discarded. Furthermore, there are few special designated color feature descriptors for blood cell images.

In recent years, the sparse coding technique has been successfully used in image classification task [1], not only directly as a classifier, but also embedded in the classification framework [2]. The sparse coding based linear spatial pyramid matching (ScSPM) is a popular sparse coding embedded classification method developed on spatial pyramid matching (SPM) [2, 3]. It computes a spatial pyramid image representation with sparse coding instead the vector quantization [2, 3]. The ScSPM and its variations [2, 4, 5] have achieved great success in image classification. The main improvements in ScSPM mainly focus on applying different regularization terms for
sparse coding [4, 5] instead of adopting new sparse coding paradigm. Furthermore, ScSPM is usually applied to classify grayscale images. When dealing with color images or any other types of vector-valued images, one would either convert it into grayscale image, or process different color channels as separate images and then combine the features at the end. The existing sparse coding methods used in ScSPM fail to consider the inherent correlation among different color components of the vector-based images.

Recently, the joint sparsity model (JSM) for sparse coding has achieved great success in image processing and analysis [6-14]. Among these JSMs, one category (named JSM-1) is very suitable to represent color images, in which all signals share a common sparse component, and meanwhile each individual signal has a sparse innovations component [15]. As different color components have same scenes, there exist common and shared information among them. Therefore, the inter-correlation among RGB channels could be represented by the common sparse component, while the unique portion of each color channel image is characterized by the sparse innovation component. This JSM-1 has been applied to image fusion [6, 7], denoising [14], and restoration [11]. To the best of our knowledge, JSM-1 has not been used in classification framework.

In this paper, we proposed a Joint Sparse Coding SPM (JScSPM) method for the classification of color blood cell images. The joint codebook construction and joint sparse coding are acted as a way to fuse inner-common and individual color information, which makes it easy to extract color descriptor, instead of special designated color features. The main contributions of our work are threefold: (1) we apply the JSM-1 to the classification framework for the recognition task; (2) we propose the joint sparse coding SPM (JScSPM) method with JSM-1 for the classification color image; (3) we apply the JScSPM method to discriminate color blood cell images.

2 Joint Sparse Coding SPM with Joint Sparsity Model

The difference between our JScSPM and the original ScSPM is that a joint sparse coding strategy is adopted to replace the original sparse coding, and it is used to represent color information. See Fig. 1, and the flowchart of joint codebook construction and joint sparse coding is shown in Fig. 2.

In the original ScSPM, let \( X \) be a set of \( D \)-dimensional local descriptors extracted from a gray image, i.e. \( X = [x_1, x_2, ..., x_N] \in \mathbb{R}^{D \times N} \). The sparse coding method in ScSPM is to solve the following optimization problem [2]:

\[
\arg\min_{\alpha} \sum_{i=1}^{N} \|x_i - D\alpha_i\|^2 + \lambda \|\alpha_i\|_1 \quad \text{s.t.} \quad \|d_k\| \leq 1, \quad \forall k = 1,2,...,K
\]  (1)

where \( \mathbf{C} = [\alpha_1, \alpha_2, ..., \alpha_N] \) is the set of sparse codes, and \( \mathbf{D} = [d_1, d_2, ..., d_K] \in \mathbb{R}^{D \times N} \) is a over-complete codebook trained with the local descriptors of gray image.

Similar to the strategy adopted in above-mentioned JSM-1 [15], all signals are represented as the summation of a common sparse component with a sparse innovation component; that is, for color image,