Chapter 2.6
Automatic Analysis of Microscopic Images in Hematological Cytology Applications

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ABSTRACT

Visual examination of blood and bone marrow smears is an important tool for diagnosis, prevention and treatment of clinical patients. The interest of computer aided decision has been identified in many medical applications: automatic methods are being explored to detect, classify and measure objects in hematological cytology. This chapter presents a comprehensive review of the state of the art and currently available literature and techniques related to automated analysis of blood smears. The most relevant image processing and machine learning techniques used to develop a fully automated blood smear analysis system which can help to reduce time spent for slide examination are presented. Advances in each component of this system are described in acquisition, segmentation and detection of cell components, feature extraction and selection approaches for describing the objects, and schemes for cell classification.

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INTRODUCTION

Traditionally, visual microscopical examination is used to perform quantitative and qualitative analysis of blood smears, which are very valuable for diagnosis of many diseases. Human visual analysis is tedious, time consuming, repetitive and has limited statistical reliability. Thus, methods that automate visual analysis tasks have been developed for enhancing the performance in hematological laboratories.

Since the end of the 80's, commercially available systems for automatic quantification of blood cells allow to count the numbers and types of different cells within the blood (Beckman Coulter LH series, Sysmex XE-2100, Siemens ADVIA 120 & 2120). These counters use flow cytometry techniques, which measure some physical and/or chemical characteristics of blood cells going through a detector of light, fluorescence or electrical impedance, allowing to identify the type of cell. Although quantification results are very precise, some morphological abnormalities can be misidentified or not detected by the machine, and then microscopic blood smear analysis is required. The development of automated methods for classification of blood cells from digitized blood smears started in 70´s decade (Miller, 1972; Bentley & Lewis, 1975) and is now a current problem in pattern recognition. So far, fully automated microscopy systems are under development, which combine advances in image processing and machine learning for reducing the human intervention in the process (Ceelie et al., 2006).

An automatic analysis system for blood or bone marrow smears generally consists in the phases illustrated in Figure 1. First, image preprocessing of the digitized smears is applied for suppressing noise and improving luminance and contrast differences in the images. Second, a segmentation process is applied for finding and isolating the interest objects in the image. The third phase aims at characterizing the objects previously extracted to be used in the last phase, i.e. classification stage. Feature selection can be applied to reduce the redundant information. Selected features are used as input to the classification method which makes the decision about the class assignment.

Figure 1. Automatic analysis of blood and bone marrow smears