Optimal Implementation of White Blood Cells Detection System

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Abstract— *WBC has three major blood cell types, namely, erythrocytes (red), leukocytes (white), and platelets. Manual classification is time consuming and susceptible to error due to the different morphological features of the cells. This paper presents an intelligent system that simulates a human visual inspection and classification of the three blood cell types.The proposed system comprises two phases: The image preprocessing phase where blood cell features are extracted via global pattern averaging, and the neural network arbitration phase where training is the first and then classification is carried out. Experimental results suggest that the proposed method performs well in identifying blood cell types regardless of their irregular shapes, sizes and orientation, thus providing a fast, simple and efficient rotational and scale invariant blood cell identification system which can be used in automating laboratory reporting.*

Keywords— Blood cells, Intelligent identification, Neural network, Pattern averaging

I. INTRODUCTION

The three blood cell types can be differentiated from each other by their different sizes and different morphological features, such as the presence or absence of a nucleus in the cells and the shape of the nucleus. Additionally, other differentiating features can be used, such as area, eccentricity, compactness, area of central pallor (for red cells), nucleus position, number of nuclear lobes, nucleus cytoplasm ratio and color of nucleus and cytoplasm [2].

The process of automatic blood cell classification involves acquisition, detection, feature extraction, and classification. During acquisition, the blood smear is magnified to a suitable scale under the microscope, and then transformed into a digital image using a modern charge-coupled device (CCD) camera. In detection, cell segmentation yields a number of single-cell images, and each single-cell image is segmented into three regions: cell nucleus, cytoplasm, and background. During feature extraction each segmented cell is analyzed to form a feature vector from color, shape, and texture features. Finally, in classification, each blood cell is labeled by the classifier according to its feature vectors [3].

Recent studies have suggested different methods for blood cell image segmentation, which is part of the cell detection process. Buxton and Abdallahi [4] proposed a multidimensional extension of the Otsu algorithm for identifying red blood cells. Scotti [5] suggested a method for enhancing blood cell microscope images by removing the undesired microscope background, and suggested a segmentation strategy to identify white cells.

In general, databases that are used in developing blood cell classification systems rely on microscopic cell images. The variety of information in these images makes cell identification difficult for machines due to the different sizes, shapes and colors. However, as our novel approach to cell identification is based on simulating a human expert's visual recognition, who is normally able to identify the three types of cells despite the above problems, the different morphological features, sizes and rotations of cells are not considered as an obstacle in this work and are left to the neural network to learn via global pattern averaging.

The development and implementation of the proposed intelligent identification system uses 360 single-cell images representing 90 different blood cells (30 red, 30 white, and 30 platelets). Fig. 1 shows examples of the different blood cells. Each cell has been rotated by 90° and its image is stored thus producing four images for each cell (at 0°, 90°, 180° and 270°), as shown in Fig. 2. The rotations are aimed at testing the trained system's rotational invariance capability. The obtained original color images were then converted from RGB to gray level, and resized to 70 × 70 pixels, in preparation for the feature extraction phase.

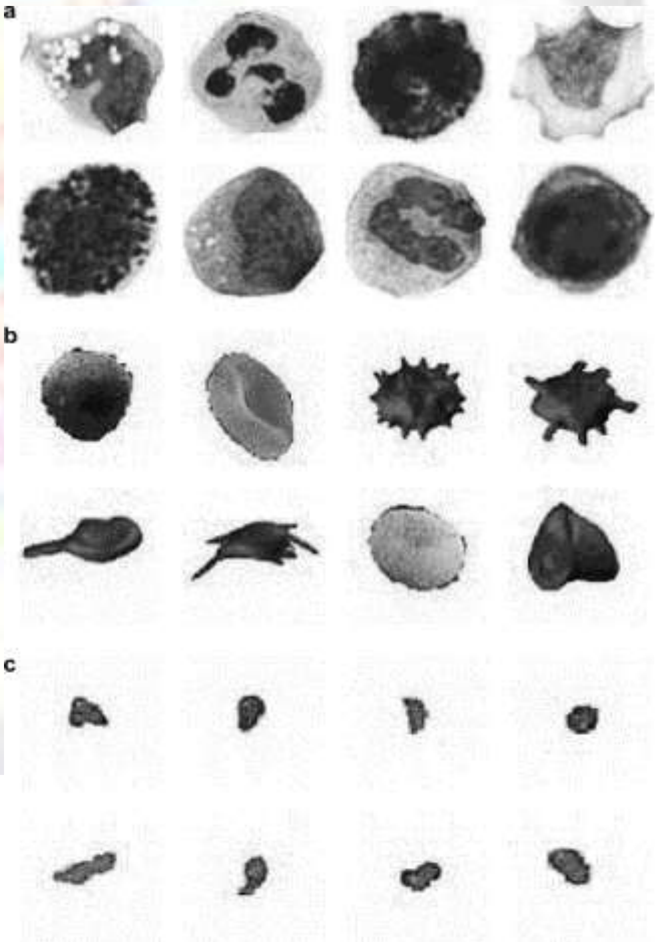

Fig-1: Blood cell examples of varying shapes and sizes. (a) Red blood cells; (b) white blood cells; (c) platelets blood cells.

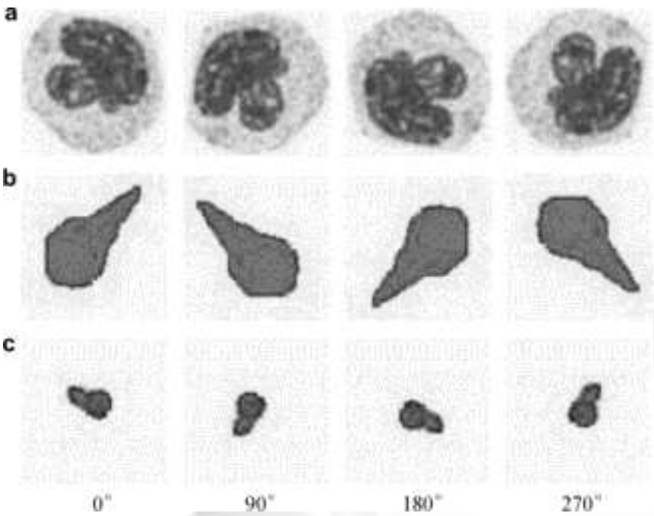

Fig-2: Examples of blood cell rotations by 90°. (a) Red; (b) white; (c) platelets.

II. Conclusion

A novel approach to blood cell identification, based on simulating a human expert's "look" and "identify", has been introduced in this paper. The "look" effect is approximated via global pattern averaging. When we, humans, have a quick "look" at a familiar object (blood cell types are familiar to a human expert), we do not observe the detailed features but rather a general global impression of the object. This in our hypothesis can be applied to identifying blood cells which usually have irregular shapes, different sizes and colors. The "identify" effect is simulated by training a simple but efficient neural network. The ability of the trained neural network to identify blood cells, despite the irregular non-uniform shapes, is due to training the network using feature approximations or "fuzzy" feature vectors rather than using "crisp" feature vectors. The averaged patterns are true representations of a cell image regardless of its size or orientation.

The system presented in this paper was implemented using 360 single-cell images of the three major blood types (red, white and platelets). The 360 images represented 90 different blood cells; each rotated by 90°, thus providing four different orientation for each cell. The images of the rotated cells were only used for testing the trained neural network, and to demonstrate the proposed system's rotational invariance.

Fig-3: Screen shot (a)

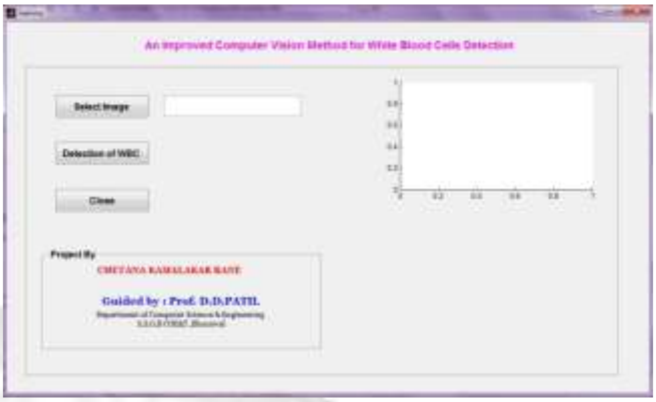

Fig-4: Screen shot (b)

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