BLOOD CELL IMAGE SEGMENTATION AND COUNTING

[1]VINOD V.KIMBAHUNE ,

[1]M.E (Second Year) Department of Information Technology, Sinhgad College of Engineering, Pune 41

[2]MR. NELESH J.UKE

[2]Assistant Professor, Department of Information Technology, Sinhgad College of Engineering, Pune 41

ABSTRACT

In traditional terms, blood cell analysis i.e. complete blood cell count (CBC) is done as a "convention". In which it measures the red blood cells, white blood cells usually assesses the size and shape of red blood cells as per old delayed procedures. Today in this busy hectic schedule; pathologists need some help in terms of software for blood cell analysis. Thus, the idea of our paper is to serve the pathologists, medical technicians for the same, by using Image Processing techniques as Pulse-Coupled Neural Network (PCNN) has been shown to be a very powerful image processing tool. Here we present a method for blood cell image segmentation and counting. The method can not only de-noise and segment blood cell image perfectly, but also can well eliminate disturbed objects which will serious impact the blood cell counting step, and is able to segment specific isolated cell from its background.. It is a novel use of Image Processing, as we take clean and properly stained blood cell sample image for our software, to assist the pathologists and medical technicians.

Keywords: ***Pulse-Coupled Neural Network (PCNN)***

1. INTRODUCTION

Blood carries out many vital functions as it circulates through the body. It transports oxygen from the lungs to other body tissues and carries away carbon dioxide. It carries nutrients from the digestive system to the cells of the body, and carries away wastes for excretion by the kidneys. Blood helps our body fight off infectious agents and inactivates toxins, stops bleeding through its clotting ability, and regulates our body temperature. Doctors rely on many blood tests to diagnose and monitor diseases. Some tests measure the components of blood itself; others examine substances found in the blood to identify abnormal functioning of various organs. Hence, we here propose a software system which will assist pathologists to detect blood cell count and help to find out the diseases. This information can be very helpful to a physician who, for example, is trying to identify the cause of a patient's diseases.

In blood cell image detection, the task is usually split into two stages; one is image enhancement, for the purpose of reducing noise, and the other is detection of blood cell characteristics. In our proposed stage, image filtering and enhancement is one part of stage and the detection in the later stage. Convolution filtering is often used to reduce the effects of noise in images or to sharpen the detail in blurred images. Counts are calculated by scanning the image and using Edge Detection Algorithm.

Also, because of cells' complex nature, it still remains a challenging task to segment cells from its background and count them automatically. The Pulse-Coupled Neural Network (PCNN) has been shown to be a very powerful image processing tool, so, after studying the characteristic of PCNN and morphology we present a method for blood cell image segmentation and counting. The method can not only de-noise and segment blood cell image perfectly, but also can well eliminate disturbed objects which will serious impact the blood cell counting step, and is able to segment specific isolated cell from its background. Experimental results show that the algorithm is effective and the results are desirable.

In the field of biomedicine, especially in the research of cellular embryology and pathology, and in the exploration of wound cicatrisation, immunity, the metabolism and invasion mechanisms of tumor cells, the research on the relation between cellular structure and function is an all-important work. And the quantitative analysis of cell images is one of foundations of the research. Because of cell images' own complex nature it is very difficult to segment cells from the background and count them automatically.

After analyzing the principle nature of PCNN, we use an algorithm for cell segmentation and counting, described briefly as follows: Firstly, the image is de-noised using PCNN model combined with median filter. Then, in order to segment blood cells form its background we adopt the PCNN segmentation algorithm based on minimum cross-entropy.

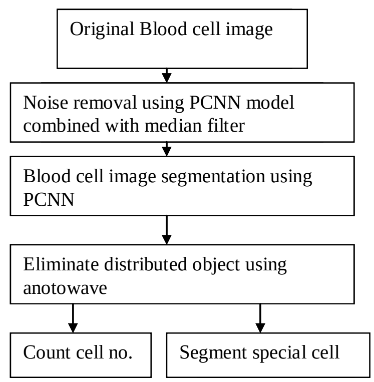

Fig 1: Overall steps of the algorithm

Finally, the cells' number can be counted and a specific cell can be segmented from its background through labeling each blood cell.Fig.1 shows the overall steps of the presented algorithm:

2. STATE OF THE ART

Recently, PCNN has been used to perform various important image processing tasks, such as edge detection, segmentation, feature extraction and pattern recognition. This paper proposes a new algorithm for a class of binary images thinning by using two PCNNs. The proposed algorithm can be used to extract the skeletons of such images, which separate the original images into two individual regions (namely region A and region B), as circularity-like images and ribbon-like images. The main procedure of the algorithm is listed below.

1. Getting input images: the Image-inner and the Image-outer. The Image-inner (Image-outer) is obtained by filling the region A (region B). The Image-inner is used as the input of a PCNN (namely PCNN1), and the Image-outer is used as the input of the other PCNN (namely PCNN2). The two PCNNs are identical except their inputs.

2. Getting thinning result: At each firing step, by using the pulses meeting criterion (this criterion will be given in Section 4) and the outputs of the two PCNNs, thinning result is obtained.

3. Getting final thinning result: When the stopping criterion is met, the final thinning result is obtained.

In the procedure above, the crucial step is to specify the parameters of the PCNN. Once the parameters are specified, the firing process of the PCNN can be determined. The proposed algorithm gives the specification of the parameters of the PCNN, which makes the implementation of the algorithm easier.

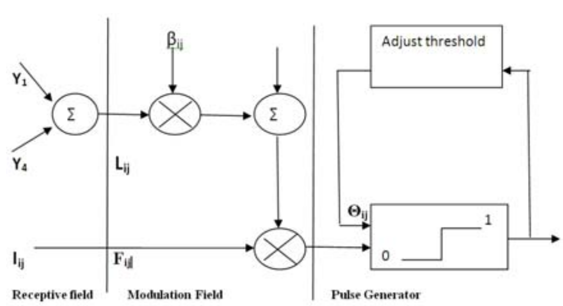

Fig 2: The structural model of the pulse coupled neuron Nij.

Recently, various pulse coupled neuron models have been proposed for different applications. The internal structure of a single neuron Nij we used for the network is shown in Fig.2. In Fig. 2, Iij is the input from external sources and Yk = $(1 \leq k \leq 4)$ is the input from adjacent neurons. Fij and Lij are feeding input and linking input of the neuron Nij, respectively. In the modulation field, internal activation Uij is calculated by

$$Uij = Fij\ (\ 1 + \beta ij\ Lij\ )$$

Where βij is the linking strength. In the pulse generator, Uij is compared with the neuron's threshold Θij, if Uij is greater than Θij, the neuron produces a spike, and its threshold is immediately raised to prevent it from firing again. The output Yi;j is represented as follows:

$$Yij = \begin{cases} 1 & Uij > \Theta ij \\ 0 & Otherwise \end{cases}$$

3. NOISE REMOVAL (MEDIAN FILTERING)

Images are usually degraded by various noises in the signal transmission, coding and decoding processing. The results of image processing such as image segmentation, feature extraction and image recognition will to a great extent depend on the noise removal results. So de-noising an image is of great importance in image processing. Recently, a rapid advance in mathematics gave impetus to the research and development of digital image processing. We find that PCNN possesses a distinctive characteristic that neurons in the same region with similar intensity tend to fire synchronously. Therefore, if a neuron cannot fire synchronously with others around it, it can be thought to be degraded heavily by noise. So we can locate the noised pixel according to the firing state and then remove it using proper algorithms such as Median filter. This avoids false operation on non noise pixels. Therefore, the algorithm can not only remove noise, but also can keep the details of the image well. The result is well illustrated in Fig.3 (b). The original blood cell image is shown in Fig.3 (a)

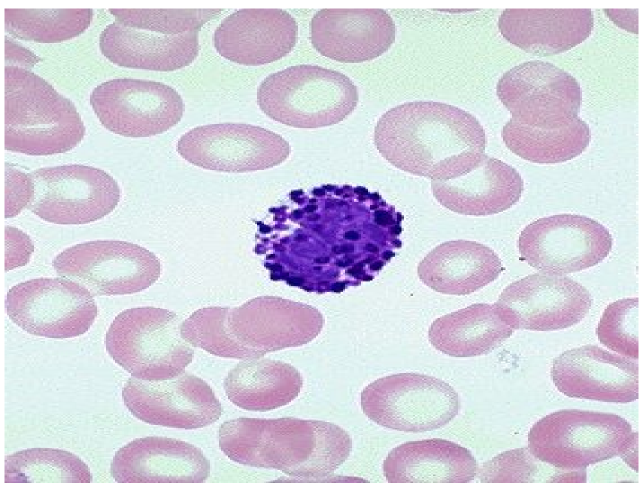

Fig. 3 (a) : Original Blood Image

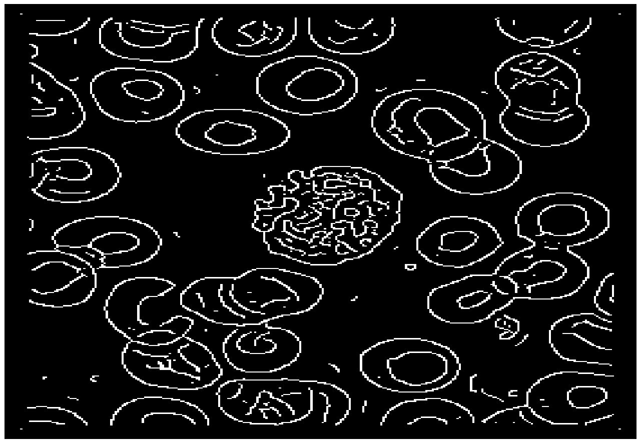

Fig.3 (b) : Image after applying PCNN for Segmentation and counting

The First figure shows the original blood image .After applying PCNN which is used for segmentation and counting this image is first converted in to gray scale and then noise is removed. Noise is any undesirable signal. Noise is everywhere and thus we have to learn to live with it. Noise gets introduced into the data via any electrical system used for storage, transmission, and/or processing. In addition, nature will always plays a "noisy" trick or two with the data under observation. When encountering an image corrupted with noise you will want to improve its appearance for a specific application. The techniques applied are application-oriented. Also, the different procedures are related to the types of noise introduced to the image. Some examples of noise are: Gaussian or White, Raleigh, Shot or Impulse, periodic, sinusoidal or coherent, uncorrelated, and granular. When performing median filtering, each pixel is determined by the median value of all pixels in a selected neighborhood (mask, template, window). The median value **m** of a population (set of pixels in a neighborhood) is that value in which half of the population has smaller values than **m**, and the other half has larger values than **m**. This class of filter belongs to the class of edge preserving smoothing filters which are non-linear filters. These filters smooth the data while keeping the small and sharp details.

Median filtering is a simple and very effective noise removal filtering process. Its performance is particularly good for removing shot noise. Shot noise consists of strong spike like isolated values.

4. IMAGE SEGMENTATION

Image segmentation is the most important step and a key technology in image processing, and it will directly affect subsequent processing. With mathematical theories, image segmentation has achieved great progress and a lot of novel segmenting algorithms have been proposed. But most algorithms have their own drawbacks. As for cell images, owing to the complex nature, it still remains a challenging task to segment and count them. Extensive researches show that PCNN is very suitable for image segmentation and can get a perfect result, which is primarily due to the inherent ability of PCNN.

5. ALGORITHAM FOR BLOOD CELL COUNTING AND SPECIFIC CELL SEGMENTATION

Blood cell counting is commonly used in various pathological and other biomedical researches. Generally we can roughly estimate the cell number with eyes under microscopic. This method is usually tedious, time-consuming and bad for eyes. In this we use the method which we count the cell number automatically:

Firstly, find any connected components which may be 4-connected objects or 8-connected objects in a binary image, that is to say, any pixels linked in horizontal, vertical or diagonal direction are considered as a whole (object). For the image Fig.5(e), where the objects are the blood cells in the binary image;

Secondly, we should mark the blood cells (the connected Components) with serial numbers. We can label the connected component by a certain number which represents its gray scale and serial number. Then each object will appear in a different gray scale, so the objects are easier to distinguish than in the original image. The pixels labeled 0 are the background. The pixels labeled 1 make up the first object, the pixels labeled 2 make up the second object, and so on, as shown in Fig.3 Using the morphological feature of circle or ellipse shape of cells, n is selected as 8, which means that any 8-connected objects (such as circle or ellipse shape blood cell) in the binary image will be counted..

5.1 Contour Tracing Algorithms

What follows are four of the most common contour tracing algorithms. The first two, namely: the Square Tracing algorithm and Moore-Neighbor Tracing are easy to implement and are therefore used frequently to trace the contour of a given pattern. Unfortunately, both of these algorithms have a number of weaknesses which cause them to fail in tracing the contour of a large class of patterns due to their special kind of connectivity. The following algorithms will ignore any "holes" present in the pattern. For example, if we're given a pattern like that of Figure below, the contour traced by the algorithms will be similar to the one shown in Figure (the blue pixels represent the contour). This could be acceptable in some applications but in other applications, like character recognition, we would want to trace the interior of the pattern as well in order to capture any holes which identify a certain character

As a result, a "hole searching" algorithm should be used to first extract the holes in a given pattern and then apply a contour tracing algorithm on each hole in order to extract the complete contour.

Square Tracing Algorithm:-

The idea behind the square tracing algorithm is very simple; this could be attributed to the fact that the algorithm was one of the first attempts to extract the contour of a binary pattern. Given a digital pattern i.e. a group of black pixels, on a background of white pixels i.e. a grid; locate a black pixel and declare it as your "**start**" pixel. (Locating a "**start**" pixel can be done in a number of ways; we'll start at the bottom left corner of the grid, scan each column of pixels from the bottom going upwards -starting from the leftmost column and proceeding to the right- until we encounter a black pixel. We'll declare that pixel as our "**start**" pixel.)
Now, imagine that you are a bug (ladybird) standing on the **start** pixel as in figure below. In order to extract the contour of the pattern, you have to do the following:

every time you find yourself standing on a black pixel, turn left, and every time you find yourself standing on a white pixel, turn right, until you encounter the **start** pixel again.
The black pixels you walked over will be the contour of the pattern.

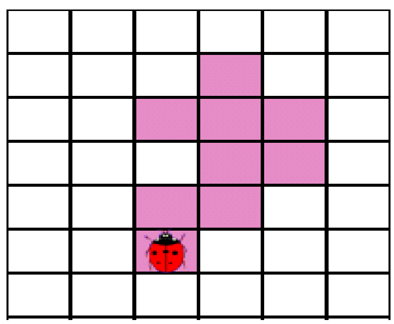

Fig. 4: Square Tracing Algorithm

The important thing in the square tracing algorithm is the "sense of direction". The left and right turns you make are with respect to your current positioning, which depends on the way you entered the pixel you are standing on. Therefore, it's important to keep track of your current orientation in order to make the right moves.

Algorithm

The following is a formal description of the square tracing algorithm:

Input: A square tessellation**, T,** containing a connected component **P** of black cells.

Output: A sequence **B** $(\mathbf{b_1}, \mathbf{b_2}, ..., \mathbf{b_k})$ of boundary pixels i.e. the contour.

Begin

- Set **B** to be empty.

- From bottom to top and left to right scan the cells of **T** until a black pixel, **s,** of **P** is found.
- Insert **s** in **B**.
- Set the current pixel, **p**, to be the starting pixel, **s**.
- Turn left i.e. visit the left adjacent pixel of **p**.
- Update **p** i.e. set it to be the current pixel.
- While **p** not equal to **s** do

If the current pixel **p** is black

- insert **p** in **B** and turn left (visit the left adjacent pixel of **p**).
- Update **p** i.e. set it to be the current pixel. else
- turn right (visit the right adjacent pixel of **p**).
- Update **p** i.e. set it to be the current pixel.

end While

6. CONCLUSIONS

This system has implemented the segmentation part and after testing this system it is concluded that, it is more timely efficient than the existing systems. It is reliable and cost effective than automated method. The aim of this system is to provide CBC i.e. complete blood Cell Count, which has been achieved by using the Powerful Image processing technique.

This system is more efficient in reducing the valuable time than manual system. The system is user friendly so that the pathologist can observe the blood cell sample image in different views. Also pathologist can get the result of blood cell test within 20 seconds to 1 min. as tested.

Also live comparison is down, the results of this system with existing one in laboratory, and they proved to be correct as guaranteed by the pathologist.

Using image processing technique, it can count the number of RBC's and platelets separately. Also it can count types of WBC's separately.

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