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Segmentation by an Improved Mathematical Morphology Approach

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Abstract: Current researches in medical diagnosis, chemotherapy, surgery and medical therapy need, use bio-images to detect diseases. Research objective is to increase the recognition rate of abnormal blood cells. For that, we have employed some morphological operators. We have developed an algorithmic processing which essentially focuses on the detection, the description, and characterization of abnormal objects. The proposed approach facilitates the interpretation and the pathologies diagnostic of the abnormal blood cells. Experimental results which are adopted by the proposed method are very satisfactory for cancer cells detection.

Keywords: Medical diagnosis, morphological operators, abnormal blood cells, cancer

1 Introduction

In the medical field, the use of image processing is considered as an indispensable tool due to its techniques for images automatic analysis or semi-automatic using computer systems. These systems allow getting a new way of thinking by obtaining new quantitative and objective measurement techniques. The challenge of computer systems is to help the doctors to secure their diagnosis, thus to make it more reliable a. The advantages are very numerous: the establishment of a reliable diagnosis can improve significantly the quality of the cancers screening and thus to foster the prevention. The aim of these systems is to model and to develop tools for the processing and analysis of medical images using the morphological operators to extract from them the useful information to do the diagnosis or to reveal details about an organ. For that, researches focuses on the use of mathematical morphology approaches based on the concepts of aggregation. Since their appearance in 1964, theses methodologies know a growing success and contribute to garnish. These methodologies have been introduced by Matheron [1] where it is considered as a basic theory for the analysis of space structures. It is called morphology in the sense that it allows to analyze the forms and the surfaces of objects, and mathematics in the sense in which the analysis is based on the theory of ensembles (topology). The morphological operations aim to simplify the images and preserving at the same time their essential shape characteristics by removing the unnecessary Residues [2]. They have been used in various areas like in the recognition of objects, the enhancement of images, and the texture analysis [3], the extraction of the primitive and the determination of the rules placement of these primitives [4]. They have been also used in remote sensing and in materials characterization. Actually, the mathematical morphology provides powerful tools (filtering, segmentation) in all disciplines where the quantitative analysis of images is needed. Although, Due to its advantages, the mathematical morphology is widely used in several fields are, especially for medical purposes like in the surgical, the diagnostic or for therapeutic practices [5–7]. One of the most important medical applications is the detection of abnormal cells to help the diagnostic of cancerous cells. This problem have been aborted with different methods, in [8] the analysis textural is used for automatic detection of leukocytes we can find a review on the imaging and cancer in [9] As well the authors of [10]. Have proposed a method for the detection of colon cancer automatic using the extraction of GLCM textures and support vector machines (SVM) for classification. This method achieves an accuracy of 96.67 % to differentiate cancerous and non-cancerous

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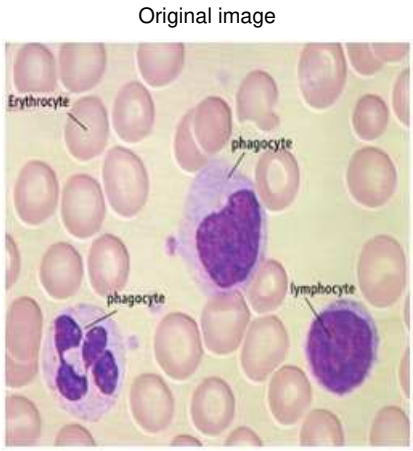

Fig. 1: Blood cell

cells. The detection of the brain tumor using networks of neurons have been proposed in [11]. This article proposes a new approach of abnormal blood cells detection by combining many mathematical morphology operations of image analysis [12–14] . We have applied our tests on samples of bio-images (blood cells) in the aim to identify anomalies (its size, shape or even its position) [15] the proposed approach provides an effective means to characterize the properties of the leukemia at the level of blood. We have measured the texture [16] of information at different points in time to allow tracing the disease progress and assessing the effectiveness of our method. The rest of this paper is organized as follows: In Section 2 illustrates the medical context of our work. In Section 3, we explain the details of our proposed approach. Section 4 reports the experimental results, and Finally, Section 5 presents the conclusion and the prospects of this work .

2 Context Medical

In this section, we present the medical context [17–19] in relation to our work. The morphological operators used in our study rely on the knowledge of the characteristics of abnormal blood cells (leukemia) [20]. The blood is composed of blood cells in suspension in the plasma (as shown in the Figure 1.). The whole is content in the blood vessels.

Cancers including leukemia and lymphoma can cause uncontrolled growth of an abnormal type of blood cell in the bone marrow, resulting in a greatly increased risk for infection and or serious bleeding.

3 Proposed Approach

In this part, we illustrate the progress of our proposed algorithmic processing until obtaining a final result which visualizes the detection of abnormal blood cells. First, we begin classically by a step pre-processing which consists on filtering the input image, then we proceeded to the calculation of a gradient magnitude. After that, the implementation of the different morphological operators is carried out, the general organization of our proposed algorithm for abnormal blood cells detection is represented in the diagram of Figure 2. In what follow, we

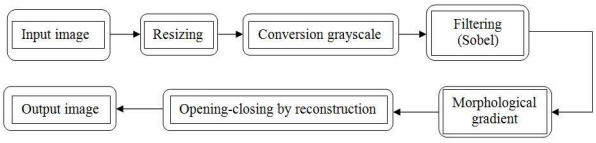

Fig. 2: Block diagram of algorithmic processing

will define in detail each step of our algorithm:

3.1 Display and resizing the image processed + conversion to grayscale

This step consists on performing the next operations on our the image:

- –Loading a medical image (patient reach the lymphoma) in RGB.
- –Making all images at the same size of 256*256 to facilitate the next manipulations.
- –Converting the RGB image into grayscale.

3.2 Filtering (operator Sobel)

This step is very essential to prepare the image for the next phases. Hawses have used the operator 'Sobel' to accomplish the task of filtering. We have choose this kind of filter because it can help us in the determination of the morphological gradient. We use the grayscale image, to extract each of vertical and horizontal contours from the two masks of Sobel. The resulting image is the module of the gradient where the most clearer pixels indicate the contours. Then, a threshold is defined as to show the contours in white.

3.3 Calculation of morphological gradient

- –The gradient gives information about the existing variations in the image. There are a considerable

number of techniques for calculating the discrete gradient. In most cases, the gradient is calculated through a convolution product. The evaluation of the different approaches shows that they all produce similar results for the majority of applications [21].

–In others words, the gradient is a vector characterized by its amplitude and its direction. The amplitude is directly related to the amount of local variation in the gray levels. The simplest method to estimate a gradient is therefore to make a calculation of one-dimensional variation, by having chosen a given direction. We calculate the gradient as:

$$G_d(x,y) = (i * W_d)(x,y) \quad (1)$$

Where W_d designates the operator to bypass in the direction of d and $*$ the product of convolution.

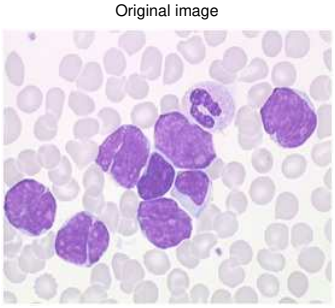

Fig. 3: The processed image

$$G_d(x,y) = Sum_i = -m, +mSum_j = -n, +nI(x+i, y+i) \quad (2)$$

In this discrete version, the size of this operator is given by the Torque (m,n)). Except in very particular case, we always put $m = n$

3.4 Morphological operators

The basic operations in mathematical morphology are the erosion, dilation, opening and closing. In our proposed algorithm we operated by using the opening and closing by reconstruction, reconstruction of morphological and squelettization to clean the bottom of the image and be able to detect the target objects.

–The dilatation of an image f by a structuring element k, denoted by $f \oplus k$, is defined by:

$$(f \oplus k)(x,y) = max\{f(x+m, y+m) \oplus k(m,n)\} \quad (3)$$

For any $(m,n) \in k$ and$(x+m, y+n) \in F$. For any$(m,n) \in k$ and$(x+m, y+n) \in F$

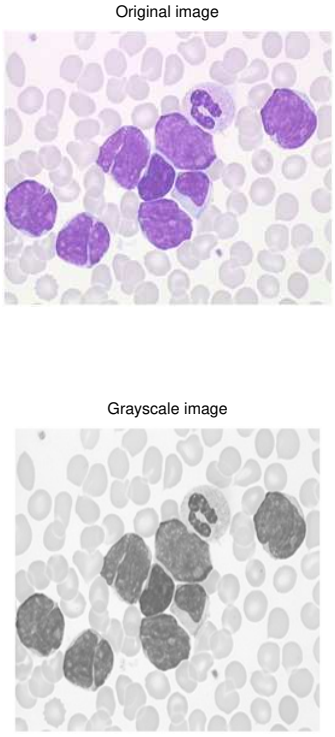

Fig. 4: Image converted to grayscale: (a) original image and (b) grayscale image.

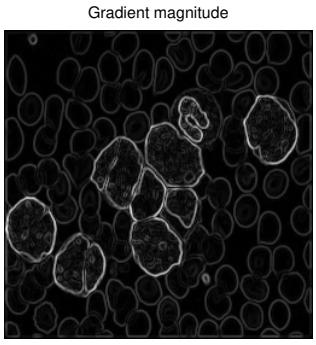

Fig. 5: Using morphological gradient

Fig. 6: Abnormal blood cells detection using opening-closing by reconstruction.

–The erosion of f by k , denoted by $f \ominus k$, is defined by:

$$(f \ominus k)(x,y) = min\{f(x+m,y+n) \ominus k(m,n)\} \quad (4)$$

For any $(m,n) \in kand(x+m,y+n) \in F$

–The opening and closing are defined from these two basic operations. The closing is a dilation followed by erosion using the same structuring element while the opening is the application of erosion followed by dilation.

–The algorithmic processing proposed contains other features of the Mathematical morphology as the opening and closing by reconstruction, the latter are more effective to eliminate the small imperfections without affecting the overall shapes of objects so we can transmit information accurately concerning the state of leukemia and their developments to hematologists.

3.5 Database

We have worked on images downloaded from [22]. We took a sample of blood cells affected by the leukemia (cancer of blood). The obtained results using our morphological algorithm on this image is represented in the Figure 3.

4 Results and Discussion

4.1 Preprocessing

4.1.1 Convert RGB image to grayscale

In practice, the algorithms of the mathematical morphology are rarely applied directly to the RGB image. This last is first (256*256 in our case), then a grayscale conversion to apply the morphological operators is performed .The result of this operation is represented in the Figure 4.

4.1.2 Filtering and Morphological Gradient

As described before, this step is based on the calculation of morphological gradient using the Sobel operator. We note that the obtained result shows the classes of the different elements compounds of the cell with a detection of storyteller for the objects in the white circle. The visualization of abnormal cells a little bite fuzzy as represented on the Figure 5.

4.2 Abnormal blood cells detection

To ameliorate the visualization of the abnormal blood cells, we have applied the elements basis morphological operations in a different way. We have performed an opening by reconstruction (erosion + reconstruction morphological) and a closing by reconstruction (dilation + morphological reconstruction). The obtained result (Figure 6.) shows that we have obtained an efficient detection of the targeted objects (abnormal blood cells).

4.3 Application on other images

We have also tried our proposed algorithm on various images to show that our algorithm can be applied for different images. We have obtained a satisfactory result as shown in Figure 7.

5 Conclusions

In this paper, we have proposed a new algorithm for abnormal blood cells detection based on a Mathematical morphology approach. Our method able to detect abnormal cells for diagnostic aid (hematologists) distinguish between cancerous and healthy [23]. The proposed approach in this work detected abnormal blood cells. It has produced remarkable results on the use of different morphological operators. We will to several apply our approach on types of cancerous cells..

Conflict of Interest.
The authors declare that there is no conflict of interest regarding the publication of this article

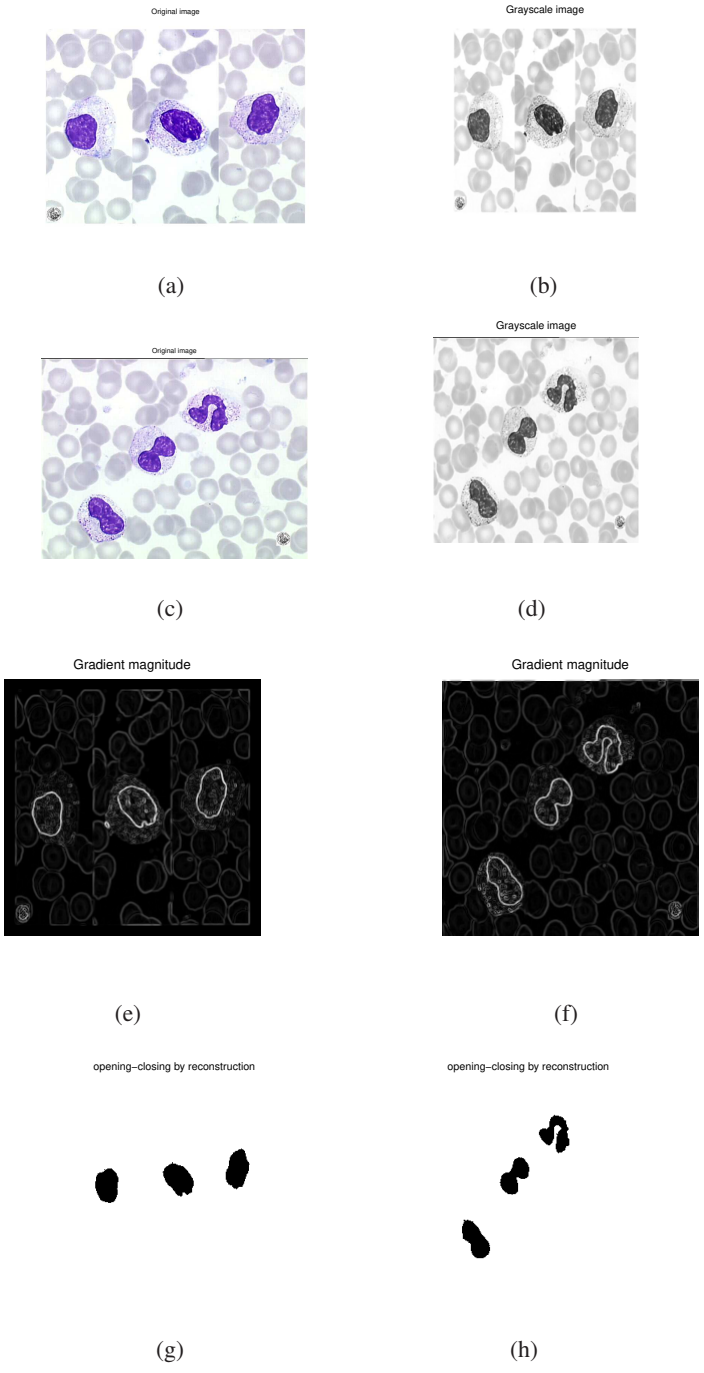

Fig. 7: (a),(e) Original image; (b),(f) Grayscale image; (c),(g) Morphological gradient; (d),(h) Abnormal blood cells detection.

References

[1] G.Matheron, La theorie des variables regionalisees et ses applications, Ecole des mines, Paris, (1973).

[2] R.M.Haralick, S.R.Sternberg and X. Zhuang, Image analysis using mathematical morphology, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.**9**, N. 4, 532-550 (1987).

[3] J.G.Verly, and R.L. Delanoy, Adaptive mathematical morphology for range imagery, IEEE Transactions on image processing, Vol. **2**, 272-275 (1993).

[4] Y.Chen, and E.Dougherty, Grey-Scale morphological granulometric texture classification, Optical Engineering, Vol. **33**, N. 8, 2713-2722 (1994).
[5] K.Sutherland, and J.W.Ironside, Automatic texture segmentation using morphological filtering on images of the human cerebellum, Proceedings of the IEEE International Conference on Image Processing and Its Applications, 777-780 (1995).
[6] P.Cichy, A.Materka and J.Tuliszkiewicz, Computerised analysis of X-ray Images for early detection of osteoporotic changes in the bone, Proc. Conf. Information Technology in Medicine TIM **97**, 53-61 (1997).
[7] N.Youssry, F. E. Z. Abou-Chadi and A.M. El-Sayad, Early detection of masses in digitized mammograms using texture features and neuro-fuzzy model, Proceedings of the Twentieth National Radio Science Conference NRSC, 1-9 (2003).
[8] G.H. Landeweerd, Gelsema, and E. S, The use of nuclear texture parameters in the automatic analysis of leukocytes, Pattern Recognition, Vol.**10,** 57-61 (1978).
[9] L.Fass, and al. Imaging and cancer, A review, Elsievier Molecular Oncology, 115-152 (2008).
[10] L. Jiao, Q.Chen, S.Li and Y.Xu, Colon cancer detection using whole slide histopathological images, In: Long M, editor, World Congress on Medical Physics and Biomedical Engineering, May **26**31, Beijing, China, Springer Berlin Heidelberg, 1283-1286 (2012).
[11] A.Sivaramakrishnan and M.Karnan, A Novel based Approach for Extraction of Brain Tumor in MRI Images Using Soft Computing Techniques, International Journal of Advanced Research in Computer and Communication Engineering, Vol.**2**, 1845-1848 (2013) .
[12] A.Bouzid-Daho and M.Boughazi, Segmentation of Abnormal Blood Cells for Biomedical Diagnostic Aid, International Journal of Image, Graphics and Signal Processing (IJIGSP), Vol. **10**, N. 1, 30-35 (2018).
[13] A.Bouzid-Daho, M.Boughazi and B.Senouci, Multispectral Images Segmentation for Biomedical Applications Diagnosis: K-Means Oriented Approach, IEEE BioSMART 2017, 2nd International Conference on Bio-engineering for Smart Technologies, In Paris, France, 1-5. (2017).
[14] A.Bouzid-Daho, M.Boughazi, and C.Tanougast, Algorithmic Processing to Aid in Leukemia Detection, Medical Technologies Journal, Vol N.**1** , N. 1, 10-11 (2017).
[15] A.Bouzid-Daho, M.Boughazi, and C. Tanougast, Classification of blood cells by method k-means, Proceeding of the 3rd International Conference on Embedded Systems in Telecommunications and Instrumentation (ICESTI'16), In Annaba, Algeria, 19 (2016).
[16] A.Bouzid-Daho, and M. Boughazi, Segmentation of textured medical images: Approach of the k-means, Proceeding of the first International Conference on Computer Science's Complex Systems and their Applications (ICCSA), In Oum El Bouaghi, Algeria, 156-161 (2016).
[17] S. Mishra, A.P. and Deshmukh, Detection of Leukemia Using Matlab, International Journal of Advanced Research in Electronics and Communication Engineering, Vol. **4**, N. 2, 394-398 (2015).
[18] X.Wu and all, Differentiation of Diffuse Large B-cell Lymphoma From Follicular Lymphoma Using Texture Analysis on Conventional MR Images at 3.0 Tesla, Academic Radiology, ELSEVIER, Vol. **23**, N. 6, 696-703 (2016).
[19] D.Warude, and R.Singh, Automatic Detection Method of Leukaemia by Using Segmentation Method, International Journal of Advanced Research in Electronics and Communication Engineering, Vol. **5**, N. 3, 495-498 (2016).
[20] A.Bouzid-Daho and al. Segmentation of Abnormal Blood Cells to Aid Leukemia Detection, In Acta HealthMedica Journal, Vol. **1**, N. 4, 88-92 (2016).
[21] A.Bouzid-Daho, M.Boughazi and E.Petit, Detection of Abnormal Blood Cells by Segmentation and Classification, In International Journal of Medical Engineering and Informatics, Vol. **11**, N. 1, 57-70 (2019).
[22] Banque-Images http://hematocell.univ-angers.fr/index.php/, Cons.(2016).
[23] A.Bouzid-Daho, and al. Textural Analysis of Bio-Images for Aid in the Detection of Abnormal Blood Cells, International Journal of Biomedical Engineering and Technology, Vol. **25**, N. 1, 1-13 (2017).

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