Al-Mustansiriyah Journal of Science
ISSN: 1814-635X (print), ISSN:2521-3520 (online) Volume 33, Issue 1, 2022 DOI: http://doi.org/10.23851/mjs.v33i1.1079

Research Article Open Access

Red Blood Cells Detecting Depending on Binary Conversion at Multi Threshold Values

Ali S. Lafta[1,*], Hazim G. Daway[1], Jamela Jouda[2]

[1]Department of Physics, College of Science, Mustansiriyah University, Baghdad, IRAQ.
[2]Department of Biology College of Science, Mustansiriyah University, Baghdad, IRAQ.

*Correspondent contact: alisadam@uomustansiriyah.edu.iq

Article Info

Received
23/08/2021

Accepted
31/08/2021

Published
10/03/2022

ABSTRACT

Automatic detection of Red Blood Cells (RBCs) by using image-processing techniques is important in determining blood disorders and diseases. This study proposes an algorithm for automatic detection of red blood cells in optical microscopy images of blood smears. The proposed method depends on binary conversion at multi-threshold and includes a morphological operation as erosion and image fill according to certain conditions. In this study, we used 50 images from IDB data of blood samples taken with an optical microscope. The suggested method is compared with other modern techniques based on the two accuracy coefficients, namely, detection and false alarm rates. Results show that the proposed method has a high detection accuracy compared to other methods.

KEYWORDS: Abnormal RBCs, binary image, RBCs detection, morphology.

الخلاصة

يعد الكشف التلقائي لخلايا الدم الحمراء (RBCs) باستخدام تقنيات معالجة الصور أمرًا مهمًا في تحديد اضطرابات الدم وأمراضه. تقترح هذه الدراسة خوارزمية للكشف التلقائي عن خلايا الدم الحمراء في الصور المجهرية الضوئية لمسحات الدم. تعتمد الطريقة المقترحة على التحويل الثنائي عند عتبات متعددة وتتضمن العملية المورفولوجية مثل الحذف وتعبئة الصورة وفقًا لشروط معينة. في هذه الدراسة استخدمنا 50 صورة من بيانات IDB لعينات الدم المأخوذة بالمجهر الضوئي. تمت مقارنة الطريقة المقترحة مع التقنيات الحديثة الأخرى بناءً على معاملي الدقة وهما معدلات الكشف والإنذار الكاذب. أظهرت النتائج أن الطريقة المقترحة تتميز بدقة كشف عالية مقارنة بالطرق الأخرى.

INTRODUCTION

Blood has been contained three types of cells that travel in the blood vessels: red blood cells, white blood cells, and platelets.

Red cells: There are about 25 trillion Red blood cells in body are soft, doughnut-shaped cells. It is the mean of transport that transports the oxygen from the lung to all living cells of the body. It also captures CO_2 gas and gaseous waste and move it to the lungs to complete the exhalation process and remove it from the body. In addition, using a microscope, we can see red blood cells, distinguished by their red color. (For example, there will be approximately fifty red blood cells in an area the size of the dot at the end of this sentence.). In case A, simple change in the blood protein hemoglobin inside the red blood cells leads to a change in its shape and causes all the problems and symptoms of the disease anemia.

White cells: white blood cells are the defenders of the human body. They help in capturing and fighting aggressor germs and protect the body from foreign cells and viruses. There are different types of white blood cells, and each type has a mission and location. An increase in the number of white blood cells is the first indication of an infection or injury attacking the body. White blood cells in sickle cell disease patients do not attack bacteria as they do in normal people without sickle cell disease. Therefore, the risk of infection and disease in patients with sickle cell anemia is greater than in normal persons.

Platelets: Platelets are tiny cells that plug holes in the blood vessels. When a cut or puncture occurs in the skin and blood vessels, bleeding occurs. The platelets work by forming a gelatinous substance to seal the wound and stop the bleeding, and it is called a blood clot.

If there are not enough platelets, or when platelets are not working, the bleeding will not stop. In the case of a large number of platelets, it is possible for the blood to clot within the blood vessels without the presence of a wound or a hole in the skin. This stops the blood flow, causing damage to the surrounding tissues.

Platelets are more active in people with sickle cell anemia than in healthy people, and this leads to an increase in blood clotting within the blood vessels even though there is no wound.

Sickle cell anemia is a chronic genetic disease of red blood cells, which results in a change in the chemical structure of the blood protein known as hemoglobin. The change caused by the disease is a change in the appearance of the red cells from their normal shape to the shape of a sickle, becoming stiff instead of a soft, flexible round that easily flows into the blood vessels. The sickle form of red cells causes blockage of the blood flow. In addition, it leads to breakage of the cells, resulting in anemia that may threaten the life of the patient [1].

There are many previous studies related to the topic of detection and discrimination of erythrocytes, the most important of them:

H. A. *et al*. (2019) using form, perimeter factor and area as feature descriptors and they proposed a method to difine the circalar and abnormal shaped RBCs image by automatic detection of the blood cell. Their produced good performance during the task completion with an acceptable error and sensitivity of excellent [2].

Singhal, Vanika and Singh, Preety used LBP texture features and geometric features for the detection of blast cells in the blood images of lymphocytes. It computed for each image in the training and test set by SVM classifier is used for classification of images as blastaor normal. The results features perform reasonably well as compared to shape features [3].

Theera, Nipon *et al* they used information about the nucleus to classify blood cells and using mathematical morphology they compared their results with other classifiers. The results show that the features using nucleus alone can be utilized to achieve a classification rate of good [4].

Devia, Salam *et al*. they developed system for quantification of erythrocytes in microscopic images of thin blood smears and using method to enhance the performance of the system are cell separation and clump cell segmentation. Results with an accuracy of exlent in comparison to the state of art method [5].

Bhavana, Reddy *et al*. (2020) used many techniques of image processing from which RBCs are separated based on size and shape of the cells. Techniques were used to get more accurate result [6].

Chadha, G.K. *et al.* They introduced a technique for automatically counting RBCs. and they classified RBCs on the basis of morphology, texture, and color.as well as they segmented the cell, and they proposed algorithm an overall accuracy of privilege. [7].

D. Avci and A. Varol used a new method to classification of human parasite eggs in microscopic images of test; exellent rates were obtained [8].

PROPOSED METHOD

In this study, a new algorithm was proposed to detect and count RBCs for a blood sample captured under an optical microscope by using digital image processing techniques.

Calculating the gray component of the image

The grey component is selected based on the lowest value among the RGB components and according to the following:

$$I(x,y) = min(r(x,y), g(x,y), b(x,y)) \qquad (1)$$

This process allows sensitivity to the lowest colour values. Figure 1 represents a sample image of a blood smear captured by a microscope and the corresponding lightness component.

Binary conversion

The lightness image is converted into multiple images in binary for multiple threshold values, as follows:

$$\left.\begin{array}{l} I(x,y) > th_i \text{ then } Ib_i(x,y) = 1 \\ \quad\text{else } Ib_i(x,y) = 0 \end{array}\right\} \qquad (2)$$

Al-Mustansiriyah Journal of Science
ISSN: 1814-635X (print), ISSN:2521-3520 (online) Volume 33, Issue 1, 2022 DOI: http://doi.org/10.23851/mjs.v33i1.1079

where $\mathrm{th_i} = 60, 70, 80$ and 90 .

Deleting Small Size Areas and Fill in the gaps

In the binary images, we use the condition to eliminate unblended and areas smaller than 250 (for image size about 600×800)

$$\text{if } A_{ij} < 250 \text{ then } A_{ij} = 0 \tag{3}$$

Erodes the binary images (with thresholds 80 and 90) returning the circle structuring have size (15 × 15). Figure 2 represents the binary image of several threshold values. We note that the number of blood cells decreases and increases with the change of these values, thereby affecting the efficiency of the count.

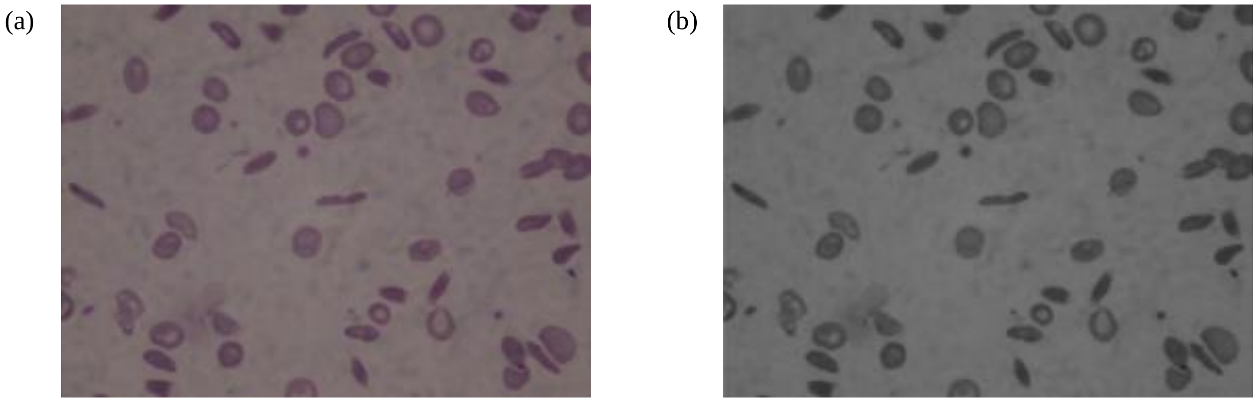


Figure 1. Blood smear image captured by an optical microscope: (a) The original image and (b) Grey or lightness component.

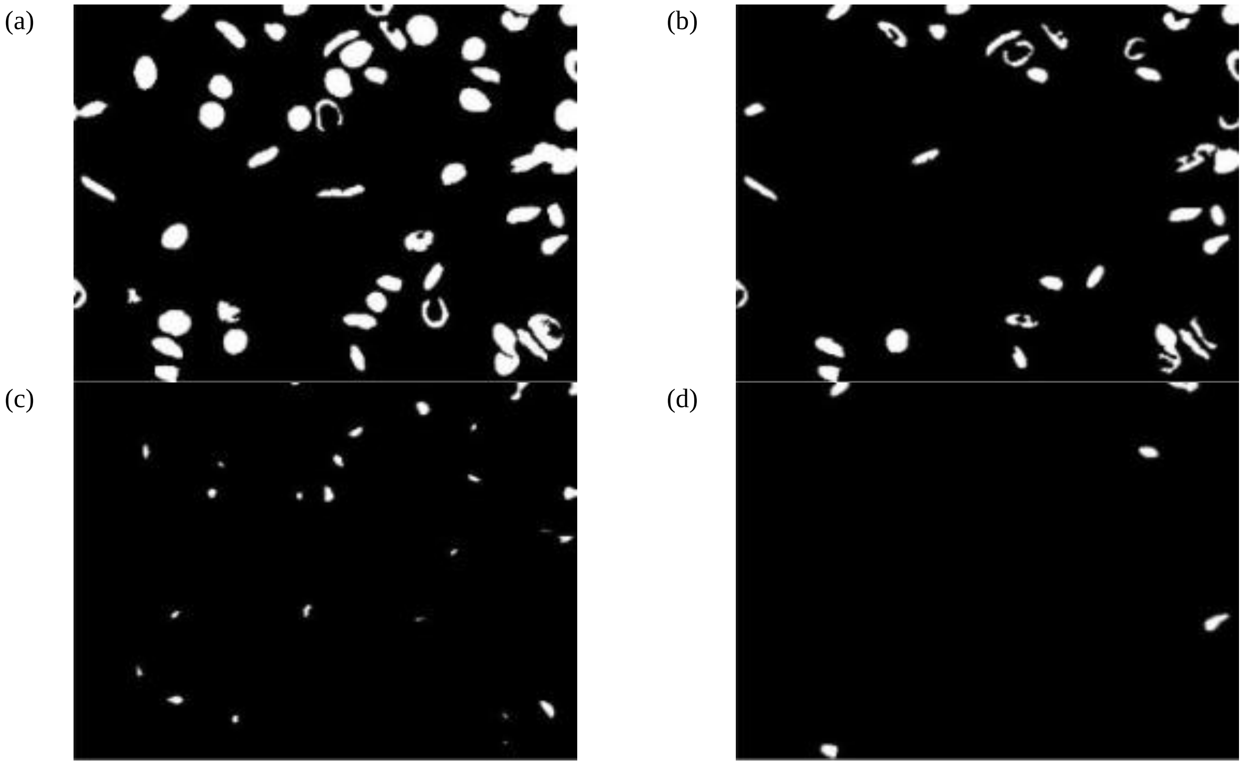
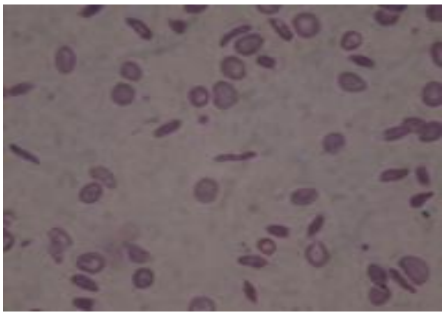


Figure 2. Binary images at different threshold values: (a) th1=60, (b) th2=70, (c) th1=80 and (d) th2=90.

Collect all binary images and count

All binary images are collected in one image and according different threshold values. This resultant image has a high efficiency in distinguishing WBCs. The images in the figure (3,b) are generated by collecting all the images in the figure 2 we can find the number of connected components in a binary image by using the label algorithm [9] as illustrated in the figure (3,c). Figure 4 illustrates the block diagram for the suggested algorithm, explaining all the stages of that algorithm.

(a)



(b)

(c)

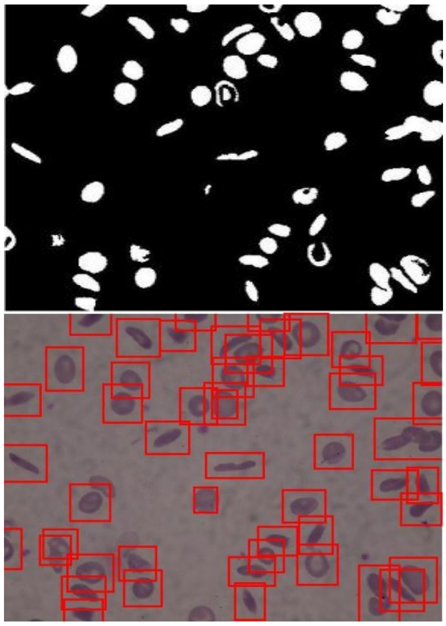


Figure 3. In (a) Blood smear image, (b) binary image, and (c) auto-detection of RC region by using the suggested algorithm.

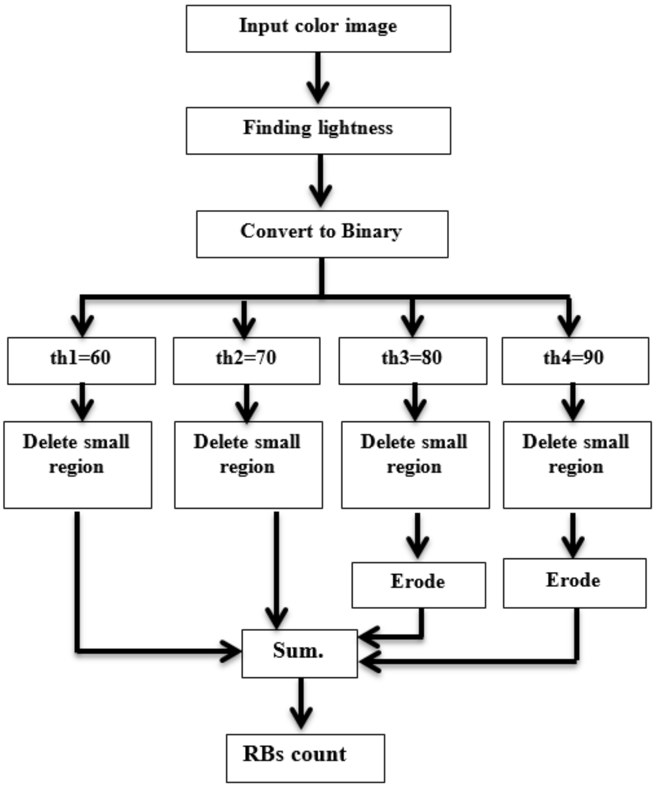


Figure 4. Block diagram for the suggested algorithm.

QUALITY ASSESSMENT

An important method for calculating accuracy in detecting RBCs in optical microscopic images is the comparison between manual counting and automatic detection. Quality is evaluated based on the accuracy of measurement between manual

ISSN: 1814-635X (print), ISSN:2521-3520 (online) Volume 33, Issue 1, 2022 DOI: http://doi.org/10.23851/mjs.v33i1.1079

counting and automatic counting of RBCs and this parameter is called detection rate(μ_e) [10]:

$$\mu_e = \frac{\text{RBC Corrected auto detection}}{\text{RBC Manual count}} \qquad (4)$$

The false alarm rate (ε) is defined as the ratio between false detection number of RBCs and the number of RBCs determined by [5]:

$$\varepsilon = \frac{\text{False detection}}{\text{RBC Manual count}} \qquad (5)$$

EXPERIMENTAL RESULTS

In this paper, we propose a new algorithm for detecting normal and abnormal RBCs. This algorithm is applied on blood smear microscopic images (50) download from erythrocytes IDB [11] with size (3264 x 2448) and type jpg. The image size is reduced to a quarter to increase the execution speed and pixels. All program is executed using Matlab software (R2020a), which is used to detect RBCs in the microscopic images. These images are illustrated in Figure 5. Detection accuracy was calculated by comparing the auto-detection and manual-detection values for RBCs depending on two parameters, namely, detection rate(μ_e) and false alarm rate (ε). The results are shown in Table 1.

Table 1. The comparison of a series of quality with previous research.

Method	μ_e	ε
[12] in 2020	78.56%	21.44%
[13] in 2020	77.9%	22.1%
[14] in 2016	88%	12%
[15] in 2020	77.%	23%
Proposed	88.45%	11.55%

The highest accuracy levels were detected for the proposed method, with values of 88.45% and 11.55%, respectively. This finding indicates the success of the proposed method in detecting RBCs, followed by the methods [12-15]. One of the images taken from the IDB of a blood smear captured by an optical microscope It was used as an example to illustrate the detection mechanism using all algorithms shown in Figure 6. The levels of accuracy were reflected in data matching, manual counting, and automatic counting for all methods used in the detection Figures 7. We also obtained the best match the distributions between the manual counting, and automatic counting for the proposed method.

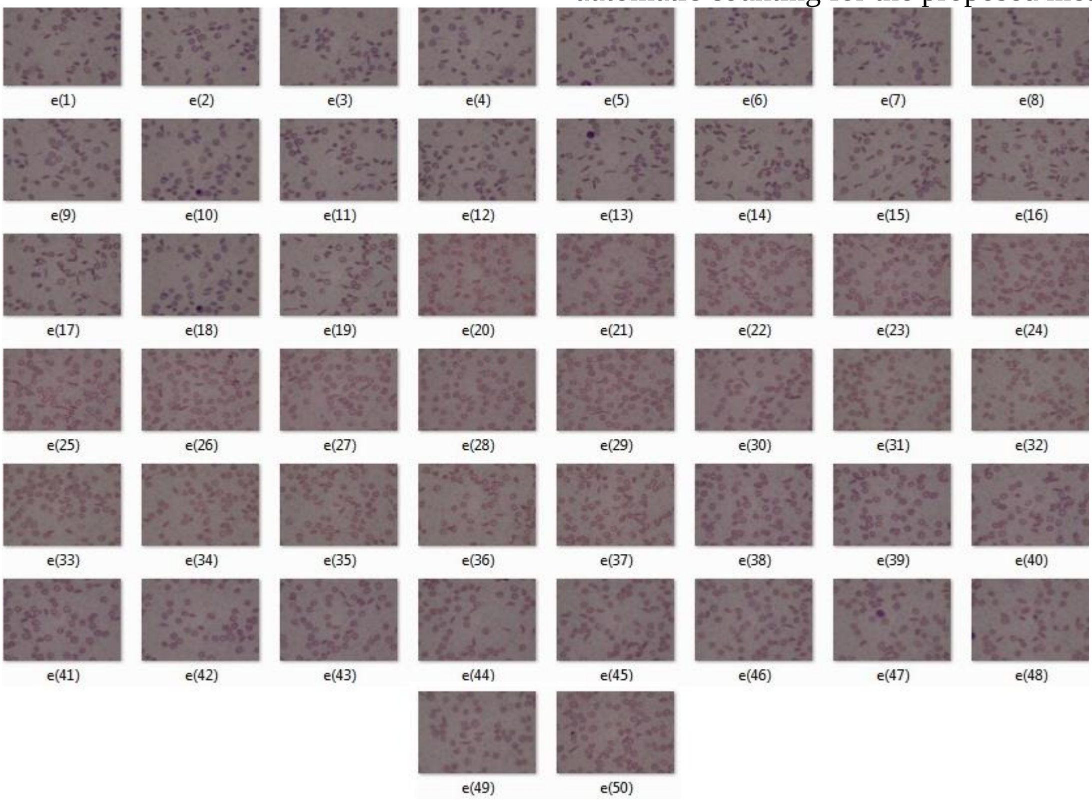


Figure 5. IDB data that used in this study.

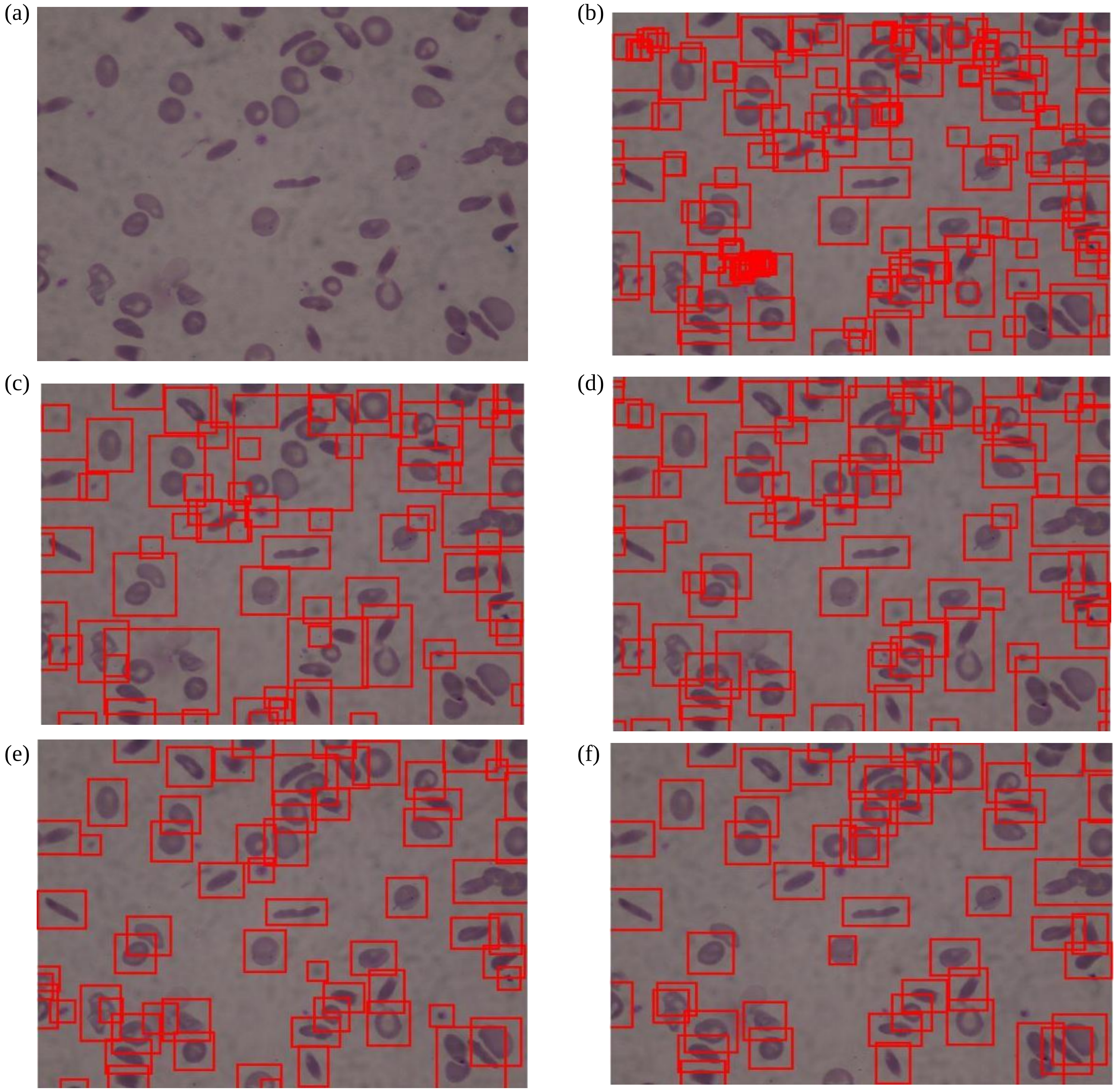


Figure 6. In (a) One of the images taken from the IDB of a blood smear captured by an optical microscope, in (b), (c), (d), (e) and (f) Detection of RBCs by [12-15] and proposed method respectively.

ISSN: 1814-635X (print), ISSN:2521-3520 (online) Volume 33, Issue 1, 2022 DOI: http://doi.org/10.23851/mjs.v33i1.1079

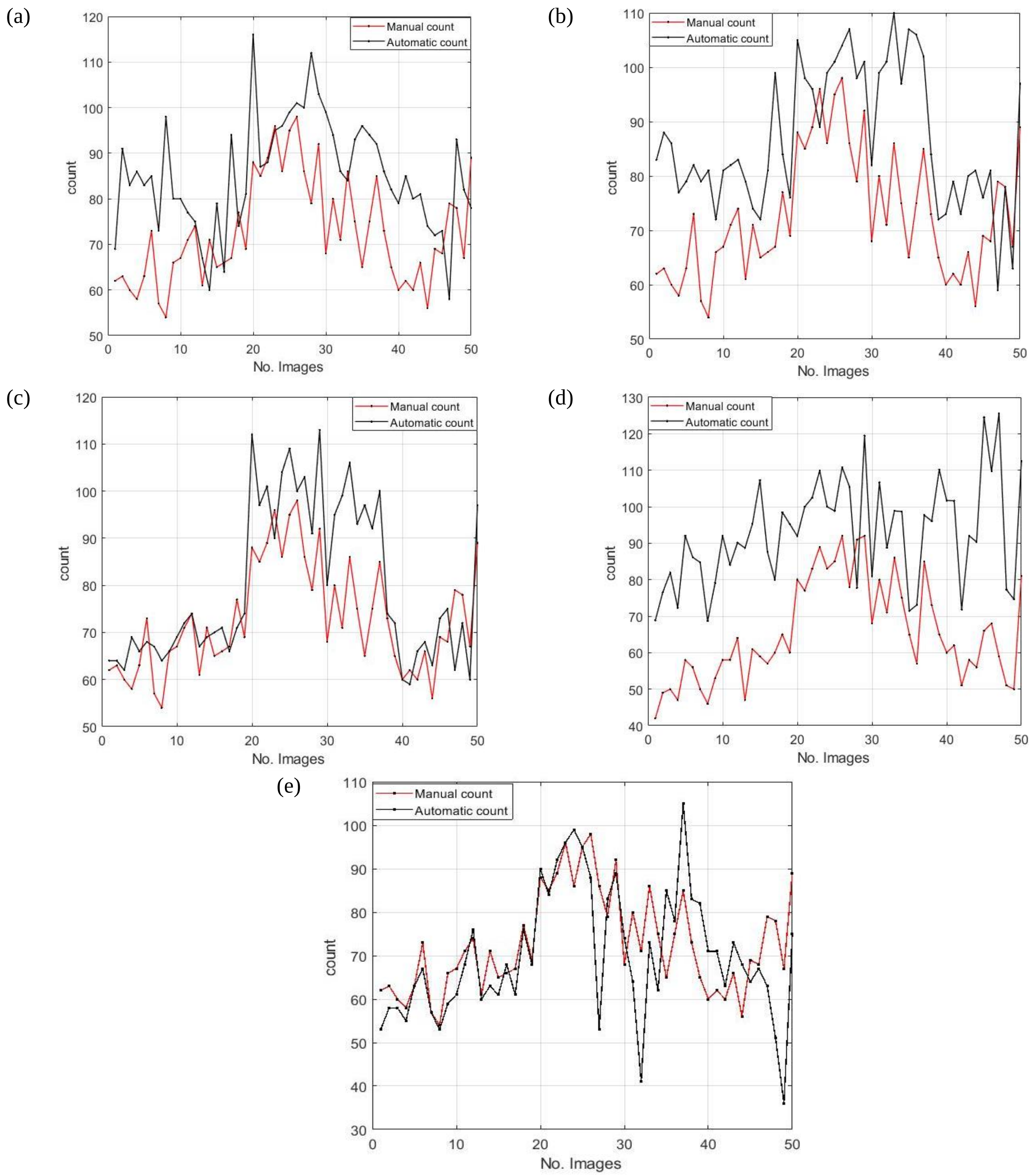


Figure 7. Relationship between manual counting and automatic detection by using (a) [12], (b) [13], (e) [14], (d) [15] and (e) proposed method.

CONCLUSIONS

In this study, WBCs were automatically detected in optical microscopic images by using image-processing techniques. The results were analysed, and accuracy was calculated by comparing manual counting and automatic detection. The proposed method has a high detection accuracy, with a detection rate of about 88.45% and false alarm rate of 11.55%.

AUTHOR CONTRIBUTIONS

Hazim H. daway has contributed to the design and implementation of the research by using Matlab. Ali S. Lafta, and Jamela Jouda have supervised the written paper and providing the necessary data. All authors approved the final versionhe authors declare no conflict of interest.

REFERENCES

[1] Allan F. Platt, Hope and Destiny: The Patient and Parent's Guide to Sickle Cell Disease and Sickle Cell Trait, 2002.

[2] Hajara Abdulkarim Aliyu .“Detection of Accurate Segmentation in Blood CellsCount –A Review” ISSN: 2455-2631 © August 2017 IJSDR | Volume 2, Issue 8.

[3] Singhal ,Vanika and Singh ,Preety.” Local Binary Pattern for Automatic Detection of Acute Lymphoblastic Leukemia ” Conference Paper February 2014

DOI: 10.1109/NCC.2014.6811261.

[4] N. Theera-Umpon and S. Dhompongsa, “Morphological Granulometric Features of Nucleus in Automatic Bone Marrow White Blood Cell Classification,” IEEE Transactions on Information Technology in Biomedicine, vol. 11, no. 3, pp. 353–359, May 2007. [Online]. Available: http://ieeexplore.ieee.org/articleDetails.jsp?arnumber=4167903

[5] Devia ,Salam. Etal “Erythrocyte segmentation for quantification in microscopic images of thin blood smears” Journal of Intelligent & Fuzzy Systems 32 (2017) 2847–2856 DOI:10.3233/JIFS-169227 IOS Press.

[6] Bhavana. Reddy , etal “Review on Identification of Red Blood Cells by Image Processing” International Journal of Engineering Research & Technology (IJERT) http://www.ijert.org ISSN: 2278-0181, IJERTV9IS050630 (This work is licensed under a Creative Commons Attribution 4.0 International License.)www.ijert.org Vol. 9 Issue 05, May-2020

[7] Chadha, G.K., Srivastava, A., Singh, A., Gupta, R., Singla, D.: An Automated Method for Counting Red Blood Cells using Image Processing. Procedia Comput. Sci. 167, 769–778 (2020). https://doi.org/10.1016/j.procs.2020.03.408.

[8] D. Avci, A. Varol, An expert diagnosis system for classification of human parasite eggs based on multi-class SVM, Exp. Syst. Appl. 36 (1) (Jan. 2009) 43–48.

[9] R. Haralock, and L. Shapiro, Computer and robot vision, Addison-Wesley Longman Publishing Co., 1991.

[10] M. Levin and M. Krause, “Incident detection: a Bayesian approach”, Transportation research record, Vol. 682, P. 52-58, 1978.

[11] Antoni Jaume-i-Capó, “erythrocytesIDB Coordinator”, Departament de Ciències Matemàtiques i Informàtica. Universitat de les Illes Balears. http://erythrocytesidb.uib.es/.

[12] N. Petrović, M.Gabriel, J. Antoni, and G. Manuel, “Sickle-cell disease diagnosis support selecting the most appropriate machine learning method: Towards a general and interpretable approach for cell morphology analysis from microscopy images”, Computers in Biology and Medicine, Vol. 126, 2020.

[13] G. Chadha, A. Srivastava, A. Singh, R. Gupta, and D. Singla, “An Automated Method for Counting Red Blood Cells using Image Processing”, Procedia Computer Science, Vol. 167, P. 769-778, 2020.

[14] G. Sayari, R. Arpan, and S. Debasish, “Assessment of morphologically altered rbcs using image processing tools”, Materials today: proceedings, Vol. 3, No. 10, P. 3361-3366, 2016.

[15] D. Wilkie , E. Miriela, G. Manuel,H. Silena, J. Antoni, and M. Arnau, “Diagnosis support of sickle cell anemia by classifying red blood cell shape in peripheral blood images”, Med Biol Eng Comput, Vol. 58, No. 6, P. 1265–1284 , 2020.

How to Cite

Lefta, A. S., Daway, H. G. ., & Jouda, J. . **Red Blood Cells Detecting Depending on Binary Conversion at Multi Threshold Values**. *Al-Mustansiriyah Journal of Science, 33*(1), 69–76, 2022. Doi: https://doi.org/10.23851/mjs.v33i1.1079