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Red Blood Cells (RBC) Segmentation with Image Sharpening and R-CNN

Nunik Destria Arianti[1,2], Azah Kamilah Muda[1*] and Norashikin Ahmad[1]

[1]Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka, Malaysia

[2]Department of Information System, Nusa Putra University, Indonesia

[*]**Corresponding author**: Azah Kamilah Muda (PhD), Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka, Malaysia, Tel: +606 270 2411; Fax: +606 270 1048

Introduction

The assessment of an individual's holistic health and well-being necessitates the recognition and measurement of red blood cells, which holds significant significance. Healthcare professionals possess the ability to identify various medical conditions through the process of quantifying red blood cells. Image processing algorithms can quantify Red Blood Cells (RBCs) based on visual data obtained from images [1-3]. Various techniques such as blob analysis, morphological methods, and machine learning methods can be employed to accurately detect and quantify individual Red Blood Cells (RBCs) following the process of segmentation. The utilization of automated image analysis techniques can contribute to the improvement of both efficiency and accuracy in the procedure of RBC counting. The three approaches to sharpening are incorporated into a model called the Assembled Boosting Model. Sharpen (WAND), Contrast Limited Adaptive Histogram Equalization (CLAHE), and OTSU Threshold are combined to enhance the sharpening process that leads to the segmentation process by R-CNN. This paper will review the overall process of the proposed technique.

Sharpening (WAND)

The WAND library is a module for the Python programming language that has a variety of image-editing-oriented functions. It is used for a wide variety of image manipulation operations, including but not limited to picture resizing, cropping, applying image effects, and executing image transformations.

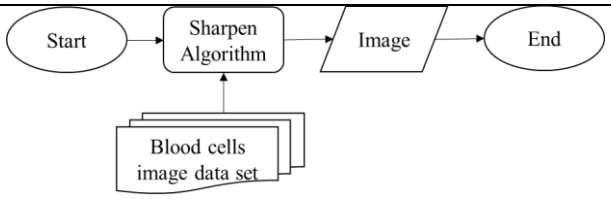

Figure 1: Flowchart of Sharpen() Function.

Figure 1 shows the flowchart for the sharpen() function. The sharpen() function is used specifically to increase the overall quality of red blood cell images. It can boost the visibility of the boundaries of individual red blood cell entities and emphasize the demarcation between entities and the backdrop. The sharpening procedure was carried out by calling upon the sharpen() method contained inside the Wand library. Importing the "wand. image" module is followed by the initialization of the "Image" variable, which is then assigned to the imported module.

CLAHE (Contrast Limited Adaptive Histogram Equalization)

The Contrast Limited Adaptive Histogram Equalization (CLAHE) method is to mitigate noise through the determination of the matrix kernel. **Figure 2** shows the flowchart of CLAHE method. It involves the substitution of the intensity value of every pixel in the input image with the mean value derived from the kernel weighting values of the pixel itself and its nearby pixels. Therefore, CLAHE effectively mitigates the noise present in the image of the red blood cell sample and accurately performs the segmentation.

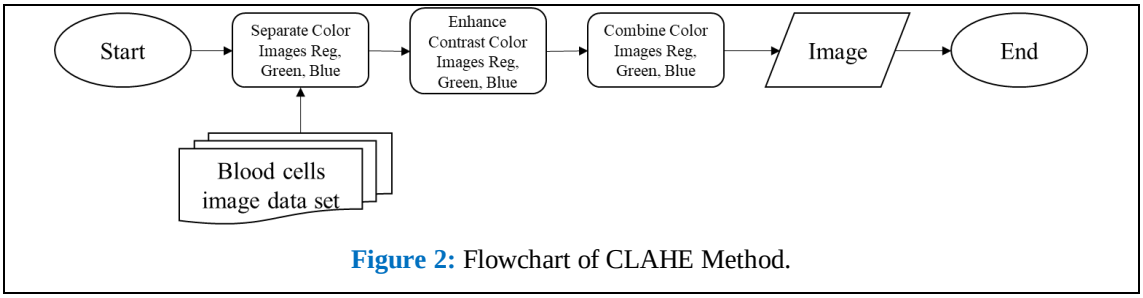

Figure 2: Flowchart of CLAHE Method.

The Contrast Limited Adaptive Histogram Equalization (CLAHE) method has been implemented to enhance image contrast by determining the clip point for CLAHE by considering block textures, to preserve the natural appearance of the image. It is also applied to enhance the contrast of myocardial fusion images by the establishment of effective color space and the improvement of underwater image quality.

OTSU Threshold

The OTSU provides a singular intensity threshold value that effectively segregates pixels into two distinct classes, namely foreground and background. **Figure 3** shows the flowchart of OTSU threshold. It is enabling the detection of edges in the images and enhances the ability to image segmentation.

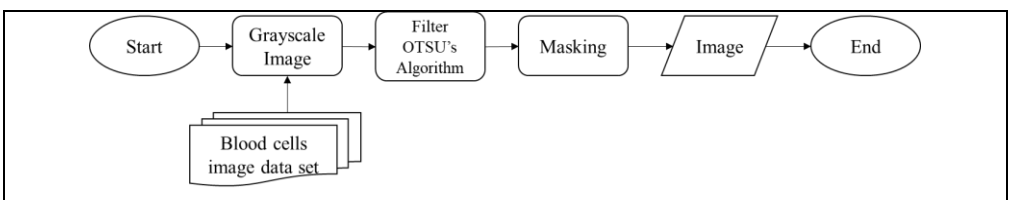

Figure 3: Flowchart of OTSU Threshold.

The OTSU threshold technique involves the generation of a histogram for the damaged region and then identifies the extreme edge of this histogram as the threshold value to segment all faulty items present in both the foreground and background of the image. It shows that the OTSU threshold exhibits superior performance and can be effectively employed in the image sharpening procedure as well as red blood cells image sharpening.

Assemble Boosting Model Algorithm for RBC's Image Sharpening

The Assemble Boosting Model is a novel methodology that aims to improve image sharpness by the combination of the sharpen() function, CLAHE, and OTSU Threshold methods. The flowchart illustrating the sharpening procedure is presented in **Figure 4.**

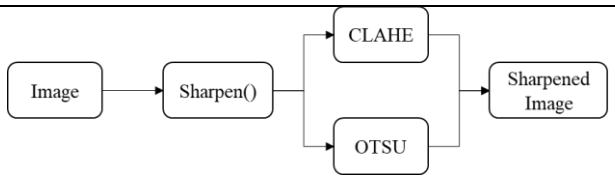

Figure 4: Flowchart of Assemble Boosting Model.

The sharpen() function inside the WAND library implements the Gaussian function, which necessitates the specification of two parameters: radius and sigma (variance). The sharpening procedure of the Weighted Average Nearest Neighbors Distance (WAND) algorithm is employed on all datasets, including the training data, validation data, and testing data. The current methodology embodies an innovative strategy wherein the results are simultaneously combined through the utilization of two algorithms, namely CLAHE and OTSU Thresholding.

Integration of Assemble Boosting Model and R-CNN for Red Blood Cells Image Segmentation

The integration of the Assemble Boosting Model and R-CNN is designed to enhance the characterization of barriers between red blood cells and the background of the image, hence enhancing the object recognition abilities of the classification method **[4]**. **Figure 5** shows the combination of The Assemble Boosting Model and R-CNN Algorithm schematic. The wand method is used to sharpen and give texture to an image, as well as wand helps clarify the objects in the image.

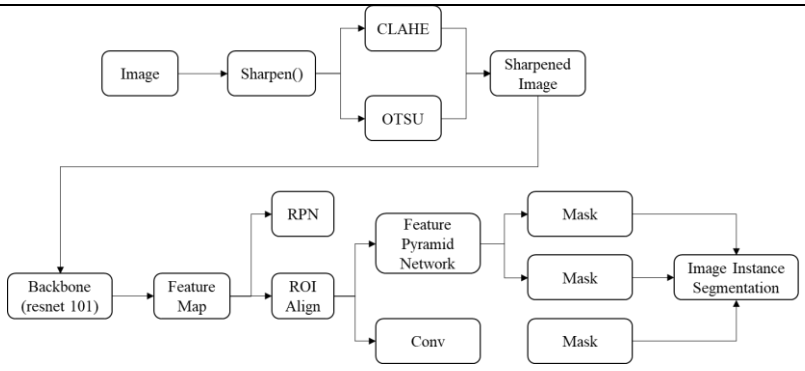

Figure 5: Combination of The Assemble Boosting Model and R-CNN Algorithm.

The Contrast Limited Adaptive Histogram Equalization (CLAHE) technique enhances the color sharpness of an image by selectively sharpening areas with low color intensity **[5]**. The CLAHE technique involves the implementation of two primary procedures, namely equalization and contrast enhancement. The equalization section partitions the image in RGB format into three distinct channels, namely red, green, and blue. The image generated using the wand sharpening technique is employed as input data for both the OTSU threshold and the CLAHE algorithm. The utilization of the maximum variance threshold value facilitates the segregation of the foreground, which represents the major object, and the background groups into distinct entities. The determination of this value is achieved through the utilization of the OTSU threshold method, which is subsequently applied to the foreground and background.

The utilization of a resilient classifier is to distinguish between individual and functioning Red Blood Cells (RBCs) in the image which employs sharpened segmentation. The R-CNN is then implemented to identify objects present in a picture and produce a segmentation mask of high quality for each instance.

Conclusion

A comprehensive and clear explanation of the sharpening method and the proposed Assembled Boosting Model technique has been elaborated. The objective of this paper is to present a thorough examination of the technique called Region-based Convolutional Neural Networks (R-CNNs) for image segmentation. The proposed algorithm is expected to yield improved outcomes in terms of red blood cell recognition.

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