Project Presentation
"Blood Cell Counting using Image Processing"

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Abstract

Blood is a connective tissue with cellular components like RBC, WBC, and platelets. If the blood cells are below the standard range it leads to varies health diseases and hence proper blood cell counting technique plays importance in the pathology department. The most widely used method for counting blood cells is the microscopic technique which gives better results however, it takes more time to count the number of blood cells. Blood cell count using a digital image processing technique can be considered to automate the microscopic method and minimize the time taken by the conventional method.

Introduction

CBC (Complete blood cell count) is a routine blood test that is done or recommended by a doctor to test his overall health condition. It is also used to identify and monitor disorders like anemia, leukemia, fatigue, fever, bleeding, thalassemia, polycythemia, and dengue, etc. The main aim of the Blood Cell Counting Algorithm is to automate blood count using a digital image processing technique. It forms accurate and easy procedures for determining and counting RBC, WBC, and platelets.

At present, the blood samples are taken to the lab and processed with various sub- strates, and the results are produced. Haemocytometer is a device that is used in the labs to count blood cells. A micro- scopic glass slide consists of a rectangular indentation which creates a chamber. A perpendicular line grid is etched in this chamber. The physician views the hemocy- tometer using a microscope and counts the blood cells using the hand counter.

The drawbacks of using the manual method for blood count are listed below

- Counting the cells manually is time-consuming and laborious.
- Overlapping cells is a great overhead.
- Visual inception is not consistent all the time.

In this worksheet, an Automated Blood Cell Count System, applies the stain, makes the blood sample absorb the stain, and then captures the image of it. Then it is digitally processed with software and the result is displayed immediately.

Methodology

Manual cell counting methods often yield inaccurate results, causing stress for technicians when reporting. Counting overlapping cells poses a significant challenge. To tackle this issue, we would leverage digital image processing to minimize errors and alleviate stress. The proposed method for counting Red Blood Cells (RBC) and White Blood Cells (WBC) aids in diagnosing diseases like anemia and polycythemia. This results in a cost-effective, automated blood cell counting approach using image analysis techniques, with a particular focus on enhancing results through Plane extraction and Counting techniques.

- **Blood Sample Acquisition**
  The process involves cleaning slides and fingers with ethanol. A blood drop is collected via lancets and smeared on a glass slide at a 45-degree angle. After a five-minute drying period, Leishman's stain is applied, followed by washing with double distilled water. Microscopic images are captured using a Nikon E 100 with adjustments for clarity. Nikon 21 Pixel Camera aids in image capture with appropriate lighting and fine adjustments.
- **Image Processing**
  The image obtained from the preprocessing step will be in RGB scale. For counting the Red blood cells, the red plane of the image will be extracted and the counting process is done. Similarly, for counting the White blood cells, the blue plane of the image is extracted and the counting process is applied.
- **Noise Removal**
  This is a pre-processing step of an image sequence before feeding into the Segmentation process. Certain noises which are found in the images include salt and pepper noise (random occurrences of both black and white intensity values) and impulse noise (random occurrences of white intensity values). After observing various sample images it was found that the median filter would be the best noise removal filter.
- **Median Filter**
  Each pixel value is replaced with the median of the gray scale values in the region of the pixel (i, j). A 3 x 3 region centered around pixel (i,j) has been taken and sorted (in ascending order) according to the intensity values of the pixels in the region. The middle value among those values is selected as the intensity of the current pixel .This is the very effective in removing salt and pepper or impulsive noise while preserving the image detail.
- **Edge Detection**
  Edge preservation is an image processing technique to recover degraded and blurred images resulted while reducing the negative effect of noise in images. It can be a preliminary step toward better binarization and object segmentation. We are employing the Canny edge detection algorithm to identify cell edges after noise removal. It performs well in sharp images but less accurately in blurry ones. Practical images sometimes result in incomplete edges. To address this, Morphological Filling is applied to produce accurate results for both complete and broken cell edge images.
- **Morphological Filling**
  The input to this block is the edge detected image. Morphological operation of filling is applied in the edge detected image. The output of the morphological filling operation is an image where the objects which was detected by Canny is highlighted with lesser pixel and the background is completely dark which explicitly differentiates the objects that is cells - Red blood cells in case of red plane extracted image and White blood cells in case of blue plane extracted image.
- **Circular Hough Transform**
  The circular Hough transform is then applied on the Red plane extracted image to count the Red blood cells as red blood cells are spherical that is circular in shape. This transform searches for the blood cells in the image and then detects them.[7] Detection process for circular hough transform is easier as the input image is morphologically filled The function "draw circle" draws circles around the detected circular objects. Even the overlapped circles are detected. This method of counting cannot be used for white blood cells as they are not circular in shape.
- **Boundary Detection and Counting**
  As the method of counting Red blood cells cannot be used for counting White blood cells, the method of Boundary detection and counting is used.[8] The input of this operation is morphologically filled Blue plane extracted image. A boundary around the filled objects is drawn and counting the number of cells drawn gives the total number of White blood cells in the image.
- **Blood Cell Calculation**

$$\text{Total RBC per cumm} = \frac{\text{RBC Counted by Hough Transform}}{\left[\dfrac{\text{Input Image Area}}{(\text{magnification} \times \text{magnification}) \times \text{film thickness}}\right] \times \text{Dilution Factor}}$$

$$\text{Total WBC per cumm} = \frac{\text{WBC Count}}{\left[\dfrac{\text{In put Image Area}}{(\text{magnification} \times \text{magnification}) \times \text{film thickness}}\right] \times \text{Dilution Factor}}$$

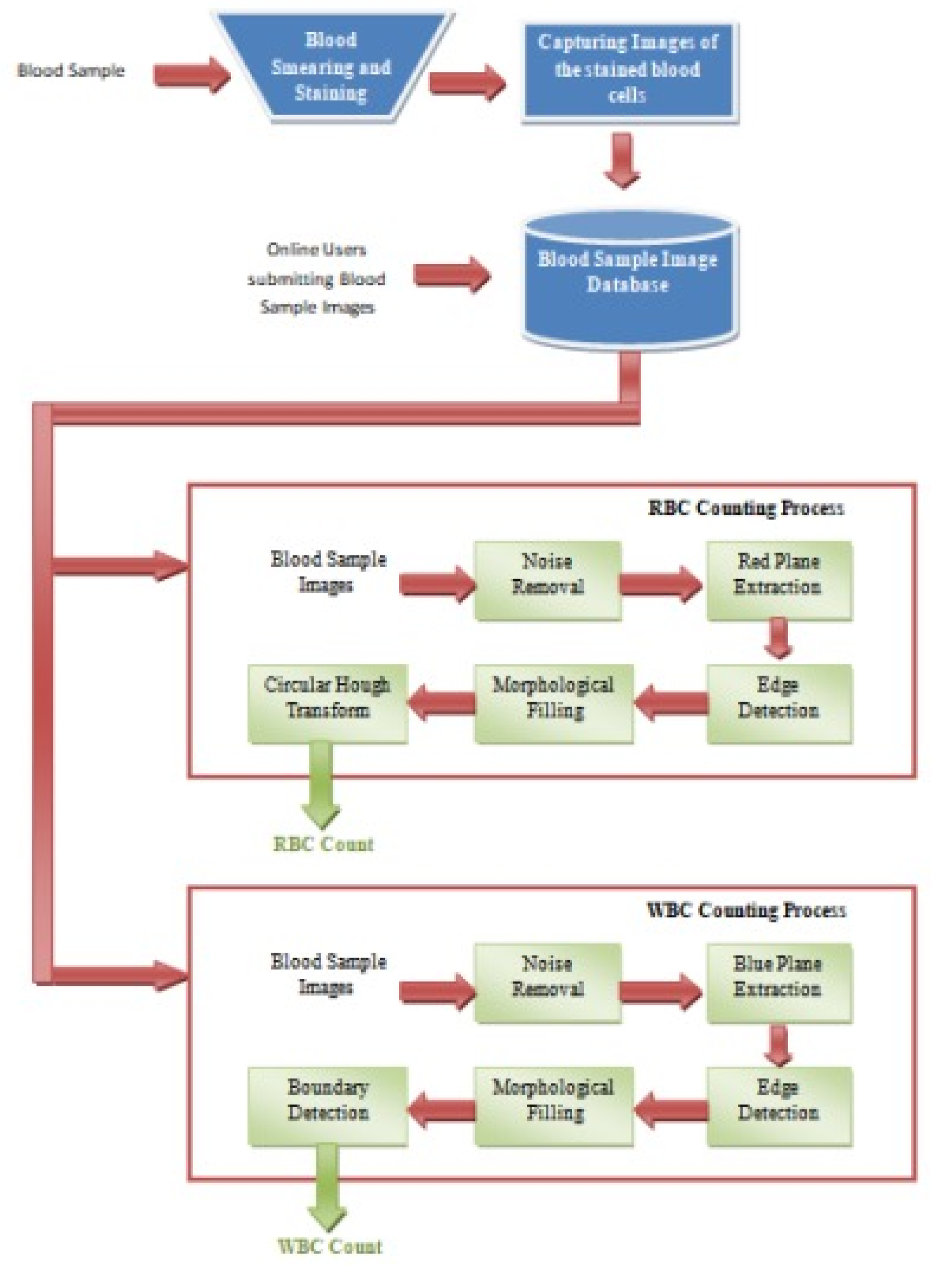

Figure 1. Block diagram of methodology

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Results

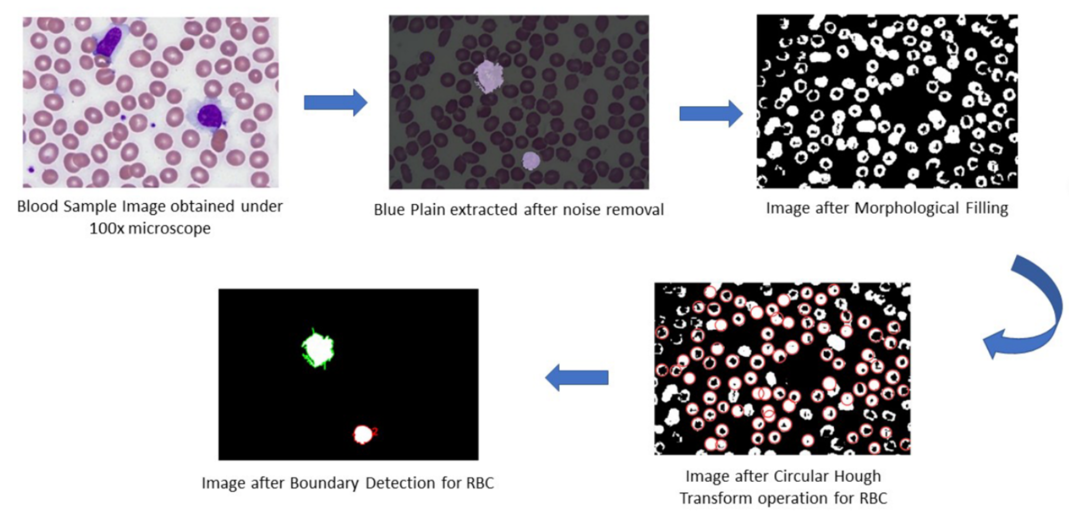
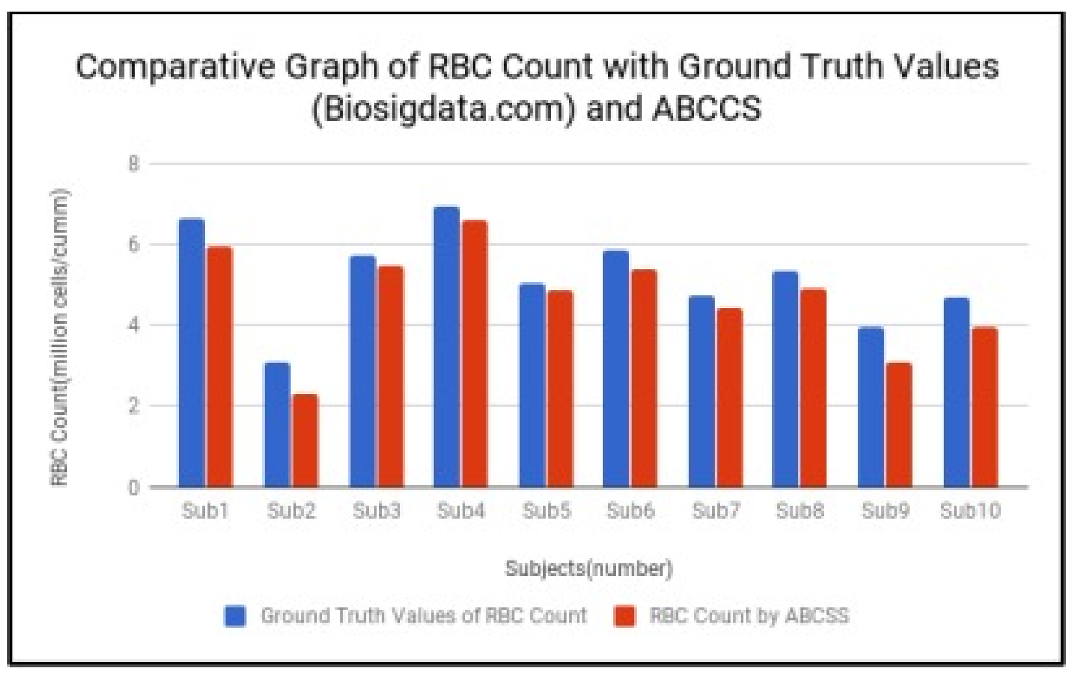
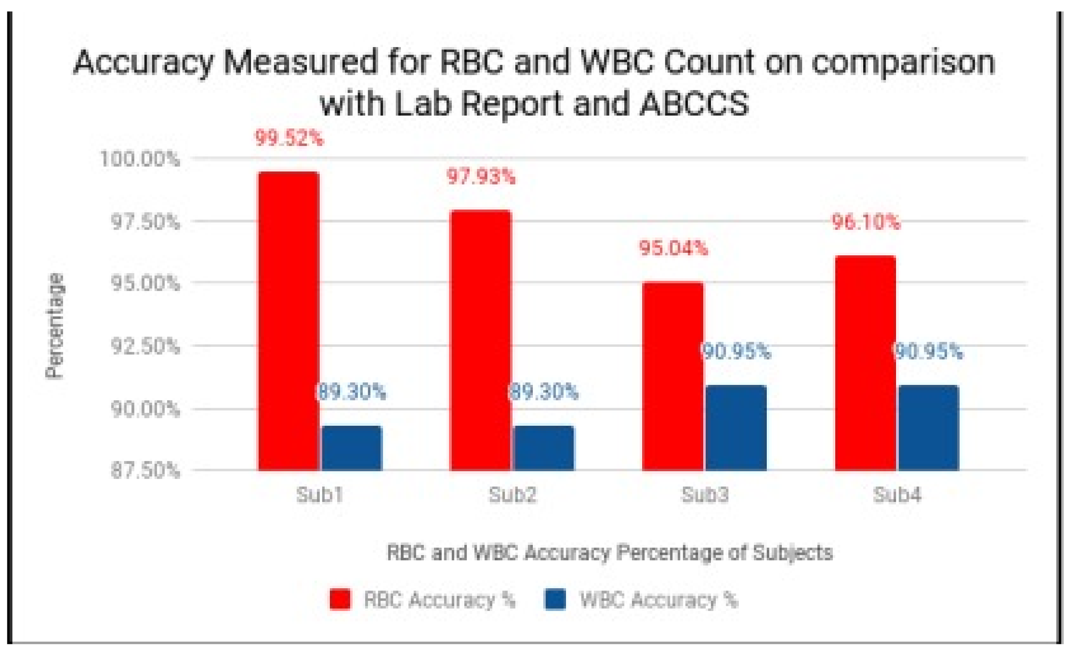


Figure 2. Result after each step

Subject	RBC Count [Lab Report]	WBC Count [Lab Report]	RBC Count [By Methodology]	WBC Count [By Methodology]	Accuracy of RBC Count	Accuracy of WBC Count
Person 1	5.12	0.009580	5.1441	0.010606	99.52%	89.3%
Person 2	4.26	0.009950	4.3486	0.010606	97.93%	89.3%
Person 3	4.91	0.007850	4.6668	0.00714	95.04%	90.95%
Person 4	4.90	0.007850	5.0911	0.00714	96.1%	90.95%

Figure 3. Comparative results of lab methods with discussed methodology





Conclusions

The ABCCS method solves the problem of counting RBC with an overall accuracy of 91% and WBC with an accuracy of 85%. By using the proposed technique in image processing, analysis of blood cell image is more accurate as well as this method is efficient in terms of time and cost compared to existing techniques of counting blood cells. The proposed method performed the segmentation and counting of RBCs and WBCs well when results were compared with the ground truth (biosigdata.com), which was determined by experts.

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References

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