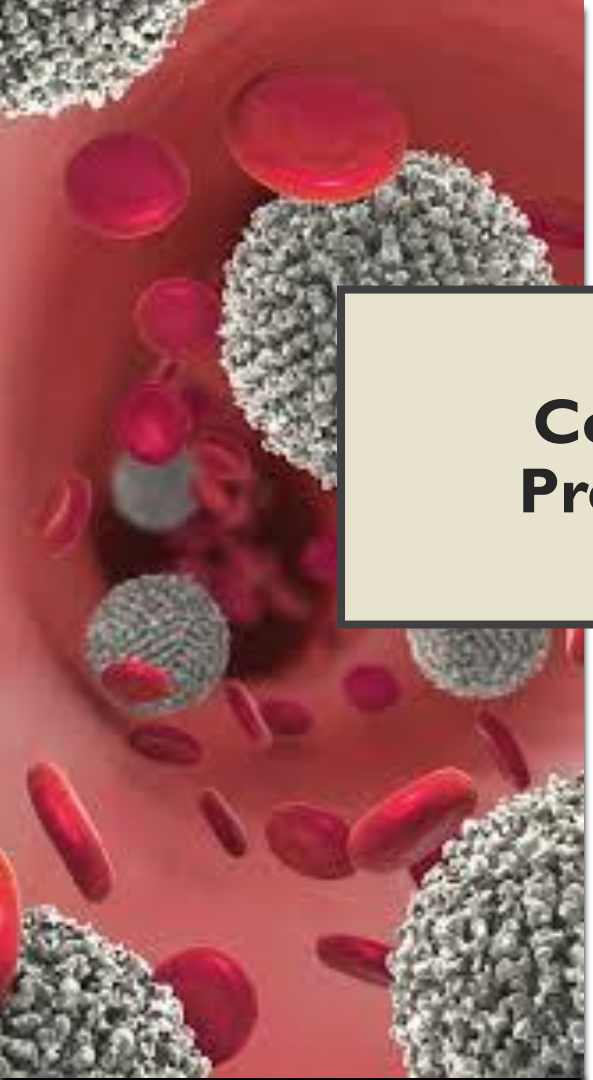

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Color Normalization For Acute Promyelocytic Leukemia Images

Author :Rabi'atul'Adawiyah binti Abdul Rahman

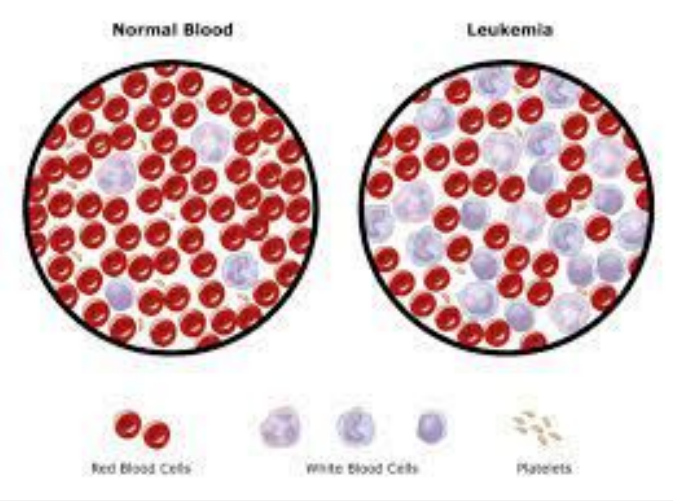
INTRODUCTION

- **Leukemia** is a cancer of the marrow and blood. It is caused by the rapid development of abnormal white blood cells.
- **Acute Promyelocytic Leukemia** (APL) is a subtype of Acute Myeloid Leukemia (AML).

Data of APL cases:

7% to **8%** of AML cases

0.34 per 100,000 persons

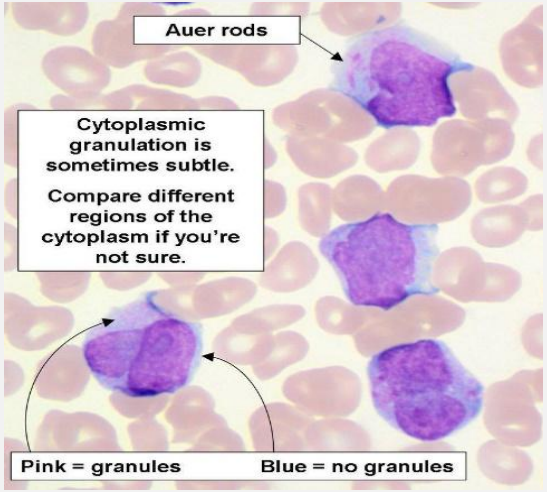


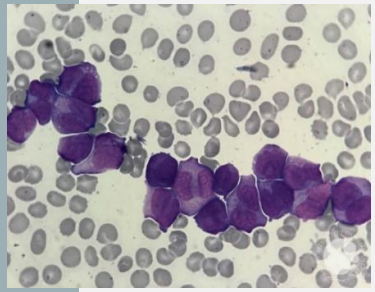
Diagnosis based on the clue provided from the morphology of the white blood cell.

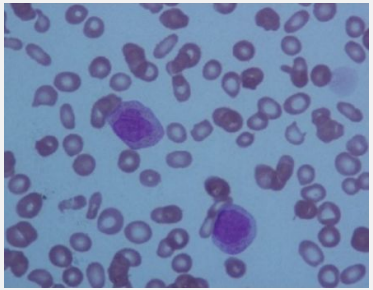
Variation of color and illumination cause difficulty in analyzing APL images.

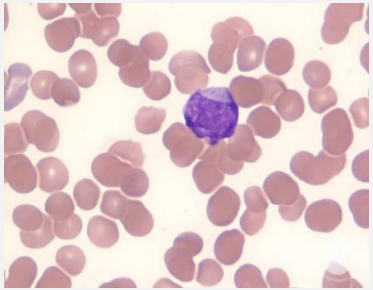
Color normalization is the process of mean color transformation from one image to another image.

In the previous research, color normalization and stain separation mainly focused on the histopathology images.







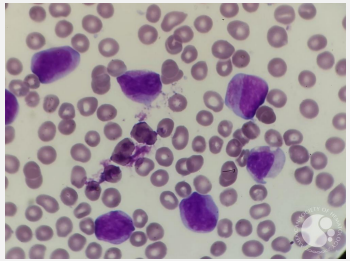
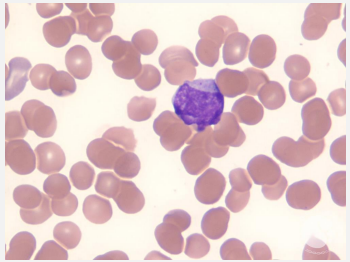
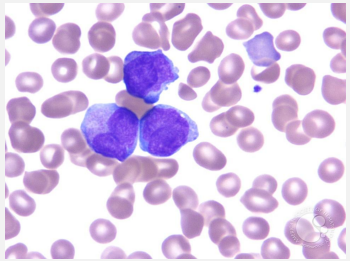
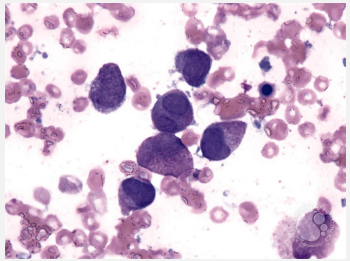


METHODOLOGY

PUBLIC SOURCE

American Society of Hematology (ASH) Image Bank

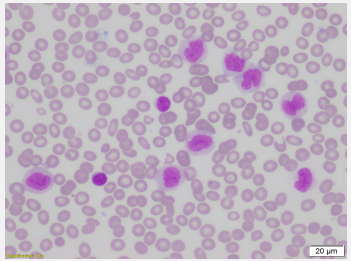
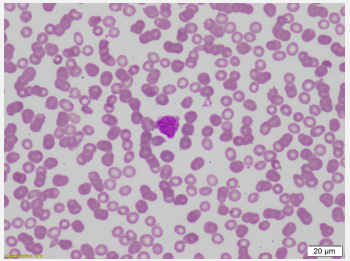
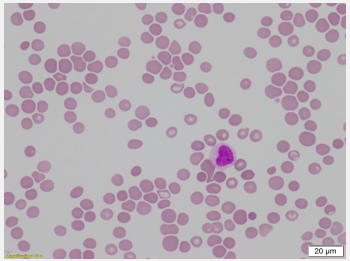
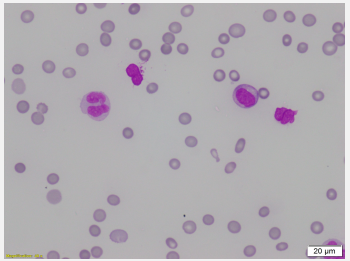
Format Image: JPEG, JPG
Number of images: 20

PRIVATE SOURCE

Department of Hematology, Hospital Universiti Sains Malaysia (HUSM)

Format Image: Bitmap (BMP)
Number of images: 30

METHODOLOGY

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Color Normalization Methods

GLOBAL COLOR NORMALIZATION

The color from the target images is transferred to the source image

- Histogram Matching
- Reinhard Method
- Standardizing Multiple Color Variations Method (SMCV)

STAIN SEPARATION

It involves separating the different components of color in an image, often referred to as "stains"

- Macenko Method
- Structure Preserving Color Normalization (SPCN)

Quality evaluation metrics

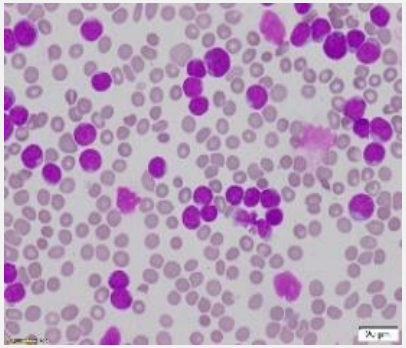
Structural similarity index metric (SSIM)

Mean absolute error (MAE)

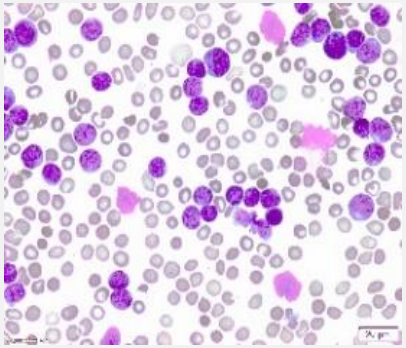
Correlation coefficient (CO)

Root mean square error (RMSE)

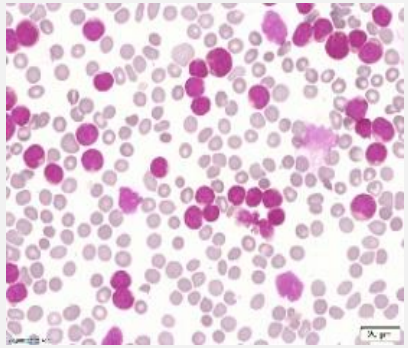
RESULT AND DISCUSSION



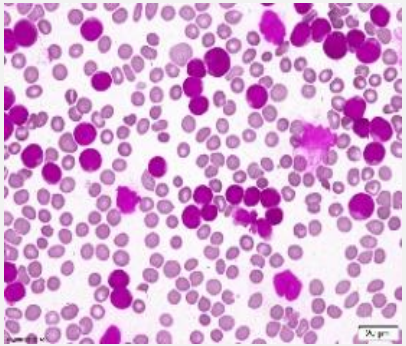
Original



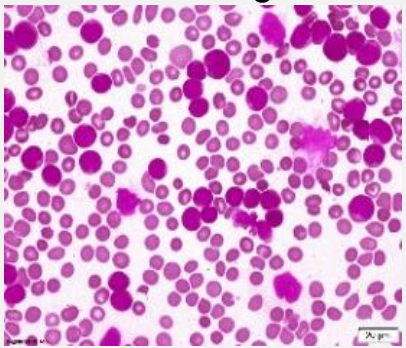
Histogram Matching



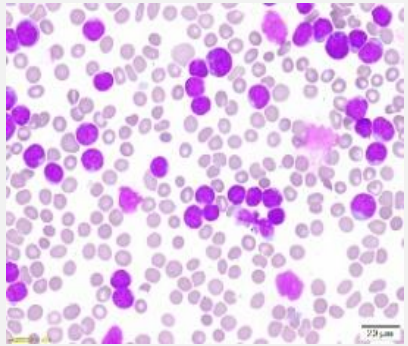
Reinhard



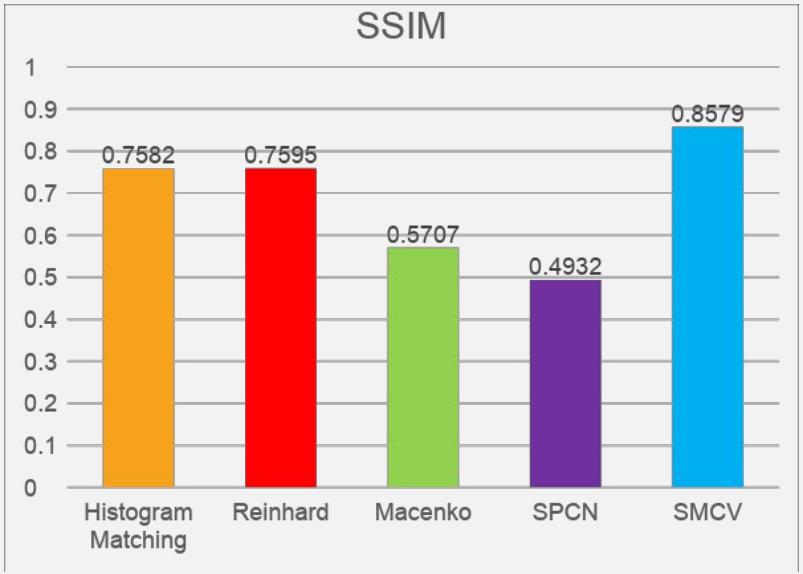
Macenko

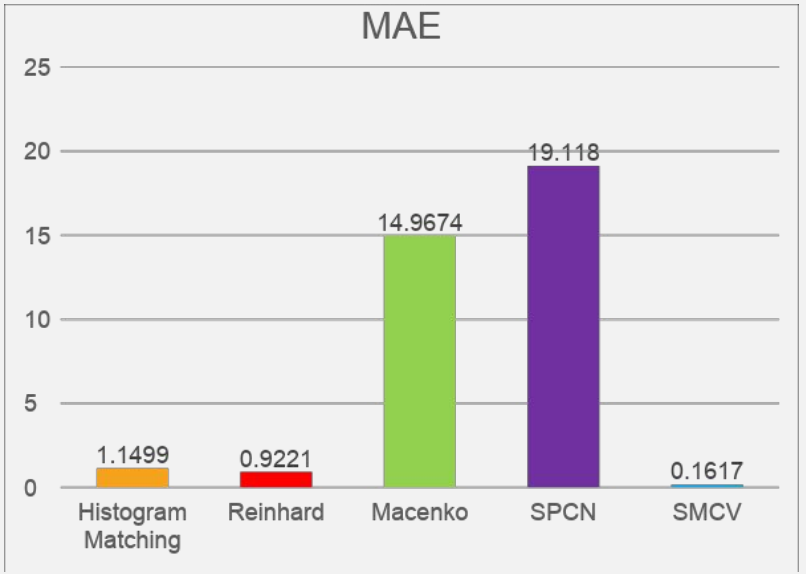


SPCN



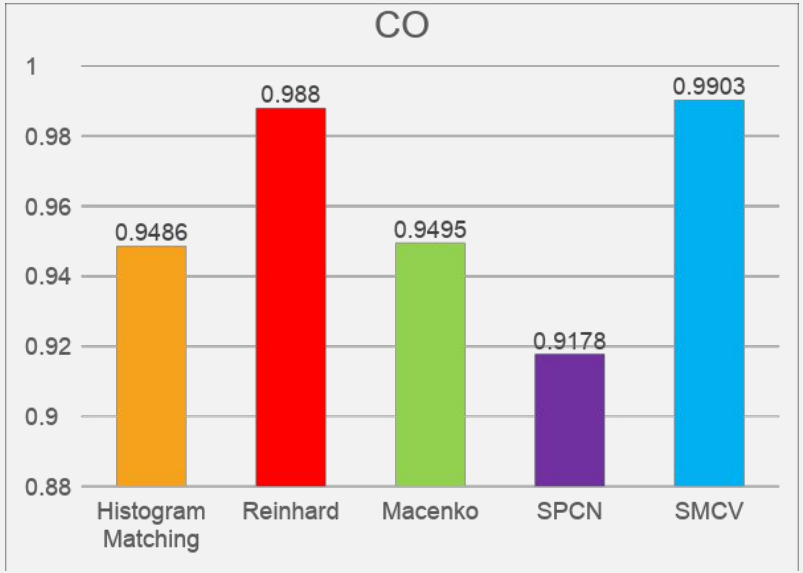
SMCV



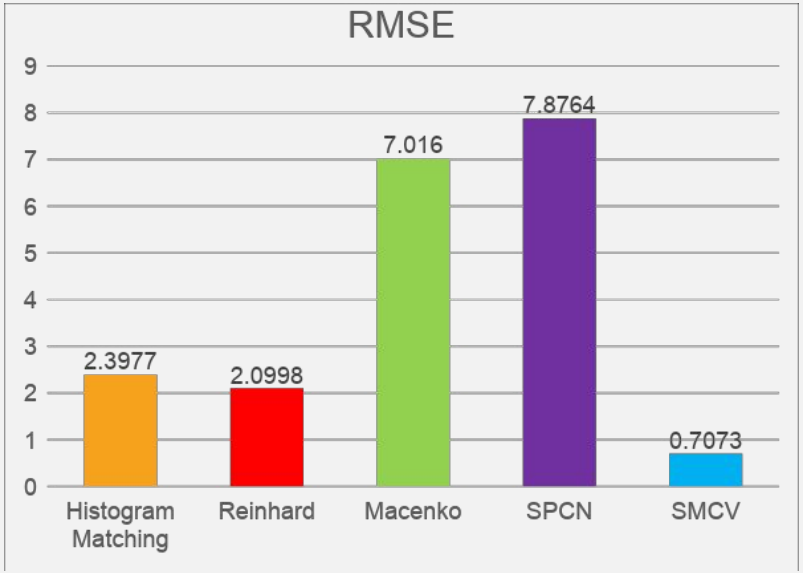


The higher similarity value indicates a small value of information loss. SMCV has the highest value, this indicates the images produced by the SMCV method are much similar to the source images with less information loss.

The higher value of MAE, indicates the lower the quality of images. It is used to detect the blurring effect present in the images. SMCV produces a lower value of MAE, which means the output image has less blurring effect.



SMCV achieved a closer value to 1 which indicates the source and output images are highly related and have similar spatial patterns



SMCV produces the lowest value of RMSE, indicating that the output images are close to the source image on a pixel-by-pixel basis.

CONCLUSION

In both qualitative and quantitative analyses, SMCV consistently outperformed other color normalization methods.

The SMCV method proved to be the most effective for normalizing APL images. By addressing color and illumination variations, SMCV enhances the quality and reliability of APL diagnosis, contributing to improved patient care.

The procedure of some methods may be remodeled to improve the effectiveness of color normalization on blood slide images.