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ENHANCEMENT OF MICROSCOPIC MEDICAL IMAGES USING FUZZY LOGIC APPROACH

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Abstract

Poor image quality and image contrast is the challenges when the image is captured using electron microscope. The method of microscopic medical image enhancement involves enhancing an image's characteristic to improve the image quality. Contrast enhancement is a difficult and intriguing field, fuzzy logic approach can be used to handle and control uncertainty present in the image. To provide efficient and effective framework for future research this paper focuses on fuzzy logic approach, the performance is evaluated on blood cell dataset using different quantitative measures. The fuzzy method gives better results for AMBE, Entropy and PSNR.

Keywords: Microscopic Medical Images, Adaptive Histogram Equalization (AHE), Histogram Equalization (HE), Dynamic Histogram Equalization (DHE).

1. INTRODUCTION

Images captured from various microscope techniques provide lot of information for the diagnosis or analysis purpose. Because of the source, focal length, magnification, aperture and lens shape, the Microscopic medical images do not same dimensions, shapes, contour descriptors of the radius, the spacing between the cell rows, the surface texture and perimeter, are utilized to describe the biological objects that are extracted from the image in order to carry out the different operations on the microscopic images. A better diagnosis may be possible with the use of microscopic medical image analysis. The image processing operations may vary depending on the alignment of the cell, texture of the image. Microscopic image enhancement is to enhance microscopic image quality and specific features to process the image further. There are different enhancement techniques which are traditional and based on spatial and frequency domain. Low contrast images with blurry edges pose challenges to microscopic medical image processing, pattern recognition and computer vision.

Enhancement is basically improving the image quality for users which provide better contribution to the automation of image processing techniques. Enhancement techniques alter the brightness, contrast of images, as the results image is altered as per the transformation done to the input images. Different enhancement methods would be able to improve the image edges and contour information as well as global and local contrast, highlighting the images internal intricacies and enhancing the visual effects. According literature using variety of image enhancement techniques leads to improved image, although low contrast microscopic image enhancement research is still comparatively scarce. Several enhancement techniques for microscopic medical images in the low frequency domain have been created utilizing this methodology. Fuzzy logic using fuzzifier produce various degrees of fuzziness in the plane the

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frequency domain is separated from the spatial domain. Contrast enhancement is accomplished using fuzzy operator.

Microscopic medical image analysis and processing is widely used and researched field in image processing domain thus microscopic medical image analysis required to be enhanced for improving the quality of microscopic image for the further image processing tasks such as edge detection, segmentation, feature extraction etc. image enhancement is mainly classified into two broad categories, spatial and frequency domain methods. The figure 1 shows different types of microscopic medical images.

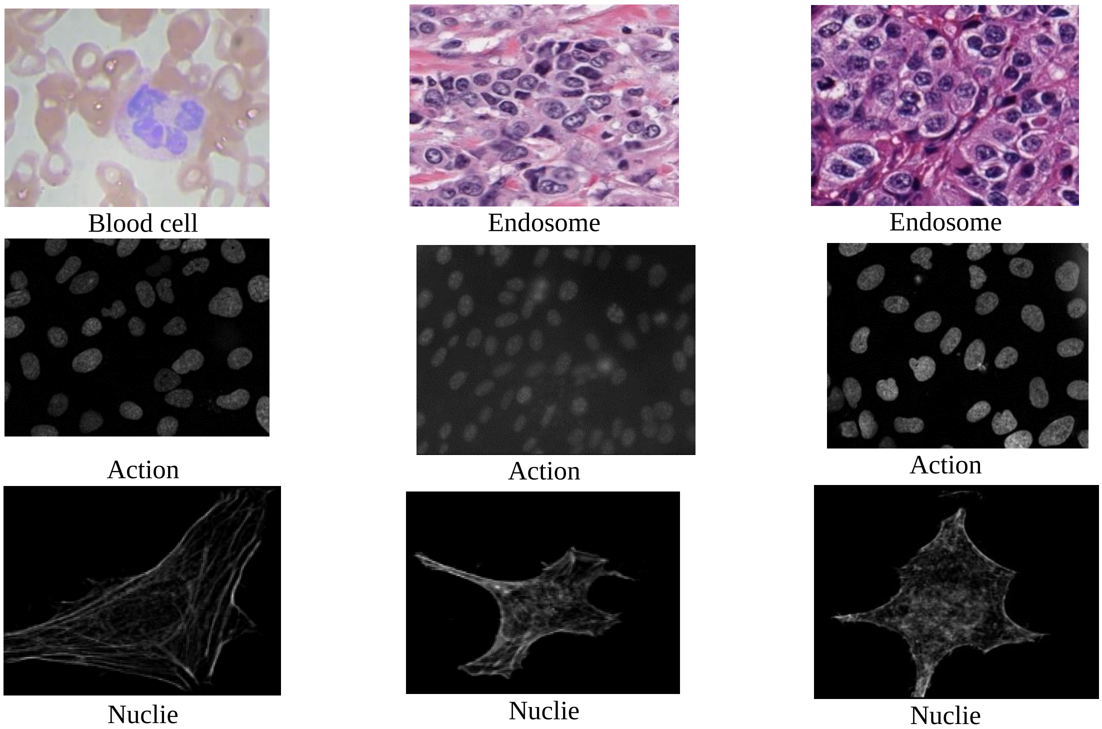

Fig 1: Different types of microscopic medical images

In past few years fuzzy set approach is used for enhancement of medical microscopic images because the image often contain uncertainties by ambiguity, the fuzzy logic is applied successfully applied to microscopic images to provide better results than other traditional methods .It is difficult to recognize the color pattern and microstructure of the microscope images using naked eyes but the fuzzy logic approach in image processing provides a method which improve the quality and reliability of the microscopic images.

2. RELATED WORK

In literature many different enhancement techniques have been proposed for microscopic medical image but accurate enhancement is an essential for preserving the details of the images for the analysis and detection of disease, which is dependent on shape color and quality of the image. Due to these factors the analysis of microscopic image is complicated.

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The analysis of microscopic images needs to resolve the illumination and contrast related issues present in the image, several illumination and contrast enhancement techniques for enhancement of medical images have been proposed like Modified global and modified linear stretching algorithms (MGCS) [2].Multi Decomposition Histogram Equalization (MDHE)[3], Intensity Weighted Subtraction Microscopy Approach for Image_Contrast and Resolution_Enhancement [4], Accurate_Microscopic_Blood Cell Image_Enhancement_and Segmentation [5],Resolution and contrast_enhancement in laser scanning_microscopy using dark beam imaging [6],Resolution and contrast_enhancement in coherent anti-Stokes Raman scattering microscopy [7],contrast limited_adaptive histogram equalization and discrete wavelet transform for image_enhancement (CLAHE-DWT)[8], Contrast image enhancement using Type II fuzzy set [9], NSCT_combining adaptive threshold and improved_fuzzy[10].fuzzy logic_basedadaptive Histogram_Equalization (AHE)[11]. For the performance evaluation of enhanced image difference performance metrices such as Peak Signal_Noise_Ratio (PSNR), Absolute Mean_Brightness Error (AMBE), Mean Square Error (MSE), Structure_Similarity index Measurement (SSIM), Entropy and_Mean Absolut Error (MAE) are used. From the literature observed that the most of the techniques for microscopic medical image enhancement are based on contrast stretching, contrast limited adaptive histogram equalization, linear contrast stretching, histogram equalization and adaptive histogram equalization were proposed, these methods use only absolute mean brightness error, peak signal noise ratio and root mean square as a quantitative measure to measure the performance of the microscopic medical images.

3. PROPOSED METHOD

In this_section, the block_diagram of proposed method for enhancing microscopic medical images is given in_fig.2

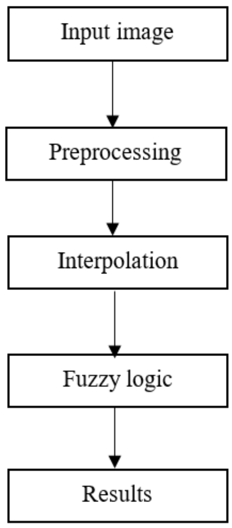

Fig 2:Block_Diagram of the Proposed Method

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The first step of the proposed method is preprocessing in that the colored image is transformed into gray scale and noise and unwanted objects are removed from the image, In the second step the bi-linear interpolation is used to preserves the visual appearance of the original image, then interpolation is used to enhance the image's quality

After interpolation fuzzy logic is applied in which the picture is divided into_sections, and each section is treated as a fuzzy window. The fuzzy window is improved by applying mean and variance.

In a similar manner, each fuzzy window is improved before being combined. Fuzzification, inference engines, and defuzzification are the fundamental components of fuzzy logic.

$$Mi\,j = \frac{(K_{i,j}(x,y))^{\Upsilon}}{\sum_{i=0}^{n}\sum_{j=1}^{m}(\_K_{i,j}(x,y)\_)^{\Upsilon}}$$

Where $M_{i\,j}$:T→ [_0, 1_]

$M_{i\,j}$,$K_{i,j}(x,y)$Describe_the membership and pixel value respectively.

$\Upsilon \in (0,\infty)$ and Υ controls the_fuzzification and_defuzzification.

After enhancement process is finished, quality of images is computed_using different quantitative measure as parameters the obtained results_are tabulated_in table 1 and the resultant images are shown in Fig. 2.

4. QUANTITATIVE ATTRIBUTES

In image enhancement technique quality of an image can be subjective. It can be different for person to person, so because of this reason it is compulsory to establish some parameters to compare the image quality. Following are the matrix used to inquire the quality of an image:

4.1 Absolute Mean Brightness Error:

AMBE is defined as difference between input and enhanced picture. It is represented as:

$$AMBE = |E(x) - E(y)$$

Where the average intensity of input picture is given by E(X), the average intensity of enhanced picture is given by E(Y). The AMBE value provides a sense of how the image global appearance has changed, with preference to lower values.

4.2 Michelson Contrast:

Contrast Measures the relation between the spread and the sum of the two luminance's. It is difference between lower and higher intensity level.

$$\text{Modulation} = (L_{max} - L_{min}) / (L_{max} + L_{min})$$

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4.3 Image Entropy:

The image entropy specifies the uncertainty in the image values. Measures the averaged amount of information required to encode the image values.

The entropy also called discrete entropy is a measure of information content in an image and is given by,

$$\sum_{i=1}^{n} -p(S_i)\log_2 p(S_i)$$

Where p (k) is the probability distribution function. Larger the entropy, larger is the information contained in the image and hence more details are visible in the image.

4.4 Structural Similarity Index Measure (SSIM)

SSIM is used for measuring the similarity between two images determines how two images are alike similarity value ranges from [0, 1].

$$\text{SSIM}\ (x, y) = \frac{(2\mu_x\ \mu_y\ +\ c_1)(2\sigma_{xy}\ + c_2)}{\left(\mu^2{}_x\ + \mu^2{}_y\ + c_1\right)(\sigma^2{}_x\ + \sigma^2{}_y\ + c_2)}$$

4.5 Peak Signal Noise Ratio (PSNR)

PSNR is an expression for the ratio between the maximum possible value (power) of a signal and the power of distorting noise that affects the quality of its representation. PSNR is calculated using

$$\text{PSNR} = 10\ \log_{10}\left(\frac{\text{Max}^2}{\text{MSE}}\right)$$

Where Max is the possible intensity of the image

5. RESULTS

For experimentation purpose we used 366 blood smear images which is downloaded from the Kaggle repository. To_enhance the microscopic medical images different methods, like Histogram_Equalization (HE), Adaptive Histogram Equalization (AHE), Dynamic Histogram Equalization (DHE), Gamma Correction (GC), Log Transform (LT) and Negative image (NI) are_used. Results of the experimentation are shown in fig.2. The results of enhanced image using log transform for different values of c are given in fig._4 and the values of PSNR are tabulated in table_2. When we measure the values taking the PSNR as a parameter, it gives good results when the c value is 1.5.

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Table 1: Comparative results of different performance metrices.

	Entropy	PSNR	AMBE	MC	SSIM
AHE	0.006	14.43	27.35	0.94	0.71
HE	3.30	6.24	76.69	1.00	0.231
DHE	2.47	16.80	32.96	0.0	0.72
Log Transform	1.50	2.29	178.06	0.20	0.21
Negative	1.92	185.8	39.01	2.0	0.64
Gamma	0.0	27.35	15.42	0.0	0.82
Proposed	3.59	25.45	12.33	0.89	0.75

Table 2: PSNR for different values of c

PSNR	16.53	17.00	17.75	18.88	14.75	13.66	12.75	11.25	10.74
Type	c=0.1	c=0.5	c=1.0	c=1.5	c=2.0	c=2.5	c=3.0	c=3.5	c=4.0

Table.1 shows that the proposed method gave good results in terms of PSNR, AMBE and Entropy. Quantitative Metrics results are shown in fig 3, from the figure it is observed that when AMBE is lower and PSNR, Entropy, MC, SSIM is higher the proposed method gives good quality image.

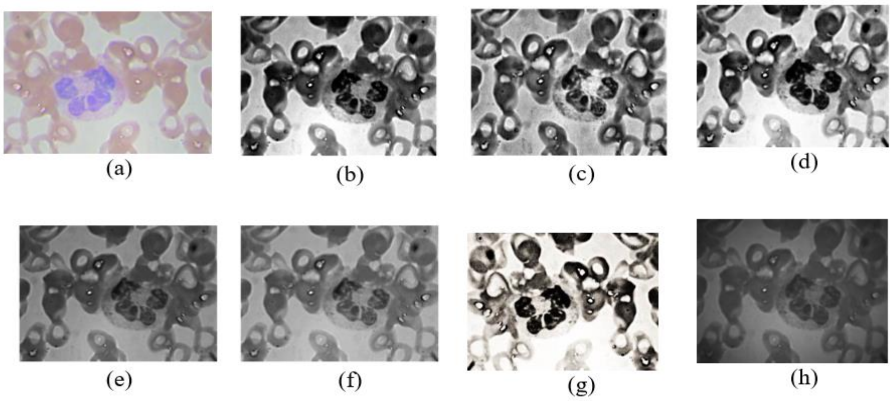

Fig 2: Qualitative results. (a). Original image (b). HE (c). AHE (d). Gamma Correction (e). DHE (f). Fuzzy Logic (g). Negative image and (h). Log Transform

The study of different enhancement methods shows that Adaptive histogram method provides maximal_brightness preservation though these methods_can perform good contrast enhancement. Thus, it is_observed that all the traditional enhancement methods have their merits or demerits based on various performance metrices according to the image's quality, these techniques can bemodified and improved to get more refined images

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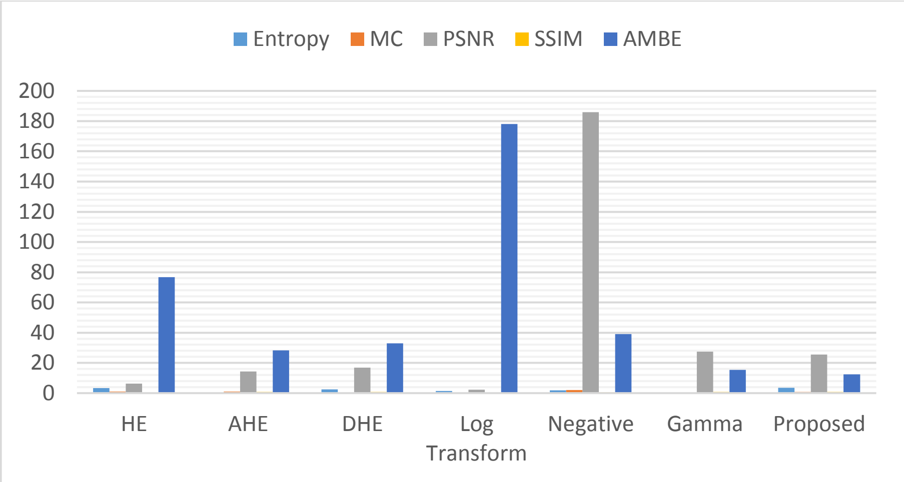

Fig 3: Representation of quantitative results

6. CONCLUSION

In this paper, we have proposed a fuzzy logic approach for enhancement of microscopic medical images. The proposed method is compared with different traditional enhancement methods, it gives better/good results both in quantitative and qualitative analysis. The different performance metrices like Entropy PSNR MC SSIM and AMBE are calculated and the proposed method gives good and effective results compared to other enhancement techniques. The results may helpful for other researcher and students to extend the work in microscopic medical image analysis.

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