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Cancer cell detection using advanced fuzzy set theories

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Abstract

The past three decades, breast cancer has evolved rapidly to diagnosis and treatment for organizing breast screening and progress of imaging modalities. The programming languages like artificial intelligence helps for medical treatments and it is reduced the work of human guided. Breast cancer has develop into the second leading cause of death in women, improve the cancer patients safety through early diagnosis. Digital pathology plays an important role to detect the stages of cancer cell and it is help to improve the diagnosis accuracy. The proposed work of triangular intuitionistic fuzzy number based contrast limited adaptive histogram equalization was produced better results and handles the uncertainty in the medical images. It was implemented for select the clip limit value by automatically and get better image quality. The existing and proposed method is compared by image quality measurement such as mean square error and peak signal noise ratio.

Keywords

Intuitionistic fuzzy set, enhancement, contrast limited adaptive histogram equalization.

AMS Subject Classification

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Contents

1. Introduction

Breast cancer is hazardous illness in the worldwide, accounting for a predictable 2.09 million death in 2018. Biopsy testing merely find of cancer and recovering the patient result. Through biopsy test, a doctor eliminates amount of tissue along with pathologist observes the biopsy model under a microscope. Recommended of mammograms scan helps to cancer prediction whether present or not. Medical digital pathology images employ to regulation and known the pathology information where shaped from a glass digital slide. Medical students, researchers, clinical research, tumor boards and health care applications are mostly used these digital pathology images. Pathology plays an augmented role in diagnosis of cancer cell, research work and treatment. In the 20th centuries, cancer was definite by the expression of metastases and invasion based on gross findings at autopsy or surgery.

2. Literature Survey

The degree of fuzzification is belonging to the interval level between zero to one. Probably, medical images have carries various noises, bad contrast or blurring of the image. The histogram equalization techniques hold the dominant position in the image pixels, however these strategies have some drawbacks such as incapability to measure the edges and non preservation of brightness. Moreover, uncertainty and ambi-

guity is occurring while histopathology image transmission or acquisition[1, 2]. Fuzzy techniques should be handling the various uncertainties. Going to enhance the image characteristics by using low and high contrast enhancement methods, low level is considered based on applications. If modifying the histogram, it referred as indirect contrast enhancement method [3]. Histogram equalization way is the primitive process to distributive the gray levels in the intensity sort. The types of the histogram equalization consist of adaptive histogram equalization, contrast limited adaptive histogram equalization and then brightness preserving bi histogram equalization [4, 5].

3. Proposed Work

The histogram is the base for most of the spatial domain techniques. A histogram of an image will give the statistics of the probable occurrence of intensity levels in an image. Over enhancement noise produced the problem of homogeneous regions. Adaptive histogram equalization method is applied to improve the contrast level and the speed of computational followed by some noise also occurred. Contrast limited adaptive histogram equalization method is applied for reduce the over enhancement and minimizing the noise ratio [6, 7]. The image is separated into non overlapping regions called the contextual region. The highest height of each contextual region of histogram was computed. The clip limit value is redistributed without exceeding the limit.

3.1 Contrast Limited Adaptive Histogram Equalization (CLAHE)

Detection of cancer nuclei is very difficult practice with microscopic images because of it is contains vagueness and uncertainties. The contrast limited adaptive histogram equalization method helps to improve the contrast level of the image and get superior results for image quality. CLAHE was developed for reduces the over amplification noise from the medical images. The clipping the histogram value computes before calculation of cumulative distribution function.

$$Cliplimit = \left[\frac{s}{256}\right] + \left[\beta.\left(S - \left[\frac{s}{256}\right]\right)\right], \tag{3.1}$$

where, β defined as the clip limit predefined value and s represented the title or window region [3]. The grayscale value has pixel range from 0 to 255.

3.2 TFM (Triangular Fuzzy Membership) CLAHE

Triangular fuzzy membership function which is used to calculate the clip limits value by using triangular fuzzy numbers. It defined as maximum, minimum and mean values of the intensity of the image. The clipping parameter μ_{im} and TFM $\mu_{im} = (x_1, y_1, z_1)$ is correspond to mathematical term is given by following equation.

$$\mu_{im} = \begin{cases} 0, if\ x < x_1; \\ \frac{x-x_1}{y_1-z_1}, x_1 \le x \le y_1; \\ \frac{z_1-x}{z_1-y_1}, y_1 \le x \le z_1; \\ 0, if x > z_1 \end{cases} \tag{3.2}$$

The triangular fuzzy member function clip limit was replaced by using membership degree of triangular fuzzy number defined as the following equation,

$$TFMCL = \left[\frac{w}{256}\right] + \left[\mu_{im}.\left(w - \left[\frac{w}{256}\right]\right)\right], \tag{3.3}$$

where μ_{im} is the TFM clipping value range from 0 to 1.

3.3 Intuitionistic Fuzzy Set Clahe

The intuitionistic fuzzy set initiated by Atanassov is distinguished by two functions expressing the degree of belongingness and the degree of non belongingness respectively,

Let $U = \{ c_1, c_2, \cdots, c_n \}$ be a finite universal set. An intuitionistic fuzzy set C, agreed universal set U is an object having the type

$$\widetilde{C} = \{ \ c1, \ \mu_{\widetilde{C}}\ (c_i), \gamma_{\widetilde{C}}\ (c_i) \ : \ \ (c_i \in U)\} \tag{3.4}$$

where the functions,

$$\mu_C : U \to [0,1]; \tag{3.5}$$

$$\gamma_c : U \to [0,1]; \tag{3.6}$$

Define the degree of membership and then degree of non-membership of an element $c_i \in$ U, is the following conditions represent as :

$$0 \le \mu_C(c) + \gamma_c(c) \le 1, \forall c_i \in U \tag{3.7}$$

which is known as the intuitionistic fuzzy set condition.

3.4 Triangular Intuitionistic Fuzzy Number (TIFN clahe)

Detect the intuitionistic fuzzy number in the proposed image and computed the mean value from the image.

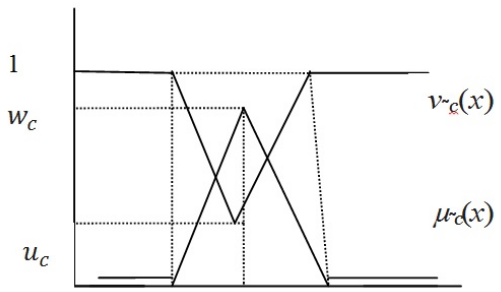

Figure 1. Triangular Intuitionistic Fuzzy Number

Triangular intuitionistic fuzzy number (TIFN) is a special intuitionistic fuzzy set, which the membership function and non-membership function was defined by Atanassov's as follows: from this algorithm helps to choose the contrast clip limit value through automatically. It was help to improve the contrast level of the breast cancer cell microscopy images. The μ_{im} value is calculated by triangular intuitionistic fuzzy number. The clip limit value is calculated through triangular intuitionistic fuzzy number. The redistributed of the pixel values by using the proposed algorithm of intuitionistic fuzzy number belongs on membership and non membership degree.

$$TFM\ Cliplimit = \left[\frac{w}{256}\right] + \left[\mu_{im}\ \left(w - \left[\frac{w}{256}\right]\right)\right] \tag{3.8}$$

The selection of clipping parameter helps to improve the image enhancement followed by automatically.

4. Experimental Results and Discussion

4.1 Mean Square Error (MSE) and Peak Signal and Noise Ratio (PSNR)

The image enhancement quality was measured through mean square error and peak signal and noise ratio. The PSNR is term by using mean square error, it is calculated ratio amid the power of corrupting noise and highest possible of a signal that have an effects on the output signal. The MSE calculated the scaling of image intensity and these values should be closer to zero. It is better and defined as, MSE measure between two images $Im1\,(i,j)$ and $Im2\,(i,j)$.

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}\left[Im1\,(i,j) - Im2\,(i,j)\right]^2 \tag{4.1}$$

The *mxn* input image of $Im1$ and $Im2$ consist of enhanced image.

The PSNR measure the image of reconstruction quality and described as

$$PSNR = 10\log_{10}\frac{MAX_I^2}{MSE}. \tag{4.2}$$

The quality of enhanced images is calculated by various methods such as PSNR and MSE. From tables, new proposed enhancement method was performed well compared to the values of existing methods shown in table1.

Table 1: Image Quality Measurement

Algorithm	Images	PSNR	MSE
AHE	1	32.0	23.0
CLAHE	2	43.1	31.88
IFS CLAHE	3	51.5	24.5
Triangular IFS CLAHE	4	67.0	20.0

5. Conclusion

Breast cancer is one of the most common diseases in women worldwide, cancer stages can be handled by biopsy testing. The biopsy testing viewed through microscopic computerized images, this image data set handover to researchers and medical students. Its help to improve the cancer cell detection accuracy. A microscopic image contains error lead of uncertainty which can handle by fuzzy set theory. The proposed works of triangular intuitionistic fuzzy number helps to select the clip limit value, it is improve the contrast level adaptive histogram equalization performance. Applied, the quality measurement methods are such as PSNR and MSE which compares the performance of existing and proposed algorithm. Finally get the best values of contrast rate for proposed algorithm, the advanced fuzzy set theories improve the contrast level and reduced the uncertainty region of the microscopic cancer cell images.

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