Enhancement Of Illumination For Medical Image Processing And Early Detection Of Lesions

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Abstract—Video and image are widely used in screening and diagnostic tests of the eyes. But sometimes, due to insufficient lighting, the quality of video or image decreases, which will limit the amount of useful information that we can get from the video images, or worse, it may render the sample inadequate for reading and diagnosis. If we want to maximize the amount of useful information extracted from the video, we must enhance the video image and analyze it. In this topic, we review an algorithm that will possibly solve the illumination problems encountered in such cases.

Keywords—Haar wavelet, wavelet fusion, image fusion, contrast enhancement, Diabetic retinopathy.

I. INTRODUCTION

Medical image processing is used to diagnose diseases and determine a patient's health status. Doctors rely heavily on medical images for more information, but some images are not accurate enough. This constitutes a hindrance for doctors to identify some lesions and diagnose diseases accurately.

In this paper, we will explain the effect of improving image contrast on increasing the resolution of medical images, especially with regard to diabetic retinopathy. And how algorithms and image-processing techniques have helped unearth the mysterious details found in medical images.

The technique used is image merging. Image merging has become a vital part of medical diagnostics, through which it is possible to improve image contrast and obtain more accurate information.

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II. MATERIALS & METHODS

A. *Color Space conversion*

In RGB color space, the chromaticity H, saturation S and brightness V of an image do not intersect with each other, that is, the color and brightness cannot be effectively separated. Basically, upgrading the three channels of RGB to change the splendor of the picture may influence the chromaticity of the image.

Therefore, the true color image can be changed from RGB space to space where the color and brightness can be effectively separated.

HSV space is not only better than RGB space is more suitable for describing human color sensation, and it effectively separates chroma, Saturation and brightness, making chroma and color saturation and brightness nearly orthogonal, which brings great convenience to subsequent true color image enhancement.

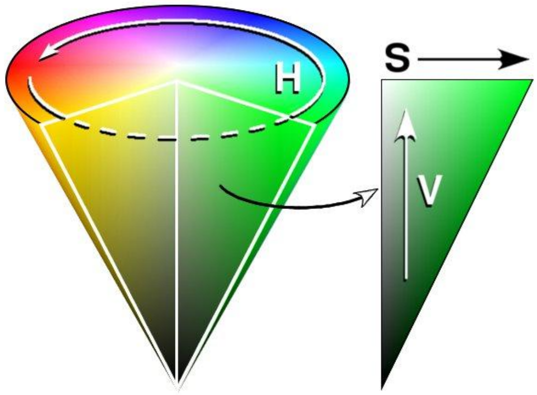
In this paper, the true color image is transformed from RGB color space to HSV color space. What HSV means? H is the abbreviation of Hue (the color type such as red, blue, or yellow), S is the abbreviation of Saturation (the "vibrancy" of the color) and V is the abbreviation of value (the brightness of the color).

Chromaticity is normally used to recognize and distinguish a certain color from a macro perspective, such as white, yellow, green, magenta, red, blue, black and etc. Saturation refers to the purity of the color. Brightness refers to the brightness of the color. The brighter the color is, the brighter the color is, the lower, the brighter the color is, and the lower the color is. Dark[19].

HSV color space is more in line with the visual characteristics of the human eye but not suitable for a display system.

So usually, color is usually converted from RGB space to HSV color space for processing, and then displayed in the RGB space.

Scholars usually use HSV mathematical model as follows: HSV color space can be represented by a cone: as shown in the figure, the H of a pixel can be represented by the center angle formed by the pointed the white reference line, and the value range of H is [0, 360]; the S of a point can be expressed by the distance between the point and the center of the circle of the circle, the greater the distance, the higher the Saturation, and vice versa; the V of a point can be expressed by the distance between the circle and the top of the cone, the greater the distance, the brightness. The higher, the lower.



This paper analyses the problems of low illumination video images, such as low brightness, blurred image details, poor visual effect and so on. Firstly, aiming at the problem of low brightness of low illumination video image, the traditional RGB space is converted to HSV space so that the brightness of the image is processed separately, instead of directly manipulating the three primary colors of R, G and B, the relationship between hue phase and Saturation of the original image cannot be changed[1]

Doctors and therapists suffer from blurred detail in medical images, and this can be an appropriate solution to increase the image's image resolution and accuracy without modifying them.

B. *Wavelet Fusion*

Combining images with two or more recorded images of the same object into one image can therefore be interpreted more easily than the original.

The purpose of photo fusion, especially in medical imaging, is to create new images that are more suitable for human visual perception purposes. Taking an average of two input images is the simplest technique for photo fusion.

Image fusion is a technology that combines the information contained in each image data organically by engineering recording the sequences of images obtained by two or more sensors at the same time or at different times using a certain algorithm, with the aim of producing new high-quality images.

The fused image is more suitable for human vision and easier to process and extract features.

Image fusion based on waveform conversion first decomposes the source image by deliberate wave conversion, and four sub-images are obtained to express low-frequency information, horizontal information, vertical information and country information, respectively. Low-frequency sub-images are then decomposition into four sub-images. The feature selection in the conversion area is then performed to create the molten image.

Finally, the fused image is reconstructed by inverse transform[20], [21].

For the object of image fusion, it can be divided into two categories: the fusion between gray image and the fusion between multispectral image (usually RGB color image) and gray image. The fusion of gray-scale images can be divided into three main categories.

One is the single fusion method, in which two images aligned in space are directly weighted average. The other is the fusion method based on pyramid decomposition and reconstruction algorithm, including gradient pyramid method. The first step is to construct pyramids that need input and then form fusion pyramids according to certain characteristics. The image is reconstructed by inverse transformation, and the fused image is finally generated, so the final effect is better than that of the first kind of method.

According to the traditional wavelet image fusion, improved the corresponding coefficient value method so as to enhance the details of the image[22]. In this paper, the wavelet transform method proposed in document[23] is used to divide the image into a subset of images containing low-frequency and high-frequency information.

We will mention the fusion laws for high frequency and low-frequency fields, respectively:

III. Algorithmic Steps

- Divide the video into frames and divide them into frames.
- Rename each frame and write each new picture to disk;
- Transform the image from RGB color space to HSV space;

The relationship between the values of three color components and the generated color in RGB color is not intuitive. However, HSV color space is more similar to the way humans perceive color. In our study, RGB color space is converted to HSV space; let Max be equal to the maximum in r, g and b, and min be the minimum. The corresponding (h, s, v) values in HSV color space are:

$$h = \begin{cases} 0^0 \\ 60^0 \times \frac{g-b}{\max - \min} + 0^0 \\ 60^0 \times \frac{g-b}{\max - \min} + 360^0 \\ 60^0 \times \frac{g-b}{\max - \min} + 120^0 \\ 60^0 \times \frac{g-b}{\max - \min} + 240^0 \end{cases}$$

Where:

- max = min, h equals segment A
- max = R and G are greater than or equal to b, h equals segment B
- max = R and G are less than b, h equals segment C
- h equals max = g, h equals segment D
- Max equals b, h equals segment E.

The value of H is usually normalized to between 0 and 360 degrees.

And H = 0 is used for max = min (that is, grey) instead of leaving h undefined. [1]

$$\boldsymbol{s} = \begin{cases} \mathbf{0} \\ \dfrac{\boldsymbol{max} - \boldsymbol{min}}{\boldsymbol{max}} = \mathbf{1} - \dfrac{\boldsymbol{min}}{\boldsymbol{max}} \end{cases}$$

Where: max=0 ⇒ s=0

$$\boldsymbol{v} = \boldsymbol{max}.$$

- In RGB, the brightness of each pixel of the picture is enhanced 10 times.
- Transfer the image from HSV space to RNG space. The specific operation is as follows:

$$h_i = \left\lfloor \frac{h}{60} \right\rfloor$$
$$f = \frac{h}{60} - h_i$$
$$p = v \times (1 - s)$$
$$q = v \times (1 - f \times s)$$
$$t = v \times (1 - (1 - f) \times s$$

The Brightness-enhanced image is processed by wavelet fusion. Haar wavelet, an orthogonal normalized wavelet, is used here.

<u>Haar wavelet transform is interpreted as follows:</u>

1-D matrix:

For example, there are 8 numbers a[8]=[4,8,8,9,5,7,8,6], and b[8] arrays are used to save the results.

The result of first-order Haar wavelet transform is obtained:

$$b[0] = (a[0] + a[1])/2$$
$$b[1] = (a[2] + a[3])/2$$
$$b[2] = (a[4] + a[5])/2$$
$$b[3] = (a[6] + a[7])/2$$

$$b[4] = (a[0] - a[1])/2$$
$$b[5] = (a[2] - a[3])/2$$
$$b[6] = (a[4] - a[5])/2$$
$$b[7] = (a[6] - a[7])/2$$

If the second-order Haar wavelet transform is needed, only the Haar wavelet transform of b[0]-b[3] is needed.

2-D matrix:

For a two-dimensional matrix, each level of Haar wavelet transform requires two one-dimensional wavelet transforms in horizontal and vertical directions, and the order of rows and columns has no effect on the results.

Example:

We will see the practical implementation of Haar Wavelet Transform step by step. We need to decide how many passes we will apply for Haar transform. Transform will be happened the first column by column, then row by row. So in the first pass, the average and difference will be calculated the first column by column then row by row. In the second pass, again average and difference will be calculated the first column by column, then row by row, and so on in more passes.

100	50	60	150
20	60	40	30
50	90	70	82
74	66	90	58

We will transform column then row by row Transform first row Original:

100	50	60	150

$a_1 = (100 + 50)/2 = 75$
$a_2 = (60 + 150)/2 = 105$

$d_1 = (100 - 50)/2 = 25$
$d_2 = (60 - 150)/2 = -45$

After transfer:

75	105	25	-45

Original:

20	**60**	**40**	**30**

$a_1 = (20 + 60)/2 = 40$
$a_2 = (40 + 30)/2 = 35$

$d_1 = (20 - 60)/2 = -20$
$d_2 = (40 - 30)/2 = 5$

After transfer:

40	**35**	**-20**	**5**

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Whole matrix after a column by column transfer

75	105	25	-45
40	35	-20	5
70	76	-20	-6
70	74	4	16

Now we will apply row by row transform. For row by row transformation, we will apply transformation only on 1* and 2nd columns because every time we apply a transformation on a column by column or row by row, then the next transformation will be applied on half of the previous width or previous height.

Then we will transform row by row transform the first column:

75	105	25	-45
40	35	-20	5
70	76	-20	-6
70	74	4	16

Original:

75
40
70
70

$$a_1 = (75 + 40)/2 = 57.5$$
$$a_2 = (70 + 70)/2 = 70$$
$$d_1 = (75 - 40)/2 = 17.5$$
$$d_2 = (70 - 70)/2 = 0$$

57.5
70
17.5
0

….

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1. By using wavelet transform, the image is divided into high-frequency parts and low-frequency parts. In this paper, the image is divided into high-frequency parts and low-frequency parts, which are the main parts of high-frequency and low-frequency images. Because the low contrast in the low-frequency part results in poor visual effect, and the local variance of the image can enhance the sensitive details of the human eye, so the square sum of the low-frequency coefficients of the image is equivalent to the local variance.

2. The high-frequency and low-frequency parts of the image are fused to obtain the final enhanced image.

3. Rename the enhanced image and write it to disk.

4. Write the image into the function of the video to get the final enhanced video.

Contrast enhancement helps make the image clearer by optimizing the color usage on the monitor. It can therefore be used to process medical images of the images on more accurate images.

Contrast manipulations involve changing the range of values in an image in order to increase contrast.

Retinal vasculature segmentation is the main step while developing automated screening systems for diabetic retinopathy. Digital fundus images are routinely analyzed by screening systems, and owing to the acquisition process, these images are very often of poor quality that hinders further analysis. Uneven illumination and contrast variability throughout the image significantly affect the vessel's segmentation process.

the brightness of the image outward from the center, leading to sort of uneven illumination known as vignetting[2], which consequently affects the contrast throughout the image. These artifacts are

significant enough to impede human grading and automated analysis in about 15% of retinal images [3], [4].

In order for doctors to detect and accurately diagnose, it is necessary to obtain high-quality retinal images.

However, studies show that approximately 12% of retinal images are difficult to analyze due to low image quality.

Nonuniform illumination and poor contrast due to the anatomy of the eye fundus (the eye fundus with a three-dimensional concave shape), opaque media, wide-angle optics of the fundus cameras, insufficient pupil size, the geometry of the sensor array, and movement of the eye are major causes of the low quality in retinal images.[7] Therefore, the improvement of image quality can play an essential role in retinal image analysis[8].

To determine the appropriate treatment for diabetic retinopathy (DR), the severity of diabetic retinopathy is to be classified.

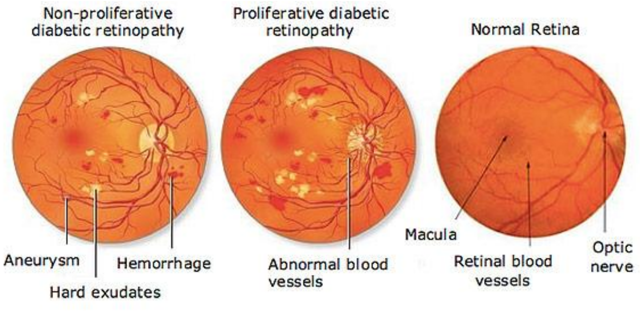
In this study, we will try to develop an automated system to help demyformic lesions in stereoscopic images.

Three different types of lesions:[10]

1. **Microaneurysms (Mas):**

is a critical step for early detection of diabetic retinopathy because they appear as the first sign of disease.[11]

2. **Hemorrhages (HEMs).**
3. **Exudates.**



Results:

Lesion detection:

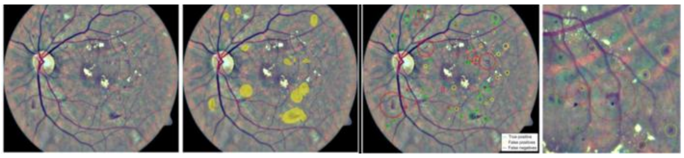
Diabetic retinopathy (DR)

As a result of progressive deterioration of the retina in the case of diabetic retinopathy, different types of lesions such as microanadology, dissonance, resin, etc. appear.

Detection of these problems plays an important role in early diagnosis, and improving images can help to diagnose the condition more accurately.

The pest detection scheme consists of 4 main steps: vessel extraction and opticdisc removal, preprocessing, candidate lesion detection, and postprocessing.

Initially, the optic disc and blood vessels are suppressed to improve treatment. The reinforcement is then made to separate dark lesions from the brightly illuminated retina background, zitm enhance the contrast between bright lesions and the background through a wide-scale filter designed optimally. . The mutual information of the maximum matched filter response and the maximum maximized. A differential evolution algorithm is used to determine the optimal values for the parameters of the fuzzy functions that determine the thresholds of segmenting the candidate regions. Morphology-based postprocessing is finally applied to exclude the falsely detected candidate pixels. [13]



Summary

Through this research, an algorithm was proposed to improve low light images and solve the problem of low contrast in medical images. The steps of the algorithm are summarized by dividing the image and then converting it from RBG space to HSV space, and then subjecting it to processing. Low-light images are processed by a vector, which helps reveal image detail.
The results showed how the algorithm helped improve the contrast in medical images, especially images related to diabetic retinopathy, providing more detailed information.

Conclusion

Image processing is becoming increasingly important in the medical field, and research shows how the algorithm helped to analyze images of a pathological lesion better and obtain more accurate information.

Through the differential evolution algorithm, we were able to determine the optimal values of the parameters of the fuzzy signs. Thus, it became possible to determine the type of lesion and take appropriate medical action.

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