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RGB Channel Analysis for Glaucoma Detection in Retinal Fundus Image

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***Abstract*— The research that used digital image processing to detect glaucoma has been known as one of the popular methods. The beginning step of the research is to choose the best channel among red, green, or blue (RGB) so it can ease the glaucoma segmentation. In choosing the channel, it is important to analyze deeply the used retinal images. Choosing of best component can affect the accuracy of glaucoma diagnosis results. In this research, the most suitable component will be analyzed to detect glaucoma based on the visual, MSE (Mean Square Error) value, and PSNR (Peak Signal to Noise Ratio). In this research, we used 85 images of glaucoma from the DRISTHI-GS database and 101 normal images from the RIM-ONE database. From the visualization, it showed that the red component had high brightness level so it can differ the optic disc and other parts of retinal eyes. The green component still has vessel blood so it will make it more difficult to segment the images. Blue component results in very dark of retinal image. From MSE and PNSR values, it showed that the green component had the smallest MSE value while the blue component has the biggest MSE value. PSNR value was obtained from the green component. Both red and blue components had PSNR value which had a small difference. From these results, it can be concluded that the MSE and PSNR values do not guarantee visual results. So that for further research, it is expected that the MSE and PSNR values will be obtained from the part that we want to observe**

Keywords—Glaucoma, RGB component, segmentation, MSE, PSNR

I. INTRODUCTION

Glaucoma is one of disease which can attack retinal eyes and cause blindness without earlier treatment [1]. In many cases, some patients did not find any symptoms until they came into the blindness phase [2]. Glaucoma is caused by increasing intraocular pressure of eyes which results in the destruction of nerve tissue in optics so the capacity of sight will decrease and cause blindness (in serious case) [3]. Glaucoma aggression can be delayed through treatment. That is why some people who potentially attacked by glaucoma because of the heredity factor can be treated routinely [4]. Some treatments such as air-puff intraocular pressure (IOP) measurement, visual field test, and optic nerve head (ONH) assessment can be implemented but those tests are very expensive and can be found in hospitals only. So, the earlier detection of glaucoma that is has high accuracy and cheap is important to develop [4].

Both optic disc and optic cup are the part in retina of the eyes which are used as a parameter in diagnosing glaucoma [5]. If the ratio of the optic cup towards optic disc more than 0.3, it means that the eyes were detected as glaucoma [6]. Both optic disc and optic cup are shown in Fig 1. The detail images are shown in Fig 2. (The brightest color is the optic cup which is surrounded by optic disc).

The research that used digital image processing to detect glaucoma has been known as one of the popular methods. The beginning step of the research is to choose the best channel among red, green, or blue (RGB) so it can ease the glaucoma segmentation. In choosing the channel, it is important to analyze deeply the used retinal images.

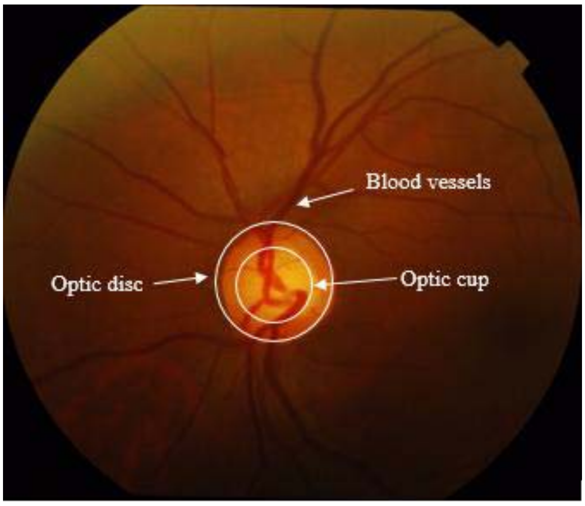

Fig 1. Retinal fundus image, optic disc and optic cup [5]

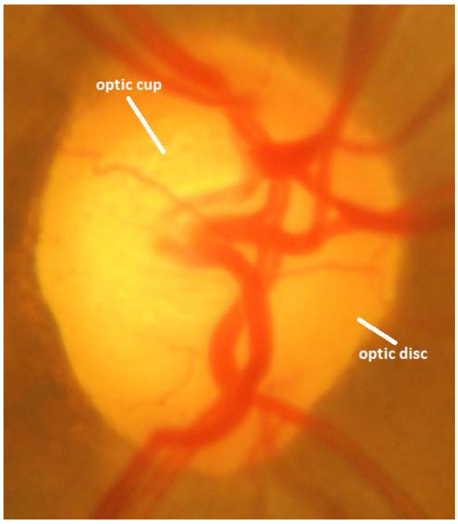

Fig 2. Optic disc and optic cup in detail aspect [5]

Issac et al [7] began his research by extracting the red component and green component for optic cup. Gaussian smoothing was used to equalize the distribution of pixel intensity in both histograms of the optic cup and optic disc. For segmentation optic disc, it will be used the obtained threshold from the calculation of size, deviation standard of Gaussian window, and the deviation standard of the imae which was obtained from the red component. Meanwhile, the

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mean value and deviation standard was used in the segmentation of optic cup. In this research, the Gaussian method can only be used at retinal data set which consist of noise that can be filtered by Gaussian filtering.

Akhade et al [8] segmented optic disc by using the algorithm of principal component analysis (PCA), mathematics morphology, and Watershed Transform. Pre-processing was begun by analyzing the red component of the retina image and erase blood vessels using mathematics morphology especially closing operation.

Nayak et al [9] diagnosed glaucoma using three features including the ratio between optic disc and optic cup, the distance between optic disc center and the head of optic nerve, and the ratio of ISNT inferior, superior, nasal, and temporal. In the ratio between optic disc and optic cup, Nayak et al used red component for optic disc while green component for the optic cup. The Morphological operation was used to remove part of the blood vessel and deviation standard of the image was used for segmentation.

From this research, there was not a detailed explanation of why the red component, blue component and green component was used. Choosing the best component can affect the accuracy of glaucoma diagnosis results. In this research, the most suitable component will be analyzed to detect glaucoma based on the visual, MSE (Mean Square Error) value, and PSNR (Peak Signal to Noise Ratio).

II. METHODOLOGY

A. Flowchart diagram of the research

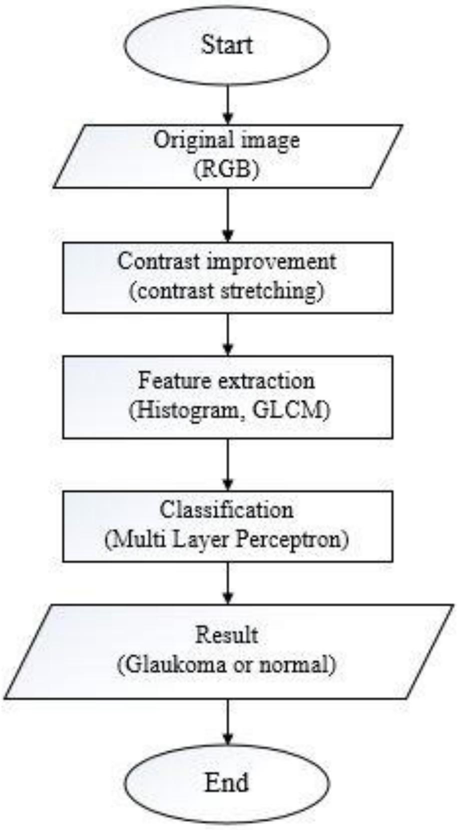

Fig 3. Flowchart diagram of the research

Based on previous research [10], glaucoma diagnoses using image processing techniques can be seen di Figure 3. There were 85 images of glaucoma in this research which were obtained from the DRISTHI-GS [5] database while 101 normal images were obtained from the RIM-ONE database [11]. Images from RIM-ONE database are shown in Figure 4 and images of RIM-ONE are shown in Figure 5.

Color images, usually named as RGB images, are one of the image which provide the colors in some forms such as R component (red), G component (green), and B component (blue). Every component of color uses 8 bit that its value is between 0 and 255. So, the probability of color which can be provided is 255 x 255 x 255 or 16.581.375 colors. The example of color images are shown in Fig 4 and Fig 5.

Grey image executes the gradation of black and white which results in grey effect. The color was shown as intensity. The intensity is between 0 and 255. 0 means black color and 255 means white color. The example of a grey image is shown in Fig 6.

Binary image is an image where every pixel is only expressed by two values (0 and 1). 0 means black color and 1 means white color. This image is usually used in image processing, such as for obtaining the edge of form an object. The example of a binary image is shown in Fig 7.

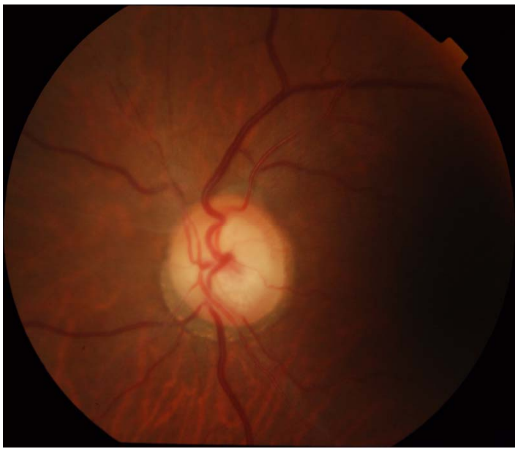

Fig 4. DRISTHI-GS image

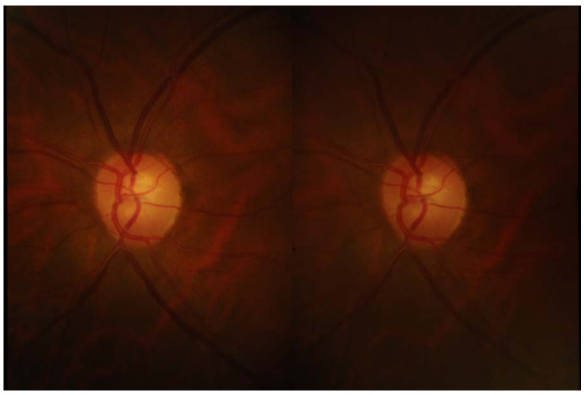

Fig 5. RIM-ONE image

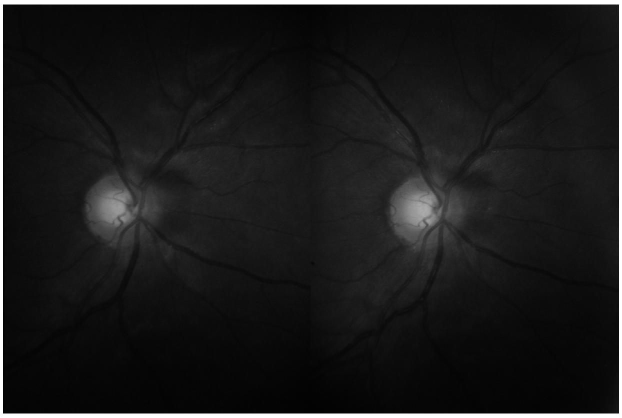

Fig 6. Grayscale image

Fig 7. Binary image

B. Image Quality Measure

IQMs (image quality measures) are divided into three groups including pixel distance-based, correlation-based, and mean square error-based [12]. In this research, the technique used for measuring the quality was Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR). MSE refers to the difference of mean square error between the segmented image and the original image. MSE value was calculated using Equation 1. PSNR is the ratio between the maximum value of measured signal and the number of noise which affect the image. PSNR value was calculated using Equation 2 [13]. The method of contrast enhancement are good if MSE value is smaller while PSNR value is bigger than other methods of contrast enhancement.

$$MSE = \frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}[F(j,k) - H(j,k)]^2 \quad (1)$$

$$PSNR = 20\log_{10}\left(\frac{\max value}{MSE}\right) \quad (2)$$

III. RESULT AND DISCUSSION

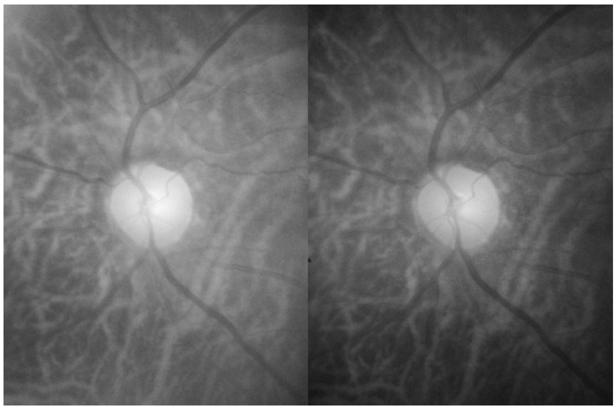

Fig 8. Red channel from RIM-ONE dataset

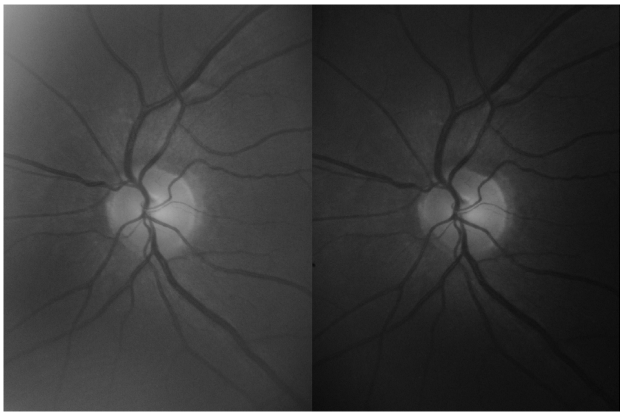

Fig 9. Green channel from RIM-ONE dataset

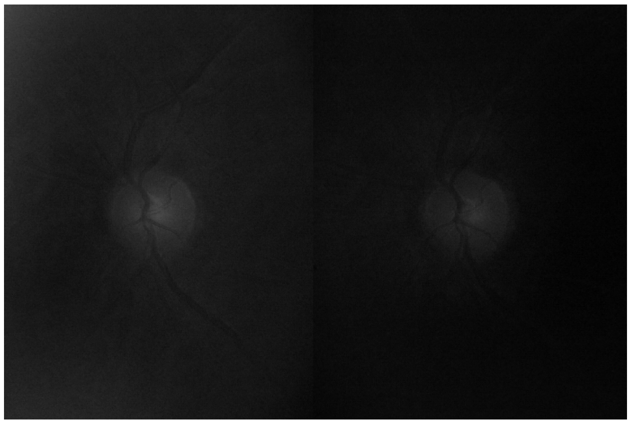

Fig 10. Blue channel from RIM-ONE dataset

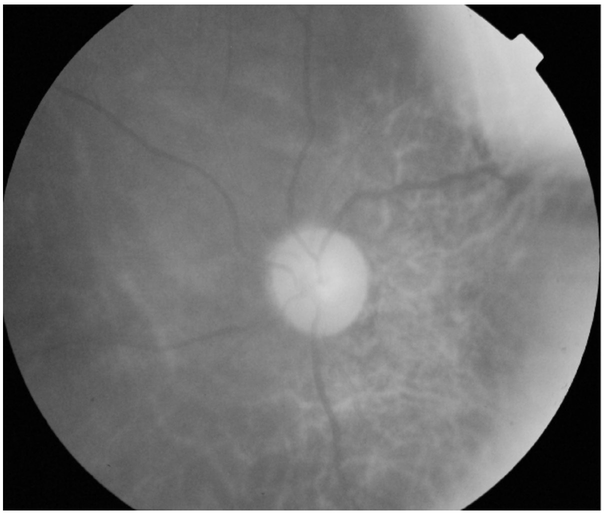

Fig 11. Red channel from DRISTHI-GS dataset

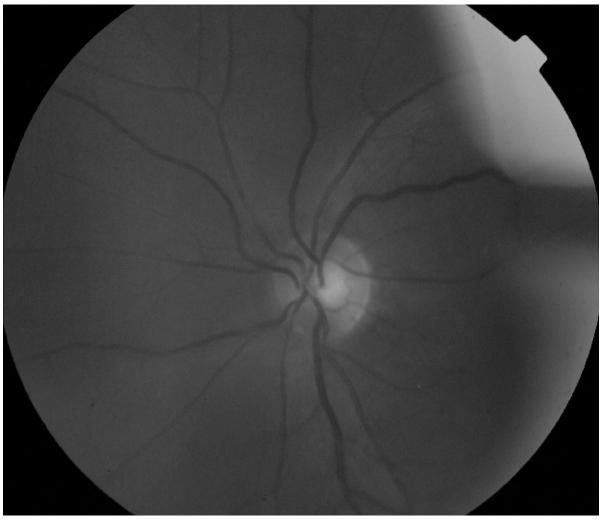

Fig 12. Green channel from DRISTHI-GS dataset

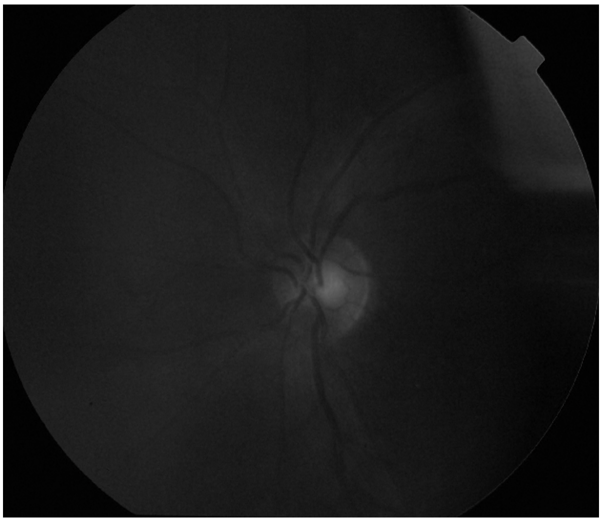

Fig 13. Blue channel from DRISTHI-GS dataset

In this research, the author used 85 images of glaucoma from the DRISTHI-GS database and 101 normal images from the RIM-ONE database. The red component, green component, and blue component will be taken from every image. Red, green, and blue components of normal images from RIM-ONE are shown in Fig 8, Fig 9, and Fig 10, respectively. Red, green, and blue components of glaucoma images from DRISTHI-GS are shown in Fig 11, Fig 12, and Fig 13, respectively.

From the visualization, it showed that the red component had high brightness level so it can differ the optic disc and other parts of retinal eyes. The green component still has vessel blood so it will make it more difficult to segment the images. Blue component results in very dark of retinal image.

Both MSE and PNSR values are shown in Fig 14 and Fig 15. From Fig 14, it showed that the green component had the smallest MSE value while the blue component of glaucoma image has the biggest MSE value. In Fig 15, it showed that the biggest PSNR value was obtained from the green component. Both red and blue the component had PSNR value which had the small difference.

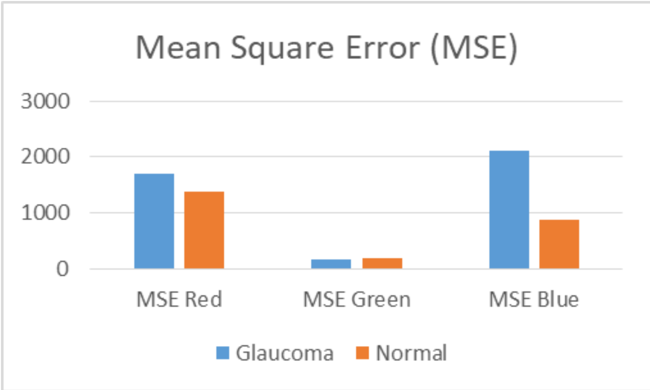

Fig 14. MSE value comparison between red, green, and blue channel

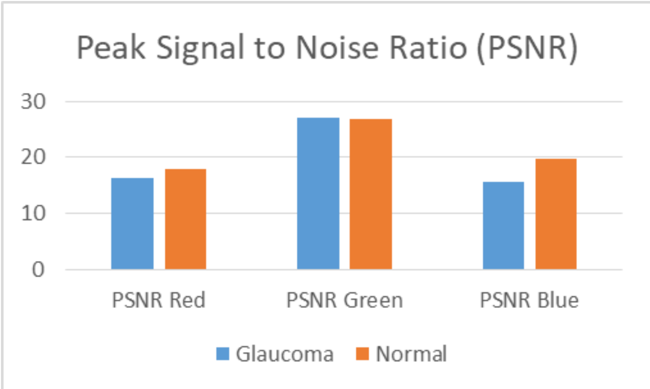

Fig 15. PSNR value comparison between red, green, and blue channel

IV. CONCLUSION

The conclusion of this study is from the visualization, it showed that the red component had high brightness level so it can differ the optic disc and other parts of retinal eyes. The green component still has vessel blood so it will make it more difficult to segment the images. Blue component results in very dark of retinal image. From MSE and PNSR values, it showed that the green component had the smallest

MSE value while the blue component of glaucoma image has the biggest MSE value. PSNR value was obtained from the green component. Both red and blue the component had PSNR value which had a small difference. From these results, it can be concluded that the MSE and PSNR values do not guarantee visual results. So that for further research, it is expected that the MSE and PSNR values will be obtained from the part that we want to observe.

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