Hybrid Method based Retinal Optic Disc Detection

Arif Muntasa¹, Indah Agustien Siradjuddin², and Moch Kautsar Sophan³
Informatics Department, University of Trunojoyo Madura, Bangkalan – Madura Island, Indonesia
arifmuntasa@if.trunojoyo.ac.id

ABSTRACT

We propose a hybrid method based for the Optic Disc (OD) detection in the retinal image. This research consists of three main steps. First, blood vessel removal with homomorphic and median filtering. Second, edge detection using canny operator. Third, OD detection using the Hough transform. The Hough transform is used since the objective object is the curve with circle shape, i.e. optic disc region. Therefore, we can find the shape by using the Hough transform with the circle equation. In this research, the generated circles from Hough transform are matched with the edge pixels of the retinal image. The closest match (showed by the maximum value of accumulator) means that the optic disc is detected. The experiments show that the best accuracy is achieved when the distance value between the generated circles is 3. The average sensitivity, specificity, and balanced accuracy are 64.6182575%, 98.58545%, and 81.6018%, respectively.

KEYWORDS

Homomorphic Filtering, Canny Edge Detection, Hough Transform, balanced accuracy, sensitivity, specificity.

1 INTRODUCTION

Nowadays, research on biomedics has been growth increasingly since many advantages are obtained from the research. Especially, the early screening of a certain deathly disease. Some research are conducted to detect the disease automatically using computational artificial intelligence method [1,2]. Therefore, the result of these researches will help the physicist or as the second opinion of finding disease.

This research proposes on automatically finding the location of Optic Disc (OD) in the retinal image using the Hough transform. This research is one of the preliminary researches of early detection of Diabetic Retinopathy disease. Early detection of Diabetic Retinopathy (DR) has been an importance issue since this disease makes the irreversible blindness. To identify the DR disease, some features in the retinal images are important, i.e. microaneurysms, exudates, and haemorrhage [3]. Other features are less important, for instance, blood vessel and optic disc. We will remove the less important features to obtain the important features for DR disease identification; therefore, we have to find the location of blood vessel and optic disc (segmentation), in order to eliminate those features.

We have done several researches to detect the location of blood vessel pixels in the retinal images[4,5]. This research focus on the OD segmentation using Hough transforms. The remainder of the paper is organized as follows, section 2 will describe the Research Method. Section 3 explains the Hough transform for the detection process, and section 5 describes the result and discussion, and finally the conclusion section in section 6.

2 RESEARCH METHOD

Three main stages are required in the Optic Disc (OD) detection of this research. First, preprocessing using homomorphic and median filtering. Second, edge detection using canny operator, and third OD detection using Hough transform. These stages are depicted in Fig. 1.

![Fig. 1. Automatic Optic Disc Detection Research Method](image-url)
In the first stage, homomorphic and median filtering is implemented for blood vessel removal in the retinal images. Since the blood vessel pixels are removed, then only the optic disc pixels and small noises are remained in the retinal image. Therefore, the accuracy of optic disc will increase. The result of homomorphic filtering and median filtering can be seen in Fig. 2.

As seen in the Fig.2, other features besides the optic disc pixels are removed. Hence only optic disc and some noises pixels are considered in the next stage.

The Second stage of this research is edge detection process. In this stage, we use canny detection algorithm since it is an optimal edge detection algorithm [6,7]. Edge detection is required since we need to find the certain shape in the retinal image, i.e. circle that is the shape of an optic disc. To ease the finding of circle shape in the image, we need the extract the edge of the retinal image. Therefore, we implement the edge detection using Canny algorithm for the retinal image. The example of the result in this stage is shown in Fig. 3.

The entirely generated circles are then matched with the edge pixels from the previous stage. The matched pixels between every generated circle and the edge pixels from the edge detection image are calculated. The most maximum number of
matched pixels of the generated circle is considered as the closest match. Hence, the generated circle is the detected optic disc pixels.

4 RESULT and DISCUSSION
Forty retinal images from INSPIRE (Iowa Normative Set for Processing Images of Retina) dataset [10] are used for the experiment in this research. The dataset provides the retinal image and also its Ground truth image. Therefore, we can justify our result of the experiment with this ground truth image. Three kinds of performance measure are used to measure the accuracy of the detection result, i.e. sensitivity, specificity, and balanced accuracy, as seen in (2), (3), and (4).

\[
\text{Balanced Accuracy} = \frac{\text{Sensitivity} + \text{Specificity}}{2} \quad (2)
\]

\[
\text{Sensitivity} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}} \quad (3)
\]

\[
\text{Specificity} = \frac{\text{True Negatives}}{\text{True Negatives} + \text{False Positives}} \quad (4)
\]

Sensitivity is the probability of true detected optic disc pixel (foreground), specificity is the probability of true detected background pixel, and meanwhile the balanced accuracy is the average accuracy of sensitivity and specificity.

Description of True Positive pixels (TP), True Negative pixels (TN), False Positive pixels (FP), and False Negative pixels (FN) are shown in Table 1.

<table>
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<tr>
<th>TABLE I. DEFINITION OF TP, TN, FP, AND FN</th>
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<td>Detected as Optic Disc Pixels</td>
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<tr>
<td>Detected as Background Pixels</td>
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Three scenarios are conducted in this experiment based on the distance of interval between the generated circles in the Hough transform process, i.e. 5, 3, and 1. The average accuracy of all scenarios is shown in Table 2.

The scenario 1 obtains the lowest sensitivity rate, i.e. 50.883%. Meanwhile, the scenario has the highest specificity rate, i.e. 99.4862. The lowest sensitivity rate is obtained, since in the maximum accumulator of generated pixels from Hough transform only cover the small part of optic disc in the retinal image (see blue pixels on the right image of Fig 5). On the contrary, this result makes the specificity is high, since all pixels beside the detected optic disc pixels considered as background pixels. Left images in the figure show the detected optic disc pixels. Meanwhile the right images show the detected optic disc pixels are superimposed on the original of the retinal images.

<table>
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<th>TABLE II. AVERAGE ACCURACY RATE FOR THE OPTIC DISC DETECTION</th>
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<td>2</td>
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Fig. 5. (Left) Detected Optic Disc pixels and (right) Detected Optic Disc pixels superimposed on original retinal image (blue pixels)

The scenario 2 is the highest balanced accuracy that is 81.6018% accuracy. Moreover, the scenario 2 has the highest sensitivity rate, i.e. 64.6183%, and unfortunately it has the lowest specificity rate, i.e. 98.585%. The example result of this scenario is depicted in Fig 6. As seen in the Figure, the detected optic disc pixels almost cover up all the entire pixels of the optic disc pixels in the original retinal image. Therefore in this scenario, the
highest sensitivity rate is achieved. The accuracy of Hough transform also depends on the edge detection process since generated circles on Hough transform are checked on the edge pixels only.

Hough transform process. Hence the best value of the distance in this research is 3 pixels. The Hough transform depends on the edge pixels in the retinal image since the generated circles are matched to the edge pixel, therefore in the future research improvement of the edge detection pixels is recommended.

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7 REFERENCES


