Face Detection Using Randomized Hough Transform (RHT) with Various Ellipses Segmentations

by Muhammad Fachrurrozi

Submission date: 08-Mar-2023 04:36PM (UTC+0700)
Submission ID: 2032007917
File name: ized_Hough_Transform_RHT_with_Various_Ellipses_Segmentations.pdf (271.61K)
Word count: 2671
Character count: 13422

Sriwijaya Journal of Informatic and Applications
Vol. 01, No. 01, August 2020, pp. 07-13
ISSN xxxx-xxxx, DOI:xxxxx

Face Detection Using Randomized Hough Transform (RHT) with Various Ellipses Segmentations

Muhammad Fachrurrozi [a,1], Saparudin [b,2], Mardiana [c,3], Desty Rodiah [d,4], Winda Agusthia [e,5]

[a, b, d, e] Computer Science Faculty, Universitas Sriwijaya, Indonesia
c Law Faculty, University Sriwijaya Indonesia
[1] mfachrz@unsri.ad.id; [2] saparudin@unsri.ac.id; [3] mardiana_rachman@yahoo.com; [4] destyrodiah@gmail.com; [5] windaa.nettom@gmail.com

ARTICLE INFO

Article history
Received
Revised

Keywords
Face detection
Randomized Hough Transform
Image segmentation
Ellipse

ABSTRACT

Face detection is one of earlier phase in face recognition process. This research aims to get the faces area on digital image without being affected by face orientation, lights condition, background and the expression. The detected face area is usually shaped by a rectangle. Many pixels on the rectangle are not part of face, especially at the four of the image corners. This research use an ellipse as replacement a rectangle. The detected face is shaped by ellipses with various sizes and orientations. The digital image segmentations is used to detect face candidates area. The ellipse is formed by using Randomized Hough Transform (RHT) method, which is influenced by the center point of ellipse candidates. RHT found three random pixels on segmented image. The rate of success of RHT is determined by segmentation results. The research result is tested by using various thresholds, and get the best accuracy at 74.4%. The rate of accuracy is measured by comparing between RHT ellipses shape and circle shape on OpenCV library as ground truth.

1. Introduction

Face detection is first step in face recognition process [1]. Some researchers classifying face detection into two categories, detection based on model (whole face) and detection based on feature (eyes, nose, lips, etc) [2]. The purpose of face detection is to recognize one or many faces in an image regardless of dimensions, orientation or lighting conditions [3]. Face detection becomes more difficult to detect when the detected image has noise, is unclear or there is a barrier on the face [4].

Research about face detection has been carried out with various methods. Some of them uses HSV color space to detect faces by distinguishing between areas of skin-color [5]. This study chose HSV because this method is fast and in accordance with the perception of human skin. The research on face detection with Principal Component Analysis (PCA) and AdaBoost have a success rate of 91.7% [6]. Furthermore, there is a study on face detection based on the skin-color and AdaBoost method with 93.2% accuracy rate done by [7]. However, these three studies still have not detected faces right in the face area, so that the value taken is not the overall face size.

Based on the research that has been done on face detection, there are several factors that must be considered in face detection, namely maximizing the facial area and changing position dynamically towards the facial area. Many pixels are in a rectangle that is not part of the face area, especially in the four corners of the image. So, in this research face detection is not use shapes of a rectangle, but using an elliptical shape with a dynamically diameter to the face region. Moreover, face detection also handles changes in the slope of the face area with various rotation angles.

2. Related work

Face detection using Principal Component Analysis (PCA) and SCM (Skin Color Modelling) has an accuracy rate of up to 98,7% [2]. However, in this research there were weaknesses that is face detection cannot rotate automatically because the threshold values are taken cumulatively. The previous research is conducted based on eye features using the template matching method, skin-color information [1]. The success of this method is proven by being able to detect faces of different races and different lighting conditions. However, this method cannot rotate more than 45° and cannot detect faces on small scale because it fails to recognize eye features. Both studies show that there are still weaknesses in face detection in the rotation factor.

An ellipse is also used for face detection because in general human faces are elliptical, so detection is right on the face area [8]. There is a research that discusses about ellipse detection in images using Randomized Hough Transform (RHT) [9]. This study states that RHT has a high degree of accuracy on many elliptical images (without noise) and noisy images compared to Standard Hough Transform and Probabilistic Hough Transform. The evaluates about the Hough Transform (HT) methods saying that the RHT can detect images with various resolutions and has a high degree of accuracy [10]. The research also mentions RHT faster and saves memory than other Hough Transform methods.

3. Face detection

a. Image Preprocessing

Image preprocessing is done to change the input image which is an RGB (Red, Green, Blue) color image into binary image. The purpose of image preprocessing is to simplify the next process by separating unnecessary information. In this research four steps of image preprocessing were carried out to obtain the following face areas,

1. Color segmentation: separating facial information through skin-color by taking the following RGB values,

$$colorSegmentation(x,y) = \begin{cases} 1 & if((y=(0.5*(r-g))>13.4224)\ \&\ (\left(\frac{r}{g}\right)<1.7602) \\ 0 & else \end{cases} \quad (1)$$

2. Change RGB images into grayscale images,

$$K = \frac{R+G+B}{3} \quad (2)$$

3. Performing edge detection using Sobel operators, edge calculation is calculated based on the magnitude of the gradient pixel (x,y) ,

$$M_G(x,y) = \sqrt{{G_x}^2 + {G_y}^2} \quad (3)$$

4. Changing the image into binary image using thresholding to convert the grayscale image into a binary image. In this study the threshold values used are 90, 100, 110, 120 and 130.

b. Face detection using Randomized Hough Transform method

Randomized Hough Transform is the method introduced by [11]. RHT selects n-tuples randomly form images of collect points in the parameter space and calculate the parameters of objects through pixels. This is useful if objects are defined as linear functions, but RHT cannot be directly used for curve parameters which are expressed as non-linear functions.

General equations for determining ellipses:

$$a(x-p)^2 + 2b(x-p)(y-q) + c(y-q)^2 = 1 \quad (4)$$

with limitations $ac - b^2 > 0$.

RHT determines ellipse by three pixels (ex. x_1, x_2, x_3) randomly from images and get the tangent estimates for each pixel. This is done by defining the neighborhood around the pixel and drawing the

appropriate line around the pixel using the least square method. Then, find the location of the ellipse center by two pixels (first x_1 and x_2, second x_2 and x_3) to determine the midpoint m and the intersection of tangents t. The elliptical center will be located on the line $\overline{tm}$.

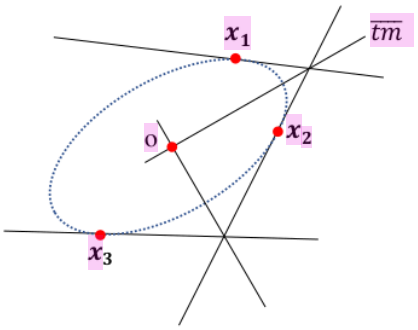

Fig. 1. Estimated midpoint of the ellipse (o) (McLaughlin, 1997)

Afterward, translate the ellipse to be centered to the starting point, so that (4) can be simplified to become:

$$ax^2 + 2bxy + cy^2 = 0 \tag{5}$$

if it meets inequality,

$$ac - b^2 > 0 \tag{6}$$

then the ellipse is represented. Otherwise, if the three pixels do not meet the inequality above, the ellipse fails to be represented. That is, these parameters will be discarded and re-choose three new pixels. This shows that the RHT only requires three pixels randomly selected to determine the ellipse and the additional information needed is contained in the tangent estimates.

This stages of the Randomized Hough Transform (RHT) process in this study can be seen as follows,

1. To search for points randomly in a list that is in range,
   $(Point > minDistance \ \& \ Point < maxDistance)$
2. traight line calculation from the neighbor uses the least square method,
3. calculation of intersection,
   - $(|x1 - x2| \geq |y1 - y2|)$, look for the values $y1$ and $y2$ throughout $Xterkecil$ until $Xterbesar$, with result $(x1, y1) = (x2, y2)$
   - $(|x1 - x2| < |y1 - y2|)$, look for the values $x1$ and $x2$ throughout $Yterkecil$ until $Yterbesar$, with result $(x1, y1) = (x2, y2)$,
4. describing a line using the Brasenham algorithm, a line form two points is then set as neighbor form the midpoint of this line,
5. the same process is done with the process number 2,
6. equation (5) is changed into the matrix as follows,

$$|A| = \begin{vmatrix} x1^2 + x1y1 + y1^2 \\ x2^2 + x2y2 + y2^2 \\ x3^2 + x3y3 + y3^2 \end{vmatrix}, |B| = \begin{vmatrix} A \\ B \\ C \end{vmatrix} \tag{7}$$

$$\begin{vmatrix} A \\ B \\ C \end{vmatrix} = |A|^{-1} \times |B| \quad (8)$$

7. ellipse will be accepted if, $(4AC - B^2 > 0)$,
8. ellipse represented.

4. Result and Discussion

The data used in this research are single face data. The data used are as many as 50 image files with format .jpg or .jpeg measuring 500 x 500 pixels. The test is carried out the same time as many as 50 single face image files with five thresholds. Testing is done by calculating the distance between the midpoint of the ellipse in the RHT method and the midpoint of the circle on the OpenCV method. This is done to find out how far the accuracy of the RHT method is. The distance will be rated at the following intervals,

- Score 5 with intervals of 0 – 100 pixels,
- Score 4 with intervals of 100 – 200 pixels,
- Score 3 with intervals of 200 – 300 pixels,
- Score 2 with intervals of 300 – 400 pixels,
- Score 1 with intervals of 400 pixels,
- Score 0 for faces not detected by the RHT method,

a score of 5 indicates that the face was detected by the RHT method or detected by two methods, one of the methods taken from OpenCV. While the score 4 – 1 indicates that one of the methods in the software successfully detects faces. The result of this test can be seen in Table IV.1 and Graph IV.1, while examples of the calculation of the level of accuracy can be seen in Table IV.2.

Table 1. Accuracy Rate

Threshold	**90**	**100**	**110**	**120**	**130**
Accuracy Rate	72.8%	74.4%	67.6%	58.8%	52.4%

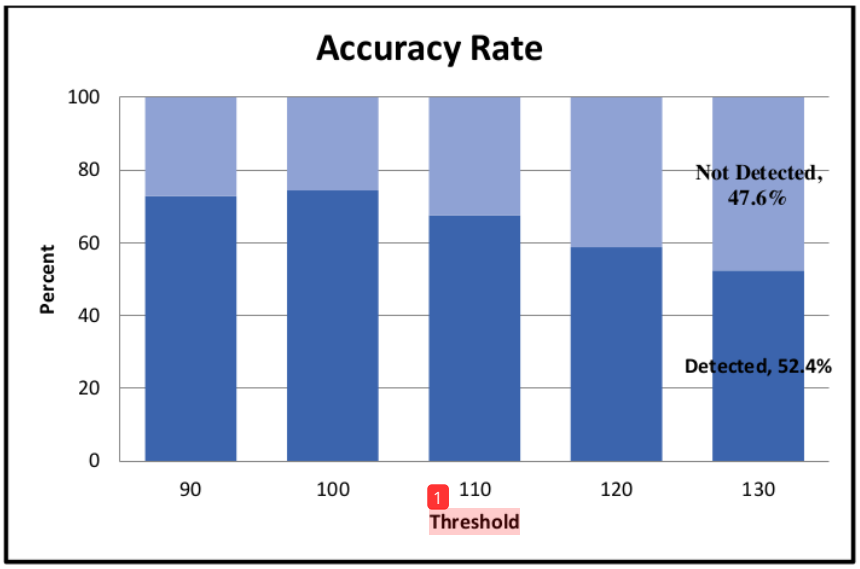

Fig. 2. Result of The RHT Method Testing

Table 2. Example of Calculation of Accuracy Rates

Threshold	Image Result	RHT		OpenCV		Distance	Score
		x	y	x	y		
90		211	153	198	146	14.8	5
100		243	141	248	172	31.4	5

Threshold	Image Result	RHT		OpenCV		Distance	Score
		x	y	x	y		
90		211	153	198	146	14.8	5

5. Conclusion

This research successfully implemented and developed face detection software using variations in segmentation and Randomized Hough Transform. This study managed to get the accuracy of the method applied at 72.8% with a threshold value of 90, 74.4% with a threshold value of 100, 67,6% with a threshold value of 110, 58.8% with a threshold value of 120 and 52.4% with a threshold value of 130.

References

[1] Z. Jin, Z. Lou, J. Yang, and Q. Sun, "Face detection using template matching and skin-color information," Neurocomputing, 2007, doi: 10.1016/j.neucom.2006.10.043.

[2] P. P. Paul and M. Gavrilova, "PCA based geometric modeling for automatic face detection," Proc. - 2011 Int. Conf. Comput. Sci. Its Appl. ICCSA 2011, pp. 33–38, 2011, doi: 10.1109/ICCSA.2011.69.

[3] M. H. Yang, D. J. Kriegman, and N. Ahuja, "Detecting faces in images: A survey," IEEE Trans. Pattern Anal. Mach. Intell., vol. 24, no. 1, pp. 34–58, 2002, doi: 10.1109/34.982883.

[4] D. Meena and R. Sharan, ''An approach to face detection and recognition,'' in Proc. Int. Conf. Recent Adv. Innov. Eng. (ICRAIE), Dec. 2016, pp. 1–6.

[5] I. Aldasouqi and M. Hassan, "Smart Human Face Detection System," International Journal of Computers, vol. 5, no. 2, pp. 210–217, 2011.

[6] S. Liu, "A novel face detection algorithm based on PCA and adaboost," Proc. - 2014 6th Int. Conf. Meas. Technol. Mechatronics Autom. ICMTMA 2014, pp. 38–41, 2014, doi: 10.1109/ICMTMA.2014.16.

[7] C. Lv, T. Zhang, and C. Lin, "Face detection based on skin color and AdaBoost algorithm," Proc. 29th Chinese Control Decis. Conf. CCDC 2017, pp. 1363–1367, 2017, doi: 10.1109/CCDC.2017.7978729.

[8] A. Aminian and M. S. Beni, "Face detection using color segmentation and RHT," 2017 3rd International Conference on Pattern Recognition and Image Analysis (IPRIA), pp. 128–132, 2017.

[9] R. A. McLaughlin, "Randomized Hough Transform: Improved ellipse detection with comparison," Pattern Recognit. Lett., vol. 19, no. 3, pp. 299–305, 1998, doi: http://dx.doi.org/10.1016/S0167-8655(98)00010-5.

[10] P. Mukhopadhyay and B. B. Chaudhuri, "A survey of Hough Transform," Pattern Recognit., vol. 48, no. 3, pp. 993–1010, 2015, doi: 10.1016/j.patcog.2014.08.027.

[11] P. Kultanen, L. Xu, and E. Oja, "Randomized Hough transform (RHT)," Proc. - Int. Conf. Pattern Recognit., vol. 1, pp. 631–635, 1990, doi: 10.1109/icpr.1990.118177.

[12] M. J. Blackledge, *Digital Image Processing: Mathematical and Computational Methods*. Unitied Kingdom: Horwood Publishing, 2005.

[13] W. Gao, L. Yang, X. Zhang, and H. Liu, "An improved Sobel edge detection," Proc. - 2010 3rd IEEE Int. Conf. Comput. Sci. Inf. Technol. ICCSIT 2010, vol. 5, pp. 67–71, 2010, doi: 10.1109/ICCSIT.2010.5563693.

[14] R. Gonzalez and R. Woods, *Digital image processing*, 2nd ed. Upper Saddle River, New Jersey: Prentice Hall, 2002.

[15] P. Kruchten, The Rational Unified Process An Introduction, 2nd ed. Canada: Addison Wesley, 2000.

[16] W. Li, Q. Yang, and X. He, "Face detection algorithm based on double ellipse skin model," ICSESS 2011 - Proc. 2011 IEEE 2nd Int. Conf. Softw. Eng. Serv. Sci., pp. 335–339, 2011, doi: 10.1109/ICSESS.2011.5982231.

[17] R. A. McLaughlin, Technical Report - Randomized Hough Transform : Improved Ellipse Detection with Comparison.

[18] P. L. Rosin, "A note on the least squares fitting of ellipses," Pattern Recognit. Lett., vol. 14, no. 10, pp. 799–808, 1993, doi: 10.1016/0167-8655(93)90062-I.

[19] Y. Wang and B. Yuan, "A novel approach for human face detection from color images under complex background," Pattern Recognit., vol. 34, no. 10, pp. 1983–1992, 2001, doi: 10.1016/S0031-3203(00)00119-9.

[20] M. H. Yang, D. J. Kriegman, and N. Ahuja, "Detecting faces in images: A survey," IEEE Trans. Pattern Anal. Mach. Intell., vol. 24, no. 1, pp. 34–58, 2002, doi: 10.1109/34.982883.

[21] G. G. Yen and N. Nithianandan, "Facial feature extraction using genetic algorithm," Proc. 2002 Congr. Evol. Comput. CEC 2002, vol. 2, pp. 1895–1900, 2002, doi: 10.1109/CEC.2002.1004532.

[22] S. Zafeiriou, C. Zhang, and Z. Zhang, "A survey on face detection in the wild: Past, present and future," Comput. Vis. Image Underst., vol. 138, no. March, pp. 1–24, 2015, doi: 10.1016/j.cviu.2015.03.015.

[23] M. A. Zia, U. Ansari, M. Jamil, O. Gillani, and Y. Ayaz, "Face and eye detection in images using skin color segmentation and circular hough transform," 2014 Int. Conf. Robot. Emerg. Allied Technol. Eng. iCREATE 2014 - Proc., pp. 211–213, 2014, doi: 10.1109/iCREATE.2014.6828367.

Face Detection Using Randomized Hough Transform (RHT) with Various Ellipses Segmentations

ORIGINALITY REPORT

96%	95%	1%	89%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	sjia.ejournal.unsri.ac.id Internet Source	73%
2	Submitted to Sriwijaya University Student Paper	23%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		