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EXPLANATION OF FEATURE EXTRACTION IN FACE RECOGNITION USING VIOLA JONES ALGORITHM

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Abstract: Facial recognition is becoming a common use in the field of surveillance and security in computer technology and image devices. This study aims to identify a person's face with 3 test images. This study examines the methods of cropping techniques, image enhancement through intensity measurement, and histogram analysis to improve the contrast and distribution of image intensity. In addition, the Viola-Jones algorithm is used to detect key facial features such as eyes, nose and mouth. The results of ana-lysis of facial features were applied to measure the ratio of facial proportions. Comparison of proportional ratios of several images was analyzed using bar graphs and line graphs to evaluate the trend and stability of facial proportions. The results showed the best ratio stability with a smaller variation of image ratio 2 is 0.4762 pixels to 0.4983 pixels. Test image 2 is the most ideal for geometric ratio base face measurement systems because it provides more consistent results.

Keywords: cropping; enhancement; face recognition; ratio; viola-jones

Abstrak: Pengenalan wajah menjadi hal yang umum digunakan pada bidang pengawasan dan keamanan pada teknologi komputer dan perangkat citra. Penelitian ini bertujuan untuk mengidentifikasi wajah seseorang dengan 3 citra uji. Penelitian ini mengkaji metode teknik cropping, image enhancement melalui pengukuran intensitas, dan analisis histogram untuk memperbaiki kontras dan distribusi intensitas citra. Selain itu, algoritma Viola-Jones digunakan untuk mendeteksi fitur wajah utama seperti mata, hidung, dan mulut. Hasil analisis fitur wajah diaplikasikan untuk mengukur rasio proporsi wajah. Perbandingan rasio proporsional beberapa citra dianalisis menggunakan grafik batang dan grafik garis untuk mengevaluasi tren dan kestabilan proporsi wajah. Hasil penelitian menunjukkan kestabilan rasio terbaik dengan variasi rasio citra 2 yang lebih kecil yaitu 0,4762 piksel hingga 0,4983 piksel. Citra uji 2 adalah yang paling ideal untuk sistem pengukuran wajah berdasarkan rasio geometris karena memberikan hasil yang lebih konsisten.

Keywords: cropping; enhancement; pengenalan wajah; rasio; viola-jones

INTRODUCTION

As computers and imaging equipment have advanced, facial recognition has become commonplace for convenience and surveillance purposes[1],[2]. Face recognition is in great demand for Face Identification[3]. The use of facial recognition technology is becoming more and more significant in the fields of crime investigation, border control surveillance, video surveillance, access control, and human-computer interaction[4],[5]. In computerized image pattern processing, face image processing has emerged as one of the computer vi-

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sion domains. One of the most essential biometrics that contains crucial data for determining a person's traits is their face[6]. The face is the most important characteristic for recognizing individuals. It serves as the essence of each person's identity[7]. The Viola-Jones method is one of the most widely used face detectors in numerous real-world applications with heterogeneous computing architectures. Viola Jones becomes a real-time and powerful face detector. In the paper, a method of selecting trainsets based on histograms was generated from AdaBoost. The training procedure was then compared with the basic training presented[8].

Face detection utilizing Viola Jones method in this study was used to examine the performance of the algorithm in detecting faces from diverse photographs from the internet. The data tested as many as 15 random images from the internet with the number of faces varies. The results obtained in detecting faces with an average accuracy of 89.86% [9].

Facial mask identification systems utilizing fuzzy logic and the Viola-Jones approach will be used in a variety of environments, such as public transportation, educational institutions, and shopping centers. Research on face and feature using the Viola-Jones method for detection method with Haar cascade to detect the face, eyes, and mouth as well as fuzzy logic to improve detection accuracy. The results showed that the combination of Viola-Jones method and fuzzy logic is more accurate in detecting faces and masks[10].

The use of MATLAB features in a more accurate, secure, and adaptive facial authentication system is built to handle a variety of facial recognition challenges. The face detection approach with Viola-Jones and Deep Learning, developed using the MATLAB application designer, makes it easy for users to register faces and authenticate. The use of metrics for accuracy, precision, recall, and processing time to guarantee that the system is working correctly. Compared to traditional approaches, the results of the combination of Viola-Jones and deep learning increase the resilience of the system to environmental variations[11]. Face detection is done in this study is to determine the ratio between objects in an image to help face recognition using Viola jones algorithm.

METHOD

The methodology used in this study discusses utilizing the Viola Jones algorithm to recognize a person's face. The process used in this study is cropping, enhancement, histogram, viola jones algorithm, feature extraction and determination of facial proportion ratio.

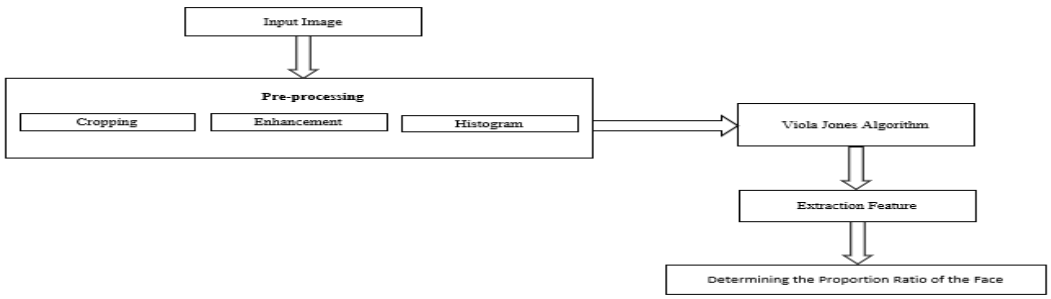

Figure 1. Research Methodology

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Input Image

Input image is an image taken from the image that is on the internet as many as 30 images, but the image presented in this process as many as 3 input images.

Pre-Processing

At the pre-processing stage will be done cropping, enhancement and histogram of the face image. The cropping stage aims to cut the image that will be used in the process and discard the image that is not used[12]. The image will be cropped into a rectangular shape by specifying the coordinates of the upper left corner point and the coordinates of the lower right corner point. The formula used is:

$$x' = x - x.L \quad \text{for } x = x.L \text{ to } x.R \qquad (1)$$

This formula is used to calculate the new x-coordinate after the image is cropped. x is the original coordinate in the image before cropping. x.L is the x-coordinate of the upper left corner point of the area to be captured (cropped area). x' is the x-coordinate in the cropped image. This means that each x-point in the part of the image to be cropped is changed to a position relative to the starting point of the crop, which is x.L. This makes the x' coordinate start from 0 in the cropped image.

$$y' = y - y.T \quad \text{for } y = y.T \text{ to } y.B \qquad (2)$$

This formula is used to calculate the new y-coordinate in the cropped image. y is the original y-coordinate before cropping. y.T is the y-coordinate of the upper left corner point of the area to be cropped. y' is the y-coordinate in the cropped result. So, all y points in the cropped area are calculated relative to y.T, starting from 0.

(x. L, y. T) and (x. R, y. B) are the coordinates of the image's lower right and upper left corner points that need to be cropped. Image size becomes:

$$w' = x.R - x.L \qquad (3)$$

Calculates the width of the cropped image. x.R = x-coordinate of the bottom right corner point of the crop area. x.L = x-coordinate of the top left corner point of the crop area. w' is the width of the cropped image. This gives the number of pixels horizontally from left to right that are taken from the original image.

$$h' = y.B - YT \qquad (4)$$

Calculate the height of the cropped image. y.B = y coordinate of the bottom right corner point of the crop area. y.T = y coordinate of the top left corner point of the crop area. h' is the height of the cropped image. It shows the number of pixels vertically from top to bottom taken from the original image.

The image from cropping has different pixel size, while in the feature extraction stage, the image used must have the same pixel size. Enhancement stage aims to improve image quality by manipulating image parameters. The image repair operation to be performed in this stage is noise filtering[13]. A histogram is a graphic representation of the frequency distribution of an image's pixel intensity values. The vertical axis shows the frequency or quantity of pixels, and the horizontal axis shows the pixel intensity value[14].

Viola Jones Algorithm

Images are categorized using the Viola-Jones face detection process using basic feature values[15]. There are numerous justifications for using features rather than pixels directly. In this Viola

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jones algorithm, the process will determine the object and detect the displayed object, specifically the mouth, nose, right and left eyes, and face[16].

$$F(X_i)=sign(\sum_t=1(a_{ti}*f_{ti}(x_i)+s))) \quad ….(5)$$

$F(X_i)$ is the final classification function for the input image data X_i (e.g., a sub-window of the image). sign(...) is the sign function if +1 means the object is detected and -1 means the object is not detected. $\sum_{t=1}$ (...) is the summation of all weak classifiers boosted into one strong classifier. t is the index of the t-th weak classifier, and the number can be hundreds or even thousands depending on the training. a_{ti} is the weight of the t-th weak classifier, indicating how much influence the decision of the weak classifier has on the final decision. $f_{ti}(x_i)$ is a function of the t-th weak classifier that takes image features x_i as input. S is a bias constant (threshold), used to set the threshold for the final decision. The Viola-Jones algorithm employs a medium, and the integral image is employed to streamline the process of determining the value of features. An integral image is one where each pixel's value is equal to the sum of the values of the pixels in the upper left to bottom right[17].

Feature Extraction

At this stage, The procedure of feature extraction will be executed from the face by determining the distance(pixels) between object points. Analyzing the obtained form's characteristics will be the next step. Feature extraction looks for important feature regions in a picture based on its inherent properties and intended use[18]. Such territories are characterized by their size, shape, texture, intensity, statistical characteristics, and other characteristics, and can be specified in a local or global context. Counting the number of dots or pixels found in each check which are conducted in different directions is how features are extracted. tracing checks on the digital image's Cartesian coordinates, namely vertical, horizontal, right diagonal, and left diagonal[19].

Ratio of Facial Proportions

At this stage, the ratio of facial proportions will be determined by comparing the distance of other facial features to the main reference distance. In this process, facial recognition will be performed to distinguish individuals based on specific facial features with the right eye-the left eye as the main reference.

Ratio = Feature Distance/(Right Eye Distance–Left Eye)……..(6)

RESULT AND DISCUSSION

Input image obtained from the internet is done preprocessing process is the process of cropping, image enhancement and histogram. At the cropping stage, the image will be cut according to what is needed in processing. The next stage is the removal of noise from the image resulting from the cropping process. This stage is used to get better results. The image enhancement technique used is an intensity-adjustable point operation.

By linearly transferring the intensity values on the original histogram into intensity values on the new histogram, intensity adjustment raises the image's contrast value. The next stage will be fa-

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cial recognition process using viola jones algorithm. The objects detected with viola jones algorithm are the face, right eye, left eye, nose and mouth. The results of the feature extraction process are presented in Table 1.

Table 1. Feature Extraction Results

No	Input image	Detection	Feature Extraction Results
1			Objek / Jarak(pixel): individu 1 / individu 2 / individu 3 / individu 4 right eye-left eye: 6,0208 / 5,94517 / 5,7959 / 5,76064 right eye-nose: 4,45253 / 3,21753 / 4,30174 / 5,14125 left eye-nose: 4,67172 / 5,29457 / 5,20216 / 4,13673 right eye-mouth: 6,73146 / 6,39727 / 7,28869 / 7,27066 left eye-mouth: 6,73146 / 7,65376 / 7,12899 / 7,13109 nose-mouth: 2,60048 / 3,36786 / 3,02655 / 3,08302
2			Objek / Jarak(pixel): individu 1 / individu 2 / individu 3 / individu 4 right eye-left eye: 12,0416 / 11,5974 / 12,51 / 11,5 right eye-nose: 9,2195 / 8,9022 / 7,9057 / 11,4018 left eye-nose: 8,4853 / 10,4043 / 10 / 7,433 right eye-mouth: 14,3178 / 13,8654 / 13,6565 / 16,5529 left eye-mouth: 13,4164 / 15,0416 / 13,8924 / 15,6605 nose-mouth: 6 / 5,5227 / 6,0828 / 8,2462
3			Objek / Jarak(pixel): individu 1 / individu 2 / individu 3 / individu 4 right eye-left eye: 8,6313 / 9.5 / 11.5 / 10,0125 right eye-nose: 5,6569 / 7,2111 / 8,6023 / 8,0623 left eye-nose: 7,1063 / 8,1394 / 9,5525 / 9,6047 right eye-mouth: 10,5475 / 10,9659 / 12,53 / 11,4127 left eye-mouth: 10,9202 / 11,1803 / 12,2984 / 11,4237 nose-mouth: 5,2202 / 4,0311 / 4,1231 / 3,3541

Based on Table 1 presented the results of feature extraction for all objects in the three images tested. Detection results with feature extraction used for the last stage in this study is the determination of the ratio of facial proportions in determining the uniqueness of the face under study. The results of the face ratios of the 3 tested images can be seen in Table 2.

Table 2. Ratio Results

Image	Object	Individual 1	Individual 2	Individual 3	Individual 4
Image 1	Right eye-nose	0.7395	0.5412	0.7422	0.8929
	Left eye-nose	0.7761	0.8904	0.8975	0.7183
	Right eye-mouth	11.179	10.760	12.582	12.625
	Left eye-mouth	11.179	12.877	12.299	12.373
	Nose-mouth	0.432	0.5665	0.5221	0.5353
Image 2	Right eye-nose	0.7657	0.7678	0.6322	0.9915
	Left eye-nose	0.7048	0.8968	0.8298	0.6463
	Right eye-mouth	11.895	11.955	10.918	14.394
	Left eye-mouth	11.142	12.968	11.107	13.627
	Nose-mouth	0.4983	0.4762	0.4863	0.7171
Image 3	Right eye-nose	0.6557	0.7591	0.7489	0.8055
	Left eye-nose	0.8235	0.8568	0.8307	0.9592
	Right eye-mouth	12.218	11.543	10.896	11.400
	Left eye-mouth	12.654	11.769	10.694	11.411
	Nose-mouth	0.6051	0.4243	0.3585	0.3351

Based on Table 2, image 1 shows a fairly wide variation in the ratio, especially in the ratio between the eye-nose and nose-mouth. The ratio of right eye-mouth and left eye-mouth is relatively

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consistent, being in the range of 11,179 to 12,873. In contrast, the nose-mouth ratio showed a more significant variation, which was between 0.432 to 0.5353. Image 2 shows a more consistent right-eye-mouth and left-eye-mouth ratio than Image 1, with a range of 11,142 to 13,627. For the nose-mouth ratio, the variation is smaller than in image 1, ranging from 0.4762 to 0.4983, which indicates a lower distortion in the ratio of facial proportions. Image 3 has a wider range of right-eye-mouth and left-eye-mouth ratios, ranging from 10,896 to 12,654. Meanwhile, the nose-mouth ratio showed higher variation compared to image 2, with values between 0.3351 to 0.6051, which may indicate instability in the capture of facial features.

The ratio of the 3 images above can be presented in the form of bar charts and line charts. The Bar chart aims to present the results of the distribution of the ratio of facial proportions of individuals in image 1, image 2, and image 3, while the line chart is used to see the trend of changes in the ratio between individuals in various images.

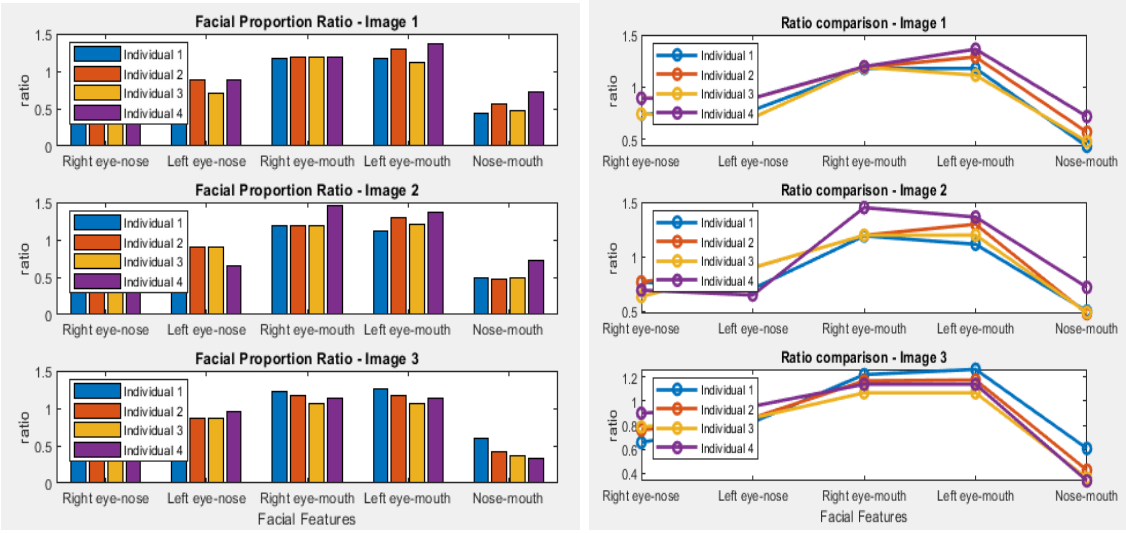

Figure 2. Bar Chart dan Line Chart

Based on Figure 2 the bar chart shows the distribution of facial proportion ratios for each individual in image 1, image 2, and image 3. This allows a direct comparison between individuals based on the measured facial features. Meanwhile, line charts are used to observe the trend of changing ratios among individuals in various images, so as to identify individuals with similar facial proportions based on the formed line patterns.

CONCLUSION

Based on the above results, Image 2 is the best for face recognition because the consistency ratio is better than Image 1 and image 3. The variation in the ratio is smaller, especially in the nose-mouth ratio, which shows less distortion. The proportion value range is more stable, which makes it more reliable for face recognition systems. So, Image 2 gives the best results in terms of stability and consistency of the face ratio, making it

more ideal for use in geometry ratio-based face recognition systems.

BIBLIOGRAPHY

[1] X. Dong, S. Kim, Z. Jin, J. Y. Hwang, S. Cho, and A. B. J. Teoh, "Open-set face identification with index-of-max hashing by learning," *Pattern Recognition*, vol. 103, hal. 107277, 2020, doi: 10.1016/j.patcog.2020.107277.

[2] A. I. Awad, A. Babu, E. Barka, and K. Shuaib, "AI-powered biometrics for Internet of Things security: A review and future vision," *Journal of Information Security and Applications*, vol. 82, no. May, hal. 103748, 2024, doi: 10.1016/j.jisa.2024.103748.

[3] S. Saleem, J. Shiney, B. Priestly Shan, and V. Kumar Mishra, "Face recognition using facial features," *Materials Today: Proceedings*, vol. 80, no. iii, hal. 3857–3862, 2023, doi: 10.1016/j.matpr.2021.07.402.

[4] I. Vukovic, P. Cisar, K. Kuk, M. Bandjur, and B. Popovic, "Influence of image enhancement techniques on effectiveness of unconstrained face detection and identification," *Elektronika ir Elektrotechnika*, vol. 27, no. 5, hal. 49–58, 2021, doi: 10.5755/j02.eie.29081.

[5] S. Komputer, A. Wijaya, B. S. Yudha, Y. Apridiansyah, N. David, and M. Veronika, "Integrasi Metode Viola-Jones dan Algoritma Pelabelan untuk Akurasi Deteksi Objek Manusia," vol. 19, no. 2, hal. 227–239, 2024.

[6] V. Wati, K. Kusrini, H. Al Fatta, and N. Kapoor, "Security of facial biometric authentication for attendance system," *Multimedia Tools and Applications*, vol. 80, no. 15, hal. 23625–23646, 2021, doi: 10.1007/s11042-020-10246-4.

[7] H. L. Gururaj, B. C. Soundarya, S. Priya, J. Shreyas, and F. Flammini, "A Comprehensive Review of Face Recognition Techniques, Trends, and Challenges," *IEEE Access*, vol. 12, no. June, hal. 107903–107926, 2024, doi: 10.1109/ACCESS.2024.3424933.

[8] P. Tavallali, M. Yazdi, and M. R. Khosravi, "A Systematic Training Procedure for Viola-Jones Face Detector in Heterogeneous Computing Architecture," *Journal of Grid Computing*, vol. 18, no. 4, hal. 847–862, 2020, doi: 10.1007/s10723-020-09517-z.

[9] M. Akbar, H. Hikmatiar, and U. M. Maumere, "Graphical User Interface (GUI) For Face Detection Using Viola-Jones," vol. 4, no. 01, hal. 1–9, 2025, doi: 10.56741/bst.v4i01.768.

[10] S. Balovsyak, O. Derevyanchuk, V. Kovalchuk, H. Kravchenko, and M. Kozhoka, "Face Mask Recognition by the Viola-Jones Method Using Fuzzy Logic," *International Journal of Image, Graphics and Signal Processing*, vol. 16, no. 3, hal. 39–51, 2024, doi: 10.5815/ijigsp.2024.03.04.

[11] L. Sudha, R. Vadhani, K. B. Aruna, V. Sureka, and V. Sasikala, "Cutting-edge Facial Authentication System in Matlab (CFAS-M)," *2024 International Conference on Communication, Computing and Internet of Things, IC3IoT 2024 - Proceedings*, no. April, hal. 17–18, 2024, doi: 10.1109/IC3IoT60841.2024.10550320.

[12] J. Kim and H. Park, "Adaptive Latent Diffusion Model for 3D Medical Image to Image Translation: Multi-modal Magnetic Resonance Imaging Study," *Proceedings - 2024 IEEE Winter Conference on Applications of Computer Vision, WACV 2024*, hal. 7589–7598, 2024, doi: 10.1109/WACV57701.2024.00743.

[13] N. R. D. Cahyo and M. M. I. Al-Ghiffary, "An Image Processing Study: Image Enhancement, Image Segmentation, and Image Classification using Milkfish Freshness Images," *IJECAR) International Journal of Engineering Computing Advanced Research*, vol. 1, no. 1, hal. 11–22, 2024.

[14] P. N. Kumar, V. Yadav, P. Ghuge, A. Varpe, and S. Rathod, "Detailed Study of Histogram Compution Algorithm in Image Processing," vol. 13, no. 2231, hal. 1071–1078, 2024.

[15] V. F. D. Algorithms, "African Journal of Advanced Pure and Applied Sciences (AJAPAS) Estimating the Number of People in Digital Still Images Based on Viola-Jones Face Detection Algorithms," vol. 3, no. 2, hal. 146–154, 2024.

[16] H. C. Erby Virta Joseph Paays, "Modeling Of Mask Detection Systems, Distance Between Objects And Facial Recogni-tion Using The Tiny-Yolov4 Method, Convolutional Neural Network, And Viola Jones," vol. 4, no. 10, hal. 9771–9790, 2024.

[17] Y. Deng, X. Liu, K. Yang, and Z. Li, "Flexible thin parts multi-target positioning method of multi-level feature fusion," *IET Image Processing*, vol. 18, no. 11, hal. 2996–3012, 2024, doi: 10.1049/ipr2.13151.

[18] J. Xu, "Image data visualization and communication system based on sensor network simulation and visual feature extraction," *Measurement: Sensors*, vol. 33, no. June, hal. 101223, 2024, doi: 10.1016/j.measen.2024.101223.

[19] C. E. Widodo and K. Adi, "Face geometry as a biometric-based identification system," *Journal of Physics: Conference Series*, vol. 1524, no. 1, 2020, doi: 10.1088/1742-6596/1524/1/012008.