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# LAMPIRAN

# The Performance of Face Recognition Using the Combination of Viola-Jones, Local Binary Pattern Histogram and Euclidean Distance

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***Abstract* - Achieving low recognition time and high accuracy in real-time face recognition is challenging. This study implements Viola-Jones, Local Binary Pattern Histogram, and Euclidean Distance for real-time face recognition and calculates the face detection time. The face image is detected using the Viola-Jones method; its features are extracted using the Local Binary Pattern Histogram, and the face is recognized using Euclidean Distance. This study processes sample images from 1013 students as training data, with 20 images represent each student. The experiments show that 268 of 342 testing data are recognized correctly, resulting in an accuracy of 78.4%, with average real-time recognition time of 0.93 seconds**.

***Keywords - Face Detection, Viola-Jones, Face Recognition, Local Binary Pattern Histogram, Euclidean Distance.***

## I. INTRODUCTION

Facial recognition is biometric that is widely used in financial security systems, surveillance, transactions, and information. Facial recognition is the most challenging in decades compares to fingerprint and iris, since it is affected by lighting, occlusion, posture, and other factors. Several methods are applied to remove exposure, influence poses, and expressions on facial recognition [1]. Over time, the face recognition methods have been improved. Many algorithms have been proposed; however, there are still many challenging problems in dealing with recognition, such as different facial conditions, which result in variations of lighting, accuracy, and recognition time.

The Viola-jones method is used to detect objects, especially on the faces of the students. Pixel size, feature extraction, and classification affect the accuracy and performance of face recognition. This section explores several methods namely LR 224 x 224-pixel method with images accuracy of 97.48% and 181.82 seconds required for five cross-validations, LDA 224 x 224-pixel method with images accuracy of 97.29% and 42.52 seconds required for five cross-validations, the k- Nearest neighbor 224 x 224-pixel method has an accuracy rate with images of 93.05% and required 7.42 seconds for five cross-validations [2]. PCA + Distance Classifier method 100 x 100 pixel has images accuracy of 93%, real-time accuracy of 61%, and recognition time of 1081 milliseconds. LDA + Distance Classifier method 100x100-pixel results in images accuracy of 91%, real-time accuracy of 58%, and recognition time of 1234 milliseconds. PCA + SVM method 100x100-pixel has images accuracy of 95%, real-time, and recognition time of 24570 milliseconds. PCA + Bayes method 100x100-pixel has images accuracy of 94%, real-time accuracy of 65%, and recognition time of 29798 milliseconds. LBPH + Distance Classifier 100x100-pixel method has images accuracy of 95%, real-time accuracy of 78%, and recognition time of 563 milliseconds [3]. LBP method 10 x 10 results accuracy of 15%, 20 x 20 results accuracy of 34%, 30 x 30 results accuracy of 81% [3]. LBPH 35 x 35 method results accuracy of 94%, LBPH 45 x 45 method results accuracy of 90% [4]. LBP and SVM methods with 127 x 91 pixels result in an accuracy rate of 94.40%, with LBP and Adaboost methods with 127 x 91 pixels results in an accuracy rate of 94.81% [5]. Using LBP and SVM methods results in 92% accuracy of 12 faces, 11 faces are identified successfully, and preserved time wastes in manual attendance [6]. Yi-kang Shen et al. conducted a study to reduce the calculation time to maintain the accuracy, where the LBP Method results in 92.8% accuracy, 0.151 s execution time, and time ratio of 0.184 s [7]. Sri Vignesh et al. Class attendance system is presented using RFID, and then the system will identify students based on card numbers and verify each student's face using the FANNC (Fast Adaptive Neural Network Classification Method) method. The results show to verify student identity correctly, 98% for frontal faces [8]. Principal component analysis method and Euclidean distance method, result in an accuracy rate of 83.36% [9]. LBP and Nearest neighbor methods with 128 X128 pixels, 400 Images, RAM 8Gb, Intel Core i5 3.2 GHz, video resolution 640x480, system testing confirms the results of 90% of accurate face recognition [10]. Where some of the previous research is not focusing on real-time face recognition, this study aims to

calculate the processing time to recognize students' faces in real-time with 1013 students as data.

## II. PROPOSED METHOD

In this paper, the authors propose to investigate facial recognition performance using Viola-Jones and LBPH. Viola-Jones Method provides a real-time, fast, efficient, and has high accuracy face detection. The Viola-Jones method is a method for detecting objects which provide a high degree of accuracy. LBPH is applied to identify face images that are detected from face images. The face identification process starts with capturing video data inside and outside the building using video data and processing the image data with digital image processing, face detection, and feature extraction. This research uses the Python programming language library and OpenCV. There are three main components in system design, which scheme shown in Figure 1.

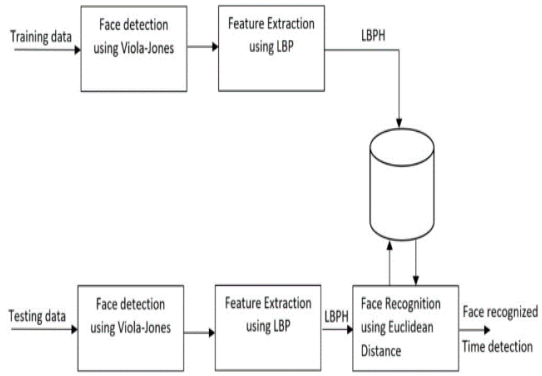


Figure 1. General System Design

Figure 1 describes the process of data training and data testing. The data training results are stored in the program, and the database includes ID, Student ID, nama_mahasiswa. The data testing process is performed in real-time. If the data testing results match the training data results, the closest value Nim and nama_mahasiswa data will be called based on student ID data, which have been trained.

### A. Viola-Jones Algorithm

The Viola-Jones method is a method for detecting objects with sufficient accuracy. In this method, the susceptibility is that the face image is not perpendicular to the camera [11]. This method combines four keys, namely the Haar feature, which consists of high interval values, low intervals, and two-dimensional images called dark areas and bright areas. The integral image is calculating the feature value. AdaBoost Learning is selecting features that are considered essential. Cascade Classifier is a classification method whose task is to reject undetected areas of the image using a classifier that has been trained by the AdaBoost algorithm at each classification level.

### B. Local Binary Pattern Histogram (LBPH)

Local Binary Patterns (LBP) is one of the methods used by Feature Extraction, combined with a histogram, known as the Local Binary Pattern Histogram (LBPH). The LBPH method is one of the Feature Extraction methods with excellent performance and a high accuracy level. This method compares or changes the pixel value with the image center value, and the pixel value will be calculated clockwise so that the binary value is obtained on the matrix, and the value represents the pixels of a face form a circle and the center of the circle. The center of the circle is the reference for the values. The distance of the binary value density is called the neighbors. The image will be divided into 3x3 pixels.

This function is shown in equation 1

$$s(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases} \quad (1)$$

Illustrated in Figure 2

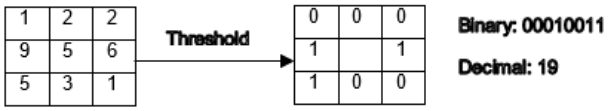


Figure 2. Original LBP Operator.

In Figure 2. We set a new value based on equation 1. If the median value of the matrix value is higher, then the value is 1; if the median value of the matrix is smaller, then the value is 0. Therefore, the value obtained is 00010011, which is written clockwise. In this way, the 8 points in the 3 * 3 environment are compared to generate an 8-bit binary number, then converted to a decimal number. The LBP value of the window center pixel point is utilized to display the feature texture area [4]. The current LBPH algorithm applies an improved circular LBP operator and is represented in Figure 3.

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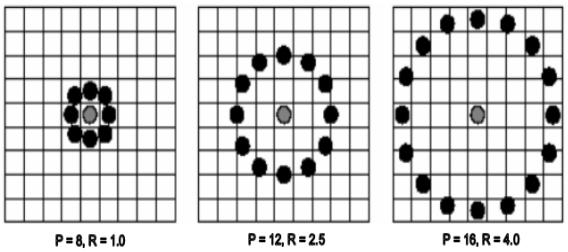


Figure 3 Circular LBP Operator.

Figure 3 shows some examples of operators that have been developed by LBP where P is neighborhood and R is the radius.

Calculation using equation 2:

$$LBP_p^p = \sum_{p=0}^{p-1} s(g_p - g_c)2^p \quad (2)$$

The grey value $g_p$ represents environment p, with R as radius and$g_c$ as pixel value $(x_c,y_c)$. Where $g_c$ represents the index value of the middle pixel and $(x_c,y_c)$ shows 8 close surrounding pixels data. Euclidean distance is calculated based on the following formula:

$$D = \sqrt{\sum_{i=1}^{n}(hist1_i - hist2_i)^2} \quad (3)$$

## III. RESULT AND DISCUSSION

### A. *Data Acquisition*

Data acquisition uses video data as input data. In the initial stage, preparing video data taken using a 1.3 MP hikviksion camera is necessary. Video data is taken outside and inside the Engineering Faculty building of Hasanuddin University, Gowa, South Sulawesi, Indonesia. The camera pole is located with 150 cm height, outward and inside the building, shown in Figure 4.

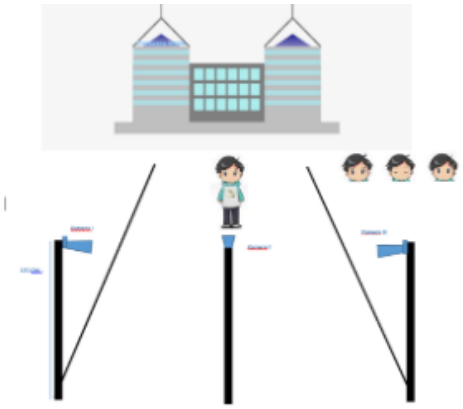

Figure 4. Pole and Camera Position

The training process uses pre-processed data using the LBPH method, which is shown in Table IV. The data used is 20,260 images and trained on the Asus ROG Strix 15 GL503GE core i7-8750H laptop with 8GB RAM

Table IV. Training Data

| Pixels | Number of Image | Image size | Training time |
|---|---|---|---|
| 100 x 100 | 20.260 | 64,8 MB | 616.05 s |

### B. Face Detection

Face detection is a computer technology implemented by several systems and applications to detect faces. This study applies the Viola-Jones method to detect faces shown in Figure 5. Viola-Jones method is preferred due to faster face detection and a better degree of accuracy [11].

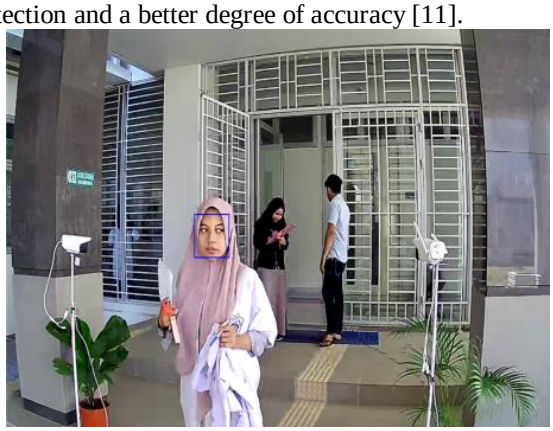

Figure 5. Face Detection Using Viola-Jones

### C. *Pre-processing*

In the pre-processing, the result image of face detection converted from RGB image to grayscale, as shown in Table II.

Table II. *Pre-processing*

| RGB | Image Resolution | Grayscale |
|---|---|---|
|  | 100X100 |  |

Pre-processing processes 20,260 images data with 100 x 100 resolution using feature extraction of BLPH method due to its better accuracy rate.

### D. *Feature Extraction using LBP*

Table III. Grayscale to LBP

| Grayscale | LBP |
|---|---|
|  |  |

This step calculates the histogram in the LBP output array. Since the 3x3 environment has 256 possible patterns, the 2D LBP arrangement thus has a minimum value of 0 and a maximum value of 255, allowing the construction of a 256-code. In table III, the results of the processing are converted into LBP images using the LBP method. Table III. Pre-processing, LBP values , and Histogram values.

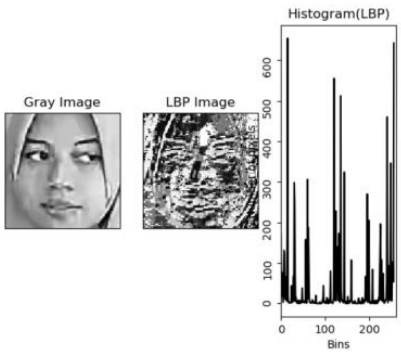


Figure 6. LBP Value

Each histogram represents each image from the training dataset. Table III shows the LBP value and the Histogram value.

Table IV. LBP Value and Histogram

| Gray Image | LBP | Histogram |
|---|---|---|
|  | [[[ 126 126 126]<br>[ 14 14 14]<br>[ 10 10 10 ]<br><br>...<br><br>[3 3 3 ]<br>[3 3 3 ]<br>[0 0 0]]] | [[ 169.] [ 18.] [ 69.] [ 19.]<br>[ 60.] [ 19.] [ 7.] [57.]<br>[128.] [ 114.] [ 16.] [ 14.]<br>[ 31.] [ 49.] [ 2.]<br><br>...<br><br>[ 117.] [ 5.] [20.] [135.]<br>[297.][ 104.] [ 6.] [ 55.] [<br>73.] [ 91.][50.] [617.]] |

*E. Face Recognition using Euclidean*

This study processes 20,260 sample images from 1013 students, with 20 images that represent each student. The face recognition of test data is carried out using Euclidean Distance. Test data is classified as sample data that has the smallest distance from the test data. For example, test data has a Histogram value, as shown in Table IV.

Data processing implements the Euclidean Distance calculation for all test data in the database. The calculation results that the test data with the smallest Euclidean Distance value of sample data is ID 838; hence the test data is recognized as sample data with ID 838 as shown in Table V.

Table V Face recognition with Euclidean Distance

| ID sample data | Euclidean distance to testing data | ID sample data | Euclidean distance to testing data |
|---|---|---|---|
| … | …….. | …… | …….. |
| 984 | 124.356 | 843 | 117.684 |
| 937 | 121.491 | 790 | 106.773 |
| 828 | 124.612 | 843 | 117.684 |
| 139 | 123.801 | 838 | 82.537 |
| …. | …….. | …… | …… |

268 of 342 test data is recognized correctly, results in face recognition accuracy of 78.4%.

Real-time face recognition testing of 20 test data shows an average face recognition time of 0.93 seconds as shown in Table VI

Table VI Time testing facial recognition in real time

| Test data | Recognized time (second) |
|---|---|
| 1 | 0.93 |
| 2 | 0.94 |
| 3 | 0.98 |
| 4 | 0.90 |
| 5 | 0.97 |
| 6 | 0.93 |
| 7 | 0.93 |
| 8 | 0.92 |
| 9 | 0.93 |
| 10 | 0.90 |
| 11 | 0.93 |
| 12 | 0.94 |
| 13 | 0.96 |
| 14 | 0.93 |
| 15 | 0.94 |
| 16 | 0.92 |
| 17 | 0.93 |
| 18 | 0.92 |
| 19 | 0.91 |
| 20 | 0.92 |
| Average | 0.93 |

## IV. CONCLUSION

This study implements the Viola-Jones method for face detection, its features are extracted using Local Binary Pattern Histogram, and the face is recognized using Euclidean Distance. This study processes 20,260 sample images from 1013 students as training data, with 20 images represent each student. The experiments show that 268 of 342 testing data are recognized correctly, resulting in 78.4% accuracy, and the average real-time recognition time is 0.93 seconds. The results are obtained using a limited number of cameras. Further research will increase the number of cameras for better accuracy.

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