Local Binary Pattern Histogram for Face Recognition in Student Attendance System

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***Abstract*— Student attendance record has an important role in the educational process. Universitas Bhayangkara Jakarta Raya, as a case study, uses attendance record as the factor for final grade calculation. Many attendance recording systems were developed using biometrics, e.g. face recognition, iris recognition, and fingerprint recognition. In this study, face recognition was proposed since the face cannot be duplicated and can eliminate fraud committed by students. In addition, this contactless method could minimize the risk of COVID-19 spread with some additional treatments. The local binary pattern (LBP) was proposed in this study. This method has the ability to describe the texture and shape of an image by dividing the image into small portions of feature extraction. The result showed that the proposed system can identify students with 86% accuracy.**

Keywords—face recognition, lbp, feature extraction, student attendance system

I. INTRODUCTION

Student attendance record has an important role in the educational process both online and face-to-face learning. Recently, the recording of student attendance is done by the student by signing the attendance form and it causes fraud committed by the student where a student signing the form belonging to the other student. This situation also happen in Universitas Bhayangkara Jakarta Raya where the academic regulations specify that the final grade is calculated from the accumulation of attendance, assignements, mid-semester examination, and final examination with the proporsion of 10%, 20% 30%, and 40%, respectively.

Many attendance recording systems were widely developed using biometrics, for example, face recognition, iris recognition, and fingerprint recognition. In this study, we focused on face recognition because the face cannot be duplicated and difficult to manipulate. Therefore, face recognition can eliminate fraud committed by students in recording attendance. In addition, this contactless system is safe and can minimize the risk of COVID-19 spread. In this study we used the Local Binary Pattern (LBP) histogram method which recognizes that certain local binary patterns (called a-uniform) are a fundamental properties of local image texture and their occurrence histogram is proven to be a very powerful texture feature[1].

Previous studies on face recognition have been done using various methods, e.g. using the feature extraction of each object by identifying the tread pattern, Rib pattern, Lug Pattern, Rib and Lug Pattern, and Block Pattern for each object pattern [2].

Other research entitled "Iris Recognition Using Feature Local Binary Pattern and Rbf Classifier" concluded that feature extraction using LBP and RBF can be used to recognize iris. The test uses 3 scenarios as follows. First, six left iris images were used for training and the results showed the highest accuracy of 53.33%. Second, six right iris images were used for training and the results showed an accuracy of 66.67%. Third, the scenario used six left iris images and six right iris images for training. The result showed an accuracy of 83.33%. This study shows that LBP representation is less sensitive to illumination changes. This means that LBP can detect or classify objects in varied lighting conditions [3]. Therefore, this method is more sustainable than the others. The object's texture is minimally affected by lighting conditions [4].

A main issue in face analysis is choosing the efficient method as descriptors. Some methods are widely used i.e. Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) [5], 2D PCA, and other proposed method that uses local binary pattern texture features based on local facial region [6]. Some previous studies used LBP as a method for object recognition [7], [8], [17]–[21], [9]–[16]. Therefore, the current study uses LBP as a method for face recognition in student attendance system.

The study contributes to support the education process after semi-lock down situation (PSBB) caused by COVID-19 situation in a sample university in Bekasi, Indonesia. The rest of the paper is organized as follows. After discussing the steps in face recognition, the proposed method will be tested using a real face data. The discussion section will be discussed to show the system performance before conclusion.

II. METHODS AND DATA

A. Grayscaling

To reduce the complexity of the system, color images should be coverted before used to get the simple number with grayscaling. This method is the process of converting color images into gray images by calculating the average value of the three colors in each pixel's channel as shown in equation (1).

$$Gr = (R+G+B)/3 \quad (1)$$

Where R, G, and B represent the red, green and blue value respectively.

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B. Local Binary Pattern

There are several methods that can be used for feature extraction in the face recognition process. One of the method used in this study is Local Binary Pattern (LBP) which was introduced by Ojala in 1996 [22]. LBP can describe the texture and shape of the image, by dividing the image into small portions of features extraction. Fitures extraction can reduce the complexity of an image that simplify the process of recognition. Fig. 1 shows the partition of an image into 64 sections.

Fig. 1. Preprocessing Phase Changes the Image Into 64 Sections

The LBP operator works with eight-pixel connectivity by using the central pixel value as the thresholding value. When a connected pixel has a gray color value that is higher than the central pixel value (or the same gray value) then the pixel will be 1, otherwise the result is 0. The LBP value of the central pixel is then obtained from the sum of the eight connectivity (Fig. 2).

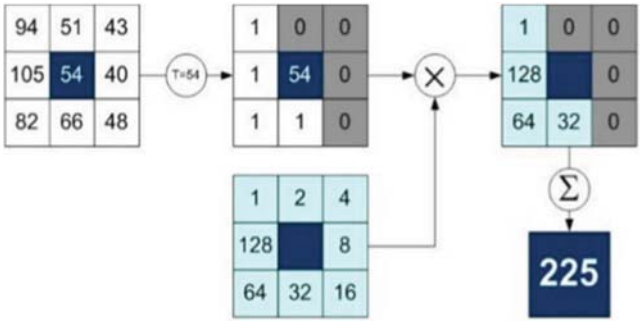

Fig. 2. Simple LBP Calculation Process

Local Binary Patterns are called uniform if they have at most two bitwise transitions from 0 to 1 or vice versa. In reality, this means that a uniform pattern does not have a transition or two transitions. Because binary strings need to be considered circular, a transition is not possible. For example, two patterns with transitions 0, in 8 bits is 00000000 and 11111111. Another example, uniform patterns with 8 bits and two transitions are 00011100 and 11100001. For patterns with two transitions, the combination is P (P −1). For uniform patterns with sample P points and radius R will be used LBP_ notation (P, R) ^ u2.

Uniform Local Binary Patterns use has two important benefits. First, this method save memory. With non-uniform patterns, there is a possibility of a combination of 2P. With *LBPP*, *u* 2 there is *P* (*P* - 1) + 2 possible patterns. The number of possible patterns for a 16 pixel (interpolated) environment is 65536 for the LBP standard and 242 for LBPu2. The second benefit is that LBPu2 only detects important local textures, such as spots, edges of lines, edges, and angles as shown in Fig. 3.

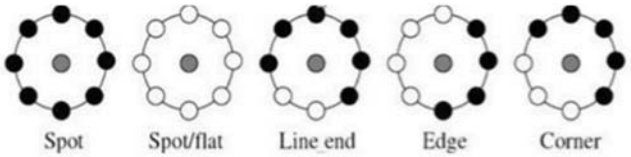

Fig. 3. Various Primitive Differences of Texture Detected by LBP_ (P, R) ^ u2

C. Local Binary Pattern in Face Recognition

Face is a kind of image with its own characteristic. The LBP method can be applied to face images in extracting features as well as to obtain the size equations. The main idea of this simple method is to calculate the LBP value of every pixel of an image while maintaining every existing pattern. Representation of the texture of the image obtained will appear in the form of a histogram. The unique histogram can be used to measure the similarity between images by calculating the distance from one histogram to another. Fig. 4 shows the face image after uniform patterns and non-uniform patterns using LBP_(P,R)^u2.

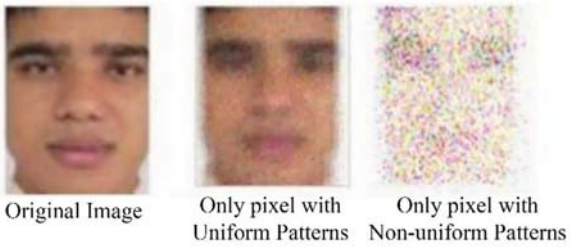

Fig. 4. Examples of Face Image with Uniform Patterns and Non-Uniform Patterns Using LBP_ (P, R) ^ u2

A prototype was created to implement the LBP method in face recognition. The graphic user interface (GUI) was prepared to input the student ID and compared the captured image to the master data for face recognition.

D. Datasets

The face image data used in this study was a captured images taken through a laptop camera (internal webcam). Data train used seven student face images where each student is taken 10 image frames. Therefore, the total training data used is 70 face images for checking the accuracy.

Other Images for recognition were also captured using a smartphone camera (Fig. 5). These images input were performed both for training and testing data. Fig. 5 shows the sample of color image matrix (RGB) with 3x3 pixels size.

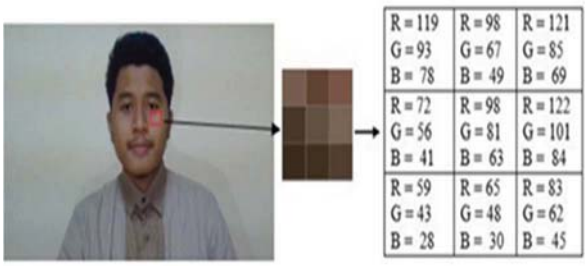

Fig. 5. Color Image Matrix (RGB) 3 x 3 Pixels Size

Image pixels that originally consisted of color RGB (Red Green Blue) should be converted into Gray value. The grayscaling process aims to reduce the parameters that will be

used for the next process to speed up the subsequent processes. Grayscaling process was calculated using equation (2):

$$I\,BW\,(x,y) = \frac{I\,R\,(x,y) + I\,G\,(x,y) + I\,B\,(x,y)}{3}$$

$$I\,BW\,(1,1) = \frac{119 + 93 + 78}{3} = \frac{290}{3} = 97 \quad (2)$$

Based on the above equation, the RGB matrix in Fig. 5 can be converted to a grayscale matrix as shown in Fig. 6.

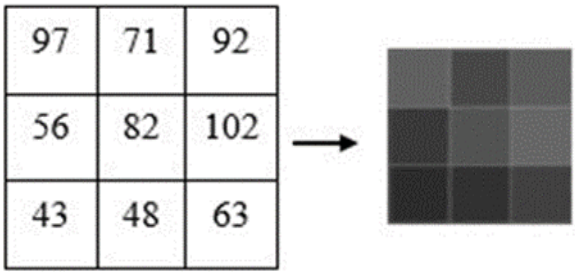

Fig. 6. Grayscale Matrix Image Size 3 x 3 Pixels

E. *Local Binary Patterns.*

In this process, the camera will detect objects in the form of face images using the Local Binary Patterns (LBP) method. After the face detection, the cropping process will be carried out as wide as the face area, followed by the resizing process to 128 x 128-pixel image. The image should be cropped and grayscalled before extracted to produce a face measurement value. The method for feature extraction uses the Local Binary Patterns Histogram (LBPH) as follows. 1) Defines the parameters (radius, pixel neighbor, grid x and grid y) needed for the LBPH process. If it doesn't have special parameters, it will use the default parameters that are already available in the library. 2) Perform algorithmic training by calling the training function for each piece of image and label based on predetermined parameters. Each image must have the same size. The label will be used as the image ID, therefore if there is more than one image that has the same texture/subject then the label must also be the same. 3) Training function will implement the LBP basic process, at first, by changing each pixel based on its neighbors using a predetermined radius standard. The LBP result can be seen in Fig. 7 (right) from the initial face image (left). 4) Algorithms should be used for training and can be used to predict the new image. 5) To predict a new some parameters should be fitted. Finally, the prediction function will extract the histogram from the testing data image then compare it with the image histogram for all stored data to check the found face image.

III. Result and Discussion

A face recognition system was created and tested. Fig. 8 shows the initial display contains button and input boxes. The application needs a computer with webcam to capture the face image.

Following the COVID-19 protocols we added some additional treatment for users as follows. First, we add distance limit for queuing. Second, the notification was added for the user not opening the masker before face recognition process. Third, do not speak to each other notification. Forth, the hand sanitizer should be prepared. Five, collecting the images should also follow the COVID-19 protocols.

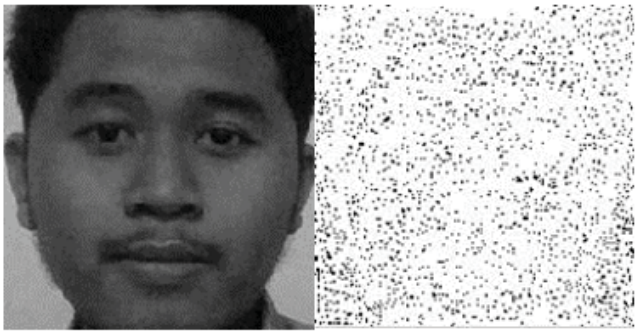

Fig. 7. Local Binary Patterns Image Imagery

Fig. 8. Interface Display

Fig. 9. The Image Acquisition Process for Learning.

Fig 10. The Image Acquisition Process for Face Recognition Process

A scan image (*dapatkan gambar*) use webcam to capture a face image before training (*melatih gambar*) and image matching (*pencocokan gambar*). Fig. 9 shows the face capturing in a small box around the detected face.

Fig. 9 and 10 also shows the face matcing with the stored data. The answer can be shown near the face boxes with the text contains ID and name of the student.

The proposed system used both mathcing and recognizing. Whereas the matching part used histogram similarity, the recognition process can detect the name of the student according the captured face image.

The contactless student attendance system has many advatages compared with the contact one, for example fingerprint detection system that have widely used. One of the main advantage is avoiding the infectious deseases, for example the COVID-19. But, some environment should be kept when using the face recognition, in particular the lightning. The stress test with a lot of students should be performed for the prototype before implementation since the image stored need some memory.

A simple questionnaire was sent to 24 respondents to understand the user satisfaction, including the seven student involved in this study and the lecturer of IT department at Universitas Bhayangkara Jakarta Raya. Table I shows the brief answers of the questionnaire. Overall accuracy for 7 students was 86% with one student could not be recognized.

TABLE 1. RESPONDENT'S ANSWER

No.	Question	Yes Answer
1	Interactive Graphic User Interface (GUI)	91.7%
2	Clear error message when input student ID	87.5%
3	User friendly when input student ID	70.8%
4	Clear face image capture	87.5%
5	User friendly when capture an image	70.8%
6	Fast capture process	87.5%
7	Minimum error in capturing	70.8%
8	Efficient application	70.8%
9	Easy to operate	87.5%
10	Satisfy when use the application	70.8%

Other studies showed the comparison of biometric-based recognition system, e.g. fingerprint, speaker, and iris. Although face recognition shows the simplicity for usage, i.e. works with the legacy photograph databases, it neither require contact nor the awareness of tested sample, and suitable for small scale verification implementation, this method has some disadvantages, i.e. need a good light instrument, better for verification than identification, and vulnerable for intrusion and criminal attack [23]. However, previous study showed that other biometric system can also be hacked by various method, e.g. fingerprints-spoofing, replay-attack DB, Iris-spoofing, etc. [24]. Therefore, some additional security treatment should be added. The contactless testing in face recognition is more safe than iris detection for the COVID-19 situation and previous study suggested to add an additional tool, i.e. the temperature sensor for the student coming to the campus integrated with the face recognition attendance system [25].

Some limitation should be checked for further study, e.g. the glasses, make-up, beard, mustache, and other distraction. The system also needed an emergency tools (emergency light) as well as combined with other method, e.g. finger print, password, etc. when the face recognition cannot be implemented in particular condition.

IV. CONCLUSION

The conclusions that can be drawn based on the results of testing the face recognition implementation system for class presence using Local Binary Patterns (LBP) Histogram are as follows. 1)The Local Binary Patterns (LBP) Histogram method processes grayscale images, and in this study, LBP was able to identify the faces of 7 students with an accuracy rate up to 86%. 2) Face recognition accuracy is affected by the lighting and background in data collection and testing training directly compared to other contacted method, e.g. fingerprint 3) Face recognition is expected to eliminate errors and fraud when recording attendance. 4) Face recognition more safe from infectious desease than the contacted method, e.g. fingerprint, signing, etc.

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