An application of viola jones method for face recognition for absence process efficiency

Rudolfo Rizki Damanik*, Delima Sitanggang, Hendra Pasaribu, Hendrik Siagian, Frisman Gulo

Faculty of Technology and Computer Science, Universitas Prima Indonesia, Indonesia

E-mail: *echos.damanik@gmail.com

Abstract. Absence was a list of documents that the company used to record the attendance time of each employee. The most common problem in a fingerprint machine is the identification of a slow sensor or a sensor not recognizing a finger. The employees late to work because they get difficulties at fingerprint system, they need about 3 – 5 minutes to absence when the condition of finger is wet or not fit. To overcome this problem, this research tried to utilize facial recognition for attendance process. The method used for facial recognition was Viola Jones. Through the processing phase of the RGB face image was converted into a histogram equalization face image for the next stage of recognition. The result of this research was the absence process could be done less than 1 second with a maximum slope of ± 700 and a distance of 20-200 cm. After implement facial recognition the process of absence is more efficient, just take less 1 minute to absence.

1. Introduction

Absence was a way to know the number of attendance to a person. Absenteeism could be done in various ways. First could be used by using the absence sheet or a tool to detect fingerprint [1]. The development of a more modern absentee system with respect to the honesty side needs to be held as a substitute for manual absence by using paper at the same time can become a new standard [2]. The use of a fingerprint presence system will reduce the problems posed by the use of manual attendance systems. With a biometric fingerprint system, frequent fraud rates such as data manipulation and preset care could be reduced [3].

Actually with the application of fingerprint system for attendance, could minimize the level of fraud that could be done in attendance system. However, it should be underlined that the fingerprint system still cannot be applied perfectly if there is someone who has physical limitations. In view of the existing weaknesses in the fingerprint system that cannot be used if a person has physical limitations, a system that can be applied to everyone without exception, and reduces the level of fraud as big as possible [4]. A fingerprint system can be took long time for process absence when the sensor is dirty or position of finger is not fit. In the field of computer vision research, facial recognition processing takes the initial stages before the facial recognition process stage itself. The process is the process of detection of human face (face detection) [5].

Based on the description above, the author was interested in designing attendance applications by utilizing face recognition. Face detection is one of the most complex and challenging problem in the field of computer vision, due to the large variations caused by the changes in facial appearance,
lighting, and facial expression [6]. Face recognition plays a vital role in many applications, which are crucial and integral part of life, and hence a high identification rate is desired [7]. The method used for face recognition was Viola Jones. Using Viola Jones method, fast processing speed and high accuracy of face detection were important factors in face recognition. In this algorithm, already define the distance between two eye when any image will be coming then processing the algorithm and matching the eyes distance and pupil distance then eyes will be detected [8]. The approach was used to construct a face detection system which is approximately 15 faster than any previous approach [9]. Viola-Jones algorithm with some specific threshold value gives the result with fast detection rate and high accuracy, the average detection rate is 97.41% [10]. Viola Jones method was a fast and accurate method in image processing [11–15]. Face Recognition was considered to reduce the shortcomings of the fingerprint system and help users to perform faster attendance.

2. Method
Viola Jones classified the image of the value of simple features and uses three types of features, which were square features, three-square features, and a four-square feature. The value of these features was the difference between black and white regions. In each sub-window image, the total number of Feature Haar was very large, much larger if compared to the number of pixels. To ensure that classification could be done quickly, the learning process should eliminate the majority of features available, and focus on a small set of necessary features. AdaBoost aimed to form face templates [16].

The facial object was searched using Viola Jones which refers to the plot as shown in Figure 1, where the grayscale image would be scanned per sub-window to look for positive features with AdaBoost and Cascade Classifier. If a face was detected, a rectangular image would be drawn on the face. The object's detection group casts an image based on the value of a simple feature. The basic operation of a feature was much faster than pixel processing. Some Haar Features represent the rectangular region of the image and add up all the pixels in the area [16].

A classification method that was used multiple levels of selection. At each level performs the selection using the AdaBoost algorithm that has been trained by using the Haar Feature. The selection was useful for separating between sub-windows containing positive objects (images that are detected to have the desired object) with negative objects (the detected images do not have the desired object) [4]. The Viola-Jones method combined four general keys: Haar Like Feature, Integral Image, Adaboost learning and Cascade classifier. Haar Like Feature was the difference of the number of pixels from the area inside the rectangle. An example of Haar Like Feature was presented in Figure 1.

Figure 1. Haar Like Feature.

Haar Like Feature values were derived from the difference in the number of dark area pixel values by the number of bright area pixels:

$$F(\text{Haar}) = \sum F_{\text{white}} - \sum F_{\text{black}}$$

(1)

F(\text{Haar}) was the total feature value, $\sum F_{\text{white}}$ was the feature value on the brightest area and $\sum F_{\text{black}}$ was the feature value on the dark area. Haar features are composed of either two or three rectangles. Face candidates are scanned and searched for Haar features of the current stage. The weight and size
of each feature and the features themselves are generated using a machine learning algorithm from AdaBoost [17]. Integral image was a technique for calculating the feature value quickly by changing the value of each pixel into a new image representation, as shown in Figure 2.

**Figure 2.** Integral image (x,y).

Based on Figure 3, integral image in \((x,y)\) \((ii(xy))\) could be find used the formula:

\[
ii(x, y) = \sum x' \leq x, y' \leq y^{i(x', y')}
\]  

(2)

where \(ii (x, y)\) was the integral image at location \(x, y\) and \(i (x', y')\) was the pixel value at the original image location. The calculation of the value of a feature could be done quickly by computing the integral image value at four points as shown in Figure 3. If the integral value of image of point 1 was \(A\), point 2 was \(A + B\), point 3 was \(A + C\), and at the point 4 was \(A + B + C + D\), then the number of pixels in region D could be known by \(4 + 1 (2 + 3)\).

**Figure 3.** The Figure Score Count.

The Adaboost learning algorithm, used to improve classification performance with simple learning to combine many weak classifier into one powerful classifier. Weak classifier was a correct answer with a less accurate truth level. A weak classifier was stated below [4]:

\[
h_j(x) = \begin{cases} 
  1, & \text{if } p_j f_j < p_j \theta_j (x) \\
  0, & \text{other}
\end{cases}
\]  

(3)

where \(h_j(x)\) was a weak classification, \(p_j\) is parity to \(j\), \(\theta_j\) was threshold to \(j\) and \(x\) is sub image dimension such as \(24 \times 24\). The steps to get a strong classifier were expressed in an algorithm as follows, giving figure as example \((x_1, y_1), \ldots, (x_n, y_n)\) \(y_i = 0\) the positive example and \(y_i = 1\) for negative example. Weight initation \(y_{i,1} = \frac{1}{2^{m+1}}\); \(m\) and \(1\) was the number of negative and positive, and for \(t = 1, \ldots, T\) then weight normal so \(w_{t+1} = \frac{w_{t+1}}{\sum_{j=1}^{T} w_{t+1}}\) for every figure, \(j\) classifier exercises \(h_j\), for every individual figure. Fault \(e_t = \sum_i w_i |h_j(x_i) - y_i|\) Classfier Choose \(CC h_t\) with smallest error where \(e_t = 0\) for \(x_t\) was the true classification, and \(e_t = 1\) for others weight update: \(w_{t+1} = w_t \beta_t^{1-e_t}\) where \(\beta_t = \frac{e_t}{1-e_t}\). There got to be a strong Classifier \(h(x) = \begin{cases} 
  1, & \sum_{t=1}^{T} \alpha_t h_t(x) \geq \frac{1}{2} \sum_{t=1}^{T} \alpha_t \text{ other} \\
  0, & \text{other}
\end{cases}\) where \(\alpha_t = \log \beta_t\).

The Cascade classifier was a method to combine complex classifier in a multilevel structure that could increase the speed of object detection by focusing on only possible imagery areas. The cascade classifier structure was presented in Figure 4.
The workings of face detection was using Viola Jones, in Figure 5 below was a scheme of how face detection works using the Viola-Jones algorithm from the beginning of the detection process to the results of the detection process. The first process was to read the sample of the face image of an image or read the sample of the face image that was facing the camera. From the image that had been captured it would be done Haar feature reading by processing the image into boxes to get the difference of threshold value of the dark areas and bright areas of the image. If the difference between the dark and the bright areas above the threshold or threshold value, then it could be said that the feature exists.

Further to determine whether or not there were hundreds of Haar features on an image and on a different scale efficiently used Integral Image. In general, the integration adds small units simultaneously. In this case the small units were pixel values. The integral value for each pixel was the sum of all the pixels from top to bottom. Starting from the top left to the bottom right, the entire image could be summed with multiple integer operations per pixel. Then to select the specific Haar feature to be used and to set the threshold value was used a machine learning method called AdaBoost. AdaBoost combines many weak classifiers to create a powerful classifier. By combining some AdaBoost classifiers as filter circuits that were efficient enough to classify the image area. Each filter was a separate AdaBoost classifier that consists of a weak classifier or a Haar filter. During the filter process, if any of the filters fail to pass an image area, then the area was immediately classed as non-face. However, when the filter passes an image area and passes through all filter processes in the filter circuit, the image area was classified as the face. The next stage was cascade classifier. The order of filters on the cascade was determined by the weight given AdaBoost. The largest weighted filter was placed in the first process, aiming to erase the non-face image area as quickly as possible. The last stage was showed the object of the sample image that has been detected face or not face.

**Figure 4.** Cascade Classifier.

**Figure 5.** Cascade Scheme Classifier Face Detection Process with Viola-Jones Method.
3. Design and development
The absence process needed a web camera or webcam as an input data media, and then the system would be processing the input data with Viola Jones method. In this method, the picture of face should be passing some steps to become valid or invalid like figure 6 below.

![Figure 6. Block Diagram of Viola-Jones Method.](image)

This process had been tried in Computer and Technology Faculty especially for staffs and lecturers. There were 15 correspondents that become participants in this try an error where there were 10 lecturers and 5 staffs. The test was done by asking 3 staffs to use glasses and did the absence, the result was taken that this system could known the face eventhough the saving data in database did not use the glasses. The rest was 12 people was tested by reduce light intention when the detection process, moving the distance and face detection corner. By the testing of this process, the system still detect the face and match with database without any trouble. For light intention, if the condition of light was dim or dark so the system would not detect the face process. The time that needed to do the process of detecting face from 20 to 50 second and of cource the presentation process would be faster than using fingerprint.

4. Results and Discussions
A better recognition rate was obtained by maximizing the number of images used as the face matching reference and governing the conditions at which the facial image retrieval image and test face image had the same conditions. Also at the time of face recognition was done using a webcam should not be too many interference behind the user. But the accuracy of the attendance system through Viola Jones method would be worse if the image of the face in training has much in common. Compared with other studies [6] where the results obtained tolerance angle for face recognition is 0 - 5 degrees, whereas in this research angle tolerance for face recognition reaches 70 degrees with improvement ratio 1:14. For the face distance from the camera in the study [6] only 20-60 cm, while in this study reached 20 - 200 cm. Applications built on this research are also able to recognize the obstructed face of objects such as eyeglasses and on dim lighting.

| Figure | Example Genres | Result | Conclusion |
|--------|----------------|--------|------------|
| ![Image](image) | Slant | Detected | The front-facing position of the webcam with accuracy is 100% with detection time of less than 1 second, while the maximum slope of ± 70°. |

Table 1. The Result with criteria.
| Light  | Detected | In dark or bright lights are still able to detect the presence of objects. |
|---------|----------|----------------------------------------------------------|
| Distance | Detected | The closest distance ± 20cm, at a distance of ± 200cm could still be detected. |
| Stunted | Detected | Able to detect facial objects even if obstructed as long as the contour was the same as the facial contours. |

The following interface was a display of attendance application with face recognition system, which users only need to face the fore face of the webcam for absenteeism and absenteeism home. First of all the users came and performs attendance by facing the fore face of the webcam, if the face of the user is declared to match the image of face training contained in the database, then the absence successfully done. The same thing was also done when the user perform absenteeism home. Display attendance system face recognition could be seen in Figure 7.

![Attendance System](image)

**Figure 7.** Face Recognition Process.
In this attendance application had provided the features of training data used as a reference matching face, as in figure 8 below:

![Figure 8. Data Training Process.](image)

5. Conclusion
Based on the results of tests performed, author could draw some conclusions were: with the absence application using face recognition, it helped users who have physical limitations such as not having a finger or wet fingers. The absence of face system was successful implemented and moved the process of fingerprint, the test was done to 20 correspondence and the result was shown that 20 faces was successful detection with time speed from 20 to 50 seconds.

Acknowledgement
This research was supported by the Faculty Technology and Computer Science Universitas Prima Indonesia

References
[1]  A. T.Kurniawati andA. Ruli Dwi Rama, 2012, “Aplikasi pengenalan wajah menggunakan metodeeigenface dengan bahasa pemrograman java”, *Seminar Nasional Sains dan Teknologi Terapan III*, 2015.
[2]  N. Haris Masrurian A. Sunyoto, “Aplikasi cambot menggunakan metode viola jones sebagai sistem penjejaj objek”, *JURNAL DASI Vol. 13*, No. 3.
[3]  C. Fifti AnasSari and L. Yulianto, 2013, “Perancangan sistem informasi absensi menggunakan finger print di badan perencanaan pembangunan daerah dan penanaman modal kabupaten pacitan”, *Seminar Riset Unggulan Nasional Informatika dan Komputer FTI UNSA, No. 1.
[4]  D. Ari Prasetya and I. Nurviyanto, 2012, “Deteksi wajah metode viola jones pada opencv menggunakan pemrograman python”, *Simposium Nasional RAPI XI FT UMS*. 
[5] Yi-Qing Wang, 2012, “An Analysis of the Viola-Jones Face Detection Algorithm”, Image Processing Online.

[6] M. K Dabhi and B. K Pancholi, 2016, “Face Detection System Based on Viola-Jones Algorithm”, International Journal of Science and Research(IJSR) Vol. 5, Issue 4, April 2016.

[7] A. Mohsen Abdul Hossen, R. Abd Alsheeb Ogla, M. Mahmood Ali, 2017, “Face Detection by Using OpenCV’s Viola Jones Algorithm based on coding eyes”, Iraqi Journal of Science, Vol. 58, No. 2A.

[8] N. T. Deshpande and S. Ravishankar, 2016, “Face Detection and Recognition using Viola-Jones algorithm and fusion of LDA and ANN”, IOSR Journal of Computer Engineering (IOSR-JCE) Vol. 18, Issue 6.

[9] A. Gupta and R. Tiwari, 2015, “Face Detection Using Modified Viola Jones Algorithm”, International Journal of Recent Research in Mathematics Computer Science and Information Technology Vol. 1, Issue 2. October 2014 – March 2015.

[10] S. Tikoo and N. Malik, 2016, “Detection of Face using Viola Jones and Recognition using Back Propagation Neural Network”, International Journal of Computer Science and Mobile Computing Vol. 5, Issue 5. May 2016.

[11] A. Sahitya, M. TN, V. N, 2016, “A Survey on Face Recognition Technology – Viola Jones Algorithm”, International Journal of Computer Applications.

[12] I. Khan, H. Abdullah and M. Shamian Bin Zainal, 2014, “Efficient Eyes and Mouth Detection Algorithm Using Combination of Viola Jones and Skin Color Pixel Detection”, International Journal of Engineering and Applied Sciences Vol. 3, No. 1, Juli 2014.

[13] M. Kumar Mathur, P. Bhati, 2017, “Face Object Detection in still image using Viola-Jones algorithm through mathlab tools”, International Journal of Innovative Research in Computer and Communication Engineering Vol. 5, Issue 2. February 2017.

[14] M. Chaudhari, S. Sondur, G. Vanjare, 2015, “A review on Face Detection and study of Viola Jones method”, International Journal of Computer Trends and Technology Vol. 25, No. 1, Juli 2015.

[15] R. Boda and M. Jasmine Pemeena Priyadarsini, 2016, “Face Detection And Tracking Using Klt And Viola Jones”, ARPN Journal of Engineering and Applied Sciences Vol. 11, No. 23, December 2016.

[16] A. Hendro Triatmoko, S. Hadi Pramono, H. S. Dachlan, 2014, “Penggunaan metode viola-jones dan algoritma eigen eyes dalam sistem kehadiran pegawai”, Jurnal EECCIS Vol. 8, No. 1, Juni 2014.

[17] R. N. Dascoudhary and R. Tripathy, 2014, “Real time face detection and tracking using haar classifier on soc”, Proceedings of SARC-IRF International Conference, April 2014.