Detection system of facial patterns with masks in new normal based on the Viola Jones method

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Abstract. Covid-19 is something that was never expected, it can turn into an endemic virus in the community. There is a possibility that this virus will not be completely destroyed. This makes the world and Indonesia in an uncomfortable position. Two months with Social Distancing conditions, the Government of Indonesia has been preparing to roll back the sluggish economic wheel as a result of the implementation of Social Distancing. Therefore, the Indonesian people must live in peace with Covid-19 until the discovery of an effective vaccine. This condition is called new normal. This study designed a detection system of facial patterns using masks during the pandemic based on Real-Time Raspberry. The purpose of detecting face patterns by using a mask is to find out if there are masked faces in the image. Although it seems easy to do by humans, it turns out that this detection system is difficult to do without the help of a computer to process facial recognition because there are some difficulties related to location, point of view, light, and occlusion. This research has implemented a detection system using the Viola Jones method. Viola Jones method is a method to get fast, accurate and efficient results in face detection on images. This study using the Viola Jones method to adjust the threshold value, and form the Cascade Classifier in determining the face area in the image. This training can be evaluated the accuracy of the system by modifying the parameter values in the Viola Jones method so that this design can produce the highest accuracy for face images using masks and low accuracy for face images without using masks. From the results of trials with 100 face samples, the accuracy percentage is 90.9% and it takes a relatively short time to detect faces using a mask that is on average 15 seconds per sample tested.

1. Introduction
Covid-19 is a type of sars-cov-2 virus that has shocked the world and was included in Indonesia in early 2020, where this virus emerged from China, Wuhan City, China. There are currently as many as 65 countries infected with the corona virus, where every day the number of cases in each country continues to increase over time. This corona virus is likely derived from animals that are transmitted to humans. Therefore, the transmission process is not known with certainty but it can be predicted that transmission between humans through droplets and contact with viruses released in droplets. Therefore, everyone is required to wear a mask or mouth cover so that the risk of contracting contact may be smaller and this is also an effort to prevent the spread of the virus[1,2]. The use of masks is a government effort to spread the corona virus and is also due to the discovery of a vaccine that still requires time. In Indonesia, people are required to wear masks, even though the type of mask used is a mask made from fabric[3]. In the use of masks, users are expected to be more careful so that the virus does not easily enter. Protocol rules are often ignored by the public. This is why patients who are
exposed to the virus are not decreasing but are increasing. This research trying to design a face pattern detection system using masks with the aim of being able to help the parties concerned in giving warnings to the public who have violated the protocol rules by identifying the images on whether or not the face is using a mask.

To design this system need a method that has a high degree of accuracy and fast computing is needed. In this study using the Viola Jones method. Viola Jones method is a feature selection method that has a high detection rate for identifying facial patterns in images with low error rates[4]. The process in this method in face pattern detection is by changing the input image into a new image representation in the form of an integral image. The integral image consists of a number of quite a number of features. These features will be selected by AdaBoost to be used as a classifier component which will be used to classify images[5]. The optimal solution in the Viola Jones method is obtained by determining the presence or absence of certain haar features in an image by selecting specific haar features that will be used to adjust the threshold[6], and the cascade classifier as the final classification determines the face area using a mask in the image of this method. With the advantages of the method, several studies have developed it as a technique, such as: [7] research conducted for the detection of acne on the face. In addition, the research conducted [8] for the introduction of human objects in the eyes, nose and mouth. In this study the Viola Jones method is able to produce an accuracy rate of 67.6%. The difference of this research with previous studies is in the process of data analysis using being able to detect obstructed faces with masks, where the contours are the same as the face contours in the template[9].

The purpose of applying this method is to produce an optimal system design in terms of accuracy and computing. Testing this system uses K-fold cross validation by observing the level of accuracy by modifying the parameter values in the Viola Jones method so that the highest accuracy is obtained for face images using masks and low accuracy for face images without using masks.

2. Research Methods

The dataset used is a sample of face images from the internet and 100 random images, can be seen in Figure 1 as a sample dataset. The research method with a mask using the Viola Jones method, has several steps to be need to produce by smart solution. Experiments conducted using Raspberry-pi and the programming language is Python. This system of design of face detection can be seen in Figure 2. After conducting experiments and testing methods, the results obtained are evaluated by calculating the level of accuracy. There are several models used for face detection systems. Viola Jones method is a method that combines support vector machines, boosting algorithms, and cascade classifier[10,11]. This face detection model is most widely used by classifying an image after a classifier was formed from training data. In this study the flow chart of the face detection process with the Viola Jones method can be seen in Figure 3. The steps in using the Viola Jones method, such as:[12]: (a) Image classification is based on the value of a feature using Integral Image. (b) The threshold value to be select the specific features. (c) The result of the last classification is T (True) for images that meet the AdaBoost and F (False) processes if not. Integral image is a technique that can speed up the process of detecting an object by combining the smallest units of the image, the pixel values into a new image representation, by adding the pixels to the left and top of the point[13]. The formula for calculating the haar value of an image:

$$D = D + A - (B + C)$$  \hspace{1cm} (1)

$$Value\ of\ Haar = |(Sum\ of\ Black\ Pixel) - (Sum\ of\ White\ Pixel)|,$$  \hspace{1cm} (2)

where D is the value of the lower right pixel, A is the value of the upper left pixel, B is the top pixel of pixel D and C is the value of the left pixel of pixel D. For an overview of these pixels, it can be seen in Figure 4.
Figure 1. Sample dataset.

Figure 2. Design of a face pattern detection system with a mask.

Figure 3. Flow chart of the masked face pattern detection system using the Viola Jones method.

Figure 4. Integral image.
The detection result from Haar is less accurate if it only uses one function, so it is usually used by several functions. The more functions used the more accurate the results will be. The numerous Haar processing is organized or arranged in a cascade classifier [15]. While machine learning on the Viola Jones method is AdaBoost. AdaBoost combines many weak classifiers to create a stronger classifier [16]. Weak means that the filter sequence in the classifier only gets fewer correct answers. If all weak classifiers are combined, they will become stronger classifiers. AdaBoost chooses a number of weak classifiers to put together and adds weight to each classifier, so that it will become a strong classifier [17,18]. The Viola Jones method combines several AdaBoost classifiers as a series of filters that are efficient enough to classify image regions. Each filter is a separate AdaBoost classifier consisting of a weak classifier or a feature filter:  
\[
    h_t(x) = \begin{cases} 
        1, & \text{if } p_t f_t(x) < p_t \theta_t(x) \\
        0, & \text{otherwise} 
    \end{cases} 
\]

where \( h_t (x) \) is a weak classification, \( p_t \) is Parity to \( t \), \( \theta_t \) = threshold to \( t \) and \( x \) is a sub image dimension for example 24x24.

The Cascade of Classifier is the final stage of the Viola Jones method by combining classifications in a cascade structure. The speed of the detection process can be increased by focusing on areas in the image that have opportunities [20]. This is done to determine where the object is located in an image. A characteristic of the Viola-Jones method is the multilevel classification which consists of three levels in which each level issues a sub-image that shows not a masked face. In the first level classification, each sub-image will be classified using one feature. The results of this first classification are True for images that meet certain Haar features and False if not. And the results of the second classification are True for images that meet the integral image process and False if not. And also the results of the last classification are True for images that meet the AdaBoost and False processes if not.

### 3. Results And Discussion

Based on the steps to solve the problem in a face detection system using a mask using the viola jones method, it results in testing images that are detected only using a mask and testing images that have not detected a face using a mask. The performance of the approach was tested on 100 sample images, the test is displayed in the form of examples of the results of images detected face and face detected, as in Table 1.

| No | Type Image | Face Detected (false/true) | Not Face Detected (no/yes) | Detected using a mask (no/yes) | Detected Not Using a Mask (no/yes) |
|----|------------|---------------------------|---------------------------|-------------------------------|-----------------------------------|
| 1  | (a)        | false                     | no                        | no                            | yes                               |
| 2  | (b)        | false                     | no                        | no                            | yes                               |
| 3  | (c)        | true                      | no                        | yes                           | no                                |
| 4  | (d)        | false                     | no                        | no                            | yes                               |
| 5  | (e)        | true                      | no                        | yes                           | no                                |
| 6  | (f)        | true                      | no                        | yes                           | no                                |
| 7  | (g)        | false                     | no                        | yes                           | no                                |
| 8  | (h)        | false                     | yes                       | no                            | no                                |
| 9  | (i)        | true                      | no                        | yes                           | no                                |
| 10 | (j)        | true                      | no                        | yes                           | no                                |

The system that has been designed has succeeded in detecting 18 face pattern images using masks from face image samples, namely 30 images with an accuracy percentage of 90.9% with false
positives of 3 images, and false negatives of 2 images. This method has also spent a relatively short time detecting faces using masks, which is an average of 15 seconds per sample tested.

4. Conclusion
In this study a system was designed to detect faces using masks in an image using the Viola Jones method. The method in this study has the right advantage compared to the face detection method not using a mask with an accuracy of 90.9% But to improve the results of research can add other methods to detect faces using masks on images that have faces that are not upright or frontal. Using this method, face detection only uses an average of 15 seconds for all samples tested.

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