PROPER FACE MASK DETECTION USING HAAR CASCADE

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ABSTRACT

This project was created to detect the use of masks, where the use of masks is now the obligation of all communities, especially in public places. In this project, we will detect people who don't care and are not wearing masks properly. In detecting the use of masks, the Haar Cascade algorithm is used to detect facial, eye, nose, and mouth objects. There are 3 libraries to help detect masks such as haarcascade_frontalface_default.xml to detect face objects from the front side, haarcascade_eye.xml to detect eye objects, Nariz.xml to detect nose objects, and haarcascade_mcs_mouth.xml to detect mouth objects. From the image obtained, it will be converted to grayscale and then black and white to be able to detect faces, eyes, noses, and mouths. To analyze the results of mask detection, it is done by using a video containing image data of the use of masks. There are a total of 125 data to measure the level of accuracy in the mask detection program. The results obtained with an average accuracy level is 89,5%.

Keywords: Mask Detection, Haar Cascade, Detect Face

BACKGROUND

Masks are items that cannot be separated from everyday life. Especially during this pandemic, mask must be used when leaving the house or doing activities outside the home. However, there are still many people who underestimate the use of masks. Example in the office, many employees sometimes don't wear masks according to the rules when in the office area. Even other people who see it sometimes don't care.

This mask detection system can detect people who use masks, do not use masks, and how to wear masks incorrectly. If the person is wearing the mask correctly, the system can detect whether the mask has been worn correctly. If you are not wearing a mask or wearing a mask incorrectly, the system can detect if you are not wearing a mask properly and the person's face will be captured and saved in a computer file.

The system for detecting the use of masks was created to monitor the use of masks. It is hoped that with this system people in the public are more aware of the use of masks during this pandemic. That way everyone will feel safe when people wear masks according to health protocols.

Initially, the system was created for the detection of masks in public places so that people pay more attention to health protocols that should be obeyed. The program will detect not wearing a mask if a nose and mouth object is detected. For this reason, photo capture is also given for people who are detected not using masks or using masks that are not correct.

LITERATURE STUDY

In facilitating the detection of masks using the Haar Cascade algorithm, it is necessary to detect the presence of the face, eyes, nose, and mouth. References from existing journals are very helpful in understanding and smoothing this research. There are 8 journals used as references in object detection. Saubari [1] aims in his research to find out how far the Haar feature selection method can detect faces. The process of detecting facial images that can be done digitally using a computer with the image verification process using the same authentication technique. The results obtained that using the Haar feature selection method has an accuracy of 91.34% in 0.6 seconds with 55cm. Iswanti [2] aim to obtain information from a particular object using only sample images such as recognizing someone. Using the Viola Jones method is the fastest and most accurate method for detecting faces. The use of this system can detect faces well with an accuracy rate of 80.55%.

Adinda Rizkita Syafira and Gunawan Ariyanto [3] with the journal title Face Detection System with Modified Viola Jones Method which aims to determine the presence or absence of faces in the image. The application of the Viola Jones method to create a face detection system with the python program using the Haar feature as a descriptor then integral image and AdaBoost to detect and select feature values. The test results using K-fold cross validation obtained 90.9% results for face images.

In the journal titled Recognition of Face Shape Patterns with OpenCV by Tengku Cut Al-Saidina Zulkhaidi, Eny Maria, and Yulianto Yulianto [4] aims to recognize face and eye shapes. Using open source from Intel to recognize faces and eyes combined with the cascade classifier module in OpenCV to convert data into facial recognition. Data samples were taken with a webcam on 1 face and 2 faces at once. When the eyes blink and use the eye in a bright place the application will recognize faces.

The difference between my idea and other existing ideas is that previously it only detects faces or face recognition. However, for the New Normal period where people are required to wear masks wherever it is necessary to detect these masks. Monitoring with this system is useful to guard against someone who does not use a mask when in public places. The method used is the Haar Cascade Classifier, which will check the face, eyes, nose, and mouth objects. An undetected nose and mouth indicate that the person is wearing a mask, while a detected nose and mouth indicates that the person is not wearing a mask.

ANALYSIS AND DESIGN

Analysis

The first processed image is to convert to grayscale then convert to black and white to determine the face, eye, and nose area. After the face and eyes are detected, the program will check whether the nose is detected or not. If the nose is not detected, then the face is wearing a mask, if the nose is detected, then the face is not wearing a mask. In the face image that is detected, it must be in sufficient light conditions. Image resolution also influences this detection, it must be in good condition. For the detection of more than one face in the frame can be detected and will be notified whether the face is wearing a mask or not. This condition will calculate the percentage of positive and negative tests. Positive tests such as successfully detecting a mask with a face using a mask and not detecting a mask with a face without a mask. Then there are negative tests such as successfully detecting masks without a face using a mask, not detecting a mask with a face using a mask.

Design

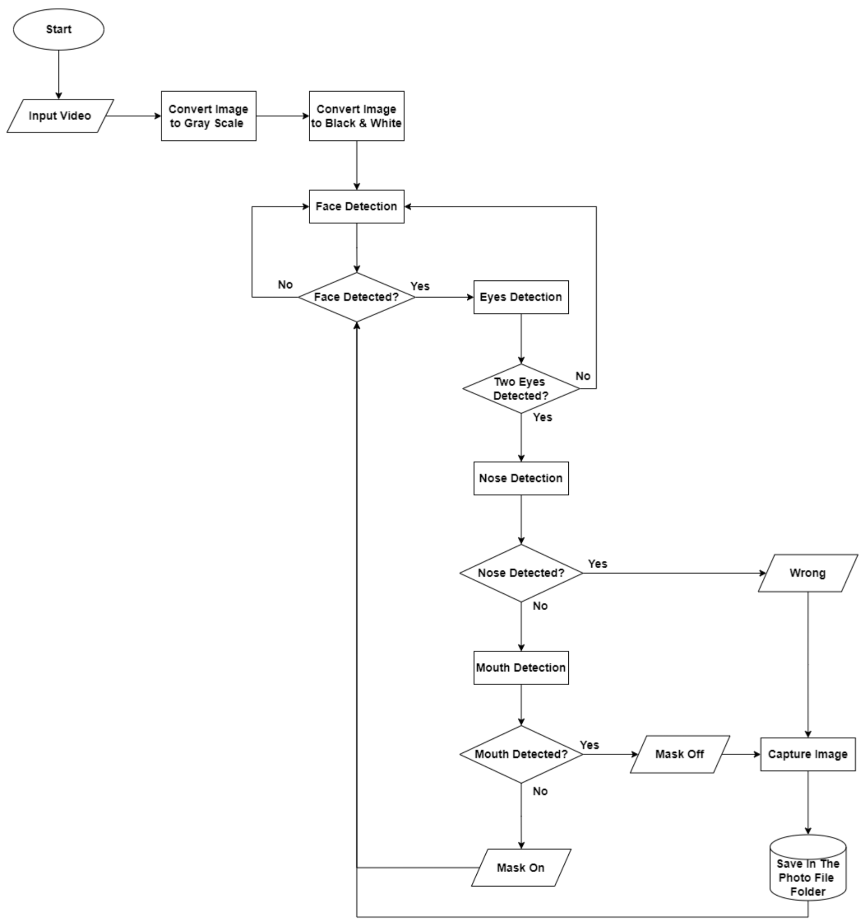

Figure 1. Mask Detection Flow Chart

In Figure 1 is an illustration of a flow chart in mask detection. This flow chart is made so that the reader can get an idea about this project. After this will be explained further about this flow chart.

Figure 2. First View Video

Firstly, a video containing an image of the use of a mask will be played. The video will be converted to grayscale and then converted to black and white. After conversion, the program will detect whether there is a face object in the video, if a face is detected, the next step is to detect an eye object, if an eye is detected it will detect a nose object. If no nose object is detected, then the face is wearing a mask.

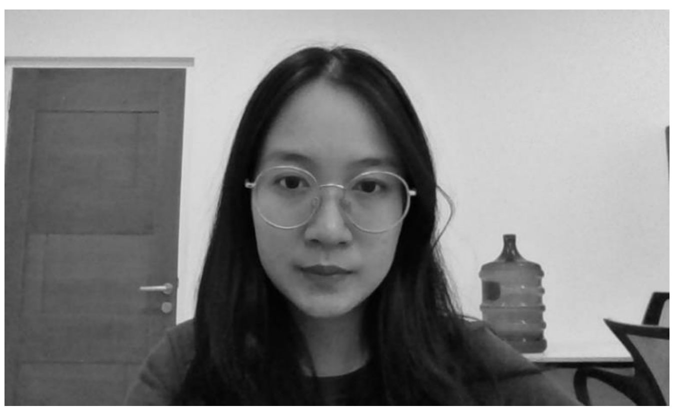

Figure 3. Convert Image to Grayscale

From the image there is a grayscale process that converts the image to gray as shown in figure 3. The goal is to remove the red, green, blue component colors and make the color intensity the same. That is the result convert image to grayscale.

Figure 4. Convert Image to Black and White

$$I_{BW}(x,y) = \frac{I_R(x,y) + I_G(x,y) + I_B(x,y)}{3} \quad (1)$$

$I_R(x,y)$ = Red pixel value point (x,y)

$I_G(x,y)$ = Green pixel value point (x,y)

$I_B(x,y)$ = Blue pixel value point (x,y)

$I_{BW}(x,y)$ = Black and White pixel value point (x,y)

The next stage is to change the image to black and white as shown in figure 4. Black and white to process the pixels in the image because there are only two colors for pixels, namely black and white. In addition, it aims to distinguish between objects and backgrounds.

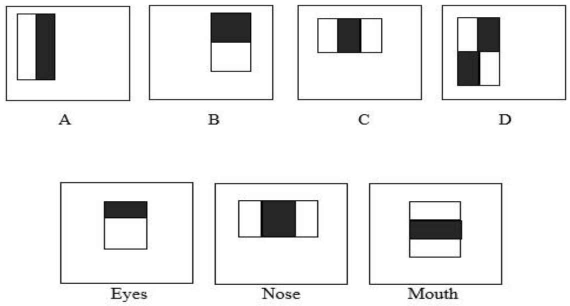

Figure 5. Haar Feature Faces, Eyes, Nose, Mouth

The way of the Haar Cascade Algorithm in detecting an object's face, eyes, nose, and mouth is to train as many positive and negative images as possible and put them into an XML file as shown in figure 5. This XML file will speed up detecting face, eyes, nose, and mouth objects. The size of the evaluated base box is 24x24 with a scale of 1.25.

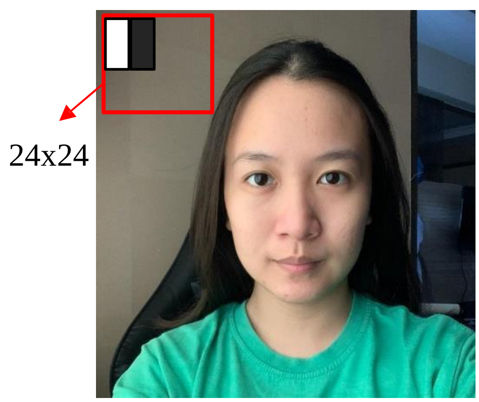

Figure 6. Haar Feature Work

The Haar Feature will move the slide all the way down. The Haar will detect whether each box passed is the object being searched for or not as shown in figure 6. The Haar will move the slide all the way down. The Haar will detect whether each box passed is the object being searched for or not.

$$F(Haar) = \sum F\ white - \sum F\ black \qquad (2)$$

In function (2), to get the difference between the pixels in black and white areas is to add up the black areas and then add up the white areas. After getting the number, the result of the white area is subtracted from the result of the black area. Haar Feature results will be obtained from the box.

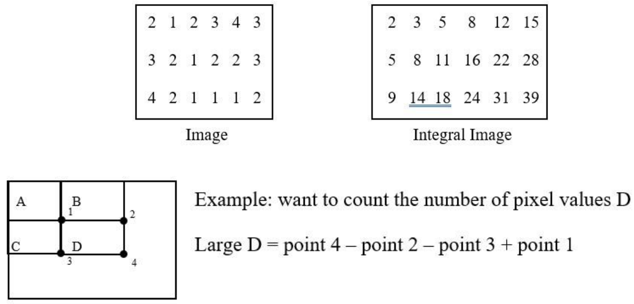

Figure 7. Integral Image

The next step is the image integral is calculated from the original image so that each pixel is the sum of all the pixels that lie on the left and above in the original image shown in figure 7. Integral image is used to make it easier to calculate the value of the area you are looking for.

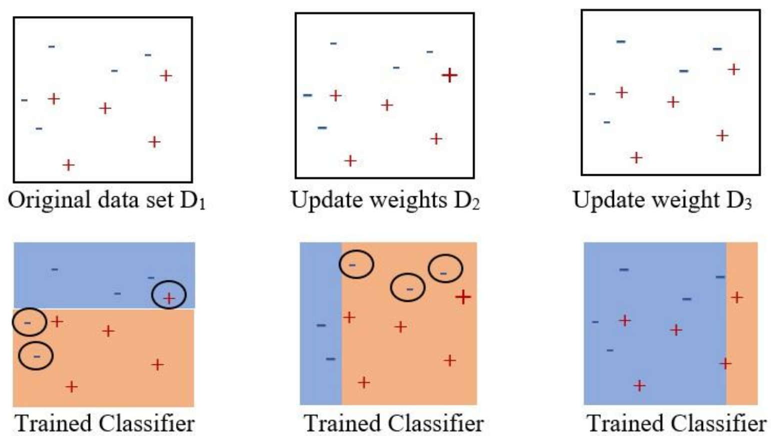

Figure 8. AdaBoost Classifier

Classification uses AdaBoost to select the smallest error shown in figure 8. Class 1 if it is positive (>=0), class 2 if positive (<0). After Training, weight each classifier and combine them. From this all, it will be determined whether the object is a face or not, whether it is an eye or not, whether it is a nose or not, and whether it is a mouth or not.

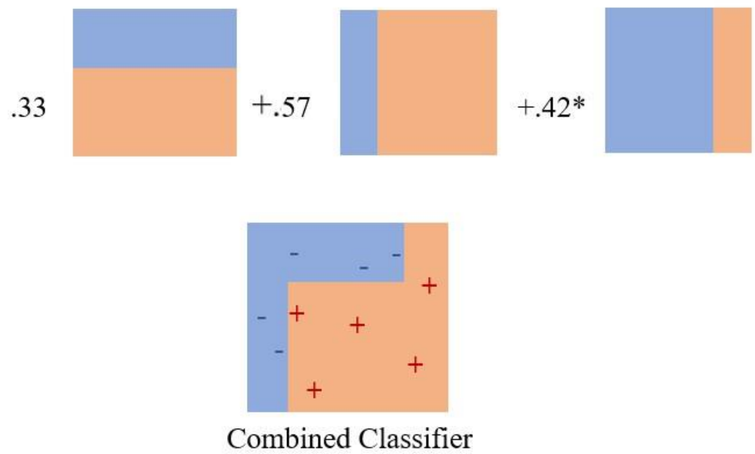

Figure 9. Combined Classifier AdaBoost

After the AdaBoost classification is trained, the region with the smallest error will be obtained. There is a weight to calculate the class. The blue region is assigned a value of -1 and the red region is assigned a value of +1 as illustrated in figure 9. the results obtained are calculated by weight according to the results in the combined classifier.

Furthermore, there is a function to determine the weight to be used in the AdaBoost classification. The weight is used to determine the area with the smallest error. Here are the functions:

$$\alpha_t = \frac{1}{2} \ln \left(\frac{1 - \epsilon t}{\epsilon t} \right) \tag{3}$$

The sign α_t means the weight and ϵt means the error rate. The error rate is obtained during classifier training with the smallest number of errors divided by the amount of data. That way it will be able to find which area is the best and can be included in the object.

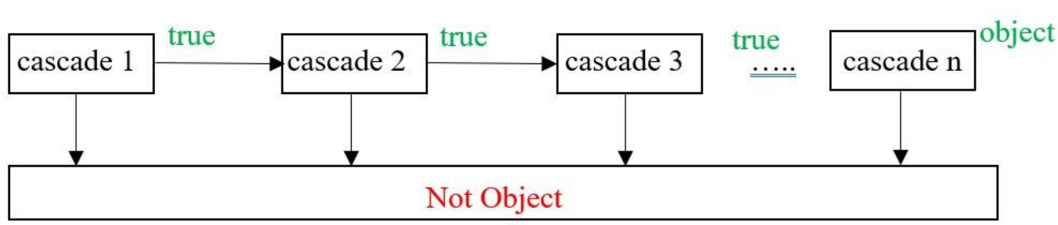

Figure 10. Cascade Classifier

After that, the last part is the cascade classifier stage. This stage determines which objects, and which are not objects [10]. If it's an object, then cascade will be true. if it is not an object then the cascade will be immediately denied entry to a non-object.

(a) (b) (c)

Figure 11. (a)People Not Wearing Mask , (b) People Wearing Mask , and (c) People Not Wearing a Mask Correctly

To detect the mask, it will be checked whether the nose and mouth of the face is closed or not. The detected nose and mouth indicate that the face is not wearing a mask figure 11(a). While the nose and mouth that are not detected indicate that the face is wearing a mask figure 11(b). When the nose is detected, and the mouth is not detected it means that the person is not wearing the mask properly figure 11(c).

Figure 12. The Result of The Image Capture Not Using a Mask

Results that are detected if the person is not wearing a mask and using the wrong mask will be captured and entered the computer file folder as shown in the image above. On the face that does not use a mask will be marked "Mask Off". Meanwhile, faces that do not use masks correctly are marked with "Wrong".

TESTING

Results

Result of Testing

The test is carried out as when someone wants to enter the place in public. Where the test uses one face first then with two faces with the following results.

Table 1. Positive and Negative Prediction

	Positive Prediction	**Negative Prediction**
Positive Class	True Positive (TP)	False Negative (FN)
Negative Class	False Positive (FP)	True Negative (TN)

True Positive if the program successfully detects using a mask if the person is indeed wearing a mask, while True Negative is when the program does not detect a mask if the person is not wearing a mask. False Positive if the program detects wearing a mask even though the person is not wearing a mask. While False Negative is if the program detects not wearing a mask even though the person is wearing a mask.

From the data obtained, there are 50 images using masks, 50 images not using masks, and 25 images not using masks correctly with 17 images not detection faces with the following result in Figure 13.

Figure 13. Video Data Used

Table 2. Result Positive and Negative Prediction

	Positive Prediction	**Negative Prediction**
Positive Class	31	6

Negative Class	11	60

Table 3. Result from the Test

Test	Data	Accuracy	Precision	Recall
Test 1	person using a mask	79%	69%	80%
Test 2	person not using a mask	79%	78%	86%
Test 3	More than 1 person using a mask	100%	100%	100%
Test 4	More than 1 person not using a mask	100%	100%	100%

The test is carried out with 4 types of data so that the results for testing accuracy, precision, and recall can be determined. From testing the 4 types of data, again the values of accuracy, precision, and recall are obtained. The average accuracy is 89,5%, the average precision is 86,7% with the highest precision 100%, and the recall average is 91,5% with the highest recall 100% as shown in Figure 14. The highest precision and recall are not necessarily 100% because some images are not detected by the face.

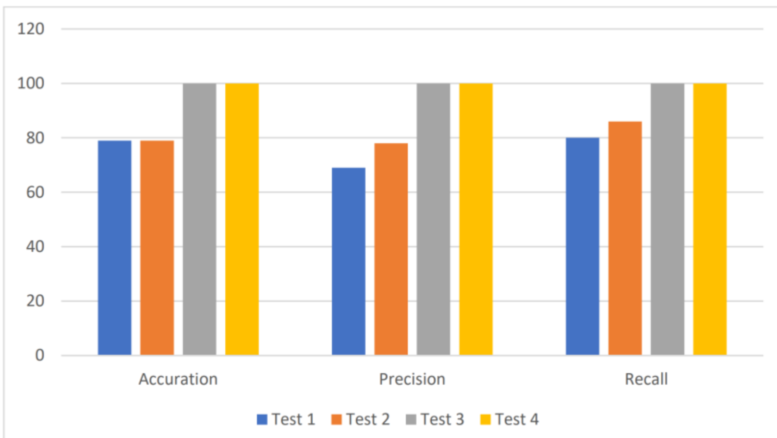

Figure 14. Chart Result for Accuration, Precision, and Recall

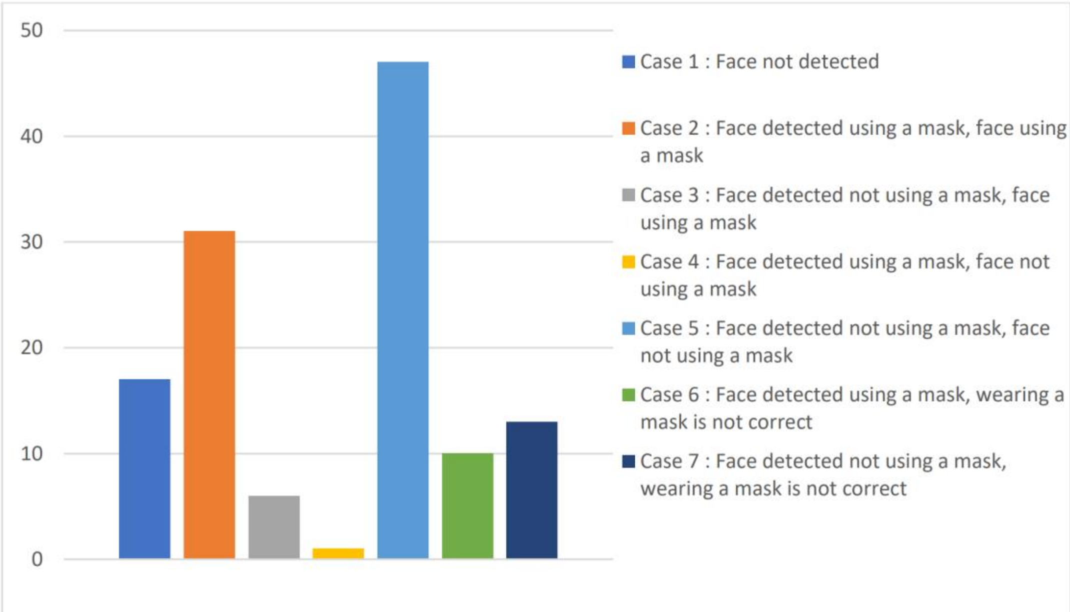

Figure 15. The Result of Test [15]

The test shown in figure 15 with 125 data, 7 cases were obtained. Case 1 with no face detected there are 17 data. Case 2 faces using masks and detected using masks there are 31 data. Case 3 faces using masks and not detected using masks, there are 6 data. Case 4 faces do not use masks but are detected using masks, there is 1 data. Case 5 faces do not use masks and are detected not using masks, there are 47 data. Case 6 faces do not use masks correctly but are detected using masks, there are 10 data. Case 7 faces do not use masks correctly and are detected not using masks, there are 13 data.

CONCLUSION

The conclusion of the mask detection results with a total of 125 data with an average success rate of 89,5% with 4 experimental scenarios. The average success rate was obtained due to several factors, namely the face is not clear, the lighting is not enough, the slanted face is not facing forward. The program can work well with the Haar Cascade Method in detecting a mask if the face is using a mask and with a good and clear image resolution.

If you want to detect masks for further research, to increase the success rate, you can search for more data with the front face and good lighting, you must ensure good image resolution, add as much data as possible, and be able to distinguish faces that use masks and do not use masks in one frame. The face that is detected is ensured to look forward and not tilted. Can also detect faces even if the face is not visible.

DAFTAR PUSTAKA

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