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Original Article

Design and Development of Mask Detectors in Effort to Prevent the Spread of Hepatitis Post-Covid-19 Pandemic using Viola-Jones Algorithm

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Abstract *- In the current New Normal Era, people are starting to be free to do activities outside the house, with the condition of wearing a mask to prevent the coronavirus. After the number of cases of the Covid-19 pandemic began to decline, the World Health Organization (WHO) received a report on April 5, 2022, from the United Kingdom regarding cases of acute hepatitis that began to spread in children and whose aetiology was unknown. The spread of the disease can be through the air, so everyone must wear a mask outside the house. Through the Ministry of Health, the Indonesian government reported that as of June 16, 2022, at 16.00, there were 28 suspected cases of severe acute hepatitis with unknown or mysterious causes for Indonesian children. This number increased by three cases from the June 9, 2022 report. Of the 28 cases, there were 13 probable and 15 pending classifications in classifying hepatitis. This research aims to design a mask detector that assists in monitoring health protocols by detecting the use of masks in public areas or office buildings so that they can continue to carry out everyday activities during the pandemic. The design of this mask detection tool uses the Viola-Jones Algorithm, where this method has four primary keys, namely the Haar feature, Integral Image, adaboost, and cascade classifier. Based on the test results, this mask detector can detect mask objects at a distance of 1 to 2 meters, with a limit of the number of people detected up to 3. Future research is expected to be able to develop a mask detection device using raspberry pi hardware to replace the arduino uno to better suit system needs and also add a sound system.*

Keywords *- Mask detection, Viola-Jones, Webcam, Arduino.*

1. Introduction

In this New Normal Era, people worldwide are starting to be free to do activities outside their houses, as well as the Indonesian people. The government makes a policy condition that requires the use of masks to be used by everyone when carrying out activities outside the house [1–3]. When engaging in activities outside the home, the government and officials working for Covid-19 (the Corona Virus Disease) consistently advise individuals to practise self-protection, maintain a safe distance, and use masks [4], [5]. In order to prevent the spread of Covid-19, it is necessary to design a mask detector as a reminder when not using a mask in office areas, shopping areas, hospitals and other public places [6, 7]. This can be seen from the low level of public awareness regarding the use of masks in public settings. Public obedience and understanding regarding preventing the spread of Covid-19 is still low. [8], [9]. The low public awareness of this health protocol will make it difficult for our country to escape the Covid-19 pandemic [10,11].

The Indonesian government takes policies in terms of studying, working, and worshipping carried out at home by implementing WFH (Work From Home) and large-scale social restrictions (P.S.B.B.), aiming to break the chain of transmission of Covid-19 in Indonesia [12,13]. On June 1, 2020, Indonesia officially enacted a new standard or adaptation of new habits with several terms and conditions, including wearing a mask when doing activities outside the house as a precaution against the coronavirus [14,15]. Studies show that wearing masks is essential in stopping the spread of Covid-19 because the coronavirus can quickly spread when humans do not wear masks [16, 17]. Therefore, people must practice physical distancing and masks in crowds to avoid spreading the Covid-19 virus [18,19].

After the number of cases of the Covid-19 pandemic began to decline, the world was again shocked by the outbreak of hepatitis cases in children. The World Health Organization (WHO) received a report on April 5, 2022, from the United Kingdom regarding a case of acute hepatitis of unknown etiology [20], laboratory tests have been carried out, and hepatitis virus types A, B, C, D, and E were not found as the cause of the disease [21, 22]. Active cases have also increased from 2,900 cases as of the end of May 2022 to 4,900 cases as of June 13, 2022, so it is in the spotlight in Indonesia regarding the ongoing Covid-19 and Hepatitis outbreaks.

Several public spaces, such as schools and children's playgrounds, do not apply health protocols, especially in using masks [23], [24]. Not using masks is a severe problem in tackling the spread of the Covid-19 virus and preventing hepatitis from entering Indonesia [8, 25, 26]. Masks are personal protection to cover the mouth and nose [27]. Masks can prevent the spread of the virus through the air and avoid splashing saliva (droplets); masks are also the first step to protect people from other airborne diseases [28]. These masks can be divided into 3 (three) types according to the Indonesian Ministry of Health, the first is an N95 mask, the second is a surgical mask, and the third is a cloth mask [20].

Spreads such as Covid-19 can occur when touching hands, droplets, talking to many people and not wearing a mask. Those things can cause a high spread of the virus [29]. Transmission of Covid-19 can be easily transmitted when in direct contact with sufferers [18]. Covid-19 is characterised primarily by respiratory disease, and the spectrum of infection with this virus ranges from mild non-respiratory symptoms to severe acute respiratory disease, sepsis with organ dysfunction, and mortality. Some infected individuals are reported to have no symptoms [30, 31]. The best way to prevent the spread is to break the chain of transmission of Covid-19, namely by sanitising hands, washing hands and using masks, and keeping a distance in activities [25]. While the spread of hepatitis is unknown, the symptoms that can occur are Nausea, Vomiting, Severe Diarrhea, and Fever [21].

As of April 21, 2022, 169 cases of acute hepatitis of unknown aetiology have been reported from 11 countries, namely the United Kingdom including Northern Ireland (114 cases), Spain (13 cases), Israel (12 cases), United States (9 cases), Denmark (6 cases), Ireland (<5 cases), Netherlands (4 cases), Italy (4 cases), Norway (2 cases), France (2 cases), Romania (1 case), and Belgium (1 case) [18], as well as in Indonesia, the Ministry of Health (Kemenkes) reported that until 16/6/2022 at 16.00 Western Indonesia Time (W.I.B.), there were 28 suspected cases of severe acute hepatitis with unknown or mysterious causes in Indonesian children. This number increased by three cases from the June 9, 2022 report. Of the 28 cases, there were 13 probable and 15 pending classifications in classifying hepatitis [32].

The spread and transmission can be reduced by wearing a mask. However, awareness of using masks in Indonesia is still shallow [8]. As a reminder to the public about the causes of disease transmission that spreads through the air, a mask detector is made as a reminder to use masks.

Based on the previous paragraph above, it can be concluded that the number of object detectors focused on the face (nose, eyes, and mouth), gesture recognition and facial recognition. In contrast to some of the studies mentioned above, in this study, object detection is focused on the use of masks and the method used is the Viola-Jones algorithm.

2. Literature Review

The mask detector is a renewal of the image detector; the image detector plays an essential role in the face recognition process used in manufacturing the mask detector design [33, 34]. Image recognition involves many variables, such as source images, image processing results, extracted images and required person profile data [35]. This mask detector uses esp[36]-Cam as an image capture, which will read whether the Image (mask) is detected. This mask detector also serves as a reminder when in public places or doing activities outside the house.

In previous studies, the design of the mask detector using the Haar Cascade method as a face reader or an image as an object detector [36–38]. The final results are Telegram notifications [19] and mask detectors as building entrance access rights [39],[40]; other studies make these mask detectors using the matlab application [1, 6, 19, 36, 37, 39, 41–44].

AdaBoost's weights determine the sequence in which the filters are applied, with the most weighted filter given priority. The Viola-Jones algorithm employs a stratified classification process to produce sub-images that are not considered faces. Through OpenCV, it is possible to determine the camera's movement and then guide the camera to monitor a room for any movement. This can make camera features more efficient because it only lights up when it detects a moving object and automatically performs the recording.

It also ensures that memory is not squandered on recording all the monitoring activities in a room [38]. An upright stance is the primary factor determining whether face detection using this method was successful. The accuracy of this method alone achieves a percentage of 90.9% [38].

Alsharekh[45], in his research titled "Facial Emotion Recognition in Verbal Communication Based on Deep Learning", the authors proposes an online evenness testing system for measuring a specific type of yarn defect called nep using imaging and computer vision techniques. Neps appear as entangled fibrous objects in yarn images, and detecting them could be considered an object detection problem in computer vision.

Bendjillali[46], the authors propose an efficient DL technique using a CNN model to classify emotions from facial images. The proposed algorithm is an improved network architecture developed to process aggregated expressions produced by theViola–Jones (V.J.) face detector.

3. Method

The Haar Cascade Classifier is a rectangular (square) feature that provides an image with a specific indication. Paul Viola and Michael John conceived the Haar cascade classifier, hence thViola & John method [33]. The goal of using a Haar-like feature is to recognise objects based not on the pixel values of the object's Image but rather on the fundamental value of the feature itself. This method has the benefit that the computation may be completed extremely quickly because it depends only on the number of pixels within a square rather than each pixel value within a picture [41]. This study uses the Viola-Jones algorithm as a method used to detect images, humans and vehicles [47]. Haar in detecting objects using statistical algorithms. This method applies sample haar-like features. This classifier will use images that are fixed in size (usually 24x24 in size). In detecting objects, Haar has a way of working, using a sliding window technique 24x24 on all images and looking for the presence or absence of parts in the Image shaped like objects.

The Haar method also can use scaling, which causes the detection of objects smaller or more significant than the Image in the classifier [48]. The use of the viola-jones algorithm as algorithm aims to analyse and find the right system to meet the objectives of this study [44, 49]. The Viola-jones algorithm uses Cascade Function to take pictures through the 4 (four) stages: (1) determine Haar features, (2) take Integral images, (3) Adaboost Training, and (4) perform Classification with Cascading Classifier [47]. The approach is associated with image processing and uses machine learning to investigate each object's unique qualities, particularly in interpreting facial objects that do and do not use masks [50]. Furthermore, the ultimate goal of this research is to produce an image processing system using image processing.

4. Result and Discussion

The Viola-Jones Algorithm this algorithm takes pictures through 4 (four) stages. First: (1) determine Haar features, (2) take Integral images, (3) Machine Learning Adaboost, and (4) perform Classification with Cascading Classifier. The initial step taken in the Viola-Jones face detection method is to read a sample image by changing RGB images to grayscale to make it easier to perform Haar features.

4.1. Determine Haar features

In the Viola-Jones method, the utilised characteristics are called Haar features. These features can also be referred to as square single-wave features (one high interval and one low interval), but in two dimensions, these features are referred to as one light and one dark. The existence of anything is calculated by deducting the average pixel count from the average pixel count in a predominantly light region.

Various types of Haar features with three types of features based on the number of rectangles contained in them. The features in sections (C) and (A) consist of two rectangles, section (E) consists of 4 rectangles, and sections (B) and (D) consist of three rectangles. Moreover, it changed to grey or black and white in Haar features for the first step of the Viola-jones algorithm.

To obtain different conditions of brightness level, all images must be in the form of an average value normalised from the previous variations. These images have a lower variation value, so that little information will be discarded from the assessment. As seen in Figure 3. Haar feature, the background in the template (A) is greyed towards the lighter part of the colour.

From the application of the Rectangular Haar features, the technique used is dividing each area in the Image from the top left to the bottom right. This process is done to determine if facial features are in the area. For the application in this study, it works when the rectangular passes through the specified Image and when it passes through the mouth area. It is expected that from the features taken, there is the information needed as facial characters and facial images can be detected by the Haar features naturally. Therefore, however, several crucial things cause this haar feature set to be sequential.

4.2. Take Integral Image

An integral Image is a type of Image in which the value of each pixel is equal to the sum of the values of the pixels in the Image, moving from the top left to the bottom right. Integral Image makes it possible to perform pixel calculations efficiently at low cost, a calculation based on the total number of pixels contained in the haar feature window constraint; the mirroring technique is used for cumulative function distribution. The Integral Image example determines the presence or absence of hundreds of haar features in an image. Rectangular features can be computed very quickly using the integral representation of the Image.

It is possible to determine the pixel values for several other rectangles using an integral image. This can be done, for instance, by combining the number of pixels in the area to select specific features to be used and to set the threshold value. Viola and Jones did this by using a machine-learning method known as AdaBoost. In order to produce a robust classifier, AdaBoost combines the results of several less effective classifiers. "Weak" in this context refers to the fact that the filter order in the classifier only generates a smaller number of valid answers.

In a general sense, the integration brings together several separate parts. In this instance, the little units being discussed are pixel values. The sum of all the individual pixels, working from the top down, constitutes the integral value of each pixel. The entirety of the Image can be totalled using several integer operations per pixel by moving from the top left to the bottom right and starting there. Then, a machine learning technique known as AdaBoost is utilised to choose the particular Haar feature used and determine the threshold value.

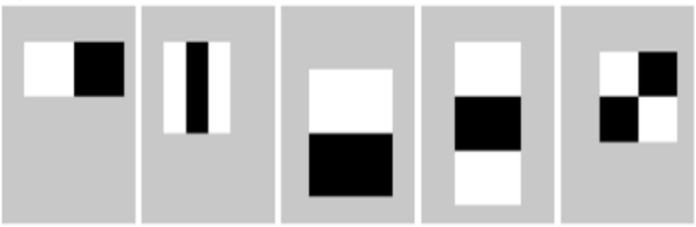
4.3. Machine Learning Adaboost

AdaBoost can produce a robust classifier by combining many less effective classifiers. Merging multiple AdaBoost classifiers into a single sequence of filters makes categorising image regions efficiently and accurately possible. Each filter has its own AdaBoost classifier, and each classifier is either weak or Haar. While filtering the Image, if one of the filters cannot pass a particular image region, that region is immediately labelled as a non-face region. However, when the filter passes through an image area and passes through all the filter processes in the filter circuit, the image area is classified as a face. It can also be interpreted as shown in Figure 5.

Where it has the original data set with symbols minus (-) and (+) to be the initial classification in finding the smallest possible error by using the two classes and taking the line where there is a minor error by being marked with a circle in each class, then the original data set is updated, and the initial error in the original data set in the next update is added to the weight by making it bold as pictured above, repeated continuously until there are no errors in each class or part of it. To increase accuracy in classifying objects.

(a) **(b)**

Fig. 1 Example conversion image (a) original in RGB format (b) Conversion results in greyscale format



(a) (b) (c) (d) (e)

Fig. 2 Rectangular Haar features

Fig. 3 Rectangular Haar features implementation

3	7	7	3
1	3	3	1
5	9	9	5
3	6	6	3

Fig. 4 Integral image

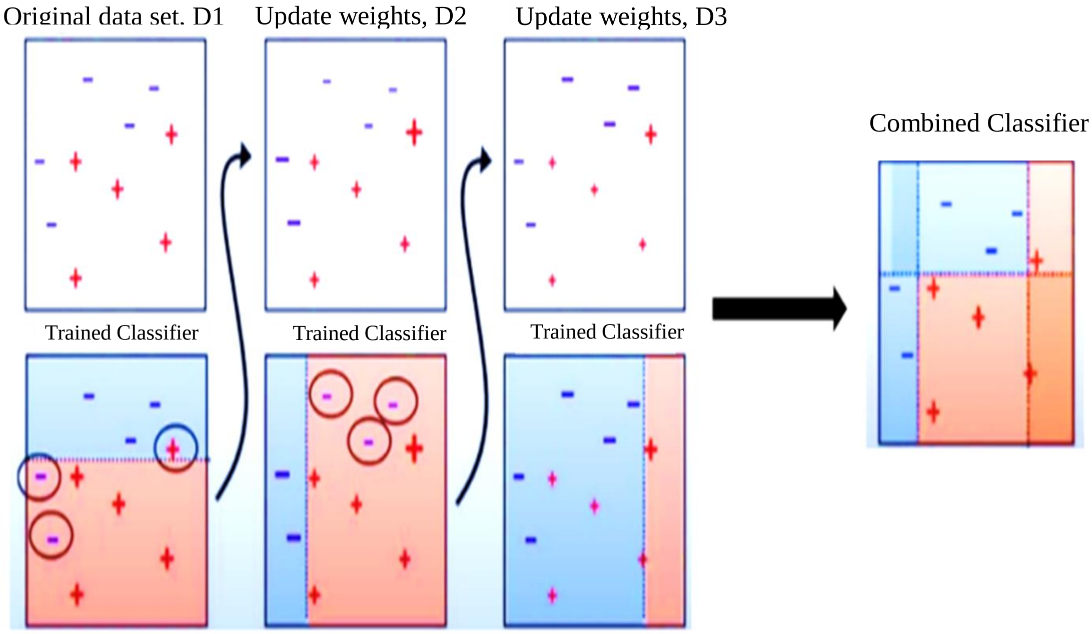


Fig. 5 Machine Learning Adaboost

4.4. Cascading Classifier

The cascade constitutes the subsequent stage. The weights that are given to AdaBoost are what decide the sequence in which the filters in the cascade are applied. The filter with the most weight is given priority in the first step of the process, and the goal is to eliminate the parts of the Image that are not faced as quickly as possible. The Viola-Jones algorithm is distinguished by the presence of a stratified classification, which is a defining feature of the algorithm. This algorithm employs a categorisation process that is comprised of three levels, each of which results in the production of a sub-image that is not thought to be a face. This is done because determining if a sub-image contains a face is more complex than determining whether or not it contains a sub-image that is believed not to be a face. Figure 6 illustrates the workflow form of the stratified classification.

Each sub-image will be categorised at the first level using a single characteristic. For photos that match specific Haar features, the outcomes of this first classification are (True); otherwise, they are (False). About half of the sub-images will still need to be categorised in the second stage as a result of this categorisation. The second classification yields the results (True) for images that adhere to the necessary image process and (False) for those that do not. More precise requirements are required to employ more features as the classification level rises.

There will be just about 2% of sub-images left after classification. When images comply with the AdaBoost procedure, the classification results are (True); otherwise, they are (False).

4.5. Mask Detector Design Schematic

Hardware system design aims to see the functions performed by the system, such as the workings of the sensors and applications used. A series of interfaces using an external webcam for processing image capture, then sending a signal to the buzzer. The workings of the mask detector design tool as shown in Figure 2 above, by taking the mask object on the face using a webcam and processing it on Arduino, the process that occurs as a mask object classification is a requirement to enter the room, after being detected or not, the mask will proceed to the buzzer as a result of the notification process. The design of this mask detector allows the system to carry out the facial recognition process using medical masks, non-medical masks, the wrong mask position, and not wearing a mask. The system can also identify the feasibility of wearing masks based on the face mask recognition class classification.

4.6. Implementation and Testing

The analysis results are implemented in a real environment in the implementation phase. Implementing this tool starts with designing hardware such as Arduino to store and run programs, a webcam to take pictures of objects and a buzzer that will sound as a warning when someone is not wearing a mask as shown in the Figure 8. The mask detector interface circuit in Figure 8(a) is the result of a series of tools used in making the mask detector, including a webcam as an image capture, an Arduino as a tool for program code processing, and a buzzer as an output in the form of sound. Furthermore, it is implemented with a 3d printing box, as shown in Figure 8(b), which shows the entire device or tool after it is fully implemented using a 2.1-meter high tripod that can be adjusted in height.

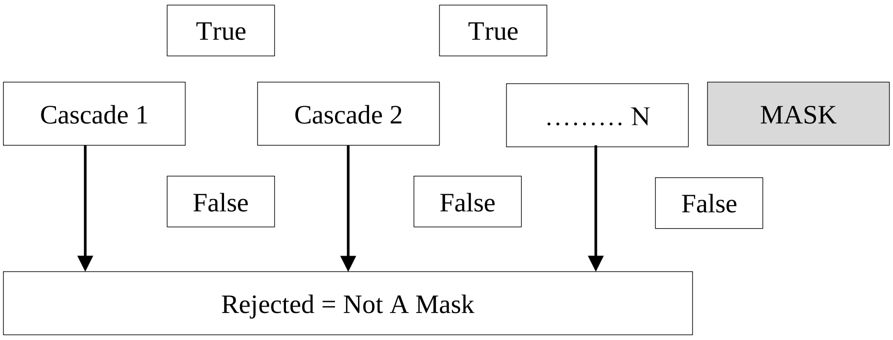


Fig. 6 Cascading classifier

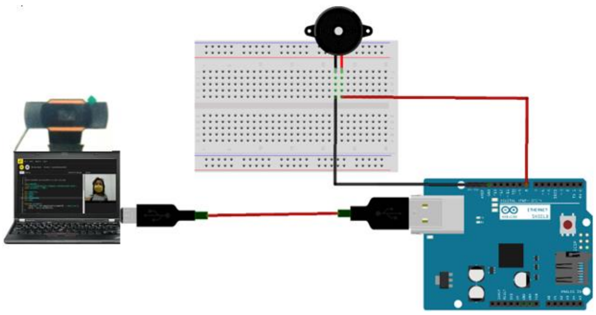
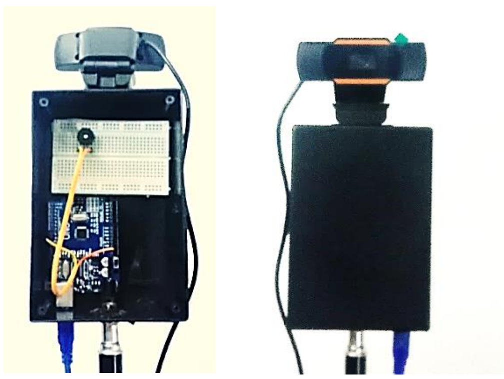


Fig. 7 Mask detector design



(a) (b)

Fig. 8 Peripheral mask detector (a) Circuit design (b) Display interface

Testing after implementation for the tool. In the next stage, testing of the tool is carried out. In this test there are two types of testing where the first type includes testing in terms of age, the distance between humans and tools, and how many people. The second testing stage is testing masks, such as colour, position, and masks with face images. It can be seen from the table below, which shows the first stage of testing. The tests in the tables above are carried out at the Cascading Classifier stage; the Cascading Classifier functions to classify an object as a mask. After testing, it can be seen in Table 1 Mask detector testing at multiple ages, getting results in the form of a tool that can detect objects in the form of masks and can detect them from various age ranges because when doing data training using a collection of images of faces that are wearing masks which makes the mask the object of the criteria for detecting. Table. 2 Mask detector testing at a distance gets the maximum distance of only 1 to 2 meters. If a distance of more than 2 meters will not work correctly because the intensity of the light obtained can influence the results of the mask detector, the more light intensity and the appropriate distance, the better in classifying objects. From Table. 3 Mask detector testing of the number of people gets results, the mask detector can detect as many as three people as listed in Table 3, the same as Table 2 the test can be influenced by the intensity of the light obtained, as well as from the distance and colour of the mask. It is also a requirement to carry out the results from Table 3. The testing occupied reach in two conditions, like detected or not.

The examples of results from testing Table 1, Table 2, and Table 3 as shown below. Figure. 9 above performs the test by covering Table 1, Table 2, and Table 3. The result can be seen in Figure 9. With the number of people at the time of doing this detection three people, the distance tested is 1 meter and includes all ages. This detection can run properly, getting the indicator number 1 in the Image above, which indicates that the tests carried out are as shown in the test table below.

Table 1. Mask detectors testing at various age

Age	Detected	Not
4-9	Detected	
11-20	Detected	
21-50	Detected	
52-56	Detected	

Table 2. Mask detectors testing at a distance

Distance (m)	Detected	Not
1 m	Detected	
2 m	Detected	
3 m		Not
4 m		Not

Table 3. Mask detector testing based

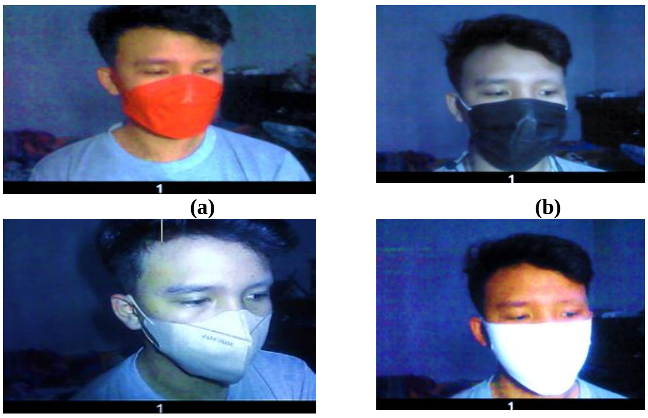
Number of people	Detected	Not
1	Detected	
2	Detected	
3	Detected	
> **4**		Not

Fig. 9 Results from the table test

The second testing stage includes testing masks such as colour, the position of the mask, masks with face image, and testing when the face is covered. This test is to test the results of the stages of the Viola-Jones Cascading Classifier algorithm. It is testing to detect an error in the mask detector against the colour of the mask image and testing to detect errors in using a mask detector. Colour testing serves to test from the results of the Cascading Classifier whether it can detect masks with different colours, as shown below.

Tests were carried out on Figure 10(a), Figure 10(d) white, and Figure 10(b) black, according to the test results Figure 10. c brown tends to be unstable in classifying because brown is the same colour as the skin colour, making the brown mask unstable in the classification results, while testing for red, white, and black is relatively stable in detecting masks because these colours are more dominant than the colour of the skin itself so that it can be detected up to a maximum distance of 2 meters from the mask detector tool. Testing of Mask Detectors in Detecting errors, in addition to colours that can affect the classification of mask detectors, testing of masks with face images and the position of the mask can also be an error in classifying, as shown in figure 10.

The results that contain errors can be seen in Figure. 11(a), Figure 11(b), and Figure 11(c), where the results of the test using a mask with a face image will be detected like not using a mask because there are images of the face (nose and mouth) making Figure 11(a) detected an error. In the test in Figure 11(b), there is an error in the position of the use of the mask, although in Figure 11(b) it uses a brightly coloured mask, the tool can detect the presence of parts of the face (nose and mouth) which makes the mask detector detect an error. In the test Figure 11(c), the man covered the face area with his hands. However, the palms of the hands cover the nose and mouth areas, the tool can detect the absence of the use of masks because, at the *Cascading Classifier* stage, which is when doing training data in addition to using a data set in the form of a collection of images of people using masks, data sets of faces that do not use masks are entered during data training or the *Machine Learning Adaboost* stage. What makes the mask detector can distinguish between people who wear masks and those who do not.



(a) **(b)** **(c)** **(d)**

Fig. 10 Image error in classification when detecting the mask coloured (a) Red mask (b) Black mask (c) Brown mask (d) White mask

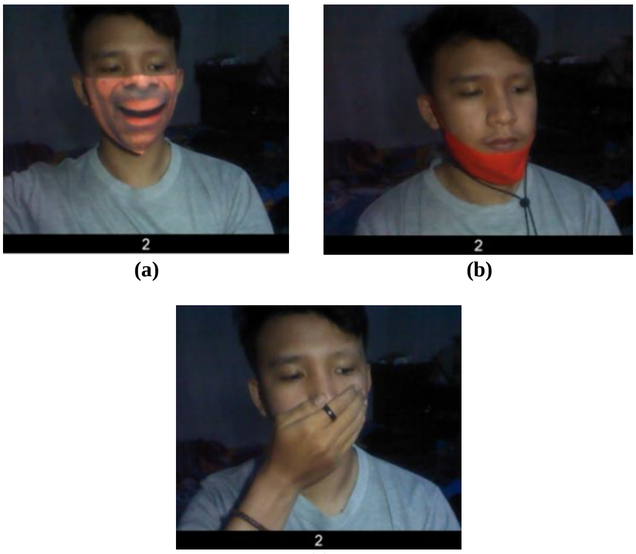


Fig. 11 (a) Error detecting mask with face image (b) Error detecting from the position of the mask (c) Error in detecting by covering the face area

5. Conclusion

This study aims to assist in supervising one of the health protocols, that is, the use of masks in public places, such as in offices, shopping places, and places of worship, so that they can still carry out everyday activities during the pandemic. This research was conducted in a crowded environment, especially in the area near the entrance. Based on the results of the research that has been done, the conclusions are to answer the formulation of the research problem. The program can detect masks at a distance of 1 to 2 meters with up to 3 people at once in detecting this mask object. It can detect errors in the mask position and detect if someone is using a mask with a face image or by covering the face area with their hands, this detector mask can detect it relatively stable. From the research that has been done, suggestions for developing the program in the future. Using a Rasbarry Pi microcontroller is recommended for other object detection, and can add a sound sensor to detect masks by adding a mini df player device. As for suggestions in taking pictures of mask objects to be more accurate, by doing more in training images, using images that vary in terms of colour, distance, position, and light from each Image to be trained to make the resulting data more accurate.

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