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Implementation of the Internet of Things to Help Public Awareness of the Importance of Using Masks

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Abstract

Coronavirusi deasease 2019 or abbreviated as COVID-19 is an infectious disease that spreads very quickly. COVID-19 is caused by a new type of virus, namely Sars-CoV-2. In the situation of the increasingly widespread COVID-19 virus, many technology-based studies have examined an application to detect mask users to help raise public awareness of the importance of using masks to protect themselves or others. In this study, a prototype windows-based application called mask detector will be developed using the internet of things as an alarm medium, with the python programming language being used for programming languages. In the development of the mask detector prototype, the reference was taken from previous research that used the haar cascade classifier method but had a maximum detection distance of 180 cm. In this study, the main focus is the implementation of a mask detector application prototype that can be used at a distance of more than 180 cm from the user using the deep neural network method. By using the deep neural network method which is accompanied by the implementation of the internet of things, it is hoped that it can become literacy material and can improve some previous research.

Keywords
COVID-19; implementation; internet of things

I. Introduction

Coronavirusi deasease 2019 or abbreviated as COVID-19 is an infectious disease that spreads very quickly. COVID-19 is caused by a new type of virus, namely Sars-CoV-2. In conditions where a virus can spread easily and a cure has not been found, one of the things that can help minimize the spread of the virus in the community is to implement a policy of mandatory wearing of masks for every individual in the community. This policy has been implemented almost all over the world (universal masking), one of which is to use cloth masks for the general public (Atmojo et al., 2020).

In conditions where a virus can spread easily and a cure has not been found, one of the things that can help minimize the spread of the virus in the community is to implement a policy of mandatory wearing of masks for every individual in the community. This policy has been implemented almost all over the world (universal masking), one of which is to use cloth masks for the general public (Atmojo et al., 2020).

In the situation of the increasingly widespread COVID-19 virus, there are many technology-based studies that examine an application to detect mask users to help raise public awareness of the importance of using masks to protect themselves or others because according to data from January to March 2021, 17,157 people have been prosecuted for noncompliance use a mask when doing activities and this is only in the North Jakarta area (Sembiring, 2021)

In developing applications similar to mask detector, there are many methods that can be used, one of which is the haar cascade classifier, an object detection method created by Pauli Viola and Michael Jones. In 2001, they published a paper called "rapid object detection using a boosted cascade of simple". The result of this research is that an application can detect the use of masks from images from photos or videos, with the highest accuracy being 88.7% and the lowest being 44.9%. Warning features in the form of audio and photographing can also work well (Anarki et al., 2021). However, the use of this method is only effective at a maximum distance of 180 cm, from these results it can be concluded that the use of this method will be very difficult to implement in detecting crowds in crowds, where the detection distance sometimes varies. In this case, a windows-based application prototype will be developed called mask detector. By using the deep neural network method accompanied by the implementation of the internet of things, it is hoped that it can become literacy material and can improve some previous research.

II. Research Methods

Method is a systematic method or process used to carry out an activity so that the desired goal can be achieved Pandiangan (2015). In other words, the method serves as a tool to achieve a goal, or how to do or make something (Octiva et al., 2018). According to Pandiangan et al. (2021), a method is used as a reference for activities because in it there is an orderly sequence of steps so that the process of achieving goals becomes more efficient. In relation to scientific efforts, the method is a way of working to be able to understand the object that is the target of the science concerned (Pandia et al., 2018). The implementation method is a method that describes the mastery of systematic work completion from start to finish covering the main work stages and job descriptions of each type of main work activity that can be technically accounted for (Octiva et al., 2021). In compiling the implementation method, it should be in accordance with the requirements in the document where the method of carrying out the work made must meet the substantive requirements specified in the selection document and describe mastery in completing the work (Octiva, 2018; Pandiangan, 2018; Asyraini et al., 2022). Stages of work from beginning to end in outline and job descriptions of each main type of work, namely the suitability of work methods (Pandiangan et al., 2018). The main equipment offered in the execution of work and the suitability of work methods with the required job specifications (Tobing et al., 2018; Pandiangan, 2022; Pandiangan et al., 2022).

2.1 System Creation

a. Dataset Preparation

Two types of photos of faces wearing masks and those not obtained, this data was obtained from internet media. These two types of photos are created in separate folders with specified labels.

b. Training and Dataset Validation

In conducting training and dataset validation, python will use the help of a deep neural network method, for the following stages:

1. Preparing Global Variables

Global variables are variables that can be accessed whenever needed, the variable to be determined is the value of:

- Learning Rate

Is a parameter in the training data to calculate the weight correction value during the training process (Fitri, 2018). The greater the learning rate, the greater the range for determining weight changes in the neural network and affects the proximity of features to other classes. When the learning rate is small, the weight change is smaller and the pattern's proximity to other classes from the initial target is also getting further away.

- Epoch

It is a hyperparameter that determines how many learning algorithms will work to process the entire training dataset (Fitri, 2018).

- Batch Size

Is the number of groups of data samples. Example: if we have 100 datasets and our batch size is 5 then the dataset will be divided into 5 parts and in each section there are 20 datasets (Nugroho et al., 2020).

For the number of variable values as shown in the following pseudocode:

```
INIT_LR = 1e-4
EPOCHS = 20
BS = 32
```

2. Dataset Partition

The intended partition has the capacity of the dataset which will be divided into 2, namely 80% of the dataset is used for training data and the rest is used for testing, as shown in the following pseudocode:

```
(trainX, testX, trainY, testY) = train_test_split(data, labels,test_size=0.20,
stratify=labels, random_state=42)
```

3. Data Augmentation

Data Augmentation is a technique of manipulating data without losing the essence or essence of the data. For data in the form of images, we can rotate, flip, crop, etc.

4. Creating a Deep Neural Network Structure

In implementing the Deep Neural Network, it is explained that it has 2 hidden layers which are described in the following pseudocode:

```
baseModel = MobileNetV2(weights="imagenet",
include_top=False,input_tensor=Input(shape=(224, 224, 3)))
headModel = baseModel.output
headModel = AveragePooling2D(pool_size=(7, 7))(headModel)
headModel = Flatten(name="flatten")(headModel)
headModel = Dense(128, activation="relu")(headModel)
headModel = Dropout(0.5)(headModel)
headModel=Dense(2,activation="softmax")(headModel)
model=Model(inputs=baseModel.input,outputs=headModel)
```

From the pseudocode above, it is explained that for input using an image with a size of 224 x 224 pixels and produces 2 outputs, namely with mask and without mask.

c. System Implementation

1. Write a Prototype Mask Detector Line of Code

There are various kinds of libraries needed, the libraries are as shown in the following pseudocode:

```
from tensorflow.cepat.applications.mobilenet_v2 import preprocess_input
from tensorflow.cepat.preprocessing.image import img_to_array
from tensorflow.cepat.models import load_model
from cuteils.video import VideoStream
import numpy as np
import argparse
import cuteils
import time
import cv2
import os
import urllib.request
```

2. Importing the ESP8266 Library

In the import of this library it has been documented on the link "https://github.com/esp8266/Arduino", explained before installing the library the first step to do is to set the preferences in File>Preferences>Additional Boards Manager URLs and fill it with " https://arduino.esp8266.com/stable/package_ esp8266com_index.json“.

3. Creating One Wi-Fi Network

At this stage the wifi network uses the hotspot feature of the smartphone.

4. Write a line of code for the Nodemcu Board Board

For the first line as shown in the following pseudocode:

```
#include <ESP8266WiFi.h>
#define BUZZER D7
const char* ssid = "Redmi";
const char* password = "kepoluya";
unsigned char status_buzzer=0;
WiFiServer server(80);
```

III. Discussion

3.1 Level of Accuracy and Loss in Conducting Training and Validation

Figure 1 shows that from 20 epochs, a high level of accuracy is obtained above 0.9, both in training and validation.

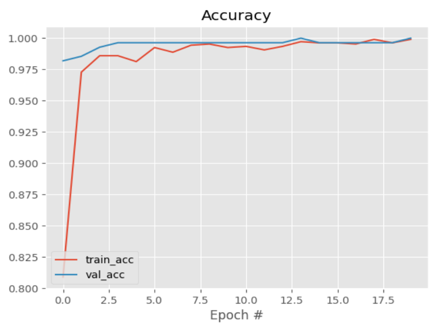

Figure 1. *Level of Accuracy*

In Figure 2, it is explained that from 20 epochs, a low failure rate is below 0.1, both in training and validation.

Figure 2. *Failure Rate*

3.2 Test Scenarios on Deep Neural Network, Viola-Jones and Convolutional Neural Network Methods

In this test, a table consisting of 5 columns will be generated, namely s (test scenario), ss (sub test scenario), r1 (average of 3 tests for each sub-test scenario), r2 (average of each sub-test scenario).), successful (if 1 means the detection is correct, and 0 means it is wrong), and j (the number of detections is correct). All numbers in the time column are the time it takes for the system to detect the use of masks, if anything that says "-" means the system does not detect the use of masks. Here are the results of the test scenarios for each method:

3.3 Deep Neural Network

Table 1. Deep Neural Network Test Scenario

s	ss	time (s)			r1(s)	r2(s)	succeed			j
s1	ss1	-	-	-	-	1.3	1	1	1	3
	ss2	1.3	1.5	2.1	1.6		1	1	1	3
	ss3	2.0	1.8	2.1	2.0		1	1	1	3
	ss4	2.1	1.7	1.5	1.7		1	1	1	3
s2	ss1	-	-	-	-	1.2	1	1	1	3
	ss2	2.1	1.2	2.1	1.8		1	1	1	3
	ss3	1.5	1.0	1.5	1.3		1	1	1	3
	ss4	2.2	1.5	1.8	1.9		1	1	1	3
s3	ss1	-	-	-	-	0.9	1	1	1	3
	ss2	1.2	0.7	0.5	0.8		1	1	1	3
	ss3	2.0	1.5	0.6	1.4		1	1	1	3
	ss4	0.6	1.8	1.4	1.3		1	1	1	3
s4	ss1	-	-	-	-	1.2	1	1	1	3
	ss2	0.7	1.0	0.8	0.8		1	1	1	3
	ss3	2.3	2.5	1.2	2.0		1	1	1	3
	ss4	2.3	2.4	1.1	1.9		1	1	1	3
s5	ss1	-	-	-	-	1.1	1	1	1	3
	ss2	1.2	1.3	1.8	1.5		1	1	1	3

	ss3	2.0	1.8	0.5	1.4		1	1	1	3
	ss4	1.4	2.1	0.8	1.5		1	1	1	3
s6	ss1	-	-	-	-	1.2	1	1	1	3
	ss2	0.6	1.8	1.6	1.3		1	1	1	3
	ss3	2.0	1.1	2.4	1.8		1	1	1	3
	ss4	2.3	2.2	0.5	1.7		1	1	1	3
Average (second)=						1.2	Accuracy (%)=	100	Total=	72

3.4 Viola-Jones

Table 2. Viola-Jones Test Scenario

s	ss	time (s)			r1(s)	r2(s)	succeed			j
s1	ss1	-	-	-	-	1.1	1	1	1	3
	ss2	1.6	0.7	1.1	1.1		1	1	1	3
	ss3	1.3	0.9	1.4	1.2		1	1	1	3
	ss4	2.1	2.5	1.7	2.1		1	1	1	3
s2	ss1	-	-	-	-	0.1	1	1	1	3
	ss2	-	-	0.7	0.2		0	0	1	1
	ss3	-	0.7	-	0.2		0	1	0	1
	ss4	-	-	-	-		0	0	0	0
s3	ss1	-	-	-	-	1.1	1	1	1	3
	ss2	0.7	2.4	1.5	1.5		1	1	1	3
	ss3	2.3	0.8	0.7	1.3		1	1	1	3
	ss4	2.1	1.0	1.6	1.6		1	1	1	3
s4	ss1	-	-	-	-	0.7	1	1	1	3
	ss2	1.1	0.8	-	0.6		1	1	0	2
	ss3	1.6	-	1.3	1.0		1	0	1	2
	ss4	1.0	2.1	-	1.0		1	1	1	3
s5	ss1	-	-	-	-	-	1	1	1	3
	ss2	-	-	-	-		0	0	0	0
	ss3	-	-	-	-		0	0	0	0
	ss4	-	-	-	-		0	0	0	0
s6	ss1	-	-	-	-	-	1	1	1	3
	ss2	-	-	-	-		0	0	0	0
	ss3	-	-	-	-		0	0	0	0
	ss4	-	-	-	-		0	0	0	0
Average (second)=						0.5	Accuracy (%)=	63	Total=	45

3.5 Convolutional Neural Network

Table 3. Convolutional Neural Network Test Scenario

s	ss	time (s)			r1(s)	r2(s)	succeed			j
s1	ss1	-	-	-	-	0.9	1	1	1	3
	ss2	-	2.1	2.2	1.5		0	1	1	2

	ss3	1.7	-	-	0.6		1	0	0	1
	ss4	-	2.4	2.0	1.5		0	1	1	2
s2	ss1	-	-	-	-	0.7	1	1	1	3
	ss2	2.0	-	1.8	1.3		1	0	1	2
	ss3	-	1.7	0.7	0.8		0	1	1	2
	ss4	1.8	-	-	0.6		1	0	0	1
s3	ss1	-	-	-	-	0.3	1	1	1	3
	ss2	-	1.6	-	0.5		0	1	0	1
	ss3	1.0	-	0.9	0.6		1	0	1	2
	ss4	-	-	0.6	0.2		0	0	1	1
s4	ss1	-	-	-	-	0.6	1	1	1	3
	ss2	2.3	1.1	-	1.1		1	1	0	2
	ss3	-	1.0	-	0.3		0	1	0	1
	ss4	1.5	-	1.4	1.0		1	0	2	3
s5	ss1	-	-	-	-	2.3	1	1	1	3
	ss2	-	3.9	6.8	3.6		0	1	1	2
	ss3	-	6.7	-	2.2		0	1	0	1
	ss4	4.3	-	6.2	3.5		1	0	1	2
s6	ss1	-	-	-	-	1.0	1	1	1	3
	ss2	-	5.1	-	1.7		0	1	0	1
	ss3	-	-	3.7	1.2		0	0	1	1
	ss4	-	3.1	-	1.0		0	1	0	1
Average (second)=						1.0	Accuracy (%)=	64	Total=	46

From the test scenario data in each table, it can be concluded for the speed of detection that by using the deep neural network method the detection is more successful, and vice versa by using the viola-jones method the detection of the use of many masks fails, especially when the test has motion and cannot detect target at a distance of 3 meters. As for the accuracy of the deep neural network, it has an accuracy rate of 100%, Convolutional neural network as much as 64%, and viola-jones as much as 63%.

3.6 Recall, Precision, and Accuracy on Deep Neural Network, Viola-Jones, and Convolutional Neural Network Methods

Deep Neural Network
Known:
TP=54, TN=18, FP=0, FN=0
From the above calculation, it can be seen that the recall, precision, and accuracy values of the deep neural network method are all 100%.

Viola-Jones
Known:
TP=27, TN=18, FP=0, FN=27
From the above calculation, it can be seen using the viola-jones method for the recall value of 50%, precision of 100%, and accuracy of 61%.

Convolutional Neural Network
Known:
TP=27, TN=18, FP=0, FN=26

From the above calculation, it can be seen using the convolutional neural network method for the recall value of 50%, precision of 100%, and accuracy of 60%.

3.7 Test Case Scenario Prototype Mask Detector

From the test results, the results are shown in Table 4.

Table 4. Test Case Scenario Prototype Mask Detector

Test Case	Pre-condition	Expented Result	Real Result
Alarm sound	The application detects the user is not wearing a mask	Alarm sounds	True
	The application detects the user using a mask	Alarm does not sound	True
Face detection and masks	There is no user in front of the camera	Not detecting face	True
	1 user in front of the camera	Detect 1 face	True
	2 or more users in front of the camera	Detect 2 or more faces	True
	There is a picture or pattern in the form of a face in front of the camera	Not detecting face	False
	Mask covers nose and mouth	The application detects the use of masks from the user and the alarm does not sound	True
	The mask does not cover the nose and mouth	The application does not detect the user using a mask and the alarm sounds	True
	The mask covers the nose but doesn't cover the mouth	The application detects the use of the wrong mask and the alarm sounds	False
	The mask covers the mouth but does not cover the nose	The application detects the use of the wrong mask and the alarm sounds	True
	The user wears a skin-colored mask and covers the nose and mouth	The application detects the use of masks from	True

		the user and the alarm does not sound	
	The user wears a mask with a character image and covers his nose and mouth	The application detects the use of masks from the user and the alarm does not sound	True
	The user wears a colored mask and covers the nose and mouth	The application detects the use of masks from the user and the alarm does not sound	True

IV. Conclusion

From the results of research conducted for the development of a mask detector prototype, the following conclusions can be drawn:

1. In pairing the prototype mask detector with the internet of things that uses a wireless network as a connecting medium, this can function properly. This can be proven through a series of tests in the prototype mask detector test case scenario that all case scenarios related to the pairing of the mask detector prototype and the internet of things in the form of alarm calls were all successful without any failures.
2. The application of the deep neural network method on the mask detector prototype at the training and dataset validation stages using 20 epochs, has a high level of accuracy, which is above 0.9 and has a low failure value, which is below 0.1.
3. The results of the comparative evaluation of 3 methods, namely deep neural network, viola-jones, and convolutional neural network, have the result that the deep neural network method has a higher value in 2 types of tests, namely test scenarios and measurements of recall, precision, and accuracy. In the test scenario, the deep neural network method has an accuracy rate of 100% even though the average mask detection speed is 1.2 seconds which is the lowest rank under the convolutional neural network method which is 1 second and viola-jones is 0.5 seconds, although the detection speed is the slowest among other methods, but the deep neural network method can detect the use of masks in all given test scenarios. In measuring recall, precision, and accuracy in these three methods the deep neural network gets a 100% level of recall, precision, and accuracy, the viola-jones method has a recall value of 50%, precision is 100%, and accuracy is 61%, and convolutional neural network has a recall value of 50%, precision of 100%, and accuracy of 60%.

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