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Mask Detection Using Framework Tensorflow and Pre-Trained CNN Model Based on Raspberry Pi

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ABSTRACT

The use of masks is one of the health protocols for the community in public places and facilities in the context of preventing and controlling Covid-19. The covid-19 pandemic around the world has encouraged decision makers and various elements of society to take part in various fields and contribute to suppressing the spread of covid-19. Machine learning and computer vision are one of the branches of Artificial Intelligence (AI) and can be developed in various image recognition. In this study, a machine learning Application Program Interface (API) was used, namely Tensorflow and the pre-trained CNN model, and the Raspberry Pi, which is a mobile device as a system for detecting masks. The analysis was conducted to determine the accuracy, precision and recall (sensitivity) of the results of system implementation. The implementation results show that the use of transfer learning and fine-tuning is sufficient to help the model training process. When the model is run on the Raspberry Pi device, an accuracy percentage of 96% is produced on testing with image file input and 91% on testing with video input (realtime), 100% precision on testing with image file input and 80% on testing with video input (realtime)). In the true positive rate (recall) performance, it was found 92% on tests with image file input and 100% on tests with video input (realtime). However, in this study, there are still type I errors in testing with video input (realtime) and type II errors in testing with image file input. In the future, it is hoped that there will be improvements and developments from this research by improving the quality of the dataset and using higher computational resources.

1. Introduction

The World Health Organization (WHO), on March 11, 2020, declared Covid-19 a global pandemic following the 1918 Spanish flu (H1N1), 1957 Asian flu (H2N2), Hong Kong flu (H3N2) 1968, and the 2009 flu pandemic (H1N1), respectively. - Each of which caused around 50 million, 1.5 million, 1 million, and 300,000 human deaths [1] the WHO report states that data collected from around the world on July 5, 2020, amounted to 11,125,245 people positive for COVID- 19, on the same date, Indonesia recorded a number of 62,142 people who were positively exposed to COVID-19 [2]. Among the efforts of the Government of the Republic of Indonesia in reducing the number of Covid-19 transmissions is to enforce new normal or new normal habits. This is a health protocol that must be used by the public in their daily activities during the Covid-19 pandemic. The new normal habit requires people to always maintain a safe distance of 1-2 meters (social distancing), always wash their hands after activities, and always wear a mask [3].

The recommendation for the use of masks in the context of the Covid-19 pandemic has been regulated in a guide to the use of masks for decision-makers, health workers, and/or health service managers, published by WHO. According to WHO, masks/face covers function as a means of protecting the respiratory process with how to protect the entry or exit of air (mouth and nose) from exposure to objects that transmit disease through the respiratory tract, in this case including COVID-19, the same thing is also stated in a decision issued by the Indonesian Ministry of Health [4]. WHO divides the types of masks into two (2) categories based on predetermined standards, namely medical and non-medical masks, both of which have a minimum standard of filtration efficiency, both of which also have different priorities in terms of their use by looking at the needs of the wearer according to the conditions in which the location is located. And the user environmental situation is [5].

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The use of masks during the Covid-19 pandemic has become a necessity for every individual, especially in certain places, where these places or locations are designated as zones with high cases of transmission or in low transmission zones but as an early preventive measure, this is also supported by many implementations of policies that are appealing and imposing sanctions for violators of the mandatory wearing masks. The implementation of the mandatory masked regulations, in the end, also creates new problems, in which the stakeholders making the rules must ensure that the rules are applied properly in the field. The COVID-19 pandemic around the world has encouraged decision-makers and various elements of society to take part in various contributions to reduce the spread of COVID-19 and other accompanying impacts, including in the fields of computer vision and machine learning technology. Computer vision and machine learning have the primary objective of making useful decisions about real physical objects and scenes based on images obtained from sensors. This field is included in the Artificial Intelligence sub-discipline and has been widely applied in various technologies such as security systems, robotic navigation, and medical analysis.

Previous research studies conducted by Yunita Aulia Hasma and Widya Silfianti regarding the Implementation of Deep Learning Using the Tensorflow Framework with the Faster Regional Convolutional Neural Network (Fast R-CNN) Method for Acne Detection [6] succeeded in displaying facial images of acne and its classification. Another research conducted by Muftah Afrizal Pangestu and Hendra Bunyamin with the topic Performance Analysis and Development of a Dog Race Detection System in Images Using the Pre-Trained CNN Model [7] has successfully analyzed the performance of the pre-trained CNN model they use to detect dog breeds. . So in the context of the current Covid-19 pandemic, there is nothing wrong with developing a system to detect the use of masks on facial images, making it easier to monitor the use of masks in places that apply mandatory masking regulations. The formulation of the problems in this study are (1) How to detect masks on human faces using the Tensorflow framework and the CNN model that has been trained (pre-trained model) based on Raspberry Pi? (2) How to test the accuracy, precision, and recall (sensitivity) of mask detection using the Tensorflow framework and the pre-trained CNN model based on the Raspberry Pi? The objectives of this study are (1) Can detect masks in images and video images (realtime) using the Tensorflow framework and the pre-trained CNN model based on the Raspberry Pi. (2) We can know the accuracy, precision, and recall (sensitivity) of the mask detection test results using the Tensorflow framework and the pre-trained CNN model based on the Raspberry Pi.

2. Research Methods

In this study, it is divided into two stages; the first stage that the writer intends to do is collecting data by conducting literature studies and literature studies; this is aimed at exploring the knowledge, theories, and facts that underlie the research that the authors do. At the same time, the second stage is the system development stage, with a discussion covering three phases: the requirements planning phase, the implementation phase, and the testing phase.

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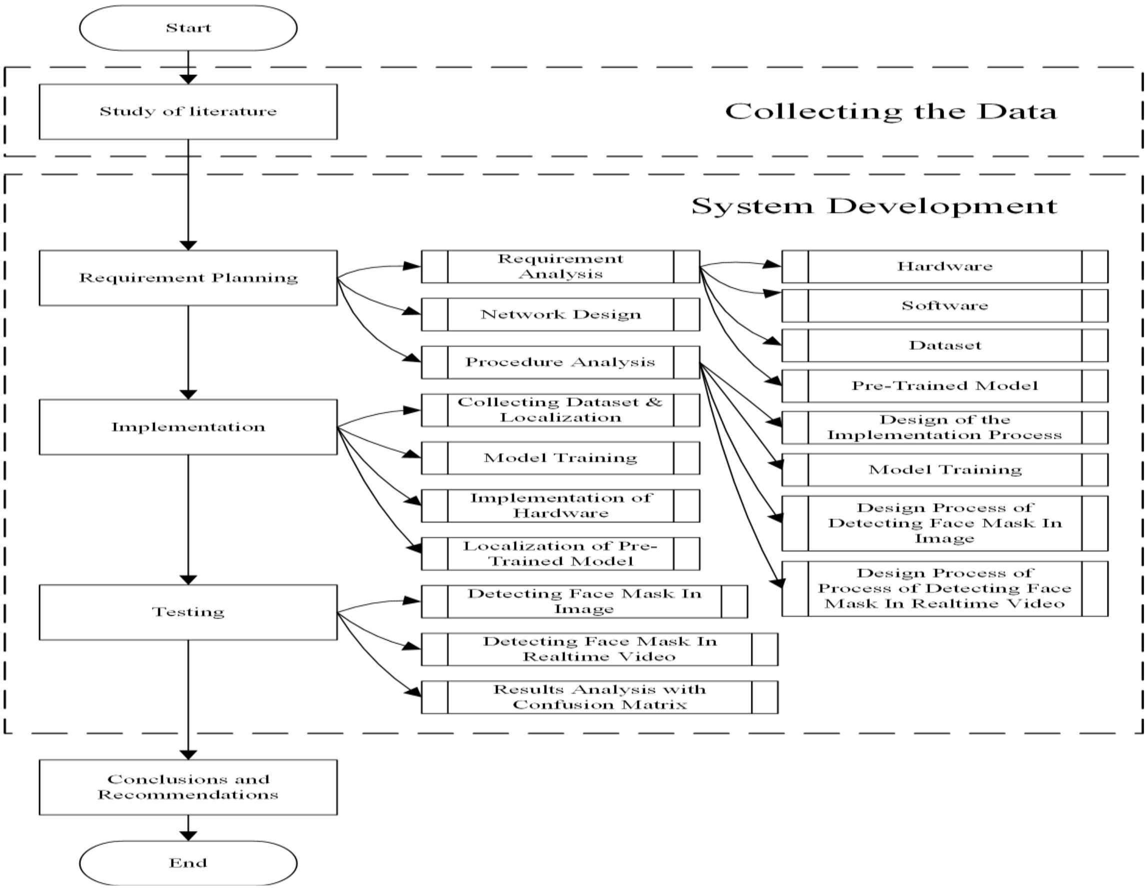

Fig 1. Research Method

3. Results

3.1 Fase Requirement Planning

a) Needs Analysis

One of the important elements in forming an object classification model is the existence of training data (dataset) in accordance with the purpose of making the model, in this study a mask detection model on human faces is needed, so the dataset in this study must be able to represent the output of the model to be made. , namely a dataset of human faces wearing masks and human faces without masks. So to fulfill the above objectives, the authors collected a dataset according to the required criteria. Basically, the author can collect datasets manually through search engine searches or capture images from camera devices, or collect images from various sources one by one. However, in this study the authors also used a dataset that is available on the Kaggle.com platform and can be accessed for free. The collected dataset is 1676 image data divided by 80% training set and 20% testing set.

b) Network Design

In this study, the authors utilized a network connection to the internet for the modeling process by training the dataset stored in Google Drive cloud storage. Access to the internet network is also very important in the training process, because the training process utilizes Google Colaboratory which provides computational resources for machine learning. In addition, access to the internet network is also used when downloading the pre-trained model for mask detection and face detection into the local storage (local disk) of the Raspberry Pi.

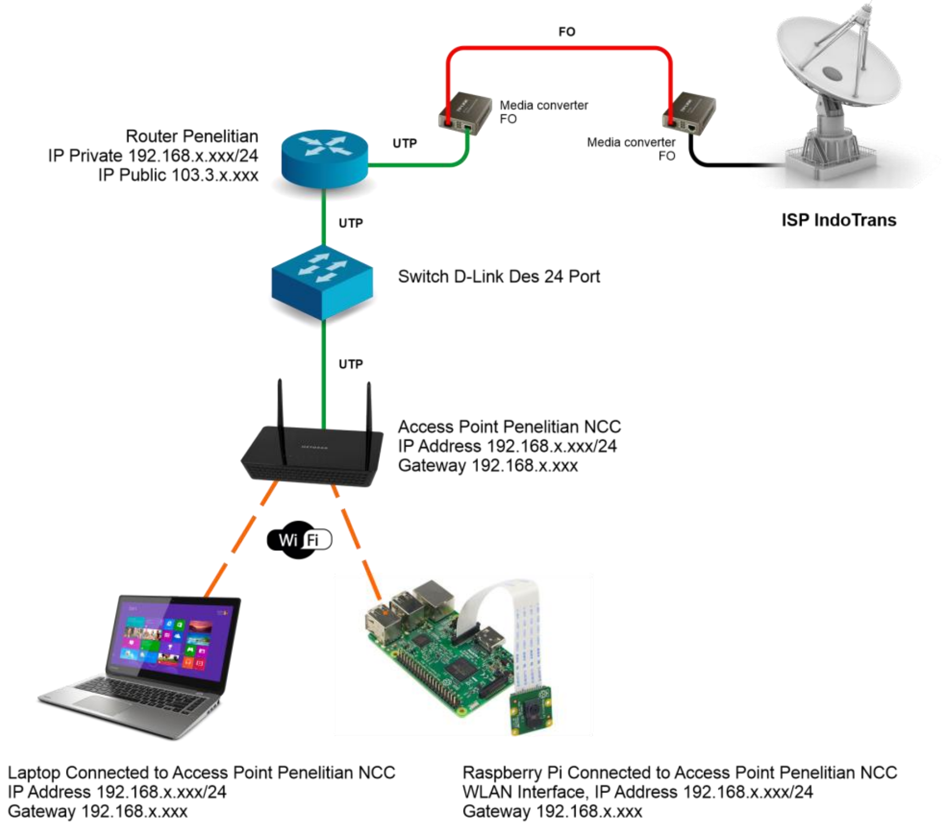

Fig 2. Network Design.

c) **Analysis of How it Works.**

The following is an analysis of how the whole work works, how the mask detection model training works, how the mask detection test works with image file input, and how the mask detection test works with video input (realtime).

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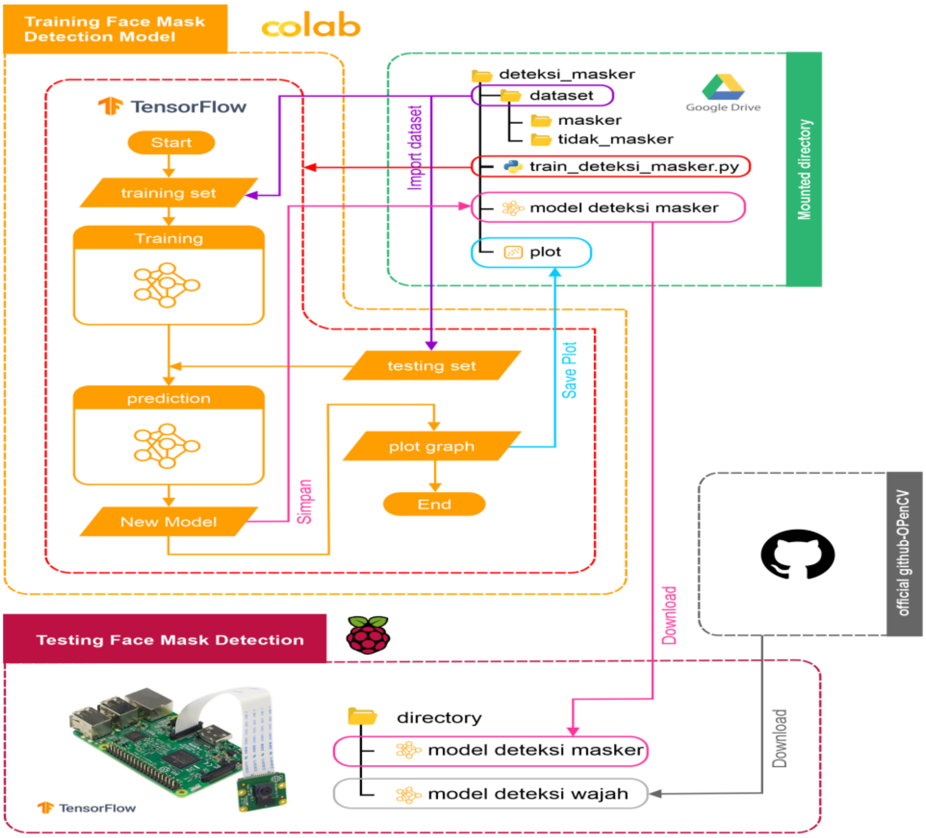

Fig 3. Analysis of How it Works.

3.2 Fase Implementations

a) Dataset Collection and Localization.

In the process of training a model, the diversity and richness of the dataset is needed to produce a model that has good effectiveness at the time of testing, the dataset used by the author in this study is image data, one of the writer's obstacles is to collect images into a dataset that is ready to be trained (training) so in this study the authors collected them from various sources, one of the sources that the author uses is the dataset available on the Kaggle.com platform.

In the training process, the number of datasets will also affect how much accuracy, precision and sensitivity a model is. In this study, 1676 images were collected which were divided into two image categories, namely a collection of 826 images of faces wearing masks and 850 images of faces without masks. At the training stage, the 1676 images will be divided by a percentage of 80% as a training set and 20% as a testing set.

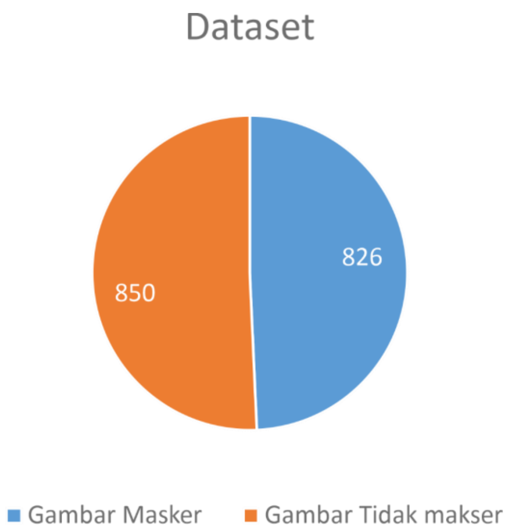

Fig 4. Comparison of the number of datasets based on 2 categories (masks and non-masks)

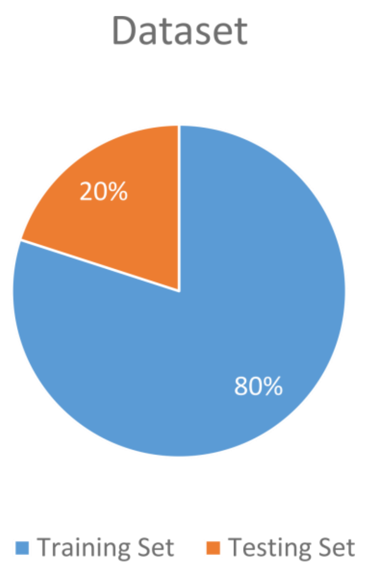

Fig 5. Percentage of allocating dataset based on function during the training process

b) Mask Detection Model Training.

To start the mask detection model training phase, the authors compile a program to be implemented in the model training process. The author first performs library dependencies including; tensorflow + hard, numpy, matplotlib, argparse, os, scikit-learn and manisils. In this training the model is formed not only relying on the dataset that the author has prepared, but through the process of transferring learning from the mobilenetv2 base model and the dataset (weight) from ImageNet through the fine-tuning function on tensorflow + hard.

The next stage is the execution of the train_deksi_masker.py program on Google Colaboratory with the previously prepared dataset and program.

```
! python train_deksi_masker.py --dataset dataset
```

In this training stage the authors conducted 5 (five) training trials with the learning rate, epoch, and batch size settings as follows:

Table 1

Experimental scenario for mask detection model training

Skenario	*Learning rate*	*Epoch*	*Batch size*
1	0.00001	20	32
2	0.0001	20	32
3	0.001	20	32
4	0.01	20	32
5	0.1	20	32

3.3 Testing

After carrying out the discussion, it can be seen that making a mask detection model can be done by utilizing Google Colaboratory to get around the computational load that cannot be done on the Raspberry Pi device, the use of datasets sourced from kaggle.com is quite easy for the author to collect datasets, transfer learning architecture of mobile-netv2 and the ImageNet dataset in the training process is sufficient to help the model achieve good accuracy. During the training dataset, a good performance was obtained in scenario 2 with a learning rate setting of 0.0001 epoch 20 batch size 32, while the lowest performance occurred in scenario 5 with a learning rate setting of 0.1 epoch 20 batch size 32 so that the training results in scenario 5 were not recommended .

At the implementation stage, the Raspberry Pi device-based mask detection is quite helpful with the use of the pre-trained mask detection model that the author created and the pre-trained face detection model based on the resnet architecture and the caffe model which was downloaded from the official OpenCV Github.

Table 2

Accuracy, precision and recall value for mask detection by input image file

Accuracy	Precision	Recall
96%	100%	92%

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In testing with the image file input, the average prediction percentage was 91.32% when the model predicted true positive and 98.80% when the model predicted true negative. In addition, there were also three type 2 false rate errors when the machine detected a masked face with a motif resembling the contours of the face. The test results with realtime video input through the camera module obtained the following values:

Table 3
Accuracy, precision and recall value for mask detection with video input (realtime)

Accuracy	Precision	Recall
91%	80%	100%

In testing with video input (realtime), an average prediction percentage of 97.25% was obtained when the model predicted true positive, 95.72% when the model predicted true negative. In addition, there were also three times the false rate error type 1 when the machine showed the detection results of the object wearing a mask, while the object was not wearing a mask.

4. Conclusion

Based on the results of the discussion which includes the requirements planning, implementation and testing phases that the author has done, the following conclusions can be drawn; (1) Mask detection on images and video (realtime) can be done by utilizing the Tensorflow framework and the pre-trained CNN model based on the Raspberry Pi. Detecting masks begins with creating (training) models to run on the Raspberry Pi device, the training process is carried out by training the image dataset through transfer learning and fine tuning methods. The model is built with MobilenetV2 architecture on top of the ImageNet model base. The use of the pre-trained face detection model, which is downloaded from the official Github OpenCV page, is quite helpful as a first filter before the mask detection model works. (2) Based on the results of the mask detection test that has been discussed, it is known that the accuracy obtained is 96% in testing with image file input and 91% on testing with video input (realtime), while for precision it is obtained 100% on testing with image file input and 80 % on testing with video input (realtime). The true positive rate (recall) performance, which is the sensitivity of the model in retrieving information, has a value of 92% on testing with image file input and 100% on testing with video input (realtime).

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