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The Role of InceptionV3 as Real-time Facemask Detection in the Health, Social, and Economic Fields During the COVID-19 Pandemic

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Abstract

The corona virus disease 2019 (COVID-19) pandemic has made all activities in human life run at a slower tempo, whereas humans are used to super-fast changes. In the health sector, the pandemic places a huge burden on the health system, including hospitals. While, economically, supply chain and production are disrupted, and the tourism industry dies. From the social side, the existence of social distancing puts psychological pressure on the community. Finally, various ways are used to support human life during this pandemic, including utilizing artificial intelligence or known as AI. One of the popular AI applications to be developed during this pandemic is facemask detection used in public areas. Therefore, in this study, the author tries to develop a facemask detector that could detect the use of masks in real time. The research aims to analyze the role of inceptionV3 as real-time facemask detection in the health, social, and economic fields. As a result, the author got 97% accuracy which is much higher than using vanilla convolutional neural network or known as CNN. The existence of the COVID-19 pandemic has had a tremendous impact on almost all people in the world, not least in Indonesia where the Ministry of Health and the relevant Government have issued health protocols to minimize exposure caused by the COVID-19 pandemic. There needs to be an inspection of masks, where the role of inceptionV3 as real-time facemask detection is to help monitor social activities such as weddings, celebrations, entertainment, and so on. Implement inceptionV3 as real-time facemask detection which helps the economic process, for example in traditional markets, which are free to transact if they wear masks, and strict action will be taken against those who do not wear masks

Keywords
inceptionv3; facemask detection; covid-19 pandemic; health; social; economic

I. Introduction

The corona virus disease 2019 (COVID-19) pandemic has made all activities in human life run at a slower tempo, whereas humans are used to super-fast changes. The emergence of the COVID-19 pandemic at the end of 2019 has brought a tremendous impact on human life, starting from the health, social, and economic fields (Haleem et al., 2020). In the health sector, the pandemic places a huge burden on the health system, including hospitals. While, economically, supply chain and production are disrupted, and the tourism industry dies. From the social side, the existence of social distancing puts psychological pressure on the community.

Finally, various ways are used to support human life during this pandemic, including utilizing artificial intelligence or known as AI. Researchers have performed various ways to help people live during the pandemic, including using AI and machine learning, such as the use of AI to diagnose patients with COVID-19 symptoms (Vaishya et al., 2020). Vaishya et al. (2020) have employed AI to monitor COVID-19 patients from the beginning until the patient recovers from COVID-19. Other studies have exploited X-rays to make predictions about COVID-19 patients (Abas et al., 2021). At the same time, Abbas et al. (2021) have applied the deep convolutional neural network (deep-CNN) to analyze lung X-rays of normal people, COVID-19 patients, and severe acute respiratory syndrome (SARS) patients.

Besides in hospitals, the application of AI for COVID-19 also occurs in public areas, such as shopping centers, terminals, airports, etc. In which, there is a high potential for the spread of the virus in these areas so that the security in these public areas needs to be improved. Although social distancing and the use of masks can reduce the chances of transmitting the virus, the spread of COVID-19 should not be ignored (Sekizuka et al., 2020). However, a single strike to anyone who is not wearing a mask is impossible. This will be a bigger problem in countries with low awareness of the use of masks, such as Indonesia (Haryanto, 2020). One of the popular AI applications to be developed during this pandemic is facemask detection used in public areas.

Therefore, in this study, the author tries to develop a facemask detector that could detect the use of masks in real time. This study is undoubtedly very useful in detecting people who have low awareness of the use of masks in public places. A robust image classifier is required to classify people's faces who wear and don't wear masks. In this case, the authors used the inception architecture and obtained an accuracy of 97% (Szegedy et al., 2016). Then, the author hypothesizes that the use of the inception architecture can improve the accuracy of the facemask detection system compared to the use of vanilla CNN alone.

II. Review of Literature

2.1 Inception

The world of image classification now has a performance that is almost on par with humans. We need to thank the concept of transfer learning, which prepares a pre-training model to improve image classification performance. One of the transfer learning applications is presented by Szegedy et al. (2016), which offers the deep convolutional neural network (deep-CNN) architecture. Pre-trained from inception could also be found with trained weights using ImageNet (Russakovsky et al., 2015). The inceptionV3 architecture is shown in Figure 1:

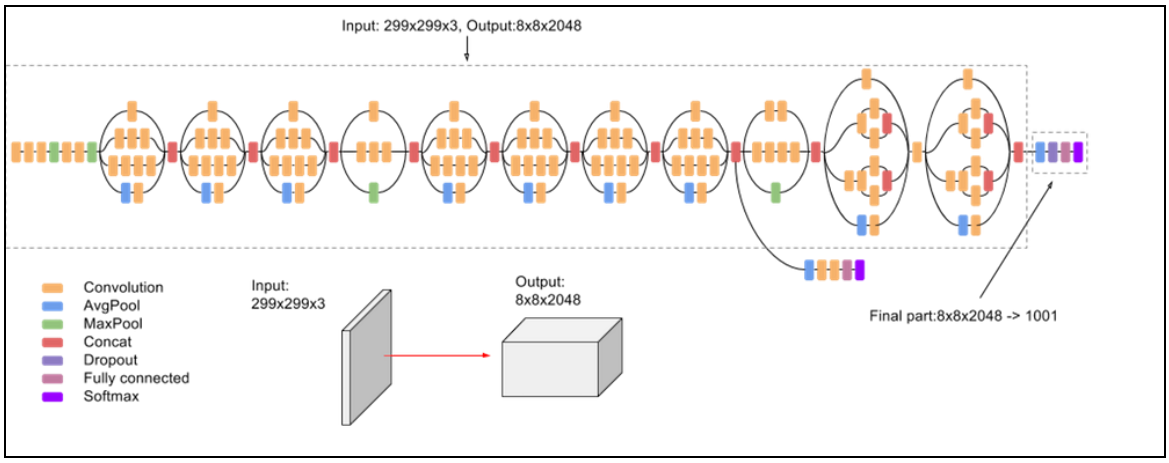

Figure 1. *InceptionV3 Architecture*

2.2 Facemask Detection

The corona virus disease 2019 (COVID-19) pandemic with the increasing number of infected people makes the awareness of the use of masks increasingly needed. Therefore, the presence of a face mask detector can be one of the keys to increasing awareness of masks' usage. Nagrath et al. performed a single-shot multi-box detector to detect faces and MobileNetV2 to perform image classification (Nagrath et al., 2021). However, this approach only provided 92% accuracy.

Ahmed et al. employed ResNet and MobileNet to create a robust facemask detector and succeeded in obtaining 2.3% and 1.5% higher precision values for faces and masks detection than baseline, and 11% and 5.9% higher recall values (Ahmed et al., 2020). However, the weakness of this approach is the complexity of the architecture, which still requires further development to be implemented in real terms.

III. Research Method

Research methods is a systematic method or process used to carry out an activity so that the desired goal can be achieved (Asyraini et al., 2022; Pandiangan, 2015; Pandiangan et al., 2022). 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; Pandiangan, 2022). 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 (Pandiangan, 2018). Stages of work from beginning to end in outline and job descriptions of each main type of work, namely the suitability of work methods (Octiva, 2018; 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).

3.1 Dataset

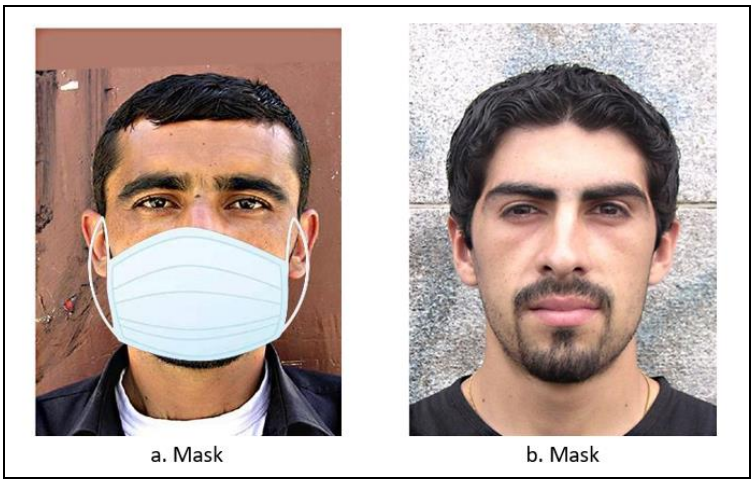

Figure 2. *Sample Data for Each Class*

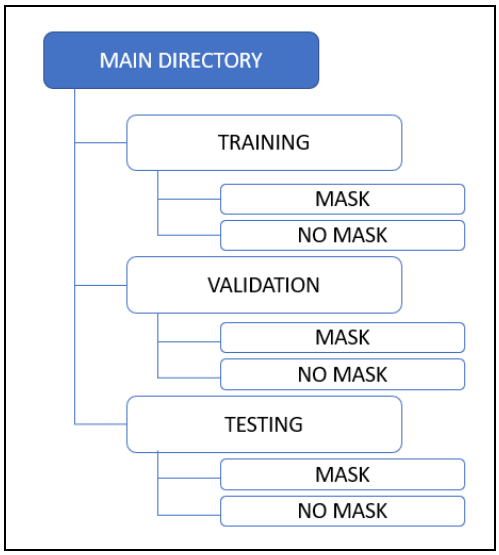

Figure 3. *Dataset Directory*

Data worked by the authors in this study consisted of 1,376 images, of which 690 images were people wearing masks, and 686 images were not wearing masks. The data were divided into training, validation, and testing data. Sample data for each class is shown in Figure 2. While the arrangement of the data directory is shown in Figure 3.

3.2 Pre-Processing

All image data was converted to a size of 150x150 pixels. To get more training data, the authors applied the ImageDataGenerator class from hard.preprocessing.image. This class functions to make 1 training data into several data by performing manipulations in the form of rotation, rescale, zoom, flip, etc. The parameters worked in this class were: Rescale = 1.0/255, rotation_range = 40, width_shift_range = 0.2, height_shift_range = 0.2, shear_range = 0.2, zoom_range = 0.2, horizontal_flip = True, fill_mode = 'nearest'.

3.3 Model

For inceptionV3 to be usable, some additional layers were required at the end of inceptionV3. These additional layers functioned to conduct fine-tuning on InceptionV3 so that we could utilize it for image classification. These additional layers are shown in Figure 4.

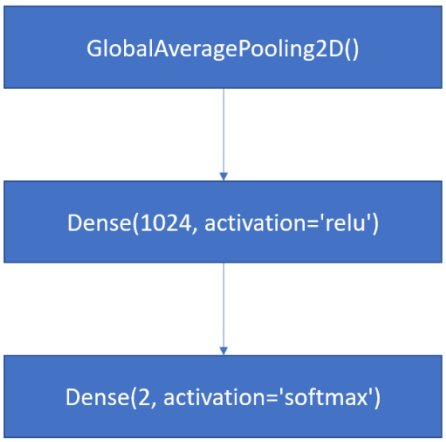

Figure 4. *Fine-Tuning InceptionV3*

For the training to be effective, the training process was firstly performed on additional layers, as shown in Figure 4. After that, we could train the entire model or freeze some layers. At this stage, it required a lot of experimentation. The training was done with epochs=10 and step_per_epoch=64. In this study, the authors compared the prediction results between inceptionV3 and vanilla convolutional neural network (CNN), as shown in Figure 5:

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 148, 148, 100)	2800
max_pooling2d_1 (MaxPooling2	(None, 74, 74, 100)	0
conv2d_2 (Conv2D)	(None, 72, 72, 100)	90100
max_pooling2d_2 (MaxPooling2	(None, 36, 36, 100)	0
flatten_1 (Flatten)	(None, 129600)	0
dropout_1 (Dropout)	(None, 129600)	0
dense_1 (Dense)	(None, 50)	6480050
dense_2 (Dense)	(None, 2)	102

Total params: 6,573,052
Trainable params: 6,573,052
Non-trainable params: 0

Figure 5. *Vanilla CNN Architecture*

IV. Results and Discussion

4.1 The Role of InceptionV3 as Real-time Facemask Detection in the Health Fields During the COVID-19 Pandemic

The existence of the corona virus disease 2019 (COVID-19) pandemic has had a tremendous impact on almost all people in the world, not least in Indonesia where the Ministry of Health and the relevant Government have issued health protocols to minimize exposure caused by the COVID-19 pandemic. One of the health protocols is to encourage people to always wear masks when doing activities both indoors and outdoors. In this context, all societies can play their respective roles by contributing to the fight against this virus. This is a good opportunity for researchers in the information technology field to take advantage of technological advances to help fight the spread of the corona virus, such as creating applications to detect the use of masks. This study makes an application to detect whether the object contained in the preview image uses a mask or not.

The results of a real-time facemask detector application are shown in Figure 6. If the image is classified as a person wearing a mask, then the face area will receive a green rectangle, while if not wearing a mask, it will be marked with a red rectangle.

Figure 6. *Prediction Results for Each Class*

Table 1. Model Performance in Training, Validation and Testing

No.	Model	Training Accuracy	Validation Accuracy	Testing Accuracy
1	Vanilla CNN	88.75%	97.4%	61.87%
2	InceptionV3	92.59%	97.43%	97.96%

The performance of inceptionv3 and vanilla convolutional neural network (CNN) is displayed in Table 1. By using inceptionV3, the authors got 97% accuracy which is much higher than using vanilla CNN. Even, the inceptionV3 performes well beyond vanilla CNN in practice and testing. High validity accuracy and low-testing accuracy indicate that vanilla CNN is overfitting. This research still focused on classification accuracy, not on the real-time speed of the face mask detector. InceptionV3 was more accurate than vanilla CNN, but it should be noted that the architectural complexity of inceptionV3 slowed down the implementation of real-time face mask detection.

4.2 The Role of InceptionV3 as Real-time Facemask Detection in the Social Fields During the COVID-19 Pandemic

The COVID-19 pandemic is receiving special attention worldwide. The transmission of the COVID-19 pandemic virus has spread almost throughout the world, including Indonesia. Indonesia is experiencing a crisis, especially in the social sector due to the COVID-19 pandemic, so the government has implemented large-scale social restrictions in every area due to the rapid spread of the virus. So that public services or public places require people to wear masks. So far, the detection of masks has been done manually with observations from security officers.

The COVID-19 pandemic has brought major changes to all levels of society in various aspects, including in the social field. The COVID-19 pandemic has forced restrictions on social activities between individuals, giving rise to different habits from their previous lives. In other words, this pandemic has given rise to a new community culture to respond to the existing policy of limiting social activities.

The COVID-19 pandemic outbreak like this certainly changes the social and cultural values of the community which have an impact on changing people's mindsets, views, and attitudes in everyday life. Always wearing a mask, diligently washing hands with soap, having hand sanitizer ready, keeping a distance, avoiding crowds, avoiding physical contact with other people, and implementing various health protocols have become habits.

Even for social activities such as weddings, celebrations, thanksgiving, entertainment, and so on, they had to be stopped. The existence of a policy of implementing restrictions on community activities that are sustainable until the last one, the imposition of restrictions on community activities at level 4 forces people to languish themselves at home. There needs to be an inspection of masks, where the role of inceptionV3 as real-time facemask detection is to help monitor social activities such as weddings, celebrations, entertainment, and so on.

4.3 The Role of InceptionV3 as Real-time Facemask Detection in the Economic Fields During the COVID-19 Pandemic

The impact of this pandemic has also hit various sectors, such as the economy. Buying and selling activities in traditional markets were previously free to transact, but now many sellers have to go out of business. This condition has only occurred because of the global pandemic that forces all parties to understand, understand, and implement existing policies.

It is said to be selfish if a person takes advantage of the existing conditions for the benefit of himself or his group without thinking about the impact on others. Such as the case of social panic in the early days of the emergence of the corona virus, where many individuals hoarded masks and hand sanitizers which ultimately resulted in material and non-material losses for others.

Therefore, it is necessary to implement inceptionV3 as real-time facemask detection which helps the economic process, for example in traditional markets, which are free to transact if they wear masks, and strict action will be taken against those who do not wear masks.

V. Conclusion

As a result, inceptionV3, the authors got 97% accuracy which is much higher than using vanilla convolutional neural network or known as CNN. The existence of the corona virus disease 2019 (COVID-19) pandemic has had a tremendous impact on almost all people in the world, not least in Indonesia where the Ministry of Health and the relevant Government have issued health protocols to minimize exposure caused by the COVID-19 pandemic. There needs to be an inspection of masks, where the role of inceptionV3 as real-time facemask detection is to help monitor social activities such as weddings, celebrations, entertainment, and so on. Implement inceptionV3 as real-time facemask detection which helps the economic process, for example in traditional markets, which are free to transact if they wear masks, and strict action will be taken against those who do not wear masks.

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