

Design of Mask Detection Application Using Tensorflow Lite based on Android Mobile

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ABSTRACT

A mask is a type of personal protective equipment (PPE) that is essential for protecting the nose and mouth from contamination by droplets or airborne particles. The use of masks became highly popular during the Covid-19 pandemic, which began in December 2019 in China and peaked in Indonesia in 2020. Despite the pandemic subsiding and vaccinations increasing immunity, some companies still require masks to prevent the spread of illnesses such as colds and flu, especially in work processes that produce smoke, such as soldering and welding. To ensure employees comply with mask usage, effective supervision is necessary. Manual supervision is less efficient, thus a digital detection method is needed. This study developed a mask detection application using deep learning algorithms and the TensorFlow Lite framework on an Android platform. The application can detect mask usage with 100% accuracy at a distance of 1 to 5 meters. The system was tested under various lighting conditions and environments to ensure reliability. Additionally, the implementation of this technology can be extended to other public areas to ensure compliance with health protocols. This tool helps companies easily monitor and enforce mask-wearing discipline among employees, thereby enhancing workplace safety and health. Future work could explore the integration of this system with other health monitoring tools to create a comprehensive safety solution.

Keywords: UML; Android; Deep Learning; Object Detection; TensorFlow

1. INTRODUCTION

Covid-19 is an infectious disease caused by a newly discovered strain of coronavirus. The virus was first identified in Wuhan, China, in December 2019 and quickly spread around the world, including Indonesia. The spread of the SARS-CoV-2 virus is very rapid due to its easy transmission from an infected person to a healthy person through water droplets from the nose or mouth when sneezing or coughing. According to the World Health Organization (WHO), Covid-19 can spread through direct contact with respiratory droplets or through contaminated surfaces (Nelson et al., 2021). The use of masks has been one of the main preventive measures to reduce the spread of this virus (Chairani, 2020). Masks serve as a physical barrier that protects the nose and mouth from airborne splashes or particles that may contain the virus (Mokobimbing et al., 2021). During the peak of the pandemic in Indonesia in 2020, the government imposed various regulations to ensure the use of masks in public places and workplaces (Atmojo et al., 2020). Although the pandemic has subsided and vaccinations have improved public immunity, some companies still require the use of masks to prevent the spread of diseases such as coughs and flu, especially in smoke-generating work processes such as soldering and welding.

However, manual monitoring of mask compliance is often ineffective and resource-intensive. Therefore, a more efficient digital detection method is needed. Deep learning technology offers a potential solution through the development of a mask detection application based on deep learning algorithms and the TensorFlow Lite framework on the Android platform (Ferdiansyah, 2021). This application is designed to detect mask usage with high accuracy, thus assisting companies in monitoring and enforcing mask usage discipline among employees. Based on the above background, the problems identified are the low public awareness in complying with health protocols in the form of wearing masks, the

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high mobility of the community which makes monitoring the use of masks difficult, the lack of effectiveness of manual monitoring in crowded centers, and the lack of application of artificial intelligence (AI) technology in Indonesia for monitoring in public places (Hasyim et al., 2021).

To focus this research, the problem limitations set are that the dataset of face mask images is taken from the Kaggle site, application development is only for the Android platform, the deep learning model uses TensorFlow Lite created on Teachable Machine, and detection of mask use is carried out through the Android application. The formulation of the problem in this research is how to collect datasets from the Kaggle site, how to develop Android applications for mask use detection, how to implement deep learning technology with the TensorFlow Lite model for mask use detection, and how to apply artificial intelligence to Android applications for mask detection. The purpose of this research is to know how to process ready-to-use datasets from Kaggle, develop efficient and fast models in learning image processing and object detection, implement artificial intelligence technology for mask detection as an application of health protocols, and know the application of artificial intelligence in Android applications for mask detection.

The benefits of this research are to add insight and knowledge about application development with the Android-based TensorFlow Lite method, and can be used as a theoretical reference at the lecture level. Practically, this research is useful for the author to apply the knowledge gained during lectures and implement it in the world of programming, as well as for the Informatics Engineering Study Program as literature in the Pelita Bangsa University library and contribute to science and scientific references, The results of the literature survey show that Tensorflow can be used to develop fish identification applications (Wiranda et al., 2020).

2. LITERATURE REVIEW

Research on mask usage detection has become a very relevant and important topic during the Covid-19 pandemic. One significant research is to create a tool that can detect the use of masks on a person, which is made using the MobileNetV2 architecture and the Convolutional Neural Network (CNN) method that classifies people not wearing masks and using masks. This tool uses Raspberry Pi as a mini computer which is the main brain by adding a camera sensor to detect someone using a mask in real-time, RGB LED as a marker whether a mask is detected or not, and LCD as a display when the system is running. The effective distance that can detect the use of masks is as far as 30-200 cm (Fran Fahlifi et al., 2021). Another relevant research in developing a mask detection prototype in a mandatory mask room for deep learning-based automatic door control. This device uses a Raspberry Pi and manages to achieve a 100% success rate in good lighting conditions. However, its effectiveness decreases in poor lighting conditions. This research shows the importance of environmental conditions in the accuracy of mask detection and provides a basis for further development using more advanced technologies such as TensorFlow Lite on the Android platform. (Abdul et al., 2020).

In addition, further research developed a mask detection system with Internet of Things (IoT)-based Telegram notifications using Raspberry Pi as the main brain with a camera module and a PIR sensor to detect mask use (Lambacing & Ferdiansyah, 2020) and the detection results are then sent as notifications to Telegram to facilitate supervision. This research emphasizes the importance of integrating IoT technology in the mask detection system to improve the efficiency and effectiveness of supervision.

Another research using the CNN algorithm to detect masks in detecting the use of masks in images automatically using the dataset used consists of 3,828 images of people who do not wear masks and 3,725 images of people who wear masks. The training process of the developed model achieved an accuracy rate of 93% on the test data it performed (Putra & Saputra, 2023) After that, the next research is to create a program that can detect masks from a person's face by utilizing the Mobilenet SSD model from Tensorflow to facilitate community monitoring in implementing health protocols. The existence of this program can also prove that artificial intelligence (AI) also has a role in suppressing the spread of the covid-19 virus. The research method used is Research and Development (R&D), a research method used to produce certain products, and test the effectiveness of these products (Muharram et al., 2022).

The above studies provide a strong basis for the development of mask detection applications using deep learning and TensorFlow Lite on the Android platform. The implementation of this technology not only improves the efficiency

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of monitoring the use of masks but can also be extended to other public areas to ensure compliance with health protocols. By utilizing deep learning and TensorFlow Lite technology, mask detection applications can achieve a high level of accuracy and can be widely implemented to support efforts to prevent the spread of Covid-19.

3. METHODS

This research uses the deep learning method with the TensorFlow Lite model to develop an Android-based mask detection application. The research process begins with data collection, data preprocessing, data sharing, model training, and implementation on the Android platform. The data used in this research is a dataset of face mask images taken from the Kaggle website. This dataset is titled "Face Mask Detection" created by Andrew Mvd and contains 853 images categorized as "mask", "no mask", and "mask worn incorrectly". This dataset was downloaded and used as training data and test data in this study (Nursulistio et al., 2022).

The first stage in this research is data collection. The data was downloaded from the Kaggle website and then data preprocessing was carried out. Data preprocessing includes resizing and augmentation to increase data variation and improve model performance. The data is then divided into training data and test data with a ratio of 80:20. Once the data is ready, the next step is model training using Teachable Machine, a web-based tool that enables quick and easy machine learning model building without coding. The model is then exported to TensorFlow Lite format to be implemented on the Android app.

Implementation of deep learning models in Android applications is done using Android Studio (Purnama et al., 2024). This application is designed to detect the use of masks with high accuracy at a distance of 1 to 5 meters. The application development process includes designing the user interface, integrating the TensorFlow Lite model, and testing the application. The user interface is designed using Balsamiq Mockups 3 to provide an overview of the structure, layout, and design of the application to be built. Application testing is carried out using the black box testing method to ensure that all parts of the system run according to the predetermined process flow (Sitorus, 2022).

Tests were conducted in various lighting and environmental conditions to ensure system reliability. The test results show that the developed mask detection application is able to detect the use of masks with 100% accuracy at a distance of 1 to 5 meters. The implementation of this technology not only improves the efficiency of monitoring the use of masks but can also be extended to other public areas to ensure compliance with health protocols.

Data Collection

Data collection is the most important part of a research. The availability of data will determine the processing and subsequent analysis. Therefore, in collecting data, techniques must be carried out that ensure that the data obtained is correct, accurate and can be accounted for so that the results of data processing and analysis are not biased. Data collection is theoretical in nature related to this research. The data collection is done by studying the literature, research journals, lecture materials and other sources that have to do with the problems discussed (Yusra et al., 2021). Data collection in this study is as follows:

1. Primary Data

Primary data is data that has been obtained through research. The research was conducted on face mask detection. The following are data samples from 853 face mask dataset images obtained in the research:

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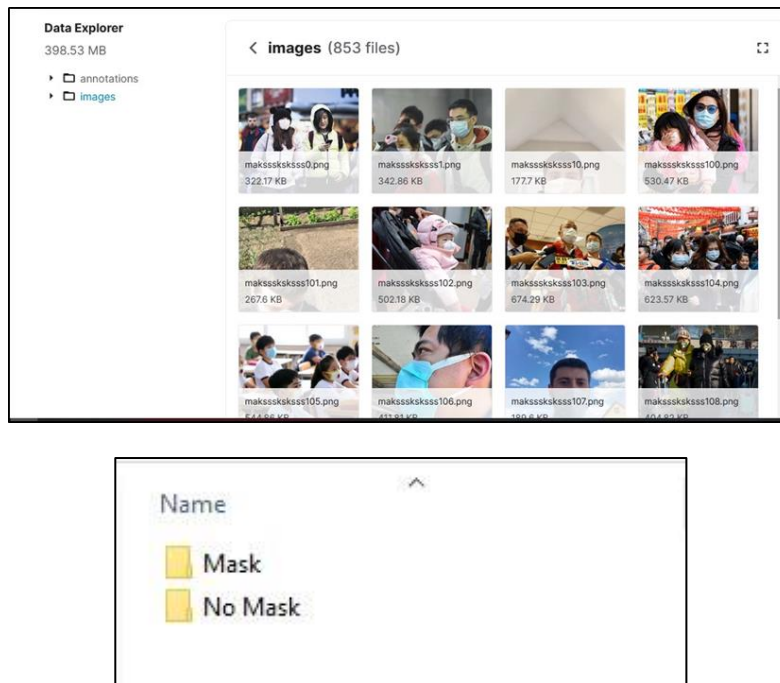


Fig.1. Sample Primary Data

2. Secondary Data

Secondary data is data as a complement or source of theory from primary data obtained from journals, books, or the internet in the form of definitions, concepts and definitions related to research and preparation of the final project.

Data Analysis Model

Once the data is collected, the next step is data preprocessing. Data preprocessing includes resizing and augmentation to increase data variation and improve model performance. The data is then divided into training and test data in a ratio of 80:20. This process is important to ensure that the model can learn from diverse data and generalize well to new data.

1. Dataset Retrieval

On the kaggle site, researchers download data that suits the research needs, namely face masks. The data taken by researchers is entitled Face Mask Detection made by a person named Larxel.

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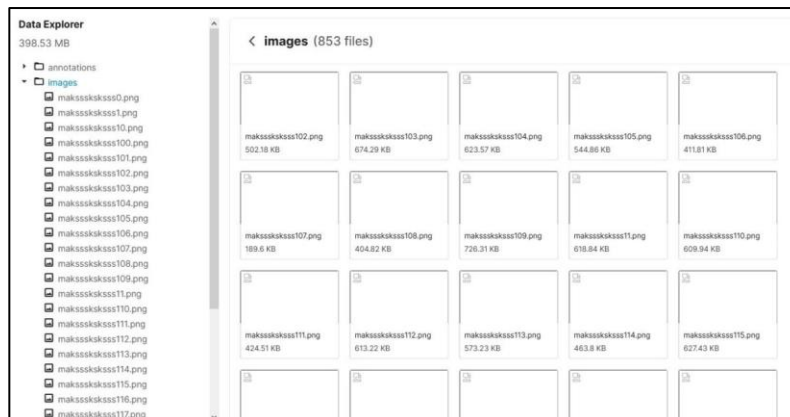


Fig. 2 Dataset in Kaggle

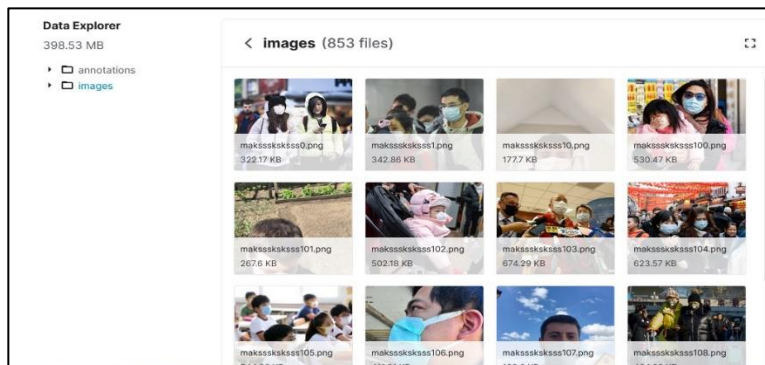


Fig. 3 Kaggle Face Mask Dataset

2. Data Preprocessing Stages

In the data preprocessing stage, all data is treated by resizing and augmenting data for all train and test data to produce more and more varied data.

3. TensorFlow Lite Design with Teachable Machine

The next step is to design the TensorFlow Lite model using Teachable Machine. Teachable Machine is a product from Google in the form of a web-based tool that makes machine learning model building fast, easy, and accessible to everyone. The training process involves several steps, including defining the model architecture, setting the training parameters, and running the training process until the model achieves optimal performance.

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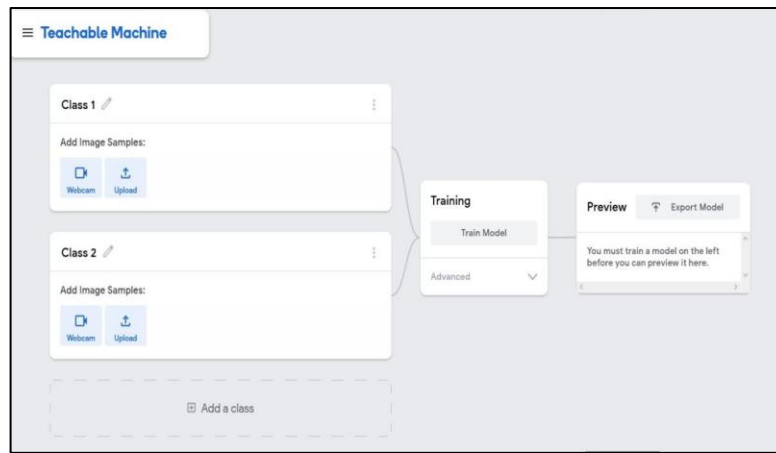


Fig. 4 Teachable Machine

4. UML Machine Design

UML (Unified Modeling Language) design is a visual modeling method for object-oriented system design tools, or the definition of UML is a language that has become a standard for visualizing, designing and documenting software systems. UML design aims to provide a visual modeling language to users of various kinds of programming and engineering processes. In making UML researchers use Draw.io software that can be accessed through a browser.

5. Android Interface Design

The design of the interface design aims to provide an overview of the structure, layout and design of the application to be built in detail, where the interface will later represent the entire application system created. Researchers in designing the android interface use Balsamiq Mockups 3 software.

6. Android Application Programming (Development)

The next stage is the programming stage, which converts the design into the form of an application or system. This stage also aims to find out how to obtain and install in the environment expected by a system.

7. Software Testing (Blackbox Testing)

Researchers use the black box testing method, which is a software testing method that emphasizes the functional accuracy of each part of the system without having to test the content or source code of the application, the purpose of testing is to ensure that all parts of the system run according to the predetermined process flow. The following is a software testing table:

Table 1. Software Testing (Blackbox Testing)

| No. | Testing | Expected realization |
|-----|-------------------|--|
| 1 | Splashscreen Page | Can enter the application loading page |
| 2 | Main Page | Can display pages with the default view of the rear camera |
| 3 | Page Flip Camera | Can move the position of the rear camera to the front camera |

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Research Flowchart

To find out more clearly about the flow in this study, it will be described through a flowchart. Figure flowchart of the research to be carried out.

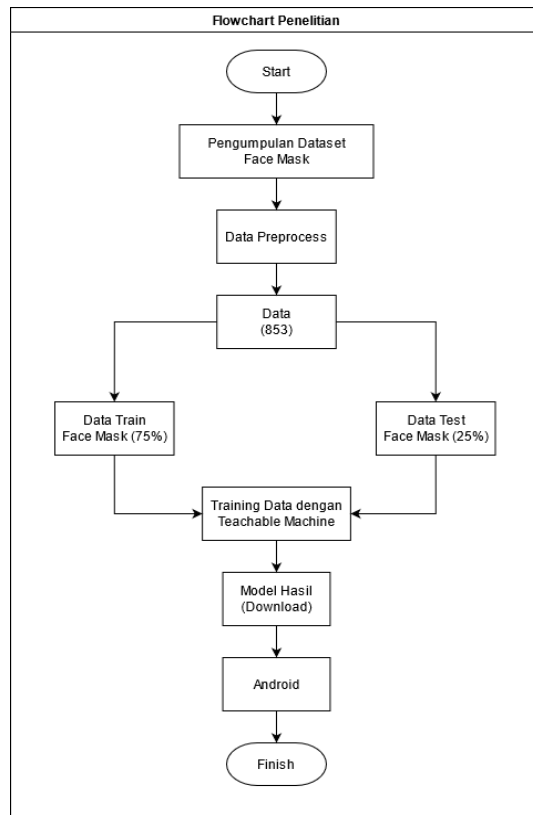


Fig.5 Research Flowchart

Research Instrument

In this research, researchers need main and supporting equipment, where the main equipment is divided into 2 categories, namely hardware and software.

1. Hardware

The hardware used is a laptop with the following specifications:

Table 2. Required Hardware

| Hardware | Description |
|----------|-------------|
|----------|-------------|

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| | |
|---------------------------|---|
| Lenovo Ideapad 310 | - Processor i5-7200U 2.5GHz - 4 GB RAM - 1 Tera HDD |
| Smartphone A7 2018 | - Exynos 7885 Octa Core 2.0 GHz Processor - 4 GB RAM - Android Version 10 |

2. Software

For the software (software) used by researchers as follows:

Table 3. Required Software

| Software | Description |
|---------------------------------|---|
| OS Windows 10 Pro 64 bit | As the operating system on the laptop used for research. |
| Android Studio 4.0 | A tool for Android app development, which is based on IntelliJ IDEA . |
| Mozilla Firefox | Function as a Search Engine |
| Balsamiq Mockups 3 | Tools for designing application interfaces |
| Mockplus | Tools for designing application interfaces |
| Microsoft Word 2019 | Tools for writing documentation |

4. RESULT

Research Results

The results of this study describe a mask usage detection system that has been implemented using the deep learning method with the TensorFlow Lite model. The main process in making this system involves several stages, namely data collection, data preprocessing, model training, implementation on the Android platform, and application testing.

Data Collection

The data used in this research is a dataset of face mask images taken from the Kaggle website. This dataset is titled "Face Mask Detection" created by Larxel and contains 853 images categorized as "mask", "no mask", and "mask worn incorrectly". This dataset was downloaded and used as training data and test data in this study.

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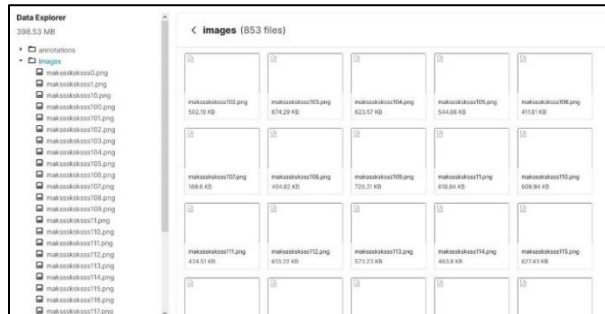


Fig.6 Dataset in Kaggle

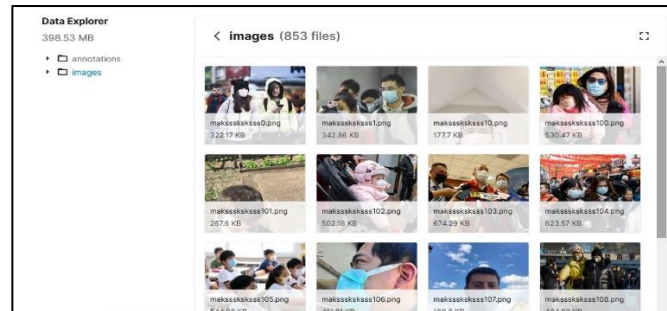


Fig.7 Kaggle Face Mask Dataset

Data Preprocessing Stages

In the data preprocessing stage, all data is treated by performing data resizing and data augmentation for all train and test data in order to produce more and more varied data. This process is important to ensure that the model can learn from diverse data and generalize well to new data.

TensorFlow Lite Design with Teachable Machine

The next step is to design the TensorFlow Lite model using Teachable Machine. Teachable Machine is a product from Google in the form of a web-based tool that makes machine learning model building fast, easy, and accessible to everyone. The training process involves several steps, including defining the model architecture, setting the training parameters, and running the training process until the model achieves optimal performance.

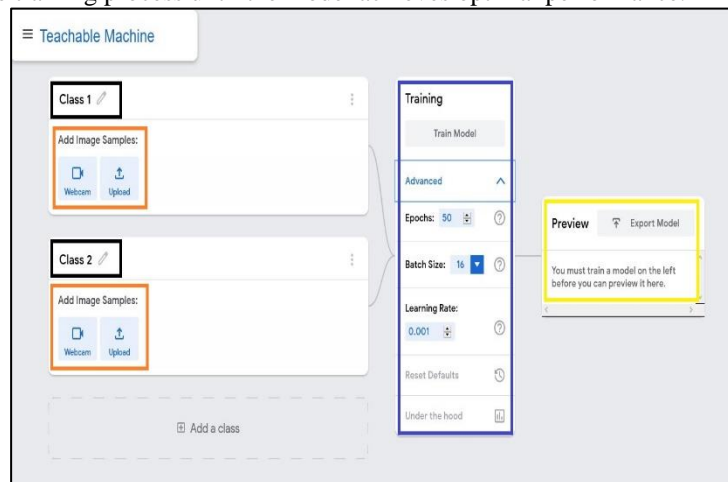


Fig.8 Teachable Machine

Implementation on Android Platform

The implementation of deep learning models in Android applications is done using Android Studio. This application is designed to detect the use of masks with high accuracy at a distance of 1 to 5 meters. The application development process includes designing the user interface, integrating the TensorFlow Lite model, and testing the

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application. The user interface is designed using Balsamiq Mockups 3 to provide an overview of the structure, layout, and design of the application to be built.



Fig.9 Splashscreen Page Display

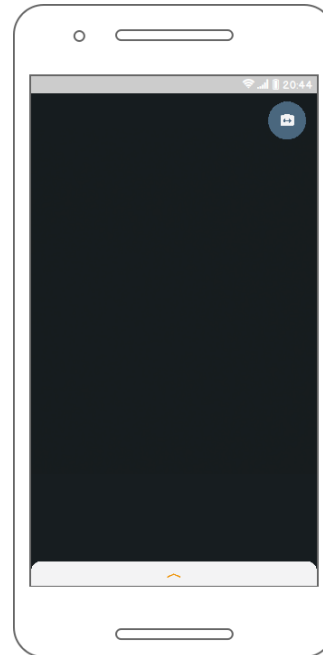


Fig.10 Page Flip Camera Display

Application Testing

Application testing is carried out using the black box testing method to ensure that all parts of the system run according to the predetermined process flow. Testing is carried out in various lighting and environmental conditions to ensure system reliability. The test results show that the developed mask detection application is able to detect the use of masks with 100% accuracy at a distance of 1 to 5 meters.

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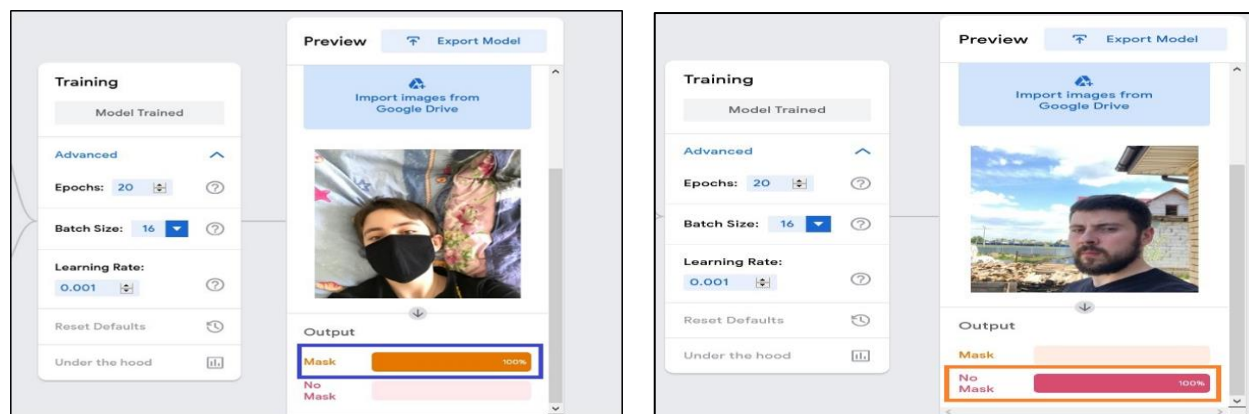


Fig. 11 Application Testing

Table 4
Application Function Testing

| No. | Test Case | Expected Results | Testing Results |
|-----|---------------------------------|--|-----------------|
| 1 | User opens the Wear a Mask app | After successfully displaying the loading page, the user is then taken to the main page which directly displays the object detection face mask. | Valid |
| 2 | User opens the Wear application | On the main page there is a flip camera button, if the user presses the button the application will move the camera position from the rear camera to the front camera or vice versa. | Valid |

Testing Results

The following is a table of application testing results:

Table 5
Software Testing (Blackbox Testing)

| No. | Testing | Expected realization | Testing Results |
|-----|-------------------|--|-----------------|
| 1 | Splashscreen Page | Can enter the application loading page | Valid |
| 2 | Main Page | Can display pages with the default view of the rear camera | Valid |
| 3 | Page Flip Camera | Can move the position of the rear camera to the front camera | Valid |

4. CONCLUSION

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The research conclusion shows that 1) Researchers concluded that the research dataset can be taken from the kaggle site, making it easier for researchers to find real data from previous researchers. 2) Creating a deep learning model using the Teachable Machine platform is very efficient in terms of time and convenience. 3) By using artificial intelligence technology, researchers can implement it to detect the use of masks as one of the applications of health protocols through android applications. 4) Mask detection applications can be made through artificial intelligence using the tensorflow lite method in the android studio application. With this application, if a company applies masks, especially to sick employees, then the health officer in the company can detect that person and prevent them from contracting the disease. The suggestion for future researchers is to add other parameters such as dropout value, use of optimizer. So it can produce a model with the best use of hyper parameters. Then future application development can be implemented into the CCTV operating system, and then for future research, you can try and study federated learning techniques in creating systems.

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