



I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>

[Register] Submission Acknowledgement

Nisa Ayunda <nisaayunda@mipa.unipdu.ac.id>
To: I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>

Thu, Dec 29, 2022 at 11:48 AM

I Nyoman Gede Arya Astawa:

Thank you for submitting the manuscript, "Dataset variation for masked face detection using YOLO-v5 method" to Register: Jurnal Ilmiah Teknologi Sistem Informasi. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Submission URL: <http://journal.unipdu.ac.id/index.php/register/authorDashboard/submission/3249>
Username: arya_kmg

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Nisa Ayunda

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Reply-To: Nisa Ayunda <register@ft.unipdu.ac.id>
To: I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>

Mon, Jan 30, 2023 at 12:58 PM

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Mon, Jan 30, 2023 at 1:30 PM

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[Register] New notification from Register: Jurnal Ilmiah Teknologi Sistem Informasi

Register Register <register@ft.unipdu.ac.id>
To: I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>

Tue, Apr 18, 2023 at 9:48 AM

I Nyoman Gede Arya Astawa, I Made Ari Dwi Suta Atmaja, Aji Prasetya Wibawa:

We have reached a decision regarding your submission to Register: Jurnal Ilmiah Teknologi Sistem Informasi, "Dataset variation for masked face detection using YOLO-v5 method".

Our decision is: Revisions Required

Reviewer B:
Recommendation: Revisions Required

4. Suggestions/ improvements on the ABSTRACT:

please your description clearly aim and result, in abstract section

8. Suggestions/ improvements on the INTRODUCTION:

please explain clearly why the author researched it.

10. Suggestions on the improvement of the RESEARCH MATERIALS and METHODS:

please add previous similar studies, and please provide a comparison

12. Suggestions and improvements on the RESULT and DISCUSSION:

the author has to make between research objectives and conclusions.

14. Suggestions and improvements on the CONCLUSION.

the author has to make between research objectives and conclusions.

19. Overall Recommendation?

Accepted after minor revision

Yours Sincerely,

Nisa Ayunda, M.Si

Editor in Chief

Register

Register: Jurnal Ilmiah Teknologi Sistem Informasi (Scientific Journals of Information System Technology)
Department of Information System | Universitas Pesantren Tinggi Darul Ulum Jombang, Indonesia

Index by:



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I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>

[Register] New notification from Register: Jurnal Ilmiah Teknologi Sistem Informasi

I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>
To: Register Register <register@ft.unipdu.ac.id>

Wed, Apr 19, 2023 at 6:38 PM

Dear,

Nisa Ayunda, M.Si

Editor in Chief

https://ci3.googleusercontent.com/mail-sig/AlorK4wl3h-m5tk9KYBAJ7J1_MyM0iUOnj7VLMf0AjjkqdKD6KqCFIjrDY1TjT8Gqb3aXg2O6wdqzmM

We thank you for the improvement input. The improvements we have made are:

improvement comments	Repair
4. Suggestions/ improvements on the ABSTRACT: please your description clearly aim and result, in abstract section	<p>The purpose of this study is to determine the accuracy of the YOLO-v5 algorithm in detecting whether someone is wearing a mask or not.</p> <p>The test results prove that the YOLO-v5 algorithm is highly recommended for detecting faces using masks.</p>
8. Suggestions/ improvements on the INTRODUCTION: please explain clearly why the author researched it.	Revision on INTRODUCTION, last paragraph: The purpose of this research is to determine the accuracy of the YOLO-v5 algorithm in detecting whether someone is wearing a mask or not. In addition, this algorithm was also tested on a dataset of people using masks and synthetic datasets.
10. Suggestions on the improvement of the RESEARCH MATERIALS and METHODS: please add previous similar studies, and please provide a comparison	Revision on MATERIALS and METHODS, in the fourth paragraph: There are several studies on masked face detection using the YOLO-v5 algorithm including; Researchers [27] the YOLO-v5 algorithm are able to accurately detect and differentiate masked or non-masked humans with complex environmental conditions. Researchers [28] developed a model and succeeded in recognizing people with masks or not, besides that the developed model can determine whether the mask on the face covers the nose and mouth. Researchers [29] developed the YOLO-v5s model with the results of being able to identify the use of masks very well, with an accuracy value of 90.37%. Based on the results of these studies, the YOLO-v5 algorithm was used to detect masked or non-masked faces and the algorithm was tested on different datasets.
12. Suggestions and improvements on the RESULT and DISCUSSION: the author has to make between research objectives and conclusions.	Revision on RESULT and DISCUSSION, in last paragraph: This study uses the YOLO-v5 algorithm to detect faces using masks on different datasets, and from the test results that this algorithm is highly recommended for detecting masked faces.

14. Suggestions and improvements on the CONCLUSION. the author has to make between research objectives and conclusions	Revision in last paragraph: The test results prove that the YOLO-v5 algorithm is highly recommended for detecting faces using masks.
---	---

thank you

salam

Dr. I Nyoman Gede Arya Astawa, ST., M.Kom

(Komang Arya)

Politeknik Negeri Bali

Jurusan Teknik Elektro

Prodi Manajemen Informatika

Telp: 08123814894

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3249_ Register v.17 - I Nyoman Gede Arya Astawa-rev.docx

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I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>

[Register] Editor Decision

Nisa Ayunda <register@ft.unipdu.ac.id>

Thu, Jun 15, 2023 at 2:34 PM

To: I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>, I Made Ari Dwi Suta Atmaja <arisuta@pnb.ac.id>, Aji Prasetya Wibawa <aji.prasetya.ft@um.ac.id>

I Nyoman Gede Arya Astawa, I Made Ari Dwi Suta Atmaja, Aji Prasetya Wibawa:

We have reached a decision regarding your submission to Register: Jurnal Ilmiah Teknologi Sistem Informasi, "Dataset variation for masked face detection using YOLO-v5 method".

Our decision is: Revisions Required

Reviewer C:Recommendation: Revisions Required

1. TITLE - Does it reflect the core of the writing content (output, method, novelty aspect) specifically and effectively (straightforward and informative)?

Yes, it does

3. ABSTRACT - Does it represent the essence of research content (goals, methods, results, and findings)?

Is it presented in good and correct English, concise, clear, intact manner and equipped with explanations for each abbreviation?

The abstract is clear, concise, and available in good and correct grammar.

4. Suggestions/ improvements on the ABSTRACT:

the abstract is good

5. KEYWORD, does it consist of 3-5 words/phrases which are consistent and reflect important concepts of the article?

Yes, it does. It is consistent and reflects important concepts of the article.

6. Suggestions/ improvements regarding the KEYWORD:

oke

7. INTRODUCTION – Does it included background problems, state of the art (minimum 5 articles sourced from reputable international or accredited journals at least the last 5 years), the gap with previous research, contribution/originality/novelty, and clear (explicit) research goals?

Yes, it does

8. Suggestions/ improvements on the INTRODUCTION:

it's good

9. RESEARCH MATERIALS and METHODS used in terms of research gaps, contribution/originality/novelty, and objectives:

Good

10. Suggestions on the improvement of the RESEARCH MATERIALS and METHODS:

you can add a related studies to compare, for the best

11. Is the sharpness of analysis and synthesis in TEST RESULT and DISCUSSION describe the research findings sharply, has a connection with previous concepts/theories, compares critically with other people's work, and reinforces or corrects previous findings?

Yes, it is (very deep and thorough).

12. Suggestions and improvements on the RESULT and DISCUSSION:

make sure the part of discussion or conclusions

13. Whether the CONCLUSIONS of this study compiled new findings supported by adequate, accurate, and in-depth research results.

Good

14. Suggestions and improvements on the CONCLUSION.

it's good

15. The meaning of research contributions for advances in technology and science and the resolution of international problems.

So real

16. Are references used from international scientific journals and international proceedings reputable, trusted, current and relevant to the contents of the article reviewed?

80% (Taken from research articles published in reputable, credible, and relevant international journals and/or proceedings).

18. Update on references (seen from the year of publication: the last five years):

Quite up to date (40% - 80% taken from the latest reference)

19. Overall Recommendation?

Accepted after minor revision

The following message is being delivered on behalf of Register _____



I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>

[Register] Editor Decision

I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>
To: Nisa Ayunda <register@ft.unipdu.ac.id>

Sun, Jun 18, 2023 at 12:09 PM

dear
Nisa Ayunda
Editor in Chief

We thank you for the improvement input. The improvements we have made are:

improvement comments	Repair
<p>10. Suggestions on the improvement of the RESEARCH MATERIALS and METHODS:</p> <p>you can add a related studies to compare, for the best</p>	<p>On RESEARCH MATERIALS and METHODS we added:</p> <p>On sub bab 2.1 Dataset preparation process</p> <p>Figure 2 illustrate the different between two conditional picture according to the requirement using the mask. The left column shows that without a mask and the right using a mask. These results indicate that it is necessary to test the suitability, accuracy and suitability of wearing a mask or not[20]. The YOLO-v5 method is a very sophisticated algorithm for recognizing object detection[27] and is very suitable for detecting masked faces in public places so as to prevent the spread of COVID-19[31]</p>
<p>12. Suggestions and improvements on the RESULT and DISCUSSION:</p> <p>make sure the part of discussion or conclusions</p>	<p>On RESULT and DISCUSSION: we added</p> <p>we add at the end of the second paragraph:</p> <p>The results of this training support previous studies[30] that time and predictions are strongly influenced by image resolution, for training with large datasets and fast training results it is better to use Google Colab. In addition, the mAP value is very dependent on the given threshold value. Thus, the results of the analysis provide an understanding that the value of mAP can be used as an evaluation parameter for good object detection performance[32].</p> <p>we add at the end of the fifth paragraph:</p> <p>The results of this study support previous studies[27] that the YOLO method is very good at detecting objects and estimating their probabilities. Thus, the results of the analysis provide an understanding that this study is very appropriate in choosing the YOLO method to detect whether a face is wearing a mask or not[30].</p> <p>we add at the end of the sixth paragraph:</p> <p>The results of this study support research conducted by[31] hat by using the YOLO-v5 method the results of detecting masked faces are very accurate.</p>
	<p>we fix the conclusion to be:</p> <p>This study prioritizes face detection when wearing a mask by analyzing a number of datasets, including datasets of faces wearing masks (dataset M), synthetic datasets (dataset S), and combined datasets (dataset G). This research resulted in three important findings. First, time and prediction are strongly influenced by image resolution. The system was developed using the YOLO-v5 algorithm, and tests were performed on multi-face photos with</p>

various data sets and resolutions. The test results obtained the best detection results at a resolution of 640 pixels, namely 98.9 percent for dataset M, 98.5 percent for dataset S, and 99.2 percent for dataset G. Second, the YOLO-v5 method is very good for detecting objects and estimating probability. The average face detection rate is 98.3 percent when wearing a mask. Third, with a varied dataset the YOLO-v5 method is very accurate. As a result of consistent test findings, our recommendations for face detection while wearing a mask apply to all datasets. The test results prove that the YOLO-v5 algorithm is highly recommended for detecting faces using masks. Although this research contributes to the accuracy of face detection with a mask or not, this research has limitations, such as further research on real-time masked face detection and addition of facial temperature detection.

salam

Dr. I Nyoman Gede Arya Astawa, ST., M.Kom
(Komang Arya)
Politeknik Negeri Bali
Jurusan Teknik Elektro
Prodi Manajemen Informatika
Telp: 08123814894

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I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>

[Register] Editor Decision

Nisa Ayunda <register@ft.unipdu.ac.id>

Wed, Jul 5, 2023 at 2:24 AM

To: I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>, I Made Ari Dwi Suta Atmaja <arisuta@pnb.ac.id>, Aji Prasetya Wibawa <aji.prasetya.ft@um.ac.id>

I Nyoman Gede Arya Astawa, I Made Ari Dwi Suta Atmaja, Aji Prasetya Wibawa:

We have reached a decision regarding your submission to Register: Jurnal Ilmiah Teknologi Sistem Informasi, "Dataset variation for masked face detection using YOLO-v5 method".

Our decision is to: Accept Submission

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I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>

Notification of Acceptation for Register-Paper 3249

2 messages

Register Register <register@ft.unipdu.ac.id>
To: I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>

Wed, Jul 5, 2023 at 2:50 AM

Dear Author(s),

Thanks your contributions to Register. We are pleased to inform you that your paper

Paper ID : 3249
Paper title : Dataset variation for masked face detection using YOLO-v5 method
Author(s) : Fachrul Kurniawan, I Nyoman Gede Arya Astawa, I Wayan Budi Sentana, I Made Ari Dwi Suta Atmaja, Aji Prasetya Wibawa

has been **accepted** and considered to be published by the **Register: Jurnal Ilmiah Teknologi Sistem Informasi** on **Volume 9 Issue 2 July 2023**. Congratulations!

We will send Letter of Acceptance and proceed publish your article, after we receive the Publication Ethics, Authorship Statement that has been full filled and signed, and Proof of Publication Payment of 2,500,000 IDR transferred to Nisa Ayunda BNI 1138246033.

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Publication Ethics, Authorship Statement and Proof of Transfer of Publication Fees can be sent via this email and/or whatsapp number +62 852-3423-1202 (Nisa).

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We thank you for your attention.

Yours Sincerely,

Nisa Ayunda, M.Si

Editor in Chief

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Index by:



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Wed, Jul 5, 2023 at 12:41 PM

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[Register] Editor Decision

Nisa Ayunda <register@ft.unipdu.ac.id>

Fri, Jul 28, 2023 at 12:57 PM

To: I Nyoman Gede Arya Astawa <arya_kmg@pnb.ac.id>, I Made Ari Dwi Suta Atmaja <arisuta@pnb.ac.id>, Aji Prasetya Wibawa <aji.prasetya.ft@um.ac.id>

I Nyoman Gede Arya Astawa, I Made Ari Dwi Suta Atmaja, Aji Prasetya Wibawa:

The editing of your submission, "Dataset variation for masked face detection using YOLO-v5 method," is complete. We are now sending it to production.

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Fri, Jul 28, 2023 at 1:17 PM

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Facemask Detection using the YOLO-v5 Algorithm: Assessing Dataset Variation and Resolutions

<https://journal.unipdu.ac.id/index.php/register/article/view/3249>

Register: Jurnal Ilmiah Teknologi Sistem Informasi, P-ISSN: 2503-0477, E-ISSN: 2502-3357, Vol 9 No. 2

Publish: 28-07-2023

DOI: <https://doi.org/10.26594/register.v9i2.3249>

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ACCEPT Q3, JURNAL BISNIS, UKM MALAYSIA

Selamat pagi bu, per minggu lalu artikel kami yang dibantu proofreadingnya sudah terbit, terima kasih atas supportnya"



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Research article

Facemask Detection using the YOLO-v5 Algorithm: Assessing Dataset Variation and Resolutions

Fachrul Kurniawan ^{a,*}, I Nyoman Gede Arya Astawa ^b, I Wayan Budi Sentana ^c, I Made Ari Dwi Suta Atmaja ^d, Aji Prasetya Wibawa ^e

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ABSTRACT

The Covid-19 pandemic has made it imperative to prioritize health standards in companies and public areas with a large number of people. Typically, officers oversee the usage of masks in public spaces; however, computer vision can be employed to facilitate this process. This study focuses on the detection of facemask usage utilizing the YOLO-v5 algorithm across various datasets and resolutions. Three datasets were employed: the face with mask dataset (M dataset), the synthetic dataset (S dataset), and the combined dataset (G dataset), with image resolutions of 320 pixels and 640 pixels, respectively. The objective of this study is to assess the accuracy of the YOLO-v5 algorithm in detecting whether an individual is wearing a mask or not. In addition, the algorithm was tested on a dataset comprising individuals wearing masks and a synthetic dataset. The training results indicate that higher resolutions lead to longer training times, but yield excellent prediction outcomes. The system test results demonstrate that face image detection using the YOLO-v5 method performs exceptionally well at a resolution of 640 pixels, achieving a detection rate of 99.2 percent for the G dataset, 98.5 percent for the S dataset, and 98.9 percent for the M dataset. These test results provide evidence that the YOLO-v5 algorithm is highly recommended for accurate detection of facemask usage.

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1. Introduction

As a consequence of the Covid-19 outbreak, wearing masks has become mandatory [1]. Given the extensive range of community interactions, companies and public venues employing a large number of people must prioritize health procedures [2, 3]. This requirement extends to the supervision of mask usage in public spaces. However, relying solely on manual supervision, such as deploying officers in airports or shopping centers to monitor mask-wearing compliance, proves to be inefficient and increases the risk of virus transmission. Therefore, it is crucial to conduct research on face detection while individuals are wearing masks. Computer vision offers a viable solution by enabling surveillance technology, particularly object detection [4, 5].

The utilization of computer vision has witnessed substantial growth in recent years, leading to the development of advanced applications and automation systems capable of real-time object detection, distinction, and localization in images and videos [4, 6, 7]. Detection, unlike classification, is a more intricate process. While classification can identify objects in an image, it fails to determine their precise location within the image [8]. Moreover, in scenarios where an image contains multiple objects

[9], the combination of feature extraction methods and a classifier for face detection may not yield optimal results [10].

Researchers have extensively explored real-time object detection, particularly face detection, in public settings [11-13]. Various methods have been employed, including the Viola-Jones method [11], Holistic Matching Methods [14], Local Binary Pattern [13], CNN [1], and others. Several face detection methods rely on features such as eyes, nose, and mouth [15, 16]. However, recognizing faces entails overcoming numerous challenges [3, 17, 18], such as variations in lighting, face position, noise, and other factors. The difficulty increases when individuals wear accessories like masks [1, 7]. Deep learning-based approaches have been employed in investigations to detect faces while individuals are wearing masks. For example, researchers [5] utilized the YOLO-v5 method with datasets from the AIZOOTe team's FaceMaskDetection. In another study, researchers [19] employed the YOLO-v3 approach with a faster R-CNN to achieve improved results in face detection with masks. Additionally, researchers [19] combined the YOLO-v3, DBSCAN, DFSD, and MobileNetv2 algorithms to detect individuals wearing masks on their faces. The choice of method is crucial for effective face detection with masks [20], and acquiring datasets for training poses a challenge [21] as face datasets with masks are not widely available.

This study presents a face detection method using the YOLO-v5 algorithm to address the challenge of mask detection. The unified model created by this deep learning approach enhances efficiency by providing a bounding box that represents the recognized face and a corresponding label indicating mask usage. What sets this research apart is the utilization of generated datasets. By generating synthetic datasets that transition from unmasked faces to masked faces, the system can effectively identify the presence of masks. To evaluate the system's accuracy, three distinct datasets will be tested: the face dataset with masks (M dataset), the synthetic dataset (S dataset), and the combined dataset (G dataset), each at different resolutions. Computer vision researchers will find the proposed synthetic dataset in this study particularly valuable. The primary objective of this research is to assess the accuracy of the YOLO-v5 algorithm in detecting mask usage. Additionally, the algorithm was tested on datasets comprising individuals wearing masks, as well as synthetic datasets.

2. Materials and Methods

Typically, a detection system utilizes a classifier or localizer to detect objects by applying the model at various locations and scales within an image [22]. The YOLO method, however, takes a distinct approach by applying a single neural network to the entire image [23]. This approach involves dividing the image into regions, predicting bounding boxes and probabilities. Each bounding box provides a prediction of object classification, allowing for identification of objects within the image. The highest probability within a bounding box is selected as the object separator, while the lowest value is disregarded. With its straightforward architecture and convolutional layers, the YOLO algorithm achieves real-time object detection. It is a powerful neural network for real-time object detection [19]. The YOLO algorithm was developed by Redmon et al. [24], who claims that it can achieve high accuracy and reliable prediction results.

The YOLO algorithm can accurately predict objects by providing bounding boxes for images [25]. It operates by labeling each grid in the image and applying image classification and object localization algorithms to these labeled grids, as described earlier. This algorithm analyzes each grid independently, marking labels that contain objects and bounding boxes within each grid. The R-CNN and YOLO algorithms share similar characteristics. Utilizing convolutional features [24], each grid cell generates a hypothetical bounding box and scores it based on the proposal. In Blaschko and Lampert's study, the bounding box approach (Bounding) is employed for object localization to overcome the limitations of the sliding window method [26]. The sliding window method is based on the CNN approach, which involves partitioning the image into windows of the same size, resulting in multiple cut areas containing various objects, classes, and object bounding boxes [19]. These objects are then combined to form a unified object. CNNs play a crucial role in pattern recognition related to computer vision due to their improved spatial feature extraction capabilities and cost-effective processing [1]. CNNs have made significant advancements in facial recognition technology by leveraging feature learning and transformation invariant components.

Numerous studies propose innovative approaches for detecting faces obscured by masks, with most of them treating the problem as a binary classification task using a simple CNN algorithm. However, when it comes to face detection while wearing masks, it requires employing an object detection model to identify a large number of individuals and provide bounding boxes. These bounding boxes are then assigned a specific color based on whether the person is wearing a mask or not, allowing for an analysis of the mask-wearing ratio using the YOLO-v5 method. The YOLO-v5 algorithm, an evolution of YOLO-v4.5, is adopted as the object recognition algorithm due to its impressive speed of 140 frames per second [5]. YOLO-v5 effectively handles the challenge of detecting faces at different scales, although it may struggle with smaller objects. This capability alleviates the difficulties associated with varying face sizes and improves overall face detection performance.

Several studies have focused on masked face detection using the YOLO-v5 algorithm. For instance, Kannan et al. [27] has successfully detected and differentiated between masked and non-masked individuals under complex environmental conditions using the YOLO-v5 algorithm. Shetty et al. [28] developed a model that accurately recognizes people with or without masks and also determines whether the mask properly covers the nose and mouth. Additionally, Fauzi et al. [29] created the YOLO-v5s model, achieving a high accuracy of 90.37% in identifying mask usage. Based on these studies' outcomes, the YOLO-v5 algorithm proves effective in detecting masked and non-masked faces, and its performance has been evaluated on various datasets.

In this paper, the methodology involves a concise three-step approach. The first step is dataset creation, followed by model training in the second step, and finally, testing the trained model in the last step. To accomplish this, NumPy, PyTorch, and OpenCV were utilized as tools in this study.

2.1. Dataset Preparation Process

The dataset utilized in this study consists of three components: the M dataset, the S dataset, and the G dataset. The M dataset comprises face images of individuals wearing masks and was obtained from Larxel [30]. The S dataset is a synthetic dataset and the G dataset is a combined dataset. The synthetic dataset was created by employing a machine learning algorithm to generate face images wearing masks from a collection of face images without masks. The process of generating the synthetic dataset is depicted in Figure 1, where face images without masks were captured using a smartphone camera.

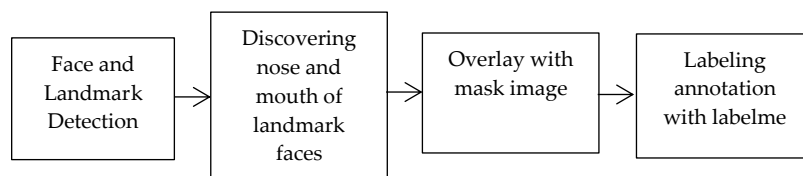


Fig. 1. Dataset Synthesizing Process

Figure 1 illustrates the step-by-step process involved in creating a synthetic dataset. The process begins by preparing a face image without a mask, followed by face and landmark detection. The next objective is to accurately determine the positioning of the nose, mouth, and chin relative to the detected facial landmarks. Subsequently, the face image is overlaid with the mask's picture, but this can only be achieved if the face is captured in a frontal orientation facing the camera. Lastly, the annotation process, in which a label for an image is produced, is performed using the labelme program, resulting in data in the form of xml files that include bounding boxes and corresponding labels. Figure 2 below showcases the annotation process, which involves assigning labels to images by specifying bounding boxes and class names for the objects present in the image.



Fig. 2. The application of a mask to a face image

Figure 2 illustrates the difference between two images based on the presence or absence of a mask, showcasing the left column without a mask and the right column with a mask. These results emphasize the importance of testing and evaluating the accuracy of mask detection, along with its suitability for various scenarios [20]. The YOLO-v5 method is an advanced algorithm known for its effectiveness in object detection [27], making it highly suitable for detecting masked faces in public spaces as a preventive measure against the spread of COVID-19 [31].

2.2. Training

The training process is presented in Figure 3. Three datasets were utilized for this study. The face image dataset consisted of 853 images depicting faces with masks. The synthetic dataset comprised 262 facial photos, and the merged dataset contained 1,115 photos in total. Each dataset was supplemented with 192 additional face photos without masks. Prior to training, the image dataset was divided into two folders: one for the training set and the other for the validation set, with an 80% and 20% split, respectively. The face images with masks were converted to Darknet format, as were the images without masks. The labeling of the face images involved assigning symbol 0 to indicate faces wearing masks and symbol 1 for faces without masks. The YOLO-v5 algorithm was employed for training. Consequently, a comprehensive database of faces wearing and not wearing masks was created through this training process.

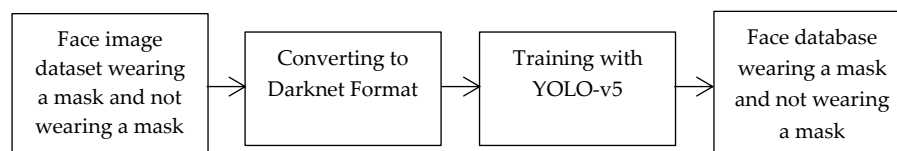


Fig. 3. The training process using YOLO-v5

The training process in this study was carried out using OpenCV (Open Source Computer Vision Library) and NumPy. Each dataset and pixel were trained separately, resulting in the creation of three databases: M, S, and G.

2.3. Testing

In this study, tests were conducted to develop a system using the PyTorch tool and then its performance was evaluated on multiple databases. The objective was to determine face detection while wearing masks. To achieve this, the study proposed a face detection procedure utilizing two models. The first model was designed to detect faces in the image, while the second model assessed the presence or

absence of masks within the discovered bounding boxes. The evaluation involved analyzing various facial photos, both with and without masks.

3. Results and Discussion

Following the training procedure depicted in Figure 3, computational training was conducted on each dataset using a GPU with the YOLO-v5 algorithm on the Google Colab server. The training utilized pre-trained weight values with epoch 30, batch size 16, and a threshold ranging from 0.5 to 0.95. The images were trained at resolutions of 320 pixels and 640 pixels, and the outcomes are presented in Table 1.

Table 1. Training outcomes for the three datasets

No	Dataset Type	Number of face images wearing masks (pieces)	Image resolution (pixel)	Training time (hour)	mAP@ 0.5	mAP@ 0.5:0.95	Prediction
1	Dataset M	853	320	0.080	0.583	0.343	0.9
2	Dataset M	853	640	0.145	0.613	0.389	0.932
3	Dataset S	262	320	0.126	0.986	0.625	0.955
4	Dataset S	262	640	0.204	0.986	0.694	0.964
5	Dataset G	1115	320	0.104	0.604	0.392	0.929
6	Dataset G	1115	640	0.275	0.634	0.44	0.965

Table 1 provides a summary of the training outcomes for the three datasets. It can be observed that training with higher-resolution images takes a longer time. The prediction value shows fairly good results, as evidenced by the accuracy of the predictions across various datasets and resolutions, which indicates good performance. The prediction value represents the ratio of true positive predictions to the overall positive projections, which is a significant measure of prediction performance. The mean Average Precision (mAP), an evaluation parameter for object detection, is calculated as the average value of Average Precision (AP). The obtained mAP values with a threshold of 0.5 to 0.95 are quite good. Increasing the threshold leads to a reduction in false positives. However, setting the threshold too high may result in missed detections and lower confidence in correct predictions. The assessment ratings obtained during the training process indicate highly precise and successful training. These training results align with a previous study by Larxel [30] that highlights the influence of image resolution on training time and predictions. It is also observed that Google Colab is a favorable platform for training with large datasets and achieving fast results. Furthermore, the mAP value is strongly dependent on the chosen threshold. Therefore, the analysis confirms that mAP can serve as an effective evaluation parameter for assessing object detection performance [32].

3.1. System testing results

Following the successful training, the developed system was tested using the training result database. The implementation of the system focuses on detecting face images. Once a face is recognized, the system generates a new image displaying a bounding box around the detected face. Additionally, a file is provided that includes the coordinates of the bounding box along with the estimated probability of the face wearing or not wearing a mask.

The testing phase involves evaluating the system's performance on single or multiple faces in public places. Figure 4 illustrates the results obtained from the testing process, showcasing the outcomes of the system's detection capabilities. As depicted in Figure 4, the system constructed with YOLO-v5 demonstrates accurate prediction of faces wearing masks and faces without masks. The utilization of the YOLO-v5 approach yields excellent results for face detection with masks, as the trained object detector effectively detects the bounding box and associated label. The bounding box visually represents the recognized faces, while the label indicates whether the individual is wearing a mask or not. The system is designed to perform real-time testing on both 2D images and videos. The test results reveal precise face detection within bounding boxes, accompanied by probability information. In this study, the system was evaluated using a test dataset consisting of 475 face images, encompassing both masked and unmasked faces. The findings of this research align with Kannan et al.'s study [27], highlighting the YOLO method's proficiency in object detection and probability estimation. Consequently, the results of this analysis establish that the utilization of the YOLO method in this study is highly suitable for detecting whether a face is wearing a mask or not [30].

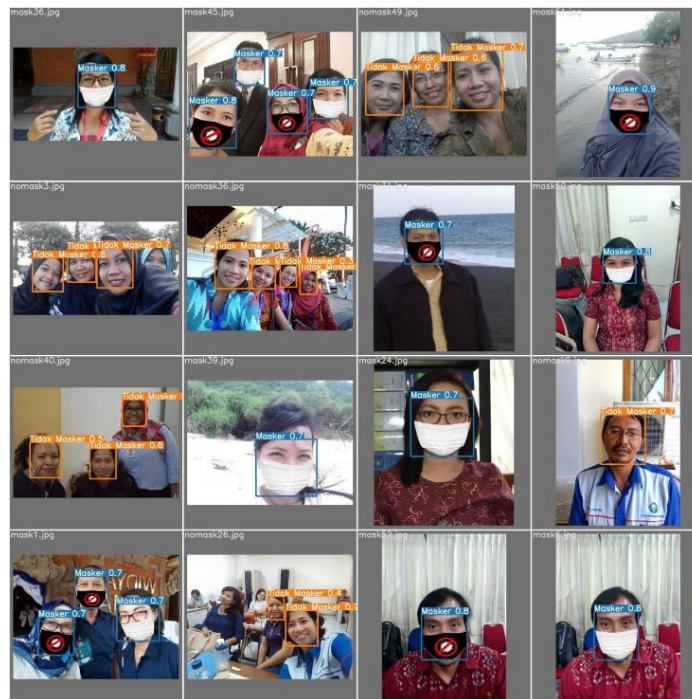


Fig. 4. Training System test results with predictive probabilities

Table 2. The results of face detection wearing masks on different datasets and resolutions

Dataset Type	Image resolution (pixel)	Detection results
Dataset M	320	97,8%
Dataset M	640	98,9%
Dataset S	320	97,4%
Dataset S	640	98,5%
Dataset G	320	98,2%
Dataset G	640	99,2%

Table 2 showcases the test results, revealing an impressive average accuracy of 98.3 percent across various datasets and resolutions. Notably, the G dataset demonstrates the highest efficacy in detecting masked faces. The YOLO-v5 algorithm, employed in this study for face detection with masks across different datasets, proves to be highly recommended based on the test results. These findings align with the research conducted by Javed et al. [31], affirming the YOLO-v5 method's remarkable accuracy in detecting masked faces.

With such accurate results, this method holds great potential in aiding the prevention of virus and germ transmission by enabling anticipation and monitoring of the presence or absence of face masks in public areas.

4. Conclusion

This study focuses on face detection when individuals are wearing masks, accomplished through the analysis of various datasets: a dataset of faces wearing masks (dataset M), synthetic datasets (dataset S), and combined datasets (dataset G). The research has yielded three significant findings. Firstly, it has been observed that time and prediction performance are strongly influenced by image resolution. The system was developed using the YOLO-v5 algorithm, and tests were conducted on multi-face photos encompassing diverse datasets and resolutions. The highest detection rates were achieved at a resolution of 640 pixels, with dataset M achieving 98.9 percent accuracy, dataset S achieving 98.5 percent accuracy, and dataset G achieving 99.2 percent accuracy. Secondly, the YOLO-v5 method has demonstrated remarkable capabilities in object detection and probability estimation. The average face detection rate when wearing masks reached 98.3 percent. Thirdly, the YOLO-v5 method showcased consistent accuracy across various datasets, reaffirming its effectiveness. As a result of these consistent findings, our recommendations for face detection while wearing masks are applicable to all datasets studied. The test results strongly advocate for the utilization of the YOLO-v5 algorithm as a highly

recommended approach for detecting faces using masks. While this research significantly contributes to the accuracy of mask-based face detection, it also has limitations. Future investigations should explore real-time masked face detection and consider the incorporation of facial temperature detection as an additional component.

Author Contributions

F. Kurniawan: Conceptualization, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing – original draft, and writing - review & editing. I. G. A. Astawa: Conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, validation, writing - original draft, and writing – review & editing. I. W. B. Sentana: Conceptualization, investigation, methodology, resources, software, supervision, validation, and writing - review & editing. I. M. A. D. S. Atmaja: Conceptualization, data curation, investigation, project administration, resources, supervision, validation, visualization, and writing - review & editing. A. P. Wibawa: Conceptualization, formal analysis, investigation, methodology, resources, software, supervision, validation, visualization, writing – original draft, and writing - review & editing.

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