Implementation Of Personal Protective Equipment Detection Using Django And Yolo Web At Paiton Steam Power Plant (PLTU)

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Implementation Of Personal Protective Equipment Detection Using Django And Yolo Web At Paiton Steam Power Plant (PLTU)

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ABSTRACT

Work accidents can occur at any time and unexpectedly, so work safety is always associated with health because the safety system in Indonesia is related to the K3 (Occupational Safety and Health) program. To create a safe and healthy work environment, occupational safety and health management is implemented to avoid work accidents by requiring every worker to use Personal Protective Equipment (PPE). In this case, it is necessary to have direct detection to make it easier to check workers' violations. The development of this system will use the Yolov8 Method with the Django web-based user interface framework where the system will detect each worker directly. The research starts from literature study, identification of problems to be solved, image data collection, then preprocessing data and modeling system or training data, finally the system deployment process using the Django framework. The system is made to detect the use of PPE and has successfully detected the four classes that have been determined based on the bounding box with accuracy from 75.1% up to 95% and has an average accuracy of 82.3% from 230 testing data and has a mAP50 value of 81.6%, a precision value of 90.3% and a recall value of 75.1%.

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1. INTRODUCTION

Every employer wants the best for the company and its workforce in order to achieve their goals. Occupational Safety and Health (K3) is at the forefront of creating a healthy and safe work environment because the safety system in Indonesia is related to the K3 (Occupational Safety and Health) program [1]. Because, work accidents can occur at any time and unexpected time starting from the tools used, machines, materials or materials, even from the behavior of the workers themselves. To create a safe and healthy work environment, Occupational Safety and Health (K3) management is implemented to avoid work accidents that cause company and labor losses by requiring workers to use Personal Protective Equipment (PPE) [2].

Indonesia has the largest power plant, the Paiton Steam Power Plant (PLTU) which has a high capacity of 4,600 megawatts (MW), located in Binor Village, Probolinggo Regency, East Java [3]. In the process of Steam Power Plant (PLTU) using a lot of fuel, machinery and heavy equipment there are potential hazards that can cause work accidents. It is known that in 2018 in this company there was a work accident that fell from the 6th floor when dropping material [4]. Personal Protective Equipment (PPE) as a form of protection in minimizing the possibility of work accidents and prioritizing safety at work. The company has a big responsibility to its workers for occupational safety and health by providing personal protective equipment in accordance with the requirements and standardization that has been determined [5].

There are several studies related to the detection of the use of Personal Protective Equipment (PPE). In 2021, The research focuses on the use of PPE Safety Helmet and Vest through videos using the You Only Look Once (YOLO) version 5 method with the best results at batch parameter 8 epoch 50 with an accuracy of 95%

from a test of 12 image data. However, the object detection results of the YOLO method are in the form of a bounding box whose segmentation is not directly on the intended object.

Researchers [6]. developed a method using Mask Region Convolutional Network (Mask R-CNN) by distinguishing four classes of objects, namely workers using personal protective equipment and hair (hair) or no_vest (not vested) and workers who do not use personal protective equipment. The best result is at parameter epoch 35 with loss value 0.1985 and val_loss value 0.1933 in 461s 922ms/step with 95% accuracy from 250 test images.

The next research [7] on the development of a system on PPE detection is using the Yolov2 method based on flask web. Stages starting from data collection, image annotation, modeling, and finally deployment using flask which produces a system with a bounding box with an average accuracy of 81.60%.

This type of research is a system development to detect Personal Protective Equipment (PPE) in the form of Safety Helmet and Vest using YOLOv8 and Django Web user interface in realtime. Detection is done using a webcam which is then marked in the form of a bounding box according to the dataset of previous training results. The purpose of system development is to produce a detection system that is more accurate than before. With this system, it is expected to be able to detect workers using personal protective equipment or not in monitoring and facilitate checking violations of the use of personal protective equipment.

2. METHODS

The research stage as shown in figure 1 starts from the literature study process based on books, research, and journals related to the topic of PPE detection, Yolo, and Django. Then formulate the problem, namely building a detection system using the latest methods to facilitate checking violations of PPE use [8]. Followed by collecting datasets and processing data according to the plan, namely detection focusing on Safety Helmet and Vest. After that, modeling and deployment of the system, finally testing and analyzing the results of the system that has been made.

Fig 1. Research Stages

2.1. Literature Study

Used to study theories and knowledge related to research problems. As a comparison to previous research and a reference in improving or completing research used as a solution to previously identified problems. Literature studies come from books, journals and previous research, namely the detection of the use of personal protective equipment for the safety and health of the workforce [9]. This is needed so that workers are aware of their discipline and obligations while in the work environment. And system development is carried out to create a user interface to make it easier to check workers' violations.

2.2. Problem Identification

The problem that often occurs is that workers are negligent about their safety and are not disciplined in using personal protective equipment while in the work environment which causes work accidents. The detection of personal protective equipment has been done a lot before so that development will be carried out from several problems that occur [10]. From the results of the problem identification, it becomes a reference or description in the development of this system, then the system development will create a user interface for detecting personal protective equipment using the Django Web-based Yolov8 method. This is to motivate the development of the system and facilitate the settlement process so that checking violations does not take a long time.

2.3. Dataset Collection

In every research, data is needed to process as needed. The dataset contains a set of images of workers in the construction sector who use PPE in the form of helmets (head protectors), vests (vests) and workers who do not use PPE. Datasets are obtained through an online-based dataset provider source, namely https://roboflow.com/. And can be accessed via the following link https://public.roboflow/object-detection/hard-hatworkers by downloading the Pascal VOC (Visual Object Classes) dataset format so that the downloaded annotation format is *.xml [11].

The development of this system uses roboflow to collect datasets as shown in figure 2. roboflow main page, the source of the online-based dataset provider is https://roboflow.com/. This dataset contains a random set of images of workers involved in construction [12].

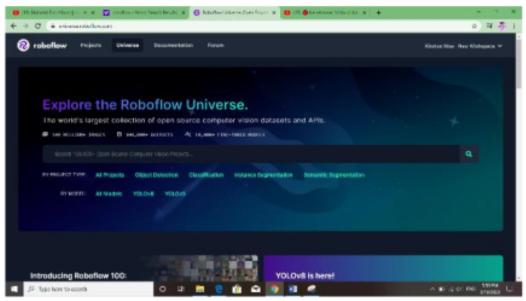

Fig 2. Roboflow Main Page

There are 7.041 image data accompanied by annotations or labeling which are then downloaded in yolov8 format to facilitate the detection process. Can be seen in figure 3 how to download roboflow data with yolov8 format.

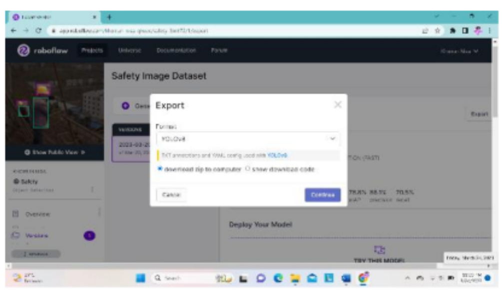

Fig 3. Format Donwload Yolov8

Can be seen in figure 4 the results of the yolov8 format download consist of test data, training data, val data, and yaml data folders. Of the 7.041 images, the dataset has several image sizes from 179 x 270 pixels to 640 x 959 pixels stored in *.jpg format and has been equipped with head, helmet, and person class annotations.

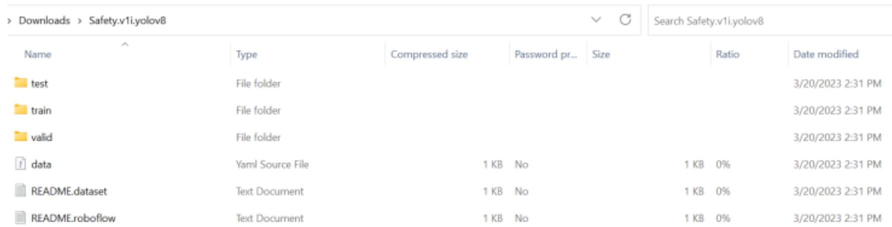

Fig 4. Raw Dataset

2.4. Prepocessing Data

The data obtained through Roboflow are random images of workers using PPE in the form of helmets and vests and there is also image data that already has annotations in the form of head, helmet, and person classes [13]. The research is categorized into 4 parts, namely helmet, no_helmet, vest, and no_vest with the image annotation process using makesense.ai, an online annotation site with the aim that the method can be trained properly and as desired [7].

From 7,041 datasets obtained through Roboflow, then from the data taken as many as 2,300 random image data that will be used as training and validation data in the study. The retrieved image and annotation names must have the same name using 4 classes, namely helmet, vest, no_helm, and no_vest, each of which will be marked with a bounding box as shown in figure 5 below.

Fig 5. Class Representation

Roboflow develops computer vision services to run AI projects. The first thing to do is upload data on the roboflow platform and then it will be organized to improve the automatic model of analyzing images in order to make it easier when doing bounding boxes and labelling, annotations on images are integrated and simplified directly with the roboflow model by labeling each object needed and the data will be input to the train model. The model can be deployed so that the detection results of the trained model can be seen [14]. Roboflow workflow is very easy as shown in figure 6 below.

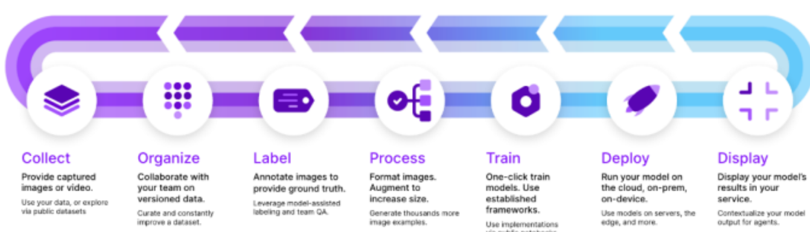

Fig 6. Roboflow Workflow

In this research, the dataset and annotation process use roboflow based on predetermined classes, namely helmet, no_helmet, vest, and no_vest. The annotation results are divided into three parts in the form of training data, testing data and validation data accompanied by yaml data. There are 230 test data, 1,610 training data, and 460 valid data, each of which already has a label. Image data that has been annotated will be used to create a detection model using Google Collaboratory by calling the data. It can be downloaded first or called directly using the link provided. Roboflow dataset samples in figure 7, namely images that use and do not use personal protective equipment.

Fig 7. Samples Dataset

The process of labeling the images is according to the needs of the class that will be used in the study. In this research, four predefined classes consist of helmet, vest, no_helmet, and no_vest. The helmet and vest classes represent workers who use Personal Protective Equipment (PPE), while the no_helmet and no_vest classes represent workers who do not use Personal Protectiv Equipment (PPE) so the person classes previously available from Roboflow can be eliminated. The annotations done is saved in *.txt format [15]. Figure 5. represents each of the classes used in this study. Process The image annotation process performed using Roboflow is depicted in figure 8.

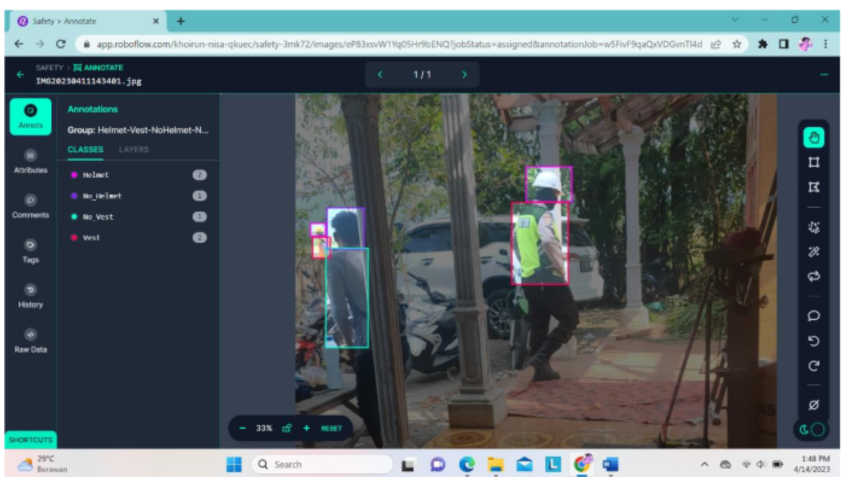

Fig 8. Class and Image Annotations

2.5. Modeling

The pre-processed data is used as training and testing of the data recording process. There are two files used as the basis for training the system, namely training data and testing data. The model uses the Yolov2 algorithm with the training process at Google Collaboratory. The testing process is directly webcam-based or in realtime using the flask web browser framework [16].

Yolov8 is the latest version of an object detection and image segmentation model designed with a strong focus on speed, size, and accuracy, making it an attractive choice for a wide range of vision AI tasks. YOLOv8 outperforms previous versions by incorporating innovations such as a new backbone network, a new anchor-free split head, and new loss functions. These improvements enable YOLOv8 to deliver superior results, while maintaining a compact size and exceptional speed. The yolov8 workflow can be seen in figure 9, which begins with dataset collection then data traning and continued with the deployment of the system as desired [17].

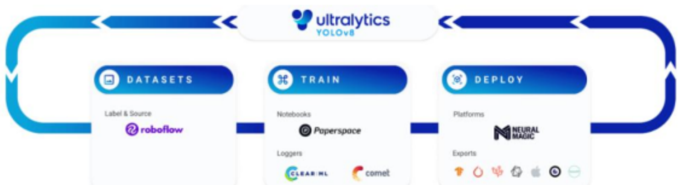

Fig 9. Yolov8 Workflow

This research uses the Yolov8 algorithm and the training process at Google Collaboratory, followed by creating a django web user interface and testing the system directly web-based or realtime using the Django web browser framework. The training process is carried out to train machine learning so that it can detect according to the data that has been processed [18]. From the training results there is a weight/best.pt file that is used for the model testing process. The training results can be seen in figure 10 below using 40 epochs.

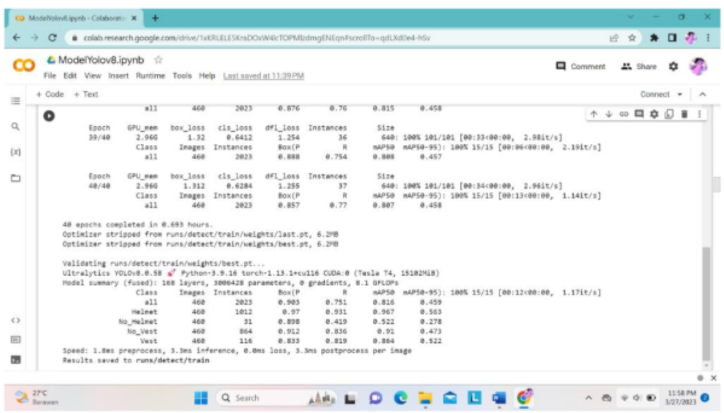

Fig 10. Training Process

After the development is complete, the system takes realtime images and sends them for analysis. Confusion matrix as an accuracy analysis in determining the number of classes in the calculation round. The following is a picture of the confusion matrix used in this study. System accuracy is needed to find out how accurate the system that has been made by relying on the predict and recall values. in table 1 the confusion matrix process used in this study [7].

Table 1. Confusion Matrix

Predict	**Actual Values**	
	Positif	**Negative**
Positif	TP	FP
Negatif	FN	TN
	True	

The type of data used and the result of the categorization, if a helmet and safety vest are found and the system is able to correctly identify both then the finding is classified as True Positive (TP). A detection finding is considered as a False Positive (FP) if the item is not a helmet and safety vest but is identified as such by the system. When the object of helmet and safety vest is detected as not helmet and safety vest, it will be classified as False Negative (FN). And if the non-helmet and safety vest object is detected as not a helmet and safety vest, it will be classified into True Negative (TN) [19]. To get the accuracy result, the accumulation will be calculated using the following formula as follows:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \tag{1}$$

To calculate Precision, the formula is used:

$$Precision = \frac{TP}{TP + FP} \tag{2}$$

To calculate Recall, the formula is used:

$$Recall = \frac{TP}{TP + FN} \tag{3}$$

2.6. Deployment System

In this process, namely creating a user interface using the django framework which is built using the python language after getting the right and accurate model. Django itself is used as a web deployment prototype that can recognize workers who use safety helmets and safety vests and do not use them [20]. Starting with CMD or using the Git Bash plugin to open the folder that will be used to deploy the system, then by creating a virtual environment so that a project is isolated. Next install the Django framework and the plugins needed for the system then build the system as desired and finally test the system. The system deployment process can be seen in figure 11 according to the flow.

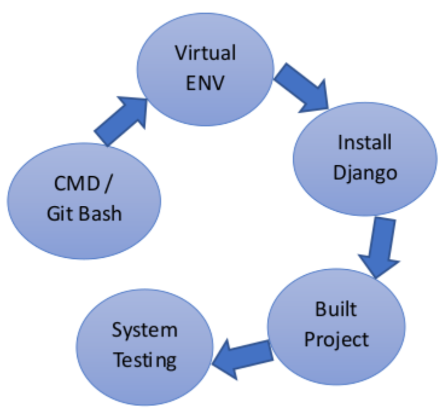

Fig 11. Deployment System Process

Previous research has made web deployment using flask with the yolov2 method. Flask is a web microframework built with python categorized as a web framework. The user interface design is made with a simple "realtime safety detection" page that contains Navigation Bar, Running Text, and realtime detection results [7]. The User Interface design of this system can be illustrated in figure 12. The simple User Interface is a detection page that can use more than one camera. detection takes place if the camera is active on the available camera.

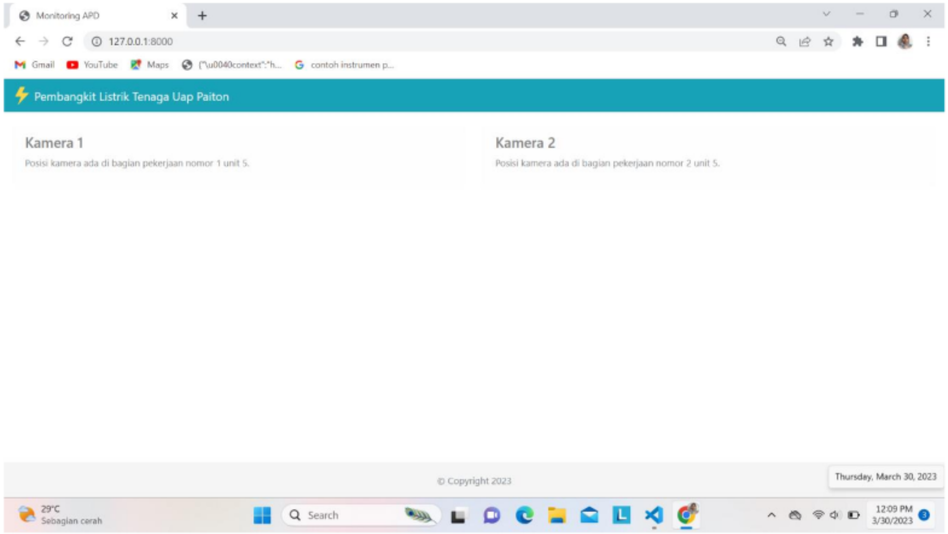

Fig 12. User Interface Design

3. RESULTS AND DISCUSSION

3.1. Results

This research produces a web-based detection system using the Yolov8 algorithm in realtime. The data used is 2,300 image data which is divided into 3 parts, namely training data totaling 1,610 images, testing data totaling 230 images and validation data totaling 460 images consisting of 4 classes namely helmet, vest, no_helmet, no_vest. The resulting model shows that to detect safety helmet and vest is maximized with an accuracy of 95% of 230 test data and has a mAP value of 78.8%, a precision value of 86.1% and a recall value of 70.5%. Detection can use more than one camera such as CCTV which is placed in every corner of the room or workplace. However, not all detections are successful because there are several factors that cause the detection results to not match the model that has been made. From the results of system testing, there are several factors that affect detection, namely lighting, objects, camera specifications and position and object distance. In figure 13 training results on google collaboratory.

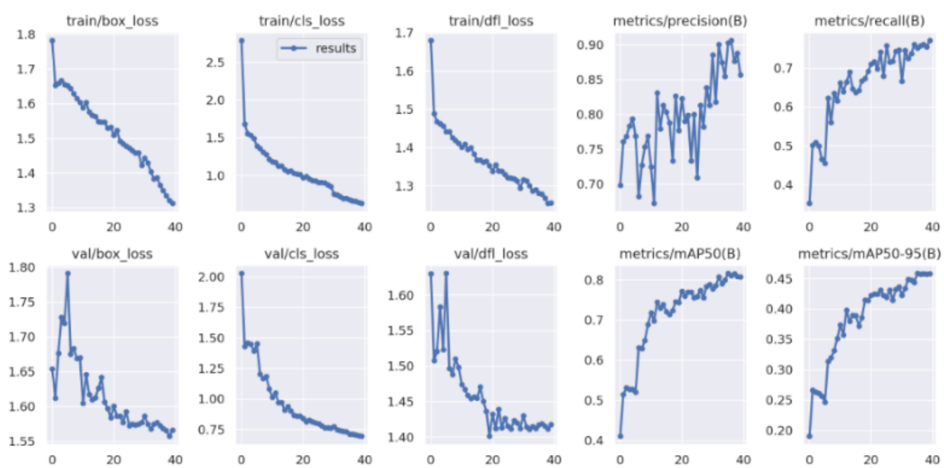

Fig 13. Training Result

Detection page using safety helmet and vest from at front view

From the detection results in realtime or live streaming on figure 14 with front facing, the test successfully detects using safety helmet and vest based on the bounding box of red color using a helmet with a helmet description and blue color using a vest with a vest description. However, the accuracy of each detection will change according to the position and lighting at the time of detection.

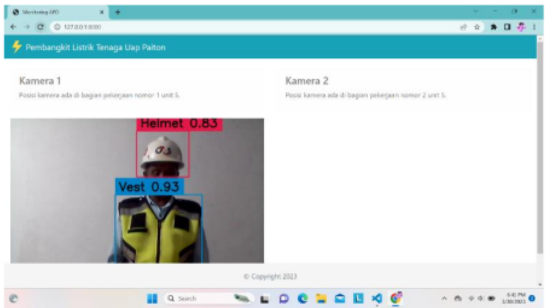

Fig 14. Front view detection result

Detection page using safety helmet and vest from at back view

From the detection results in realtime or live streaming on figure 15 with rear facing, the test successfully detects using safety helmet and vest based on the bounding box of red color using a helmet with a helmet description and blue color using a vest with a vest description.

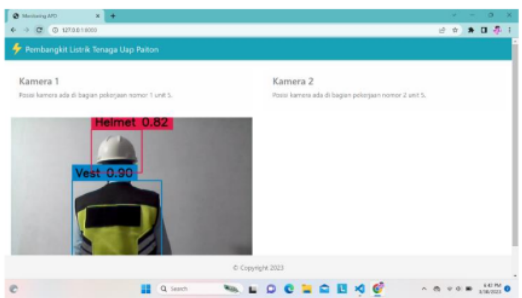

Fig 15. Rear view detection result

Detection page not using safety helmet and vest from at front view

From the detection results in realtime or live streaming on figure 16 with front facing, the test successfully detects not using safety helmets and vests based on the bounding box of green color not using a helmet with the description no_helmet and yellow color not using a vest with the description no_vest.

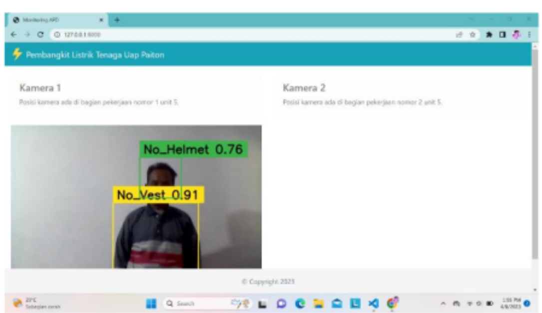

Fig 16. Front view detection result

Detection page not using safety helmet and vest from at back view

From the detection results in realtime or live streaming on figure 17 with rear facing, the test successfully detects not using safety helmets and vests based on the bounding box of green color not using a helmet with the description no_helmet and yellow color not using a vest with the description no_vest.

Fig 17. Rear view detection result

However, there are errors in detection due to lighting, internet slowness, camera specifications and also pre-made models. This happens because there are similarities in the intended object and the image is not clearly legible. For example, in Figure 18, the detection does not match the model that has been made before.

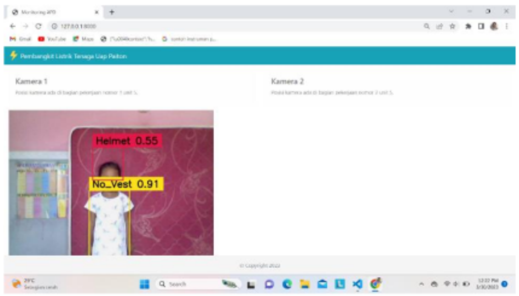

Fig 18. Detection results is not suitable

Safety no helmet and vest detection page

From the detection results in realtime or live streaming in the image, the test successfully detects the use of safety helmet and vest based on the bounding box of each color according to the previous annotation. The system can distinguish between safety helmet and vest as shown in the picture. Figure 19 shows that the system can detect objects not wearing a helmet and using a vest with an accuracy that continues to run as long as the object is detected by the camera marked by the bounding box.

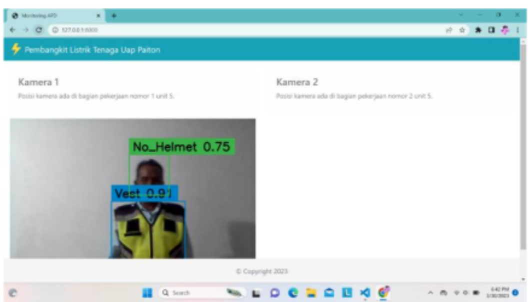

Fig 19. Detection of no_helmet (head) and vest

Figure 20 shows that the system can detect objects not wearing a helmet but wearing a kopyah and not using a vest with an accuracy that continues to run as long as the object is detected by the camera marked by the bounding box.

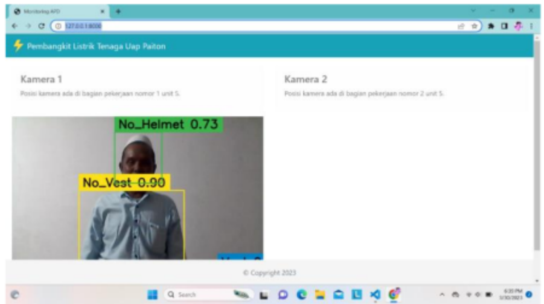

Fig 20. Detection of no_helmet (skullcap) and no_vest (shirt)

3.2. Discussion

This research requires calculations to determine the ability of the system and the accuracy value obtained. To determine the amount of accuracy between information and response using precision and recall using confusion matrix as shown in Figure 15. With mAP results of 86.1%, precision value of 90.3% and recall value of 75.1%. From these results the image can be detected correctly and accurately according to the model that has been made. Figure 21 is the result of a confusion matrix that has been created using Google Collaboratory.

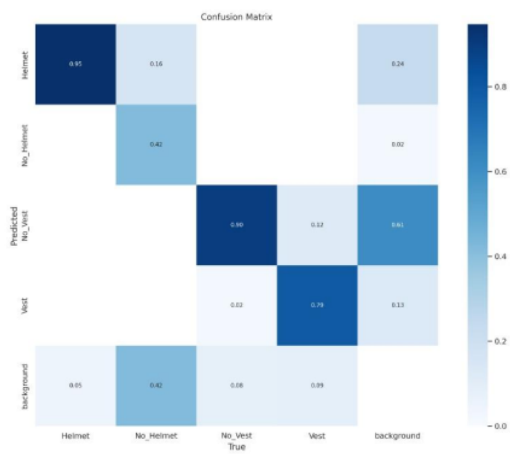

Fig 21. Confusion Matrix Results

The calculation of the mantrix can be seen in Figure 21 with the highest value of 95% helmet object. to calculate the average accuracy in this study, it can be seen in Table 2 below.

Table 2. Average Accuracy

Predict Class	Actual Value				
	Images	**Intances**	**Box (P)**	**Box (R)**	**mAP50**
All	460	2023	0.903	0.751	0.816
Helmet	460	1012	0.97	0.931	0.967
No_Helmet	460	31	0.898	0.419	0.522
No_Vest	460	864	0.912	0.86	0.91
Vest	460	116	0.833	0.819	0.522

$$Average\ Accuracy\ (Precision) = \frac{\text{H} + \text{NH} + \text{NV} + \text{V}}{\text{Object}} = \frac{97 + 89.8 + 91.2 + 83.3}{4} = 90.3\%$$

$$Average\ Accuracy\ (Recall) = \frac{\text{H} + \text{NH} + \text{NV} + \text{V}}{\text{Object}} = \frac{93.1 + 41.9 + 86 + 81.9}{4} = 75.1\%$$

$$Average\ Accuracy\ (mAP50) = \frac{\text{H} + \text{NH} + \text{NV} + \text{V}}{\text{Object}} = \frac{96.7 + 52.2 + 91 + 52.2}{4} = 81.6\%$$

$$Average\ Accuracy = \frac{\text{AP} + \text{AR} + \text{AmAP50}}{\text{Object}} = \frac{90.3 + 75.1 + 81.6}{3} = 82.3\%$$

There are images that are not clearly read due to distance or lighting during live streaming detection which causes the results to be incorrect. To reduce the occurrence of errors during detection by increasing the image data used in modeling. Taking datasets is attempted to pay more attention to the distance and clarity of the image to match the specified class. The addition of a more varied dataset both from the situation (morning and night) or various directions of data collection so that it can distinguish from each camera point of view.

4. CONCLUSION

This research uses the yolov8 algorithm to detect the use of personal protective equipment for workers. The data used is 2300 image data which is divided into three parts, namely 1,610 training data, 230 testing data and 460 validation data with four predetermined classes namely helmet, no_helmet, vest, and no_vest. This research has successfully built a django web-based realtime safety helmet and vest detection system and can detect properly and correctly images that use and do not use safety helmets and vests. The result of this detection accuracy from 75.1% up to 95% and has an average accuracy of 82.3% of 230 testing data and has a mAP50 value of 81.6%, a precision value of 90.3% and a recall value of 75.1%. There are images that are not clearly legible so that the detection results do not match the model that has been made. Some factors that affect detection are lighting, object, camera specifications and position and object distance.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

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