



Technology Computer Vision Detects Plastic Waste Objects in Public Areas Using YOLOv8

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Abstract

The increasing volume of plastic waste that continues to increase from year to year has the potential to damage the environment and endanger public health. Various waste handling efforts are carried out manually to sort the types of plastic waste in several public areas. Public areas are places of activity that have the potential to have a lot of plastic waste. Where the purpose of this study is to apply *computer vision* technology for the detection of plastic waste objects in public areas using YOLOv8. The results of this research are expected to contribute to more modern and efficient waste management efforts. Where the automatic detection system of plastic waste objects can make a scientific contribution to the development and application of *computer vision technology* in the environment.

Keywords: *Technology, Computer Vision, Plastic Waste, Public Areas, Yolov8*

1. Introduction

The development of digital technology in the modern era today has an impact on various aspects of human life. The global challenge that continues to be faced is environmental problems, especially pollution due to plastic waste. In Indonesia itself, the data on the volume of waste has increased to around 175,000 tons per day[1]. Plastic waste is a serious threat due to its hard-to-decompose nature, and has a negative impact on the environment if not managed properly[2][3][4].

Public areas that are crowded with various activities such as streets, tourist attractions, markets, parks and so on have the potential to experience an increase in the amount of plastic waste due to people's unawareness to dispose of waste in its place, this certainly has an impact on the surrounding environment if not handled properly[5][6].

Based on data from the Ministry of Environment and Forestry (MoEF), more than 60 million tons of waste per year are generated and about 17% is plastic waste[7]. Meanwhile, according to the International Union for Conservation of Nature (IUCN), 14 million tons of plastic waste from land ends up in the ocean, and is expected to triple by 2040 and by 2050 could exceed the number of fish[8].

Many efforts have been made by the government to overcome the problem of plastic waste, ranging from manual cleaning by cleaners, calling for a reduction in the use of single-use plastics, implementing paid plastic in supermarkets, sorting plastic waste by type for recycling, and so on.

Computer Vision technology as an intelligent system was developed to overcome challenges in various areas of waste management, where information about objects is obtained based on automatic detection in the form of images or videos[9][10].

Detection of plastic waste in public areas using YOLOv8 allows the system to recognize the shape and type of plastic waste such as bottles, food packaging, plastic bags, and others that can help in the sorting of waste for the recycling process. The system was trained with a dataset of the results of taking objects at the research site using Yolov8 computer vision technology.

The formulation of the problem in this study is that the increase in the volume of plastic waste that continues to increase from year to year has the potential to damage the environment and endanger public health, one of which is in public areas. Therefore, an effort is needed to handle plastic waste quickly by applying computer vision technology to detect the type of plastic waste in public areas. The purpose of the study is to find out the types of plastic waste that are widely found in public areas in the city of Ambon by applying the YOLOv8 algorithm and evaluating the performance of the YOLOv8 model with accuracy in detecting the type of plastic waste. The urgency of conducting this research is that the handling of plastic waste needs to be handled from an early age, considering the volume of plastic waste that has increased significantly.

2. Literature Review

There are several studies that discuss Computer Vision Technology with Yolov8, namely research conducted by Muhammad Diko Aprilyanto, Reni Rahmadew in 2025, with the title implementation of yolov8 (you only look once) for waste detection in Indonesian waters, This research aims to develop a waste detection system in water using YOLOv8[11].

The research was also conducted by Visen, Novrido Charibaldi in 2025 with the title The Application of Object Detection Using Yolov8 Deep Learning to Identify Inorganic Waste (Maximum of Ten Objects) in One Image. This research aims to use artificial intelligence (deep learning) with the YOLOv8 nano model to recognize several types of inorganic waste[6].

The research conducted by Bima Prasetyo, Nunik Pratiwi in 2025 entitled Detection of Organic and Inorganic Waste Using the Yolov8 Model, This research aims to develop a model for detecting organic and inorganic waste using the YOLOv8 algorithm with the addition of noise to the image such as normal, gaussian blur, darkness, low resolution, and motion blur. [12].

The next research conducted by Jerry Anggara in 2025, with the title Implementation of Object Detection in Waste Classification to Improve the Efficiency of Waste Management [13].

Some of the previous studies have the same goal as the research to be conducted, namely the use of computer vision technology with Yolov8 is very necessary in an effort to detect plastic waste objects quickly. However, in the research carried out, the dataset object will be taken in several public areas in the city of Ambon, with the aim of detecting the most common types of plastic waste objects found in public areas.

The following is a research roadmap as follows:

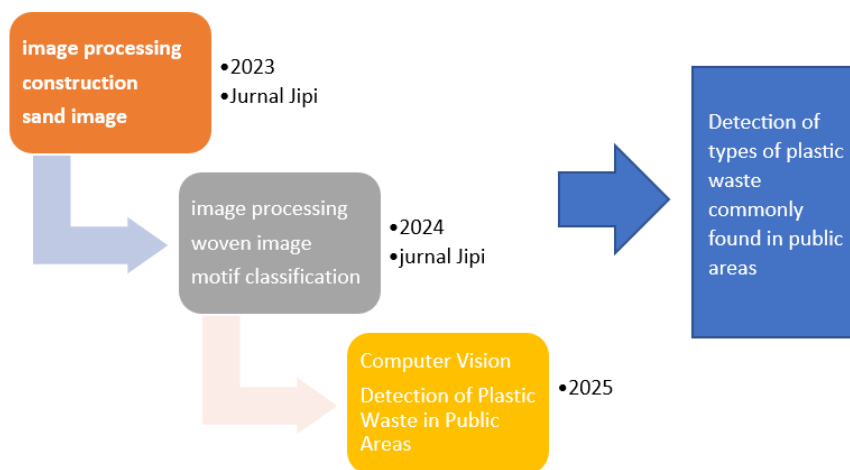


Fig. 1: Research Roadmap

3. Research Methods

This research aims to develop a YOLOv8-based waste type detection system in public areas in waste sorting. Some of the stages of research can be seen in figure 2.

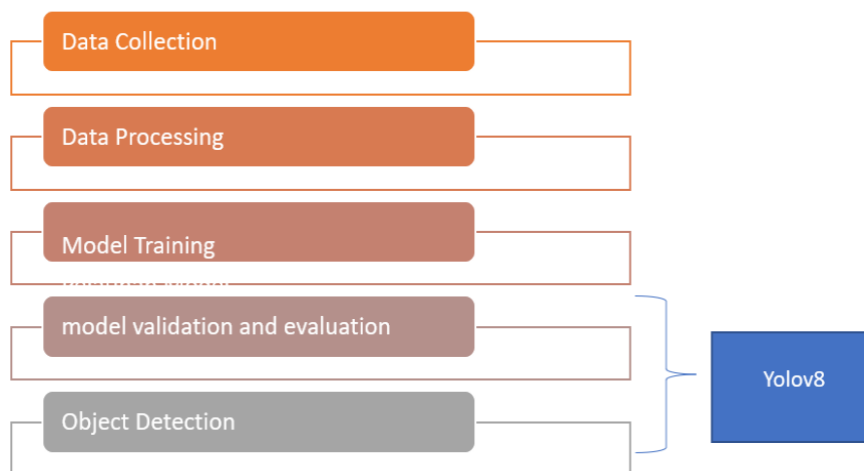


Fig. 2 : Stages of garbage object detection using Yolov8

At the Data Collection stage, the process of collecting plastic waste data in public areas including roads, parks, and others in the city of Ambon is carried out. Where the data is collected through the process of acquiring various images of plastic waste found in public areas. After Data Collection, the next stage is to carry out data processing which aims to process data before conducting model training[14]. Check image quality and image size to increase the diversity of training data by making variations on existing data. Then, the data is separated into training data, validation data, and test data with a percentage of 80:20:10.

In the dataset model training, the labeling process was carried out on the object to obtain the characteristics of the object using the Yolov8 algorithm. Furthermore, at the stage of validation and evaluation of the model to assess the performance of the artificial intelligence model based on the data used for testing, with the aim of ensuring that the model works well and is able to provide accurate results. The evaluation process is carried out to be able to determine the strengths and weaknesses of the model, so that improvements can be made if needed. The metrics used in the model evaluation are precision, recall, map and confusion matrix. So that the final result was obtained in the form of plastic waste object detection.

4. Research Results

The following are the results of research conducted from the data collection process, data processing, model training, model evaluation and validation to object detection.

4.1 Data collection

In the Data Collection process, the process of collecting 102 plastic waste object datasets in public areas of Ambon city includes park areas, roads, parking areas, and so on. The process of shooting plastic waste objects with a smartphone camera is about 70 cm away so that a data preprocessing process is needed to take the object closer, so that several plastic waste objects are obtained as shown in the following 3 pictures:





Fig. 3 : Plastic Waste in Public Areas

Based on the results of data collection in the field, it can be seen that plastic waste in public areas is mostly plastic bottle waste, plastic cups, sterophome, plastic packaging, candy wrappers and so on. Plastic waste data obtained in public areas is still intact in shape or damaged due to various factors.

4.2 Data Processing

Data processing is carried out to take objects closer using an editing application, which is a cropping process with varying sizes to later carry out model training with Yolov8 on roboflow. The model training process uses YOLOv8 because this algorithm excels in accuracy and speed[11].

4.3 Model Training

Before conducting model training, the labelling process is carried out, namely the image of plastic waste is differentiated based on the type of plastic cups, candy wrappers, plastic bottles, plastic packaging, as in the example in figure 4.



Fig. 4 : One of the plastic waste objects labeled plastic cups

From the total of 102 image datasets, an annotation process was carried out to increase the number of training data to 262 images. Then from the 262 images, it was separated into training data of 92%, validation data of 5%, and testing data of 4%. After obtaining the dataset model with Yolov8, the next step is to run the ultralytics library on google collabs to train the plastic waste image model by giving the epoch value parameter 100 times.

1. Model Validation and Evaluation

From the results of the training, a confusion matrix value was obtained to measure the quality of object detection as seen from the values of mAP (Mean Average Precision), precision, recall[15][16]. The value of the confusion matrix and the normalized confusion matrix can be seen in figure 5.

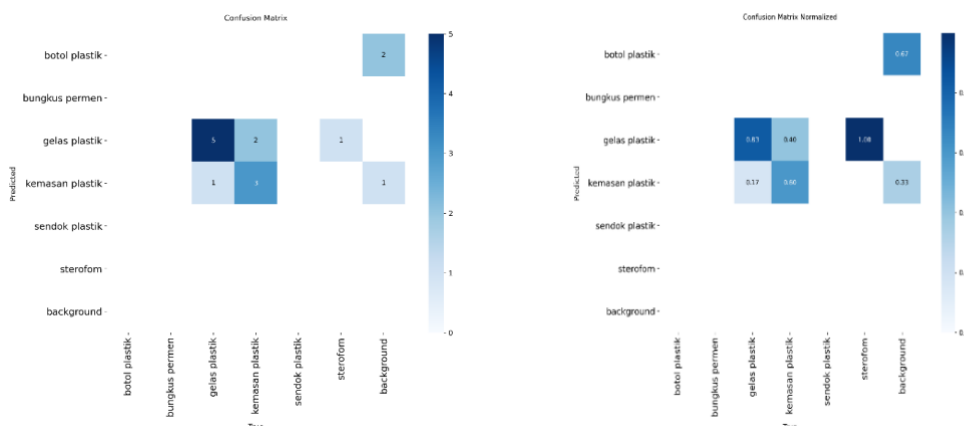


Fig.5: Visualization of the confusion matrix

Based on the results of the confusion matrix, it can be seen that for plastic cups 5 times it is predicted to be true, and 2 times wrong as candy wrappers. While plastic packaging labels 3 times are predicted to be correct as plastic packaging, 1 time is recognized as plastic cups and sterophome. For plastic bottles, it is predicted to be 2 times true. As for the object of plastic spoons and candy wrappers, it is almost undetectable, and for the object of the sterophom is only detected 1 time. While the results of the normalized matrix confusion showed that Sterophom and plastic cups were the best labels, Plastic bottles and plastic packaging were medium labels, Low-label candy wrappers and plastic spoons failed to be recognized. Plastic cups and plastic packaging are mistaken even though the model is 93% precision, the recall is low at 48% which means some labels are well recognizable.

Identify objects with the ability of the model to use precision (correct prediction). Recall is the ability of the model to find labels that are relevant to the object. To calculate precision values and recall labelling, it must be classified with TP (True Positive) i.e. the detected object is true, FP (False Positive) i.e. incorrectly detected, FN (False Negative) i.e. labeling is not detected[17]. Table 1 is the evaluation parameter of object detection.

Table 1: Object Detection Evaluation Parameters

Label	Precision and Recall values are classified by TP, FP and FN		
	TP (True Positive)	FP (False Positive)	FN (False Negative)
Plastic Bottles	2	0	0
Candy Wrap	0	2	0
Gelas Plastik	5	1	2
Plastic Packaging	3	2	2
Plastic Spoon	0	0	0
Sterofom	1	1	1

Based on table 1, it appears that the model still mistakenly distinguishes labels that have similarities, for example plastic cups and candy wrappers or plastic packaging and plastic cups. The model is better at reading plastic cups but still often misreads candy wrappers, this is due to the possibility of similar shapes and textures in the image, in addition to the lack of variation in the training data. The following are the parameters of the COCO metric as shown in table 2.

Table 1: Results of Object Detection Model Evaluation

Metrics	Value
Precision	0,932
Recall	0,478
mAP@0,5	0,618
mAp@0,5:0,95	0,428

From table 2, it can be seen that 98% of the Precision value detects plastic waste but the recall value is 48% which is due to the dataset obtained only around 102 images, then the lack of object diversity and data augmentation. Meanwhile, the mAP value with an IoU (Intersection over Union) threshold of 0.5 is higher than the IoU mAP of 0.5:0.95 which means that this model can detect objects in general, but lacks in accuracy. IoU is the accuracy of the bounding box prediction compared to ground truth[18].

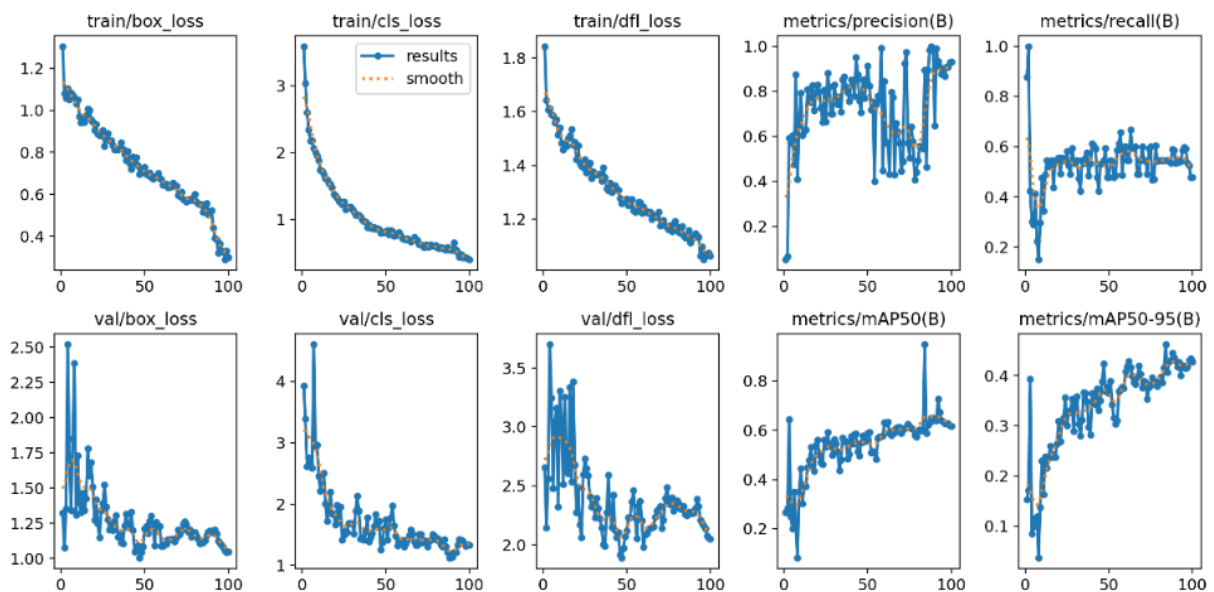


Fig.6 : graphic, loss, precision, recall, mAP

From the results of the graph analysis in figure 6, it can be seen that the model has been successfully trained, characterized by steadily decreasing train losses, despite the overfitting due to the small dataset. The graph shows that the training results of the object detection

model have decreased significantly as the epoch increases, which indicates that the model has managed to learn the data patterns well. Meanwhile, based on the metric parameters on the graph, the precision value is relatively high at >0.6 which means that the model is quite good at avoiding false predictions. However, the recall value is relatively low at around 0.4 – 0.6 which shows that the model erroneously detected most objects, especially candy wrappers and plastic spoons, due to the unbalanced distribution of the dataset, where the data on plastic cups and plastic packaging is much more than other classes.

In addition, based on graph analysis, the mAP50 value is quite high around 0.7 – 0.8 but the mAP value of 50 – 95 is lower, which is 0.4 – 0.5, indicating that the model is easier to recognize large objects, but it is difficult to detect small objects that have similar shapes.

4.5 Object Detection

Based on the research conducted, it was found that the model was able to achieve quite good performance in the dominant class, but improvements need to be made to small objects with augmentation in the data that is able to increase accuracy. The following is a visualization of label distribution as shown in figure 7.

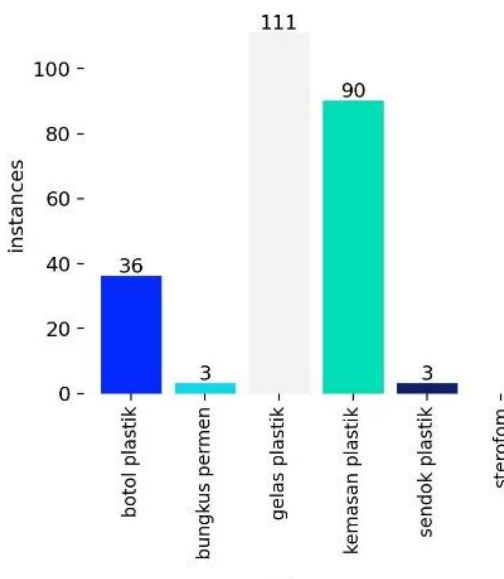


Fig.7: Label distribution visualization

Detection of plastic waste objects based on the visualization of label distribution can be involved in table 3.

Table 3: Object detection results by label

Label	Objek
Plastic Bottles	111
Candy Wrap	3
Gelas Plastik	3
Plastic Packaging	90
Plastic Spoon	3
Sterofom	0

From the results of the graph and object detection visualization table, it was concluded that the most detected plastic cup data was 111 objects, followed by plastic packaging of 90 objects, plastic bottles, candy wrappers and plastic spoons as many as 3 objects in a row, and 0 sterophomemy objects. From the detection of objects based on trained models, it is better to detect glasses or plastic packaging, but weak on candy wrappers and plastic spoons.

5 Conclusion

The conclusion obtained after conducting research on the detection of plastic waste objects in public areas based on model training using YOLOv8 which has quite good performance, namely being able to detect types of plastic waste with plastic cup labels and plastic packaging based on a fairly high precision and mAP50 values, namely greater than 0.6 and 0.7–0.8. However, the model has not optimally detected all plastic waste objects, especially for candy wrappers and plastic spoons, marked with a recall value of 0.4 - 0.6.

The training model is easier to detect large objects but is limited to small objects that have similarities. Therefore, based on this study, it was obtained that a small dataset and an unbalanced distribution of labels can affect the quality of object detection results. The suggestion for further research is to increase the number of datasets, and more varied and specific augmentations in the form of rotation, blur, brightness and class balancing.

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