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Multiple Object Recognition System for Lake using the Yolov8 Technique

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Abstract

This research tackles the challenges of underwater photography in lakes, concentrating on developing and evaluating a multiple object detection system through the advanced You Only Look Once Version 8 (YOLOv8) architecture. The inherent limited visibility in underwater environments poses difficulties in accurately capturing object shapes and colors, crucial for applications like underwater robots engaged in search missions. Leveraging Python and Google Colaboratory, the project implements YOLOv8 for multiple object detection using a dataset of 1116 lake underwater images, processed with LabelImg for object recognition and dataset development. The publicly accessible dataset at http://tinyurl.com/32z25b serves as a valuable resource. YOLOv8 consistently demonstrates exceptional performance in lake environments, achieving an impressive mean Average Precision 50-95 (mAP 50-95) of 95.5% for single-object detection in both training and validation sets. Despite a gradual decrease to 73.8% for 5 objects in more complex scenes, the model maintains a robust overall average of 87.42% in the test set. These findings offer valuable insights for informed decisions when deploying YOLOv8 across diverse underwater settings, particularly in lakes.

1. Introduction

This research addresses challenges in underwater photography in lakes, focusing on developing and evaluating a multiple object detection system using the advanced You Only Look Once Version 8 (YOLOv8) architecture [1]. Lakes pose unique obstacles for accurate object recognition due to limited visibility and distinct water properties, particularly relevant for underwater robots and search missions [2]. The study aims to enhance precision and efficiency in object detection in lake underwater conditions, emphasizing multiple object recognition [3]. The significance lies in its potential impact on underwater exploration and conservation efforts. By establishing a robust lake dataset and evaluating YOLOv8 performance, the project contributes to advancing object recognition systems in dynamic underwater lake settings. The outlined objectives, focusing on dataset establishment and YOLOv8 performance improvement, collectively aim to enhance underwater image recognition for practical applications in challenging lake environments [4].

2. Methodology

2.1 Dataset Development

The dataset encompasses five distinct classes, representing real-world objects such as Male, Female, Airplanes, Car, and Helicopter. These classes are categorized based on the number of objects in each image: 1 object, 2 objects, 3 objects, 4 objects, and 5 objects. Captured under diverse conditions and positions, the dataset ensures variability with factors including object heights from the surface (20 cm, 40 cm, 60 cm), object to camera distances (10 cm, 20 cm, 30 cm), and object surface directions (0°/360°, 90°, 180°, 270°). The images depict different times of the day, contributing to a comprehensive database portraying real-world scenario. The dataset, totaling 1116 images, has been carefully curated to exclude the lake location, streamlining the conditions for effective object recognition. The location for lake is at Tasik Kemajuan UTHM. Fig. 1 shows the location for Tasik Kemajuan UTHM. Fig. 2 show Example of underwater image acquisition.

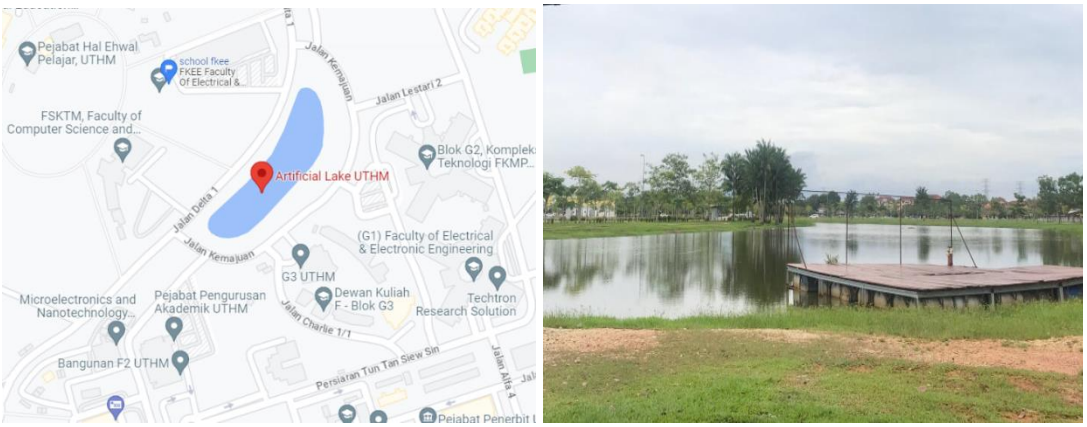

Fig. 1 *Location 1 for experiment; (a) UTHM lake from Google Map, (b) Tasik Kemajuan*

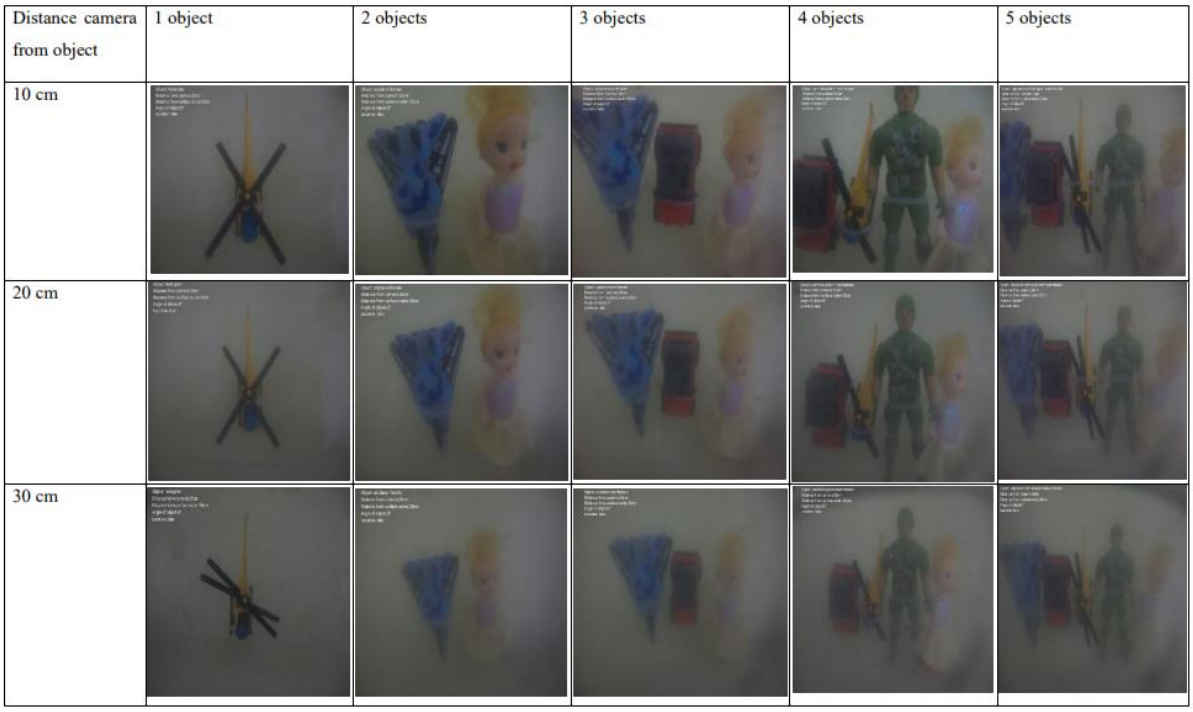

Fig. 2 *Example of underwater image acquisition*

2.2 You Only Look Once version 8 (YOLOv8)

In the context of the research presented in this study, the YOLOv8-based model for underwater object identification follows a systematic flowchart. The process begins with the input images, representing underwater scenes, which are then fed into the YOLOv8 architecture. During the YOLOv8 processing, the model predicts bounding boxes and assigns class probabilities to identify objects within the input images. This phase encapsulates crucial steps, including pre-processing, labeling, and captioning, specifically tailored for underwater images to

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enhance the model's efficiency [5]. The outcome of this process is the generation of output images, enriched with bounding box annotations and class predictions. The performance of the model is subsequently evaluated using metrics such as mean average accuracy and training arcs, ensuring a comprehensive assessment of its capabilities [6]. The flowchart, visualized in Fig. 3, provides a clear representation of the sequential steps involved, from the initial input images through the YOLOv8 processing to the final output images, thus elucidating the methodology employed for efficient underwater object identification [7].

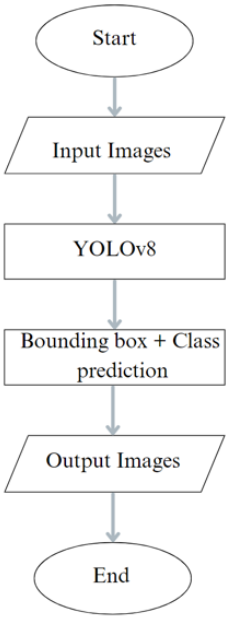

Fig. 3 *Flowchart of YOLOv8*

2.3 Object Recognition Performance Evaluation Method

The accuracy of training in the object recognition system is a crucial metric that gauges how well the model learns and generalizes from the provided training dataset. During training, the system refines its parameters to minimize the difference between its predictions and the ground truth annotations. The accuracy equation quantifies the model's performance by measuring the ratio of correctly predicted instances to the total number of predictions expressed as a percentage. A higher training accuracy indicates better convergence and learning within the model. The equation of detected object accuracy results as stated (1).

$$Average\ accuracy = \frac{\sum detected\ object\ accuracy}{Number\ of\ object} \quad (1)$$

Water source type	Object quantity	Train folder		Test folder		Valid folder		Total number of images
		Percentage	Number of images	Percentage	Number of images	Percentage	Number of images	
Lake	1	80%	144	10%	18	10%	18	180
	2	80%	288	10%	36	10%	36	360
	3	80%	288	10%	36	10%	36	360
	4	80%	144	10%	18	10%	18	180
	5	80%	29	10%	4	10%	3	36
	Combine all images	80%	892	10%	112	10%	112	1116

Fig. 4 *Dataset organization for YOLOv8*

2.4 Dataset organization for YOLOv8

In constructing dataset for the YOLOv8 training, meticulous attention was given to ensure a balanced and representative distribution of images across different subsets. The dataset was organized into folders with a strategic allocation of 80% for the training set, 10% for the testing set, and an additional 10% for the validation set. This partitioning scheme is designed to provide an effective training environment, robust testing metrics, and a dedicated validation subset for fine-tuning the model parameters. Fig. 4 shows the images distribution of underwater images dataset.

3. Result and Discussion

3.1 YOLOv8 performance analysis for Lake underwater images

In this analysis, the focus is on assessing the performance of the YOLOv8 using a dataset tailored to underwater images within lake environments. The evaluation encompasses crucial components including confusion matrices, result graphs, result values, and exemplar images showcasing the model's detection outcomes. Through an exploration of these metrics, the aim is to offer a comprehensive understanding of the YOLOv8's efficacy in detecting and identifying objects amid the distinctive challenges presented by underwater conditions in lake environments.

3.1.1 Underwater images for Lake (1 object)

In the context of the YOLOv8 analysis on Lake 1 object detection, the generated results are systematically organized within the 'runs' folder. This directory encompasses distinct subfolders, namely 'train,' 'valid,' and 'test,' each containing valuable insights into the model's performance across various datasets. The images dataset, a critical component of this analysis, has been meticulously split according to a standardized ratio of 80% for training, 10% for validation, and 10% for testing. This strategic partitioning ensures a balanced representation of the dataset to foster robust model training, thorough validation, and reliable testing. Notably, the total number of images in the dataset stands at 180, with the training set comprising 144 images, the testing set encompassing 18 images, and the validation set also consisting of 18 images. This carefully designed dataset distribution sets the foundation for a comprehensive evaluation of the YOLOv8's performance in detecting Lake 1 objects. Figs. 5-10 show the performance analysis for lake underwater images.

Training: Confusion matrix and result graph for Lake images (1 object)

Fig. 5 shows the training confusion matrix for Lake images for 1 object. In this specific case, out of a total of 18 samples, 18 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 6 shows the training result graph for Lake images for 1 object. The YOLOv8 model, trained over 150 epochs. The mAP 50 and mAP 50-95 metrics, which assess the mean average precision at different IoU thresholds, reflected the model's proficiency in localization and classification tasks.

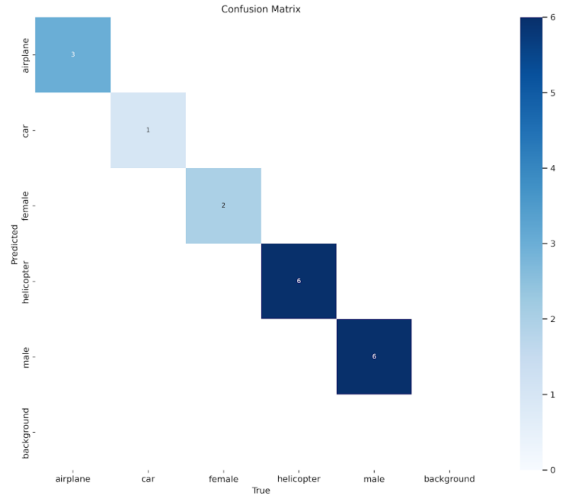

Fig. 5 *Training Confusion matrix for Lake images (1 object)*

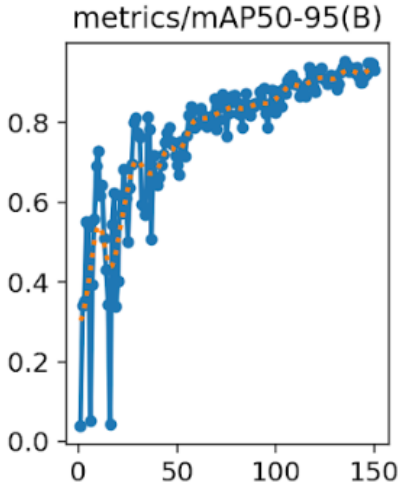

Fig. 6 *Training Result graph for Lake images (1 object)*

Validation: Confusion matrix and Visual result for Lake images (1 object)

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Fig. 7 shows the validation confusion matrix for Lake images for 1 object. In this specific case, out of a total of 18 samples, 18 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 8 show the example of images randomly chosen from validation set of lake image for one object. The image chosen is helicopter with the detected value is 96%. The system was detected the object with correct classes which is helicopter.

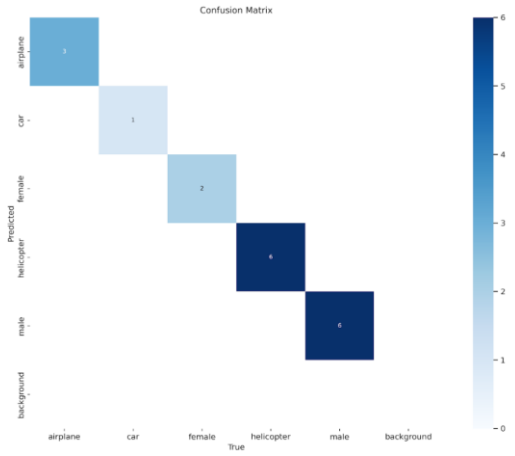

Fig. 7 *Validation Confusion matrix for lake image (1 object)*

Fig. 8 *Validation Visual result for lake image (1 object)*

Test: Confusion matrix and Visual Result for Lake images (1 object)

Fig. 9 shows the test confusion matrix for Lake images for 1 object. In this specific case, out of a total of 18 samples, 18 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 10 show the example of images randomly chosen from test set of lake image for one object. The image chosen is female with the detected value is 92%. The system was detected the object with correct classes which is female.

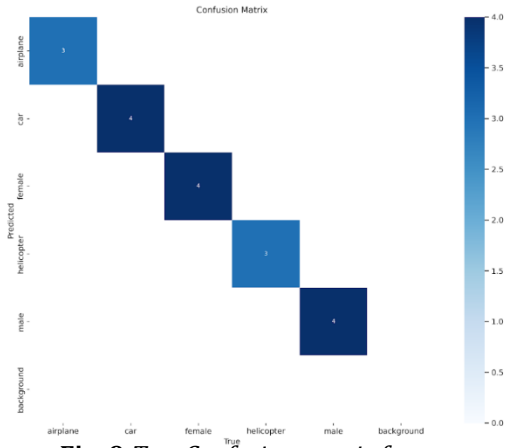

Fig. 9 *Test Confusion matrix for Lake images (1 object)*

Fig. 10 *Test Visual result for lake image (1 object)*

3.1.2 Underwater images for Lake (2 objects)

In the context of the YOLOv8 analysis on Lake 2 objects detection, the generated results are systematically organized within the 'runs' folder. This directory encompasses distinct subfolders, namely 'train,' 'valid,' and 'test,' each containing valuable insights into the model's performance across various datasets. The images dataset, a critical component of this analysis, has been meticulously split according to a standardized ratio of 80% for training, 10% for validation, and 10% for testing. This strategic partitioning ensures a balanced representation of the dataset to foster robust model training, thorough validation, and reliable testing. Notably, the total number of images in the dataset stands at 360, with the training set comprising 288 images, the testing set encompassing 36 images, and the validation set also consisting of 36 images. This carefully designed dataset distribution sets the foundation for a comprehensive evaluation of the YOLOv8's performance in detecting Lake 2 objects. Fig. 11-16 show the performance analysis for lake underwater images.

Training: Confusion matrix and Result graph for Lake images (2 object)

Fig. 11 shows the train confusion matrix for Lake images for 2 objects. In this specific case, out of a total of 36 samples, 36 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 12 shows the training result graph for Lake images for 2 objects. The YOLOv8 model, trained over 150 epochs. The mAP 50 and mAP 50-95 metrics, which assess the mean average precision at different IoU thresholds, reflected the model's proficiency in localization and classification tasks.

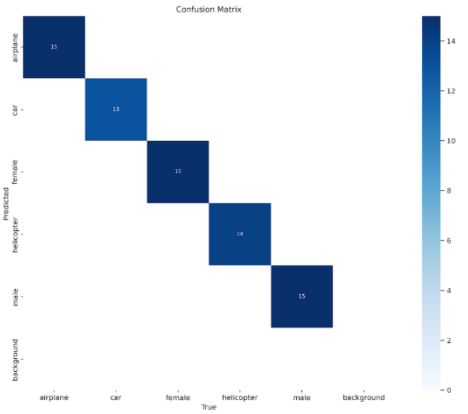

Fig. 11 *Training Confusion matrix for Lake images (2 objects)*

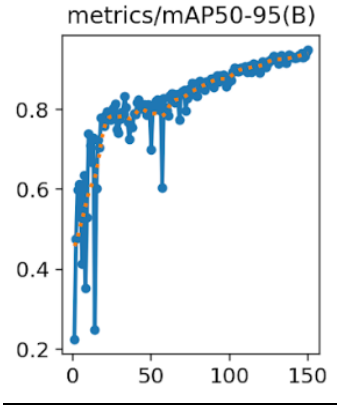

Fig. 12 *Training Result graph for Lake images (2 objects)*

Validation: Confusion matrix and Visual result for Lake images (2 objects)

Fig. 13 show the validation confusion matrix for Lake images for 2 objects. In this specific case, out of a total of 36 samples, 36 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 14 show the example of images randomly chosen from validation set of lake image for 2 objects. The image chosen is airplane with the detected value is 94% and female detected value is 93%. The system was detected the object with correct classes which is airplane and female.

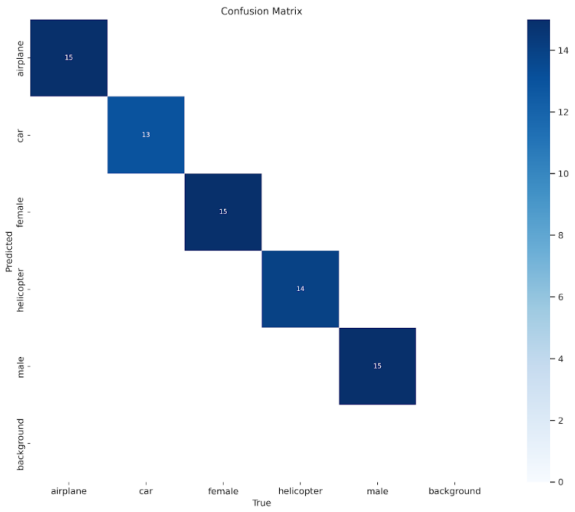

Fig. 13 *Validation Confusion matrix for Lake images (2 objects)*

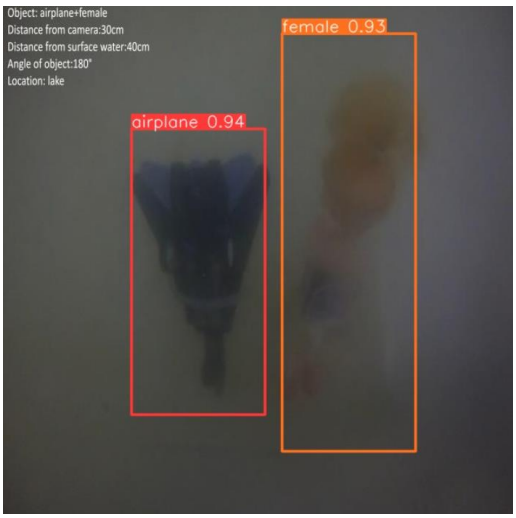

Fig. 14 *Validation Visual result for lake images (2 objects)*

Test: Confusion matrix and Visual result for Lake images (2 objects)

Figure 15 shows the test confusion matrix for Lake images for 2 objects. In this specific case, out of a total of 36 samples, 36 samples were accurately predicted, leading to an overall accuracy of 100%. Figure 16 show the example of images randomly chosen from test set of lake image for 2 objects. The image chosen is male with the detected value is 96% and female detected value is 97%. The system was detected the object with correct classes which is male and female.

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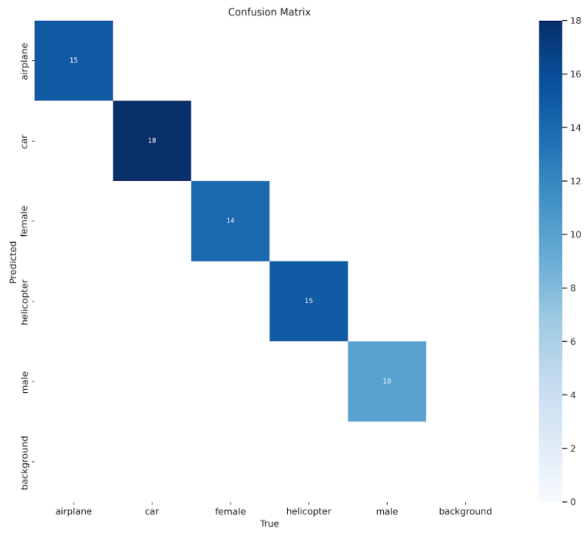

Fig. 15 *Test Confusion matrix for Lake images (2 objects)*

Fig. 16 *Test Visual result for lake image (2 objects)*

3.1.3 Underwater images for Lake (3 objects)

In the context of the YOLOv8 analysis on Lake 3 objects detection, the generated results are systematically organized within the 'runs' folder. This directory encompasses distinct subfolders, namely 'train,' 'valid,' and 'test,' each containing valuable insights into the model's performance across various datasets. The images dataset, a critical component of this analysis, has been meticulously split according to a standardized ratio of 80% for training, 10% for validation, and 10% for testing. This strategic partitioning ensures a balanced representation of the dataset to foster robust model training, thorough validation, and reliable testing. Notably, the total number of images in the dataset stands at 360, with the training set comprising 288 images, the testing set encompassing 36 images, and the validation set also consisting of 36 images. This carefully designed dataset distribution sets the foundation for a comprehensive evaluation of the YOLOv8's performance in detecting Lake 3 objects. Fig. 17 – 22 show the performance analysis for lake underwater images.

Training: Confusion matrix and Result graph for Lake images (3 objects)

Fig. 17 shows the train confusion matrix for Lake images for 3 objects. In this specific case, out of a total of 36 samples, 36 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 18 shows the training result graph for Lake images for 3 objects. The YOLOv8 model, trained over 150 epochs. The mAP 50 and mAP 50-95 metrics, which assess the mean average precision at different IoU thresholds, reflected the model's proficiency in localization and classification tasks.

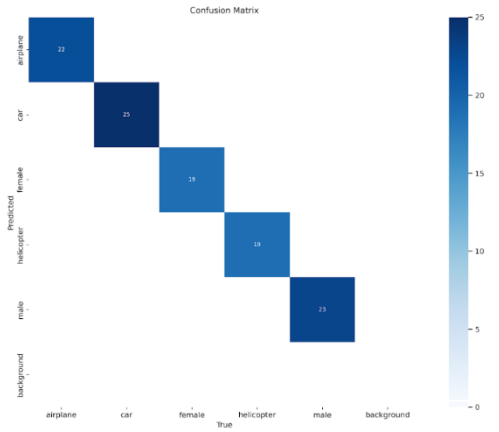

Fig. 17 *Training Confusion matrix for Lake images (3 objects)*

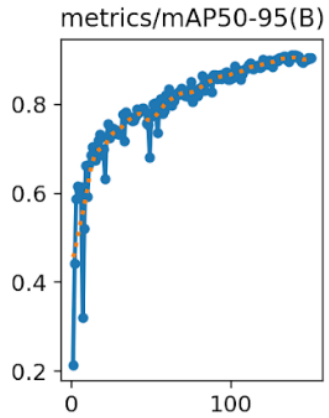

Fig 18 *Training Result graph for Lake images (3 objects)*

Validation: Confusion matrix for and Visual Result Lake images (3 objects)

Fig. 19 shows the validation confusion matrix for Lake images for 3 objects. In this specific case, out of a total of 36 samples, 36 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 20 show the example of images randomly chosen from validation set of lake image for 3 objects. The image chosen is airplane with the detected value is 93%, male with the detected value is 93% and female detected value is 94%. The system was detected the object with correct classes which is airplane, male and female.

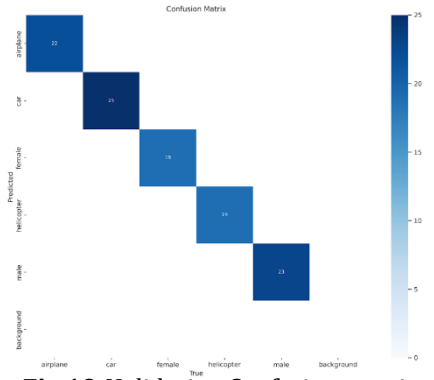

Fig 19 *Validation Confusion matrix for Lake images (3 objects)*

Fig. 20 *Validation Visual result for lake image (3 objects)*

Test: Confusion matrix and Visual result for Lake images (3 objects)

Fig. 21 shows the test confusion matrix for Lake images for 3 objects. In this specific case, out of a total of 36 samples, 36 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 22 shows the example of images randomly chosen from test set of lake image for 3 objects. The image chosen is airplane with the detected value is 93%, car with the detected value is 92% and helicopter detected value is 91%. The system was detected the object with correct classes which is airplane, car and helicopter.

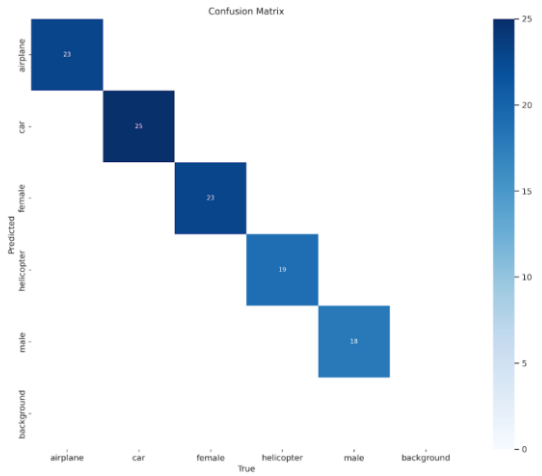

Fig. 21 *Test Confusion matrix for Lake images (3 objects)*

Fig. 22 *Test Visual result for lake image (3 objects)*

3.1.4 Underwater images for Lake (4 objects)

In the context of the YOLOv8 analysis on Lake 4 objects detection, the generated results are systematically organized within the 'runs' folder. This directory encompasses distinct subfolders, namely 'train,' 'valid,' and 'test,' each containing valuable insights into the model's performance across various datasets. The images dataset, a critical component of this analysis, has been meticulously split according to a standardized ratio of 80% for training, 10% for validation, and 10% for testing. This strategic partitioning ensures a balanced representation of the dataset to foster robust model training, thorough validation, and reliable testing. Notably, the total number of images in the dataset stands at 180, with the training set comprising 144 images, the testing set encompassing 19 images, and the validation set also consisting of 18 images. This carefully designed dataset distribution sets the foundation for a comprehensive evaluation of the YOLOv8's performance in detecting Lake 4 objects. Fig. 23-28 show the performance analysis for lake underwater images.

Training: Confusion matrix and Result graph for Lake images (4 objects)

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Fig. 23 shows the train confusion matrix for Lake images for 4 objects. In this specific case, out of a total of 18 samples, 18 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 24 shows the training result graph for Lake images for 4 objects. The YOLOv8 model, trained over 150 epochs. The mAP 50 and mAP 50-95 metrics, which assess the mean average precision at different IoU thresholds, reflected the model's proficiency in localization and classification tasks.

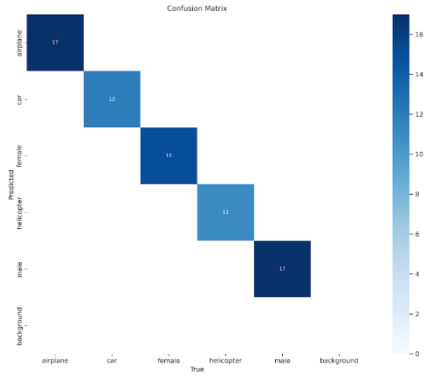

Fig. 23 *Training Confusion matrix for Lake images (4 objects)*

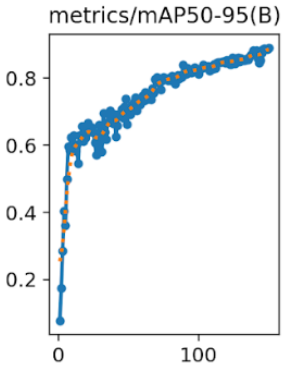

Fig. 24 *Training Result graph for Lake images (4 objects)*

Validation: Confusion matrix and Visual result for Lake images (4 objects)

Fig. 25 shows the validation confusion matrix for Lake images for 4 objects. In this specific case, out of a total of 18 samples, 18 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 26 shows the example of images randomly chosen from validation set of lake image for 4 objects. The image chosen is airplane with the detected value is 92%, helicopter with the detected value is 90%, male with the detected value with 94% and female detected value is 95%. The system was detected the object with correct classes which is airplane, helicopter, male and female.

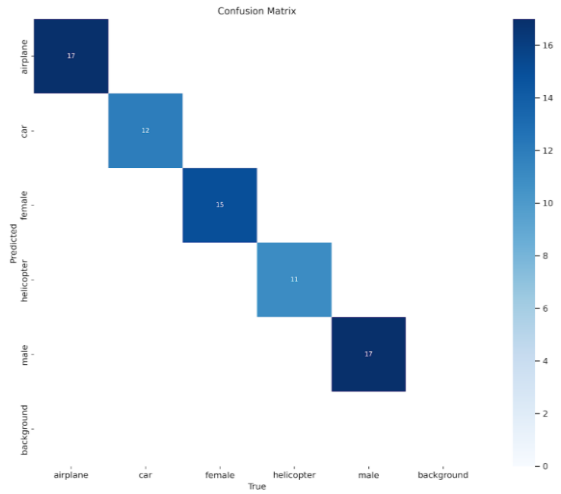

Fig. 25 *Validation Confusion matrix for Lake images (4 objects)*

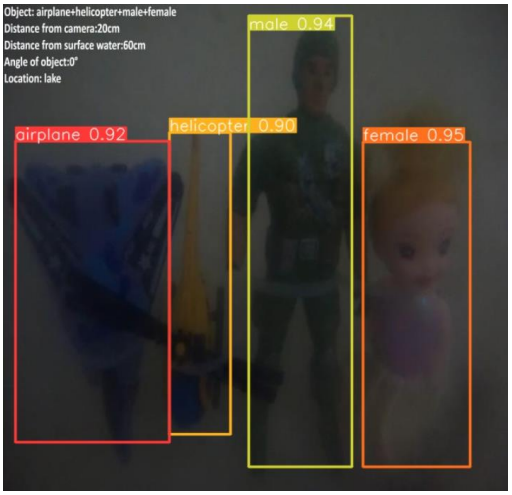

Fig. 26 *Validation Visual result for lake image (4 objects)*

Test: Confusion matrix and Visual result for Lake images (4 objects)

Figure 26 shows the test confusion matrix for Lake images for 4 objects. In this specific case, out of a total of 18 samples, 18 samples were accurately predicted, leading to an overall accuracy of 100%. Figure 27 shows the example of images randomly chosen from testing set of lake image for 4 objects. The image chosen is car with the detected value is 96%, helicopter with the detected value is 96%, male with the detected value with 94% and female detected value is 92%. The system was detected the object with correct classes which is car, helicopter, male and female.

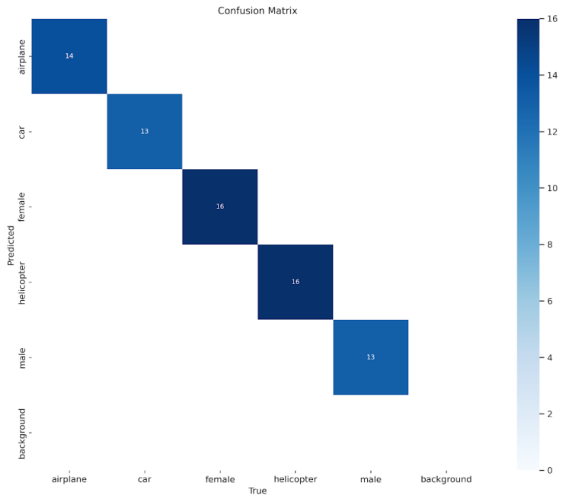

Fig. 26 *Test Confusion matrix for Lake images (4 objects)*

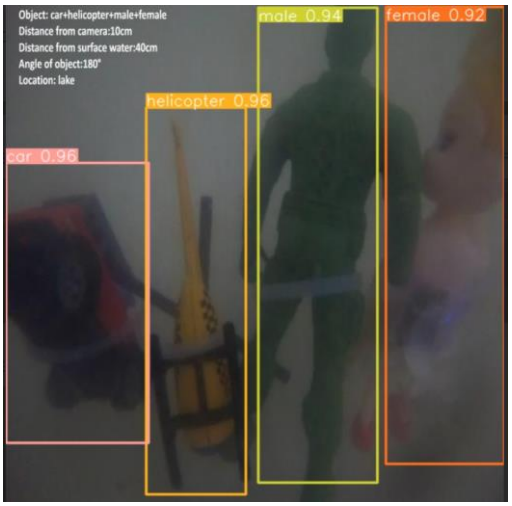

Fig. 27 *Test Visual result for lake image (4 objects)*

3.1.5 Underwater images for Lake (5 objects)

In the context of the YOLOv8 analysis on Lake 5 objects detection, the generated results are systematically organized within the 'runs' folder. This directory encompasses distinct subfolders, namely 'train,' 'valid,' and 'test,' each containing valuable insights into the model's performance across various datasets. The images dataset, a critical component of this analysis, has been meticulously split according to a standardized ratio of 80% for training, 10% for validation, and 10% for testing. This strategic partitioning ensures a balanced representation of the dataset to foster robust model training, thorough validation, and reliable testing. Notably, the total number of images in the dataset stands at 36, with the training set comprising 29 images, the testing set encompassing 4 images, and the validation set also consisting of 3 images. This carefully designed dataset distribution sets the foundation for a comprehensive evaluation of theYOLOv8's performance in detecting Lake 5 objects. Fig. 28-33 show the performance analysis for lake underwater images.

Training: Confusion matrix and Result graph for Lake images (5 objects)

Fig. 28 shows the train confusion matrix for Lake images for 5 objects. In this specific case, out of a total of 3 samples, 3 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 29 shows the training result graph for Lake images for 5 objects. The YOLOv8 model, trained over 150 epochs. The mAP 50 and mAP 50-95 metrics, which assess the mean average precision at different IoU thresholds, reflected the model's proficiency in localization and classification tasks.

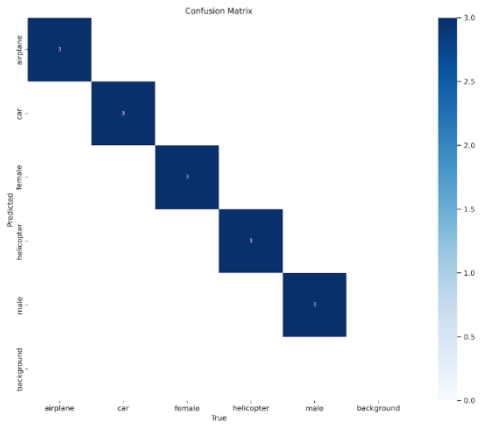

Fig. 28 *Training Confusion matrix for Lake images (5 objects)*

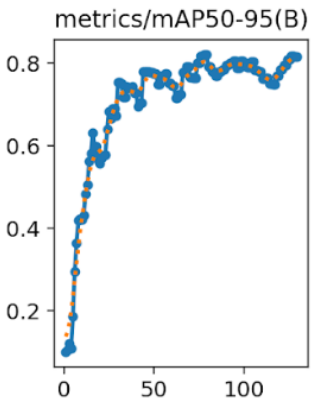

Fig. 29 *Training Result graph for Lake images (5 objects)*

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Validation: Confusion matrix and Visual result for Lake images (5 objects)

Fig. 30 shows the validation confusion matrix for Lake images for 5 objects. In this specific case, out of a total of 3 samples, 3 samples were accurately predicted, leading to an overall accuracy of 94.5%. From these 3 samples, 3 times of airplane classes has detected, 3 time of car classes has detected, 3 times of female classes has detected, 3 times of male classes has detected, and 3 times of male classes has detected. The error while detected background is 5.5% since 1 background automatically detected. Fig. 31 show the example of images randomly chosen from validation set of lake image for 5 objects. The image chosen is airplane with the detected value is 92%, car with the detected value is 99%, helicopter with the detected value is 99%, male with the detected value with 77% and female detected value is 98%. The system was detected the object with correct classes which is airplane, car, helicopter, male and female.

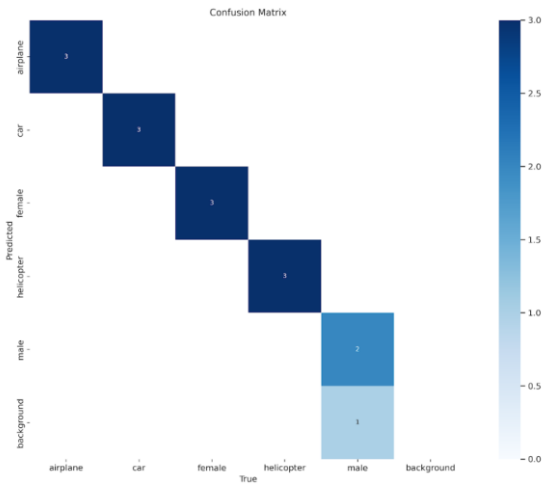

Fig. 30 *Validation Confusion matrix for Lake images (5 objects)*

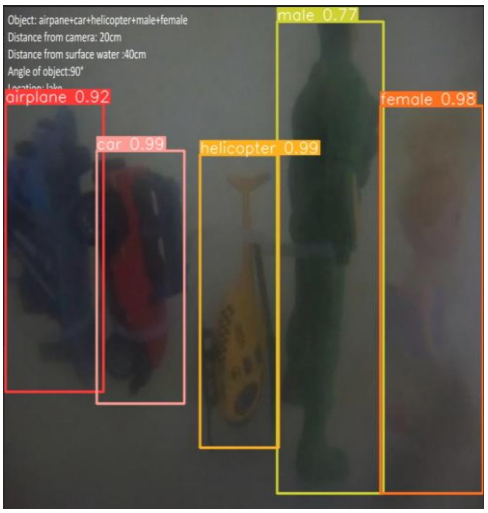

Fig. 31 *Validation Visual result for lake image (5 objects)*

Test: Confusion matrix and Visual result for Lake images (5 objects)

Fig. 32 shows the test confusion matrix for Lake images for 5 objects. In this specific case, out of a total of 4 samples, 4 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 33 shows the example of images randomly chosen from test set of lake image for 5 objects. The image chosen is airplane with the detected value is 87%, car with the detected value is 99%, helicopter with the detected value is 100%, male with the detected value with 71% and female detected value is 74%. The system was detected the object with correct classes which is airplane, car, helicopter, male and female.

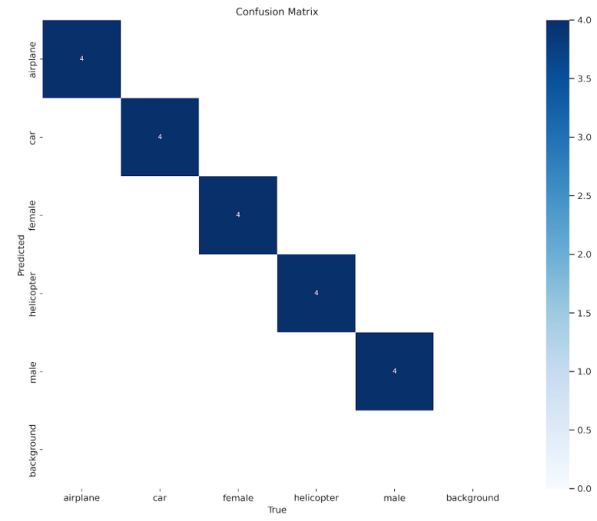

Fig. 32 *Test Confusion matrix for Lake images (5 objects)*

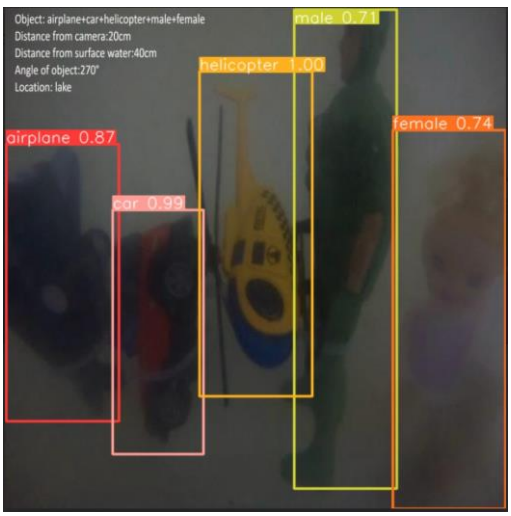

Fig. 33 *Test Visual result for lake image (5 objects)*

3.1.6 Underwater images for Lake (Combine all images)

In the context of the YOLOv8 analysis for overall lake underwater images, the generated results are systematically organized within the 'runs' folder. This directory comprises distinct subfolders, specifically 'train,' 'valid,' and 'test,' each providing valuable insights into the model's performance across various datasets. The images dataset, a pivotal component of this analysis, has been meticulously divided according to a standardized ratio of 80% for training, 10% for validation, and 10% for testing. This deliberate partitioning ensures a balanced representation of the dataset, fostering robust model training, thorough validation, and reliable testing. Notably, the total number of images in the dataset amounts to 1116, with 892 images in the training set, 112 images in the testing set, and an additional 112 images in the validation set. This carefully designed dataset distribution serves as the foundation for a comprehensive evaluation of the YOLOv8's performance in detecting objects within the broader context of lake underwater images. Fig. 34-39 illustrate the performance analysis for these overall lake underwater images.

Training: Confusion matrix and Result graph for Lake images (Combine all images)

Fig. 34 shows the train confusion matrix for Lake images for combine all images. In this specific case, out of a total of 112 samples, 112 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 35 shows the training result graph for Lake images for combine all images. The YOLOv8 model, trained over 150 epochs. The mAP 50 and mAP 50-95 metrics, which assess the mean average precision at different IoU thresholds, reflected the model's proficiency in localization and classification tasks.

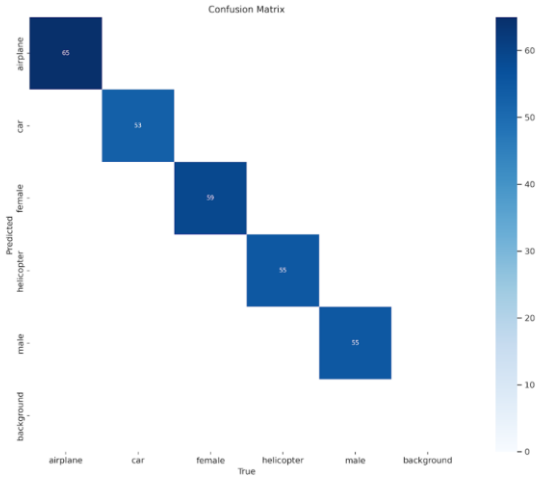

Fig. 34 *Training Confusion matrix for Lake images (Combine all iamges)*

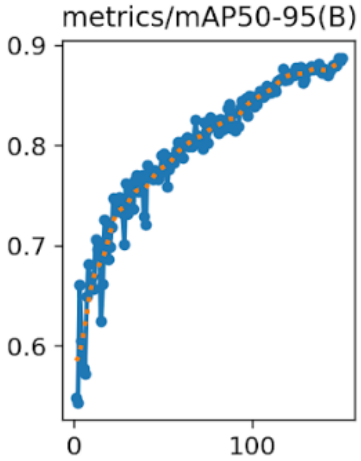

Fig. 35 *Training Result graph for Lake images (Combine all images)*

Validation: Confusion matrix and Visual result for Lake images (Combine all images)

Fig. 36 shows the validation confusion matrix for Lake images for combine all images. In this specific case, out of a total of 112 samples, 112 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 37 shows the example of images randomly chosen from validation set of lake images for combine all images. The image chosen is include 1 object, 2 objects, 3 objects, 4 objects and 5 objects. The system was detected the object with correct classes which is airplane, car, helicopter, male and female with the average accuracy detected value above 90%.

Test: Confusion matrix and Visual result for Lake images (Combine all images)

Fig. 38 shows the test confusion matrix for Lake images for combine all images. In this specific case, out of a total of 112 samples, 112 samples were accurately predicted, leading to an overall accuracy of 100%. Fig. 39 shows the example of images randomly chosen from test set of lake images for combine all images. The image chosen is include 1 object, 2 objects, 3 objects, 4 objects and 5 objects. The system was detected the object with correct classes which is airplane, car, helicopter, male and female with the average accuracy detected value above 90%.

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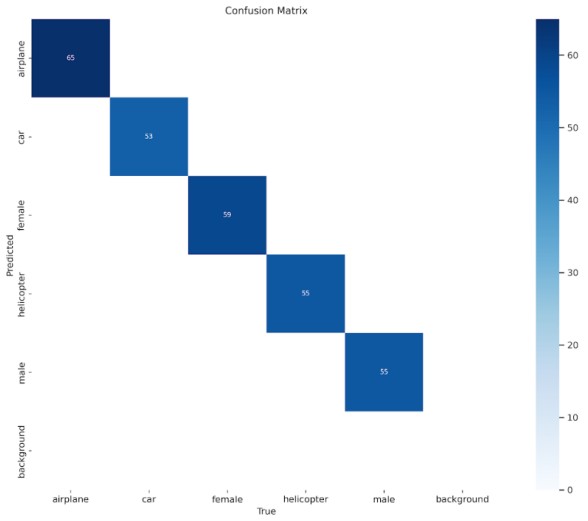

Fig. 36 *Validation Confusion matrix for lake images (Combine all images)*

Fig. 37 *Validation Visual result for lake images (Combine all images)*

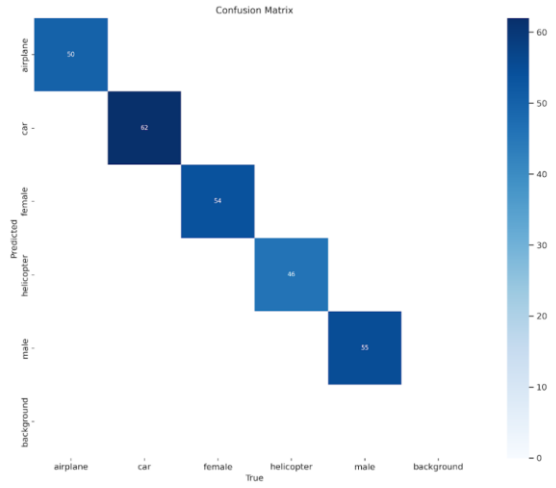

Fig. 38 *Test Confusion matrix for lake images (Combine all images)*

Fig. 39 *Test Visual result for lake images (Combine all images)*

3.2 Result analysis for YOLOv8 performance

In this analysis, the focus is on assessing the performance of the YOLOv8 using a dataset tailored to underwater images within lake environments. The evaluation encompasses crucial components including confusion matrices, result graphs, result values, and exemplar images showcasing the model's detection outcomes. Through an exploration of these metrics, the aim is to offer a comprehensive understanding of the YOLOv8's efficacy in detecting and identifying objects amid the distinctive challenges presented by underwater conditions in lake environments. Table 1 shows the result analysis for YOLOv8 performance.

The test results for object detection using YOLOv8 in Lake categories exhibit strong performance. In the Lake category, the average mAP for the test set is 87.42%, with individual object counts ranging from 73.8% to 91.7%. The achieve of mAP values above 80% for all object counts during testing. This suggests that the model generalizes well and maintains reliable performance across diverse scenarios. These results indicate a successful implementation of YOLOv8 for object detection, particularly in the context of Lake scenarios.

Table 1 *Result analysis for YOLOv8 performance*

Image of object category	mAP 50-95% for YOLOv8 (Lake)		
	Train	Validation	**Test**
1 object	95.50%	95.50%	**91.70%**
2 objects	94.90%	94.70%	**90.70%**
3 objects	91.20%	91.10%	**88.40%**
4 objects	89.20%	88.60%	**88.90%**
5 objects	82.10%	82.10%	**73.80%**
Combine all images	88.70%	88.70%	**88.60%**
Average	90.27%	90.28%	**87.42%**

4. Conclusion

In conclusion, this research successfully addressed underwater photography challenges in lakes by implementing the YOLOv8 architecture for multiple object detection. Utilizing a dataset of 1116 lake images and Python in Google Colaboratory, the model consistently demonstrated strong performance, achieving a mean Average Precision 50-95 of 95.5% for single-object detection. Despite a slight decrease to 73.8% for 5 objects in complex scenes, the overall test set average remained robust at 87.42%. These findings provide valuable insights for deploying YOLOv8 in diverse underwater settings, particularly in lakes, with implications for applications like underwater robots in search missions.

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Conflict of Interest

There is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Hazli Roslan, Nabilah Ibrahim, Siti Zarina Mohd Muji;* ***data collection:*** *Ng Wei Jie;* ***analysis and interpretation of results:*** *Ng Wei Jie, Suhaila Sari, Nik Shahidah Afifi Md Taujuddin;* ***draft manuscript preparation:*** *Ng Wei Jie, Suhaila Sari. All authors reviewed the results and approved the final version of the manuscript.*

References

Azlin, N. A. I. N. (2022). Object Recognition System with Image Enhancement for Lake Underwater Images (Publication No. 12832). [Bachelor's degree dissertation, Universiti Tun Hussein Onn Malaysia]. UTHM.

Britton, J. (2022, October 31). Formation and Features of Ponds and Lakes. https://study.com/learn/lesson/pond-vs-lake-formation-features.html

Han, F., Yao, J., Zhu, H., & Wang, C. (2020) Underwater image processing and object detection based on Deep CNN method, *Journal of Sensors, 2020*, 1–20, https://doi.org/10.1155/2020/6707328

MSU Extension Natural Resources. (2022, March 29). What is that color in my pond? https://www.canr.msu.edu/news/what-is-that-color-in-my-pond#:~:text=One%20of%20the%20most%20common,the% 20algae%20die%20and%20decompose

Phan, V. T., Dao, H. Q., & Nguyen, Q. V. (2022) A Deep Learning-Based Method for Automatic Skin Lesion Segmentation and Classification, *Applied Sciences, 12 (10)*, 4898, https://doi.org/10.3390/app12104898

Weng, C. N. (2005, January). *Water Resources Management in Malaysia: NGO Perspectives* [Conference session]. Water Resources Management in Malaysia: NGO Perspectives, PWTC, Kuala Lumpur, Malaysia.

Zou, Y., Liong, X., & Wang, T. (2020) Visible and infrared image fusion using the lifting wavelet, *TELKOMNIKA Indonesian Journal of Electrical Engineering and Computer Science, 11 (11)*, 6290–6295, http://dx.doi.org/10.11591/ telkomnika.v11i11.2898