DePondFi'23 Challenge Submission

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STATIS

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1. Block Diagram and Algorithm Explanation

CLAHE Algorithm

1. Divide the input image into non-overlapping tiles of equal size.
2. Calculate the histogram of pixel intensities for each tile.
3. Clip histogram peaks that exceed a predefined threshold.
4. Redistribute the clipped pixel values to preserve the histogram's shape.
5. Interpolate pixel values to ensure smooth transitions between adjacent tiles, avoiding visible artifacts or seams.

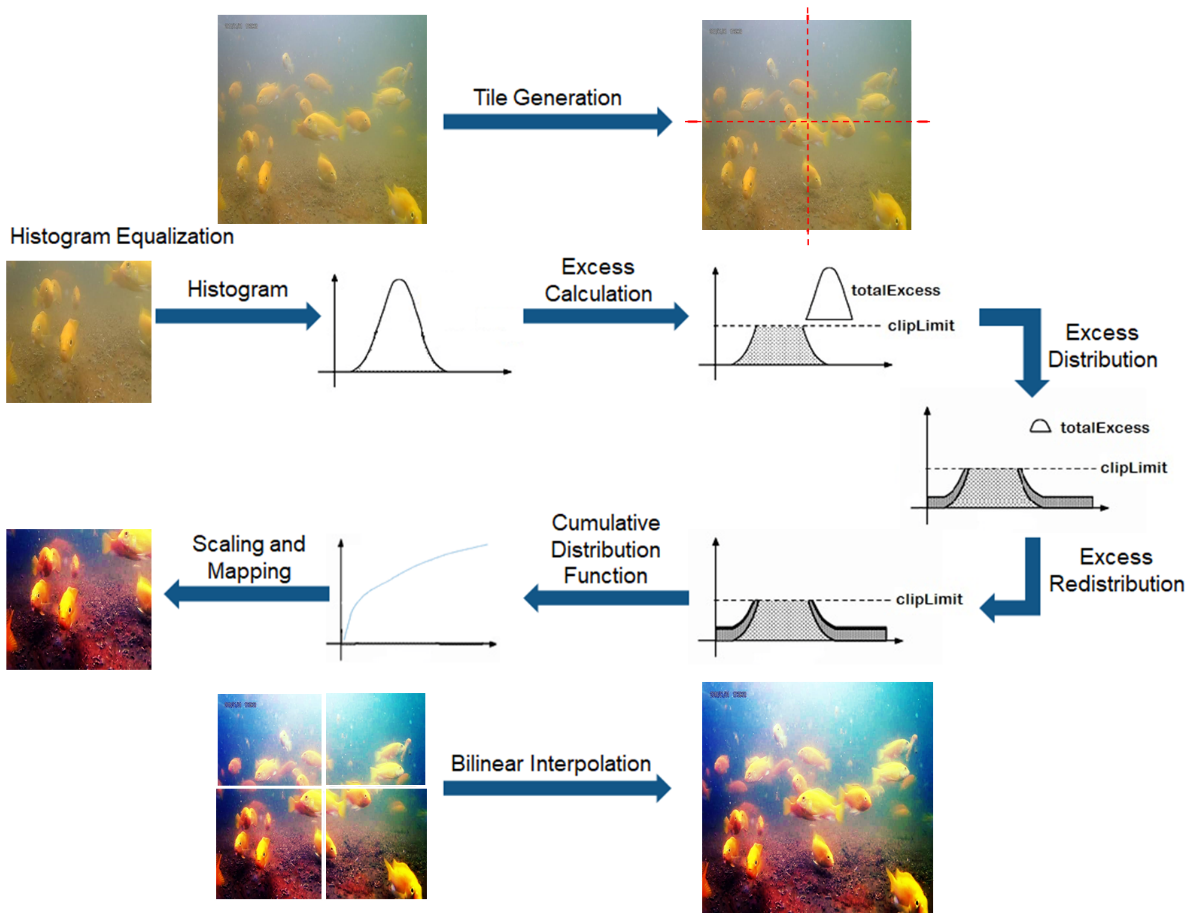


Fig 1. Flow Chart of CLAHE Algorithm

YOLO Algorithm

1. Input image is divided into a grid of cells.
2. Each cell predicts bounding boxes and class probabilities using convolutional neural networks.
3. Bounding box coordinates are adjusted relative to anchor boxes, which capture object shape variations.
4. Non-maximum suppression is applied to eliminate overlapping and redundant bounding boxes.
5. Remaining boxes with high confidence scores are selected as potential object detections.
6. The final output includes class labels, bounding box coordinates, and confidence scores for the detected objects

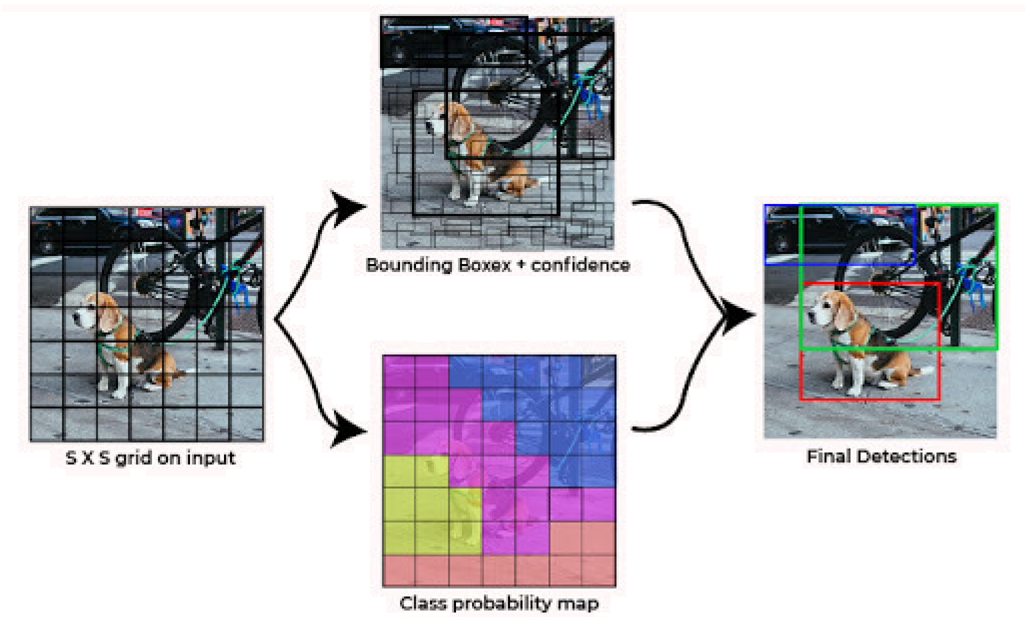


Fig 2. Flow Chart of Yolo Algorithm

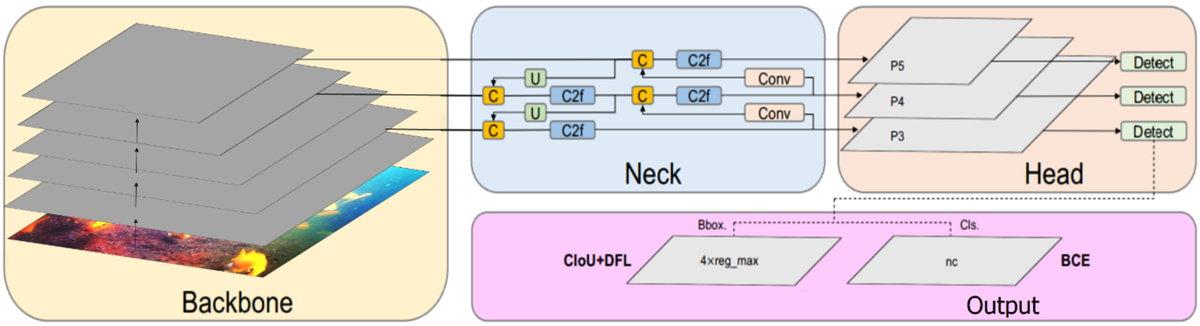


Fig 3. Architecture of YOLO v8

Proposed Work:

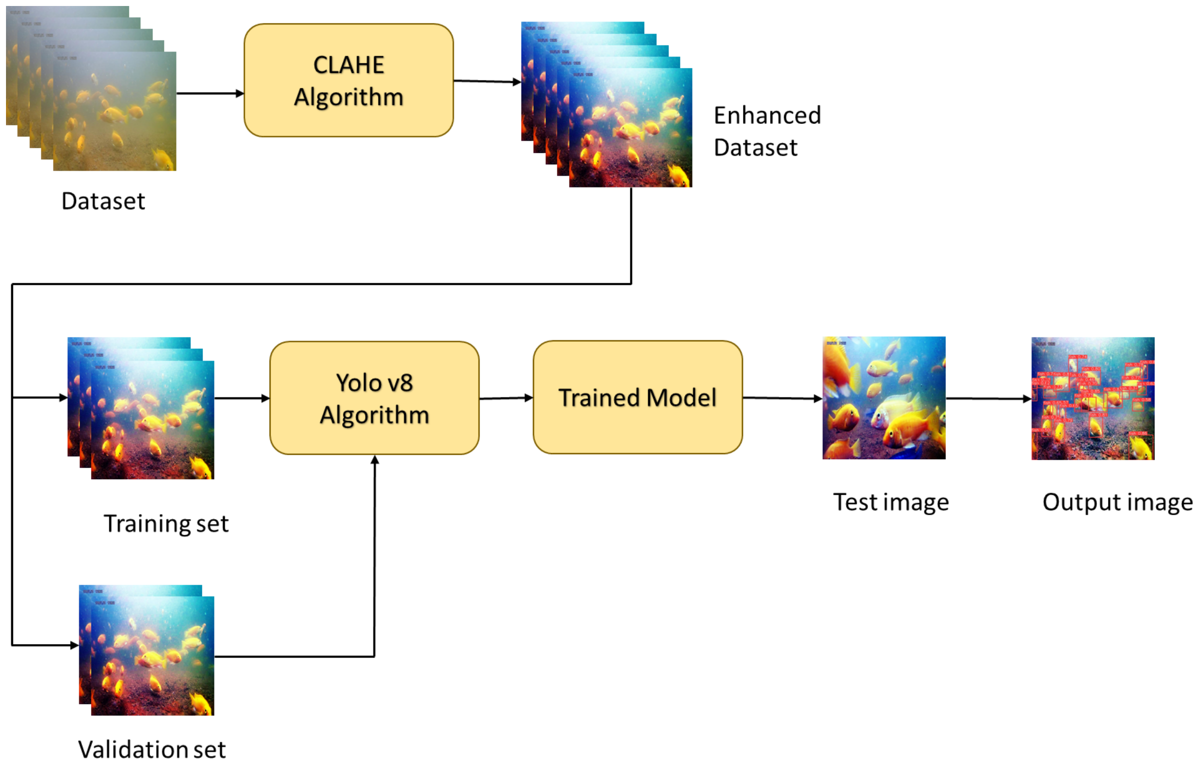


Fig 4. Flow Chart of Proposed Work

2. Summary of the approach and experimental result – Phase-I and Phase- II

Summary:

We propose an approach, named CLAHE-yolov8s, for pond fish detection in the context of the DePondFi'23 challenge. As part of this challenge, two models were developed: MSR-yolov8s and CLAHE-yolov8s. Through evaluation on the validation dataset, the performance of CLAHE-yolov8s was found to be slightly higher than that of MSR-yolov8s. Moreover, the CLAHE-yolov8s model exhibited slightly faster image processing speed compared to the MSR-yolov8s model. Consequently, both models have been made available in the project folder, enabling users to choose the model that aligns with their preferences. Additionally, the project encompasses scripts that facilitate the generation of bounding box coordinates in the yolov5 annotations

format, as well as the utilization of the models for fish detection for images and videos, respectively.

CLAHE-yolov8s was implemented by applying the CLAHE image enhancement algorithm into the image before feeding it into the model for prediction.

Other details regarding the models are given below:

Table 1: Table depicting the performance of the models based on multiple metrics

Model	mAp50 (training)	F1 score (training)	Image preprocessing time	Inference time	Total time
MSR-YOLOv8s	0.964	0.9288	0.0218	1.256s	1.277s
CLAHE-YOLOv8s	0.970	0.929	0.0185	1.165s	1.183s

Training results of CLAHE-yolov8s is given below:

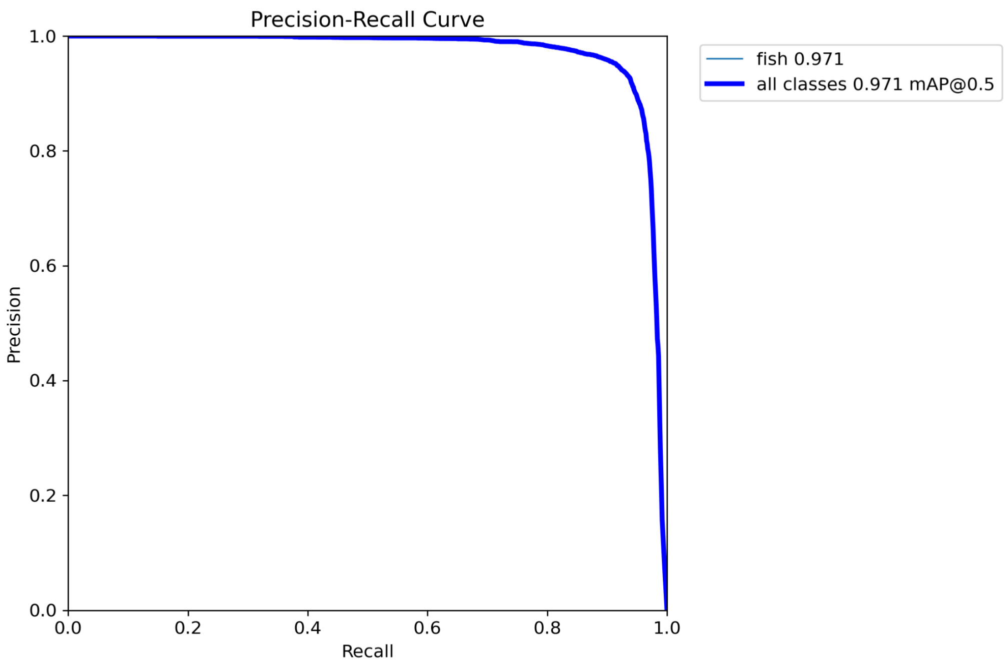


Fig 5. Precision-Recall curve of CLAHE-yolov8s on training dataset

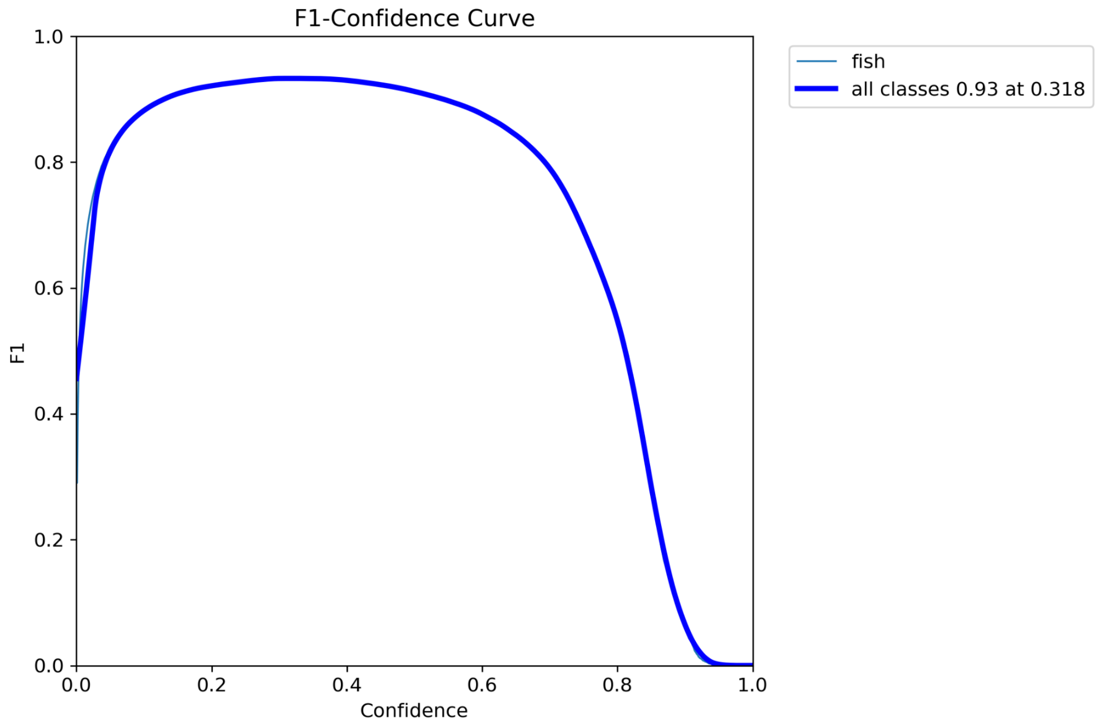


Fig 6. F1-Confidence curve of CLAHE-yolov8s on training dataset

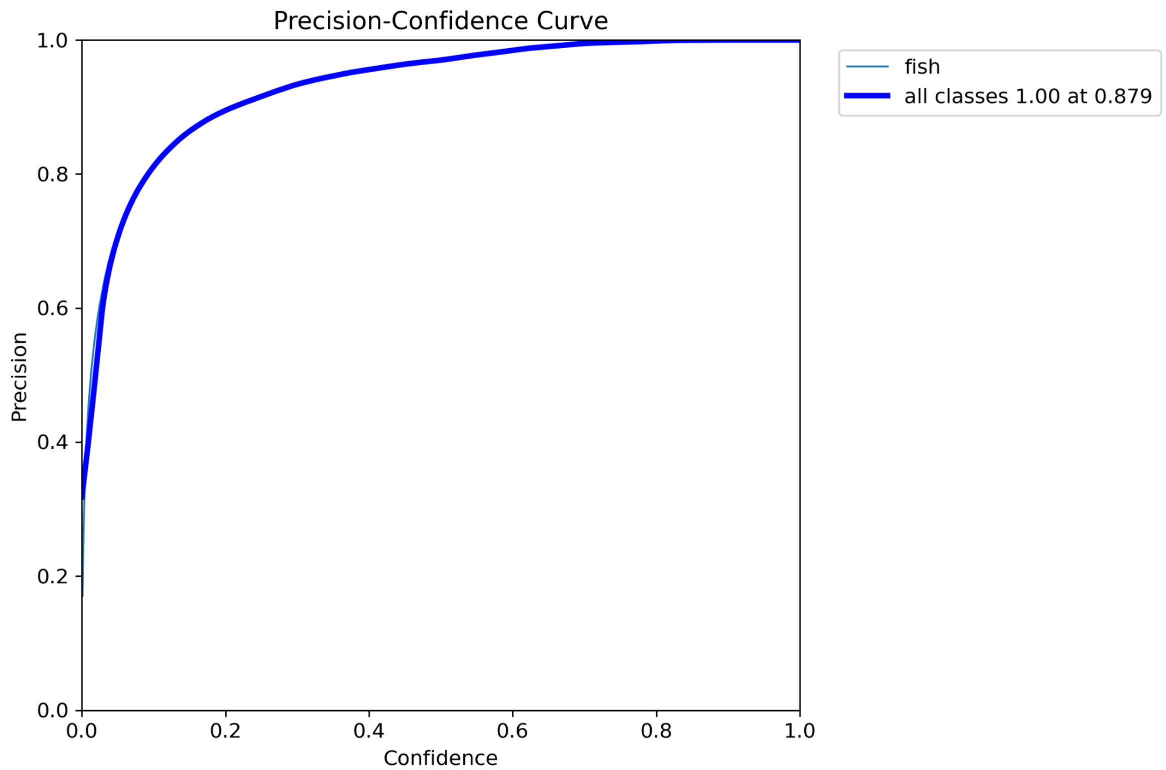


Fig 7. Precision-Confidence curve of CLAHE-yolov8s on training dataset

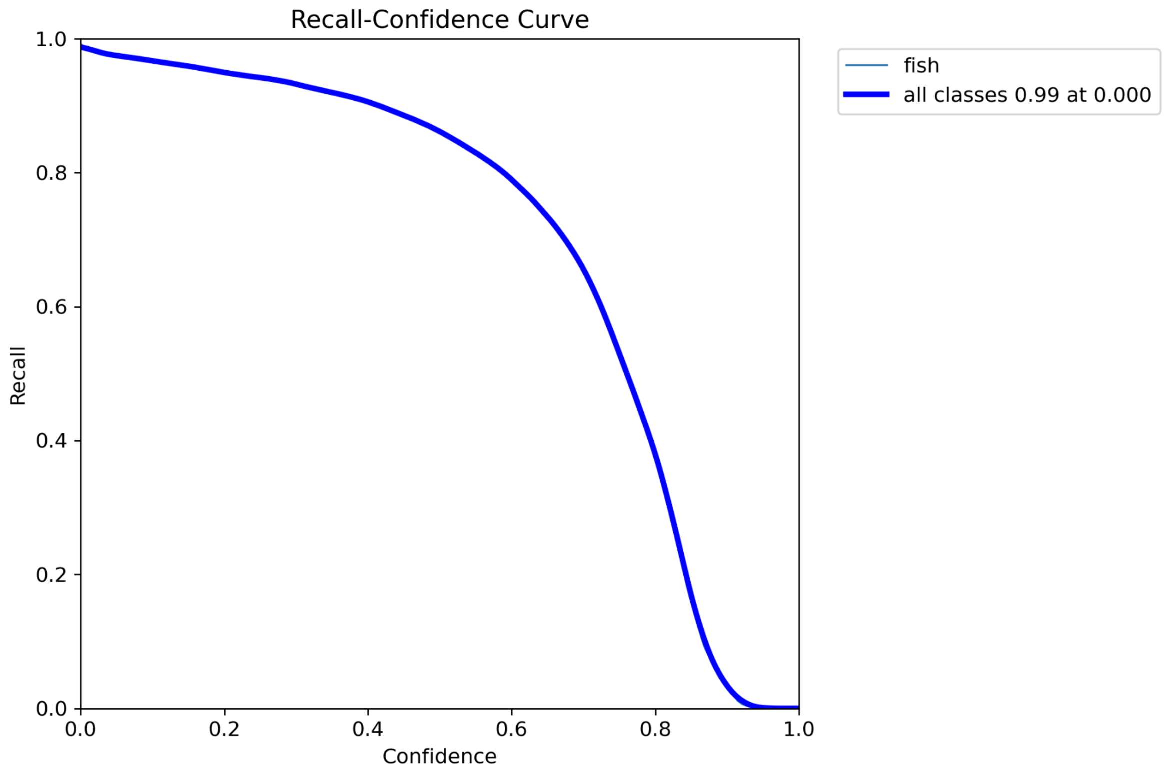
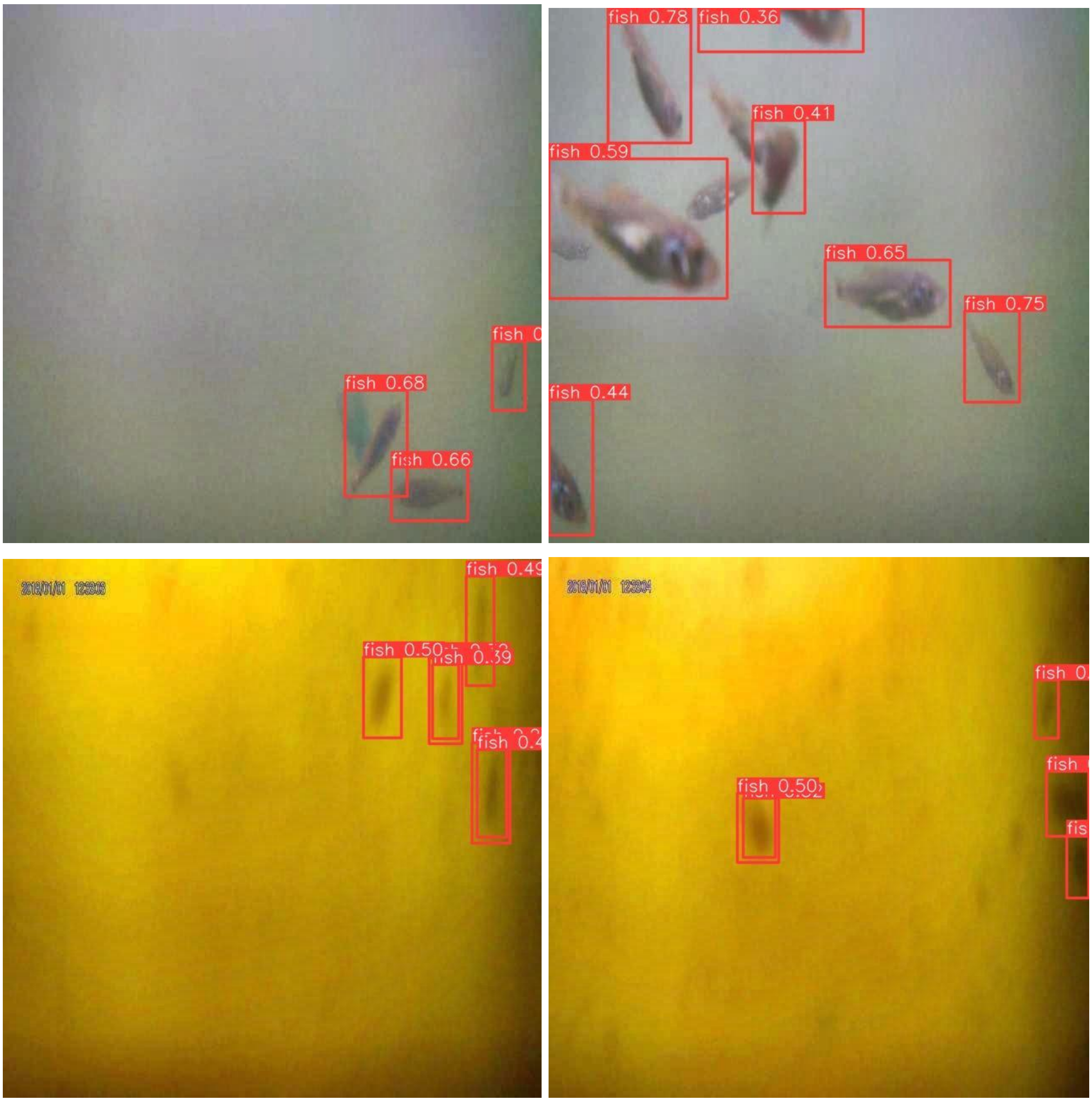


Fig 8. Recall-Confidence curve of CLAHE-yolov8s on training dataset

Phase I testing set results:

Example images for detections performed on phase I testing dataset using CLAHE-yolov8s is given below



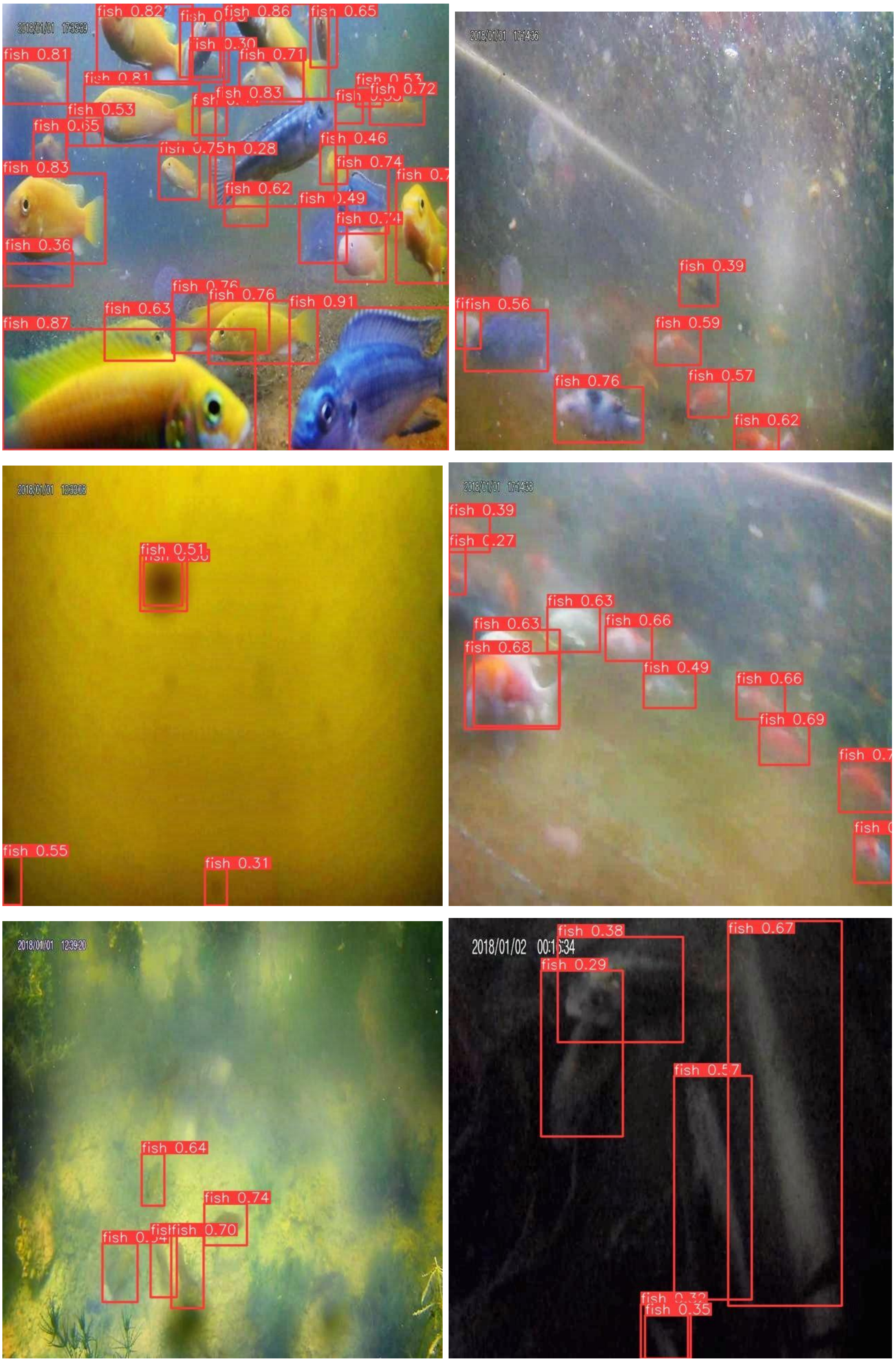
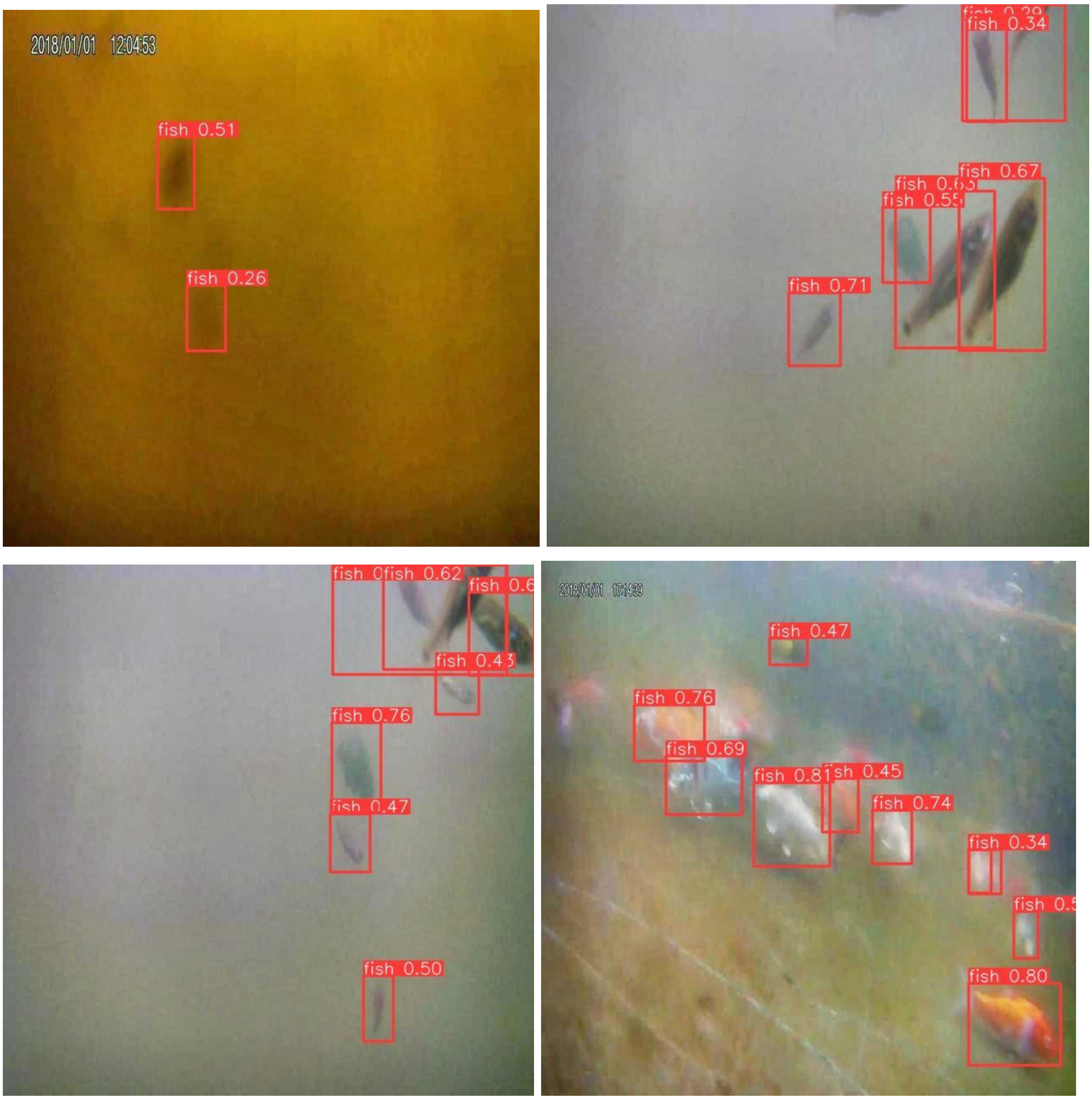


Fig 9. Some examples of testing dataset phase I results

Phase II testing set results:

Example images for detections performed on phase I testing dataset using CLAHE-yolov8s is given below



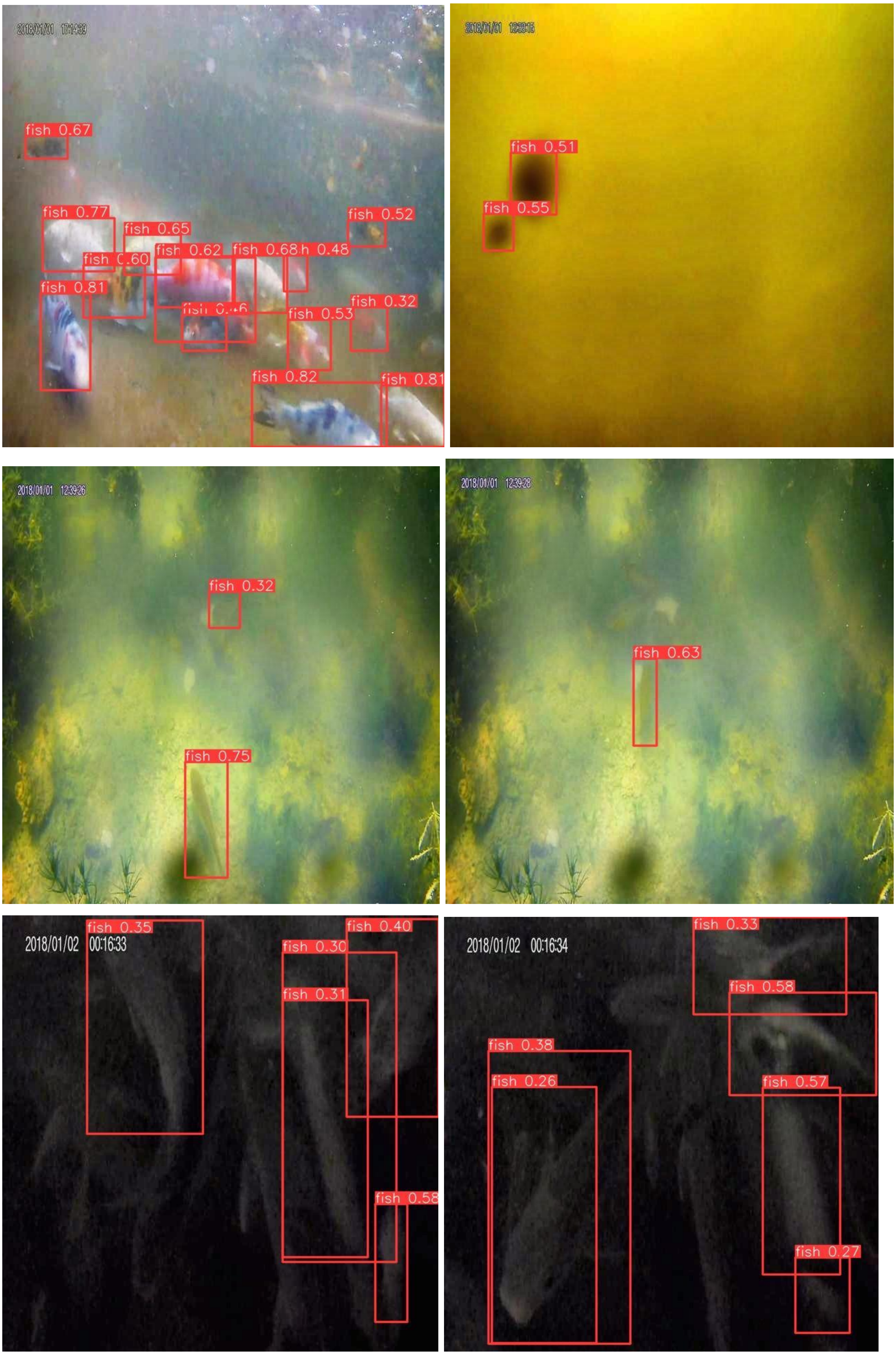


Fig 10. Some examples of testing dataset phase II results

Tabulation:

CLAHE-YOLOv8s:

S.No.	Parameters	Details
1	Train Count	5950
2	Validation Count	823
3	Augmentation	no augmentation done
4	Loss Function Name	VFL - Varifocal loss
5	Ensemble Learning (Yes/No)	Yes
6	Experimental Setup Details	
	• TensorFlow/Pytorch	PyTorch
	• Learning Rate	0.01
	• Optimizer	SGD - Stochastic Gradient Descent
	• Image enhancement technique	CLAHE
7	Model Details with number of parameters	225 layers, 11135987 parameters, 0 gradients, 28.6 GFLOPs
8	Details about Pre-Processing	pre-processing algorithm: CLAHE pre-processing time: 0.0185s
9	Others (if any specific)	model inference time: 1.165

MSR-YOLOv8s:

S.No.	Parameters	Details
1	Train Count	5950
2	Validation Count	823
3	Augmentation	no augmentation done
4	Loss Function Name	VFL - Varifocal loss
5	Ensemble Learning (Yes/No)	Yes
6	Experimental Setup Details	
	• TensorFlow/Pytorch	PyTorch
	• Learning Rate	0.01
	• Optimizer	SGD - Stochastic Gradient Descent
	• Image enhancement technique	MSR
7	Model Details with number of parameters	225 layers, 11135987 parameters, 0 gradients, 28.6 GFLOPs
8	Details about Pre-Processing	pre-processing algorithm: MSR pre-processing time: 0.0218s
9	Others (if any specific)	model inference time: 1.256s

3. Conclusion

Fish health monitoring is necessary to minimize the economical loss in aquaculture farms ranging from small-scale to large-scale. However, the labor load for identifying unhealthy fishes is significantly high. Hence, there is a need for a system that can perform automated and accurate detection of fishes, as it is one of the primary requirements of fish health monitoring in water bodies. This study proposed a CLAHE-YOLOv8s fish detection algorithm that uses Contrast Light Adaptive Histogram Equalization for enhancing underwater images and facilitating more accurate fish detection. The study trained CLAHE-YOLOv8s and MSR-YOLOv8s (Multi Scale Retinex Enhancement) models using a pond fish dataset consisting of 5,950 images. Results show that the performance of CLAHE-YOLOv8s was superior to MSR-YOLOv8s in terms of accuracy and processing time. Future works can include improving the accuracy of the models by training the models using pre-trained weights of other public fish detection datasets.

4. References

1) Ma, J., Fan, X., Yang, S. X., Zhang, X., & Zhu, X. (2018). Contrast limited adaptive histogram equalization-based fusion in YIQ and HSI color spaces for underwater image enhancement. International Journal of Pattern Recognition and Artificial Intelligence, 32(07), 1854018.

2) Z. Rahman, D. J. Jobson and G. A. Woodell, "Multi-scale retinex for color image enhancement," Proceedings of 3rd IEEE International Conference on Image Processing, Lausanne, Switzerland, 1996, pp. 1003-1006 vol.3, doi: 10.1109/ICIP.1996.560995.

3) YOLOv8 documentation: https://docs.ultralytics.com/