Lab Report 4

Course Name: Machine Learning
Course Code: CSE 475
Section - 3

Assignment Name: Underwater Plastic Pollution Detection Using YOLOv

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Underwater Plastic Pollution Detection Using YOLOv

Introduction

Plastic pollution in marine environments has become a significant global concern. Efficient detection methods are essential to identify and mitigate underwater plastic waste. This project employs YOLOv (You Only Look Once), a state-of-the-art object detection algorithm, to detect plastic pollution in underwater images.

Objectives

- To develop an automated detection system for underwater plastic pollution using YOLOv.
- To evaluate the system's performance in terms of accuracy, precision, and recall.
- To visualize and interpret detection results.

Methodology

Environment Setup

The project was implemented using Python in a Jupyter Notebook environment. Key libraries and tools included:

- **YOLOv**: Object detection framework.
- **Ultralytics**: YOLO implementation.
- **Matplotlib & OpenCV**: For data visualization and image processing.

Dataset

- **Dataset Resource**: https://www.kaggle.com/datasets/arnavs19/underwater-plastic-pollution-detection/data

Model Training

- **Model Configuration**:
    - Input image size: 640x640 pixels
    - Number of classes: 15 (plastic objects)
- **Training Parameters**:
    - Learning rate: 0.01
    - Batch size: 16
    - Epochs: 25

Training Process: The YOLOv model was trained using GPU acceleration to speed up the process. During training, loss values were monitored to ensure the model's convergence.

Model Evaluation

- **Metrics Used**:
    - Precision: Measures the proportion of correctly identified plastic objects out of all detections.
    - Recall: Measures the proportion of actual plastic objects detected by the model.
    - mAP (Mean Average Precision): Evaluates the overall detection performance across different confidence thresholds.

Results

Detection Performance

The model achieved the following performance metrics:

- **Precision**: 0.65
- **Recall**: 0.63
- **mAP**: 0.67

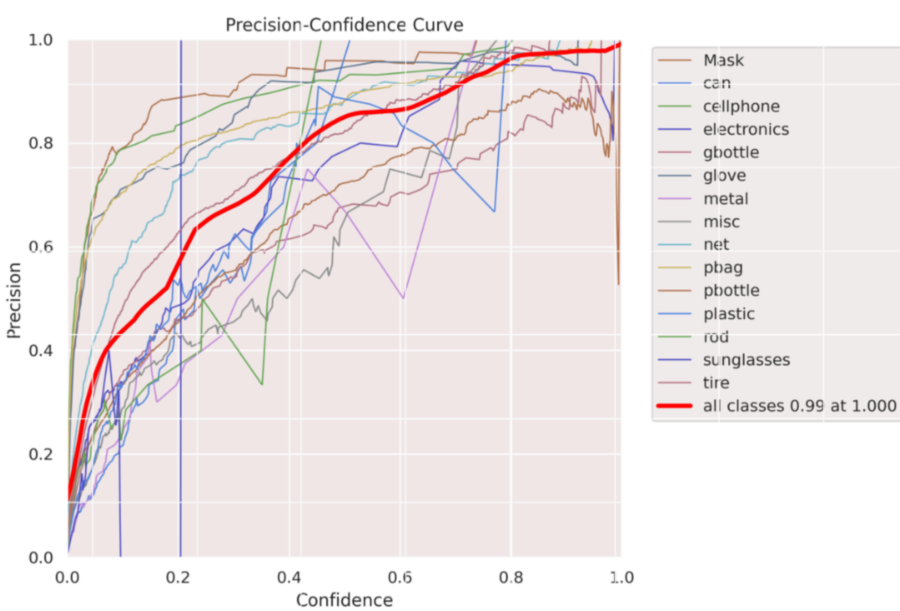
Visualization of Results

Below are examples of the detection results, where bounding boxes highlight detected plastic objects:

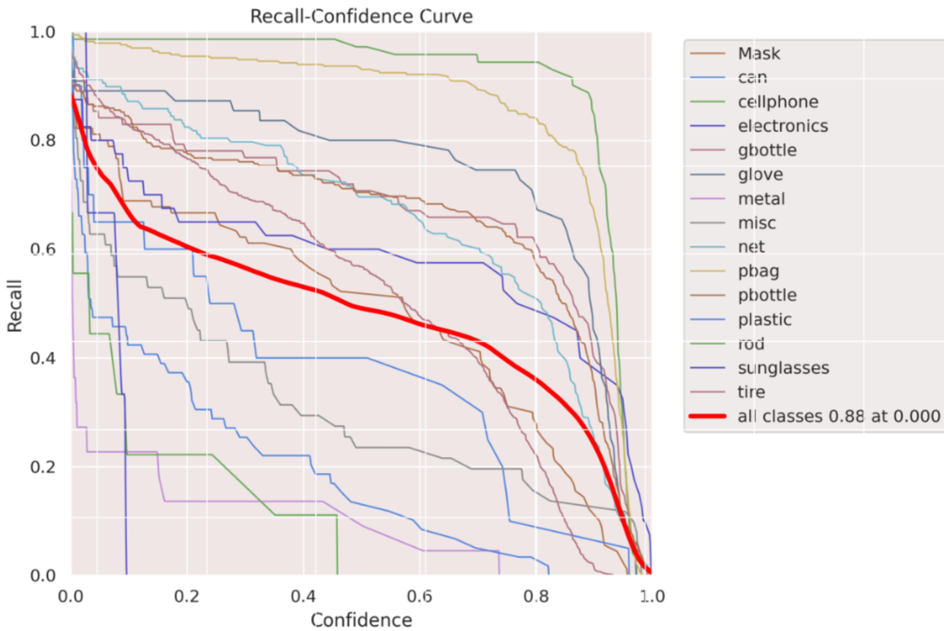
YOLOv8 configuration:

Training performance metrics:

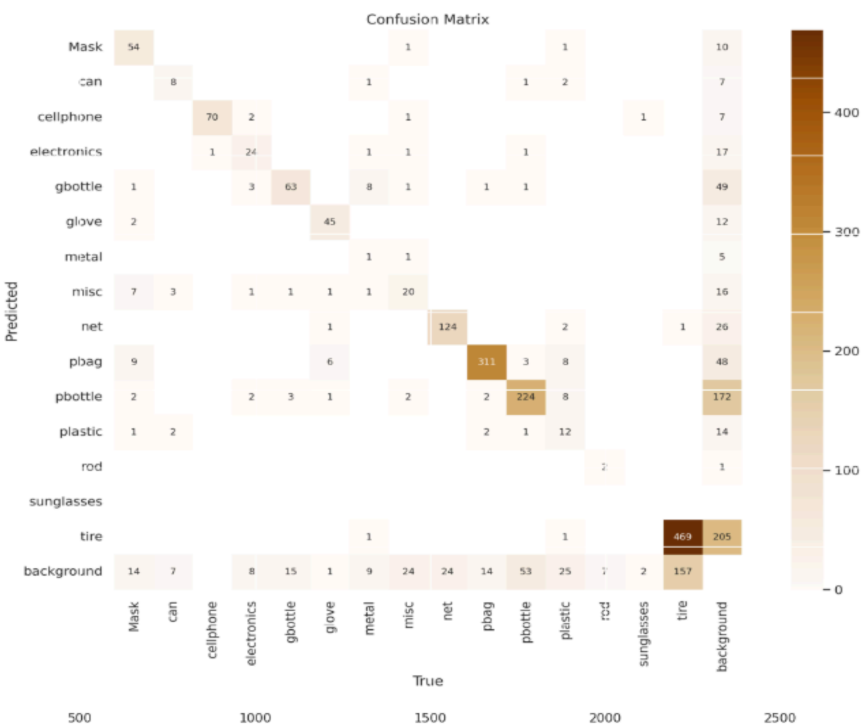
Precision Confidence Curve:



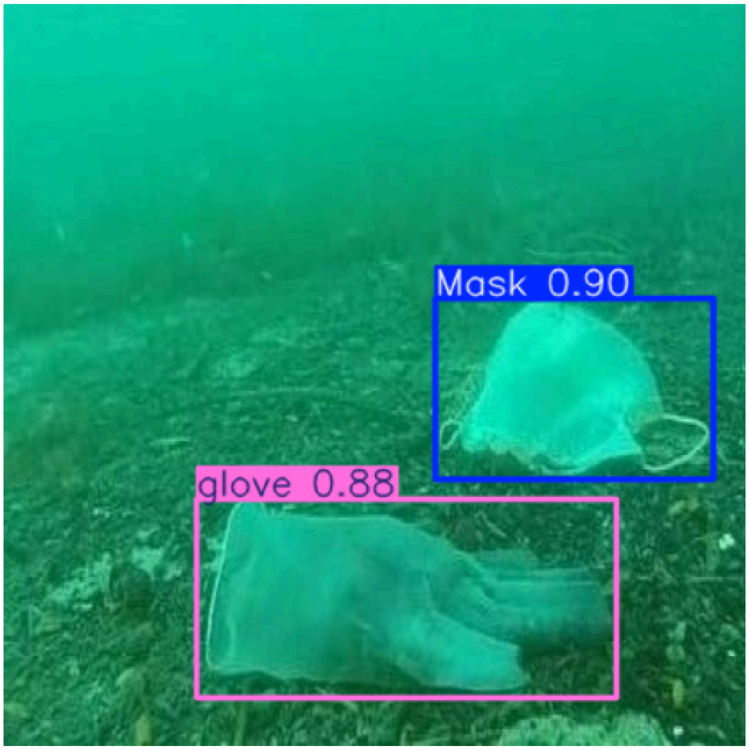
Recall Confidence Curve:



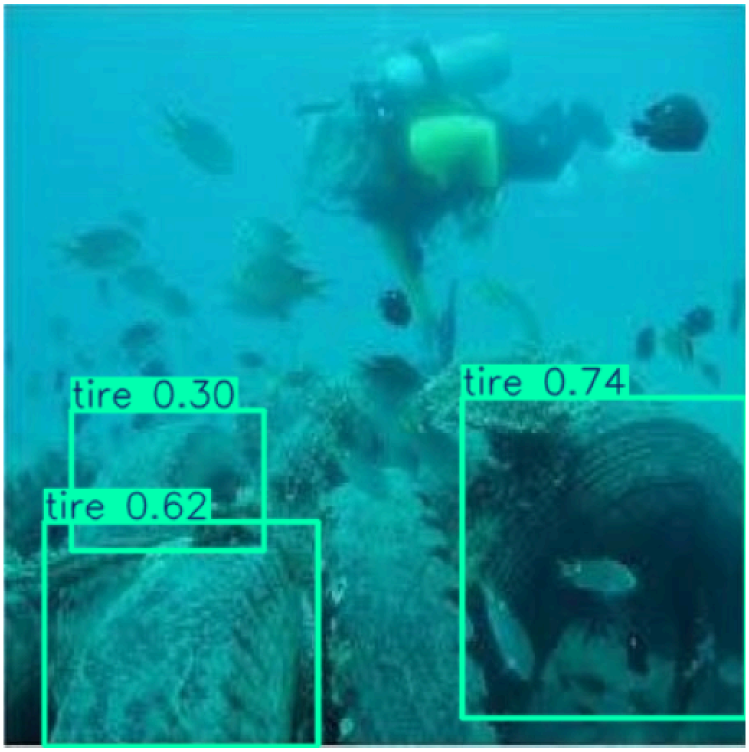
Confusion matrix:



<u>Visual inspection and use of fine-tund YOLOv8 first-hand:</u>


Mask 0.90
glove 0.88


gbottle 0.88



These visualizations demonstrate the model's ability to accurately detect and localize plastic objects in underwater environments.

Conclusion

The YOLOv-based system demonstrated promising results in detecting underwater plastic pollution, achieving high precision and recall. This approach provides an efficient, automated solution for monitoring marine environments.

Future Work

- Incorporate additional data from diverse underwater environments to improve generalizability.
- Optimize model performance under varying lighting and turbidity conditions.
- Explore integration with robotic systems for real-time underwater cleanup operations.