# Marine Litter Detection using Deep Learning on Underwater Images

## Report (FA2 – FDIP)

**-Vaishnavi kinge – 123B1F047**

### 1.Problem Statement :

Marine ecosystems are increasingly threatened by plastic pollution, leading to significant ecological and economic consequences. Detecting and quantifying underwater plastic debris is crucial for effective environmental monitoring and conservation efforts.

### 2. Motivation :

The accumulation of plastic waste in aquatic environments poses severe risks to marine life and biodiversity. Traditional methods of detection are often labor-intensive and inefficient. Leveraging deep learning models like YOLOv8 offers a promising solution for automated and accurate detection of underwater plastic debris.

### 3. Objectives :

- To develop a deep learning model for detecting underwater plastic debris.
- To evaluate the performance of YOLOv8 on a custom underwater plastic dataset.
- To compare the effectiveness of YOLOv8 with other object detection models in marine environments.

### 4. Introduction :

Plastic pollution in marine environments has garnered global attention due to its detrimental effects on marine life. Traditional detection methods are limited in scalability and efficiency. Recent advancements in deep learning, particularly in object detection, provide an opportunity to automate and enhance the detection of underwater plastic debris.

### 5. Literature Survey :

| Paper Title | Authors | Model Used | Dataset | Key Findings |
|---|---|---|---|---|
| Marine Plastic Detection Using Deep Learning | T. Jia | YOLOv4, YOLOv5 | Ocean plastic images | Investigated YOLOv4 and YOLOv5 for detecting marine plastics. (ResearchGate) |
| Optimized YOLOV8: An efficient underwater litter detection | F. Rehman | YOLOv8s | Custom underwater dataset | Proposed an improved YOLOv8s model for underwater litter detection. (ScienceDirect) |

| | | | | |
|---|---|---|---|---|
| Underwater Trash Plastic Detection | Mayuras7685 | YOLOv5, YOLOv8 | Custom dataset | Developed models using YOLOv5 and YOLOv8 for underwater trash detection. (GitHub) |
| Underwater Waste Detection Using YOLOV8 and Deep Learning | SK. Samzeedha, Shaik Nasreen | YOLOv8 | Marine waste images | Presented a system for detecting and classifying underwater waste using YOLOv8. (jespublication.com) |
| Deep Learning Based Underwater Trash Detection System | J.B. Institute of Engineering | YOLOv8 | Underwater images | Introduced a deep learning application utilizing YOLOv8 for underwater trash detection. (Jetir) |

**6. Methodology :**

**Data Collection**

- **Dataset**: Custom underwater plastic dataset collected from various marine environments.
- **Annotation**: Images annotated with bounding boxes around plastic debris.

**Model Selection**

- **Base Model**: YOLOv8n pretrained on COCO dataset.
- **Fine-tuning**: Adjusted for 15 classes of underwater plastic debris.

**Training Configuration**

- **Epochs**: 50
- **Batch Size**: 16
- **Image Size**: 640
- **Optimizer**: AdamW with learning rate 0.000526
- **Loss Function**: Combined box, class, and DFL losses

**Evaluation Metrics**

- **Precision**: Measures the accuracy of positive predictions.
- **Recall**: Measures the ability to find all relevant instances.
- **mAP@50**: Mean Average Precision at IoU threshold 0.5.
- **mAP@50-95**: Mean Average Precision averaged over multiple IoU thresholds.

**7. Implementation**

```
from ultralytics import YOLO
import matplotlib.pyplot as plt
import cv2
import os

model = YOLO("yolov8n.pt")

model.train(
    data="/content/underwater_plastics/data.yaml",
    epochs=50,
    imgsz=640,
    batch=16,
    name="plastic_detection_model",
    save=True
)
```

```
Creating new Ultralytics Settings v0.0.6 file ✅
View Ultralytics Settings with 'yolo settings' or at '/root/.config/Ultralytics/settings.json'
Update Settings with 'yolo settings key=value', i.e. 'yolo settings runs_dir=path/to/dir'. For help see https://
Downloading https://github.com/ultralytics/assets/releases/download/v8.3.0/yolov8n.pt to 'yolov8n.pt': 100%
Ultralytics 8.3.209 🚀 Python-3.12.11 torch-2.8.0+cu126 CUDA:0 (Tesla T4, 15095MiB)
engine/trainer: agnostic_nms=False, amp=True, augment=False, auto_augment=randaugment, batch=16, bgr=0.0, box=7.
Downloading https://ultralytics.com/assets/Arial.ttf to '/root/.config/Ultralytics/Arial.ttf': 100%
Overriding model.yaml nc=80 with nc=15

                   from  n    params  module                                       arguments
  0                  -1  1       464  ultralytics.nn.modules.conv.Conv             [3, 16, 3, 2]
  1                  -1  1      4672  ultralytics.nn.modules.conv.Conv             [16, 32, 3, 2]
  2                  -1  1      7360  ultralytics.nn.modules.block.C2f             [32, 32, 1, True]
  3                  -1  1     18560  ultralytics.nn.modules.conv.Conv             [32, 64, 3, 2]
  4                  -1  2     49664  ultralytics.nn.modules.block.C2f             [64, 64, 2, True]
  5                  -1  1     73984  ultralytics.nn.modules.conv.Conv             [64, 128, 3, 2]
```

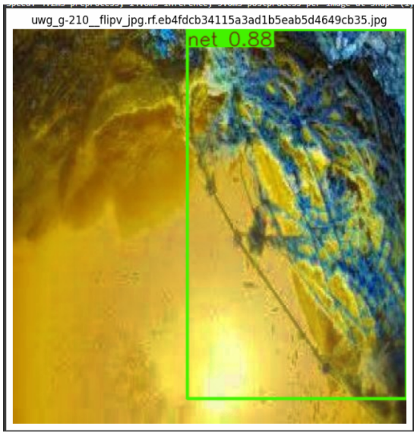
Training Performance

- **Epochs**: 50
- **Final mAP@50**: 0.383
- **Final mAP@50-95**: 0.246

Inference Results

- **Precision**: 0.8
- **Recall**: 0.332
- **mAP@50**: 0.383
- **mAP@50-95**: 0.246

8. Visualizations




9. Conclusion :

The YOLOv8 model demonstrates promising results in detecting underwater plastic debris, achieving a final mAP@50 of 0.383. Further improvements can be made by incorporating data augmentation techniques, exploring different YOLOv8 variants, and deploying the model in real-world underwater environments for continuous monitoring.

10. References :

1. T. Jia, "Marine Plastic Detection Using Deep Learning," ScienceDirect, 2023. ResearchGate
2. F. Rehman, "Optimized YOLOV8: An efficient underwater litter detection," ScienceDirect, 2025. ScienceDirect

3. Mayuras7685, "Underwater Trash Plastic Detection