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Saving The Indian Ocean: Plastic Pollution Assessment and Monitoring Along the Tana River

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Google TensorFlow

By 2050, the Indian Ocean might have more marine plastic waste than fish

- 4 million tons of plastic waste drain in the Indian Ocean every year
- 80% of the debris flows through the Tana River.
- Poses threat to the marine environment, food safety, human health, eco-tourism, & climate change.

Plastic pellets inside a dead fish washed ashore on a beach

Problem

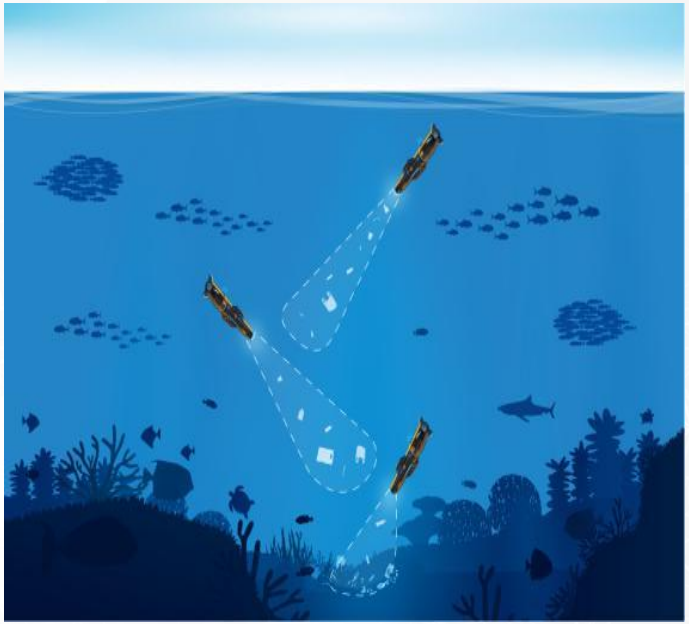
- Detecting, tracking & measuring how the plastic waste leaks into the Indian Ocean remains a tough challenge
- How do we identify hotspots for targeted cleanups?
- Manta Trawls are inefficient, expensive & labor intensive

Preserve the beauty, health, & biodiversity of the Indian Ocean & Waterways

1. Develop real-time detection of different types of plastic trash in the Tana River and beyond
2. Create a public dataset of annotated marine plastic debris images.
3. Investigate the usefulness of the state of the art deep-learning architectures to quantify buoyant aquatic plastic litter.

Related Work

- Visioned-equipped Autonomous Underwater Vehicle Deployments (University of Minnesota robotics lab)
- LIDAR — Light Detection and Ranging technology
- Sonar Image Target Detection & Recognition based on CNN
- Submersibles Development (Buoys)



Concept of real-time plastic detection via AUV's equipped with cameras and DeepTrash vision

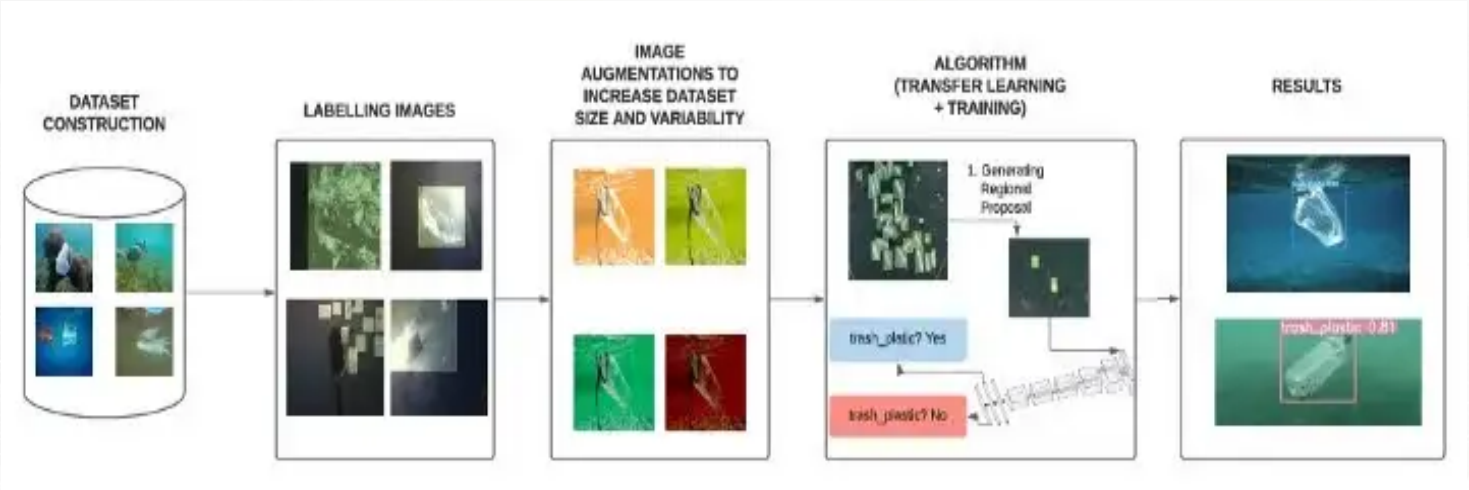
Dataset Construction & Processing

- Drone-mounted cameras captured 9,720 aerial photos & videos
- Scrapped 1,047 images from Google Images
- Community-sourced geospatial data
- Data Annotation with Supervisely tool
- Data Formatting & Augmentation

Network Architectures Implemented

- Faster RCNN Inception v2
- Single Shot Multibox Detector MobileNet v2 Single
- YOLOv4-Tiny
- YOLOv5-S

Methodology for detecting marine plastic trash

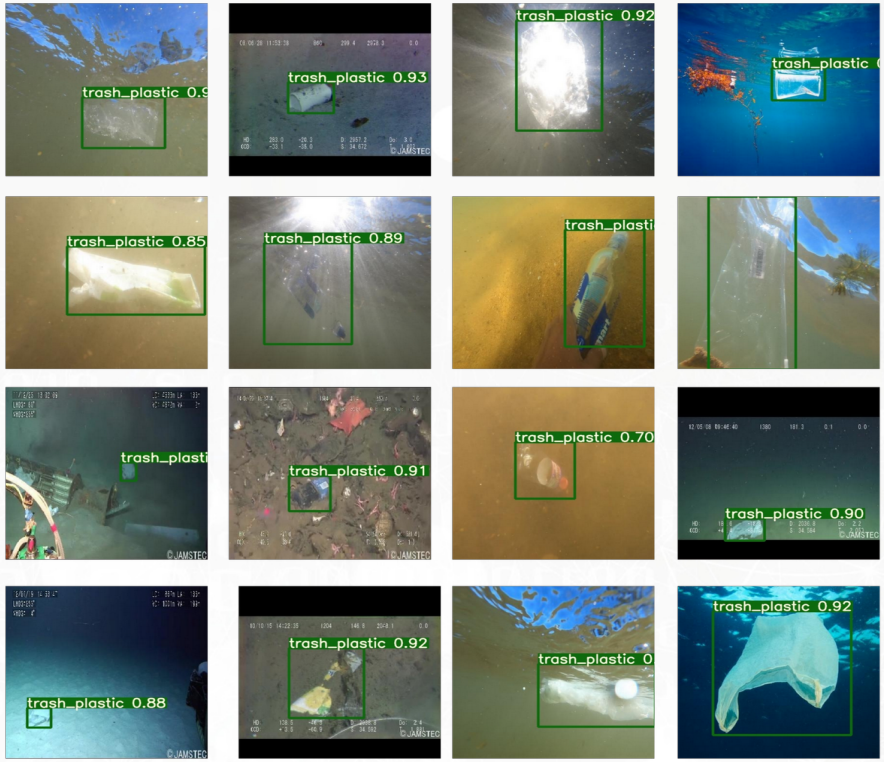


Detection Metrics in mAP, F1 and Precision

Network	mAP	F1-Score	Precision
YOLOv5s	85.0	0.89	0.93
Tiny-YOLOv4	84.0	0.80	0.96
Faster R-CNN	79.0	0.76	0.84
SSD	76.0	0.71	0.83

Performance Metrics for Inference (ms/img)

Network	P100	V100
YOLOv5s	2.8	1.4
Tiny-YOLOv4	1.9	1.2
Faster R-CNN	2.4	1.5
SSD	2.5	2.1



Results generated by the model with bounding boxes and confidence scores rendered over marine plastic debris.

Discussions

- YOLOv5-S model is fast, accurate, & robust enough to enable real-time marine plastic debris detection
- Effective object detection models can be built using readily available, pre-enabled GPUs for reasonable costs
- Implementing data augmentation techniques improved the model's precision rate
- Model can be implemented in robotic platforms (AUVs or Buoys)

Future Directions

Improve our model:

- To detect plastic cells & microplastics in the Tana River, the Indian Ocean & beyond.
- To recognize logos & brands on trash & identify from which companies different types of aquatic trash originate.
- Model inference speeds (GPU technology)

Dataset creation:

- Produce synthetic images containing (Use a 2-stage Autoencoder)

thank you

Keeping the Tana River clean is the most effective strategy for protecting the Indian Ocean & our waterways.

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