Title : **An Onshore Plastic Waste Detection Framework Using Near-Infrared Images And Yolov5m**


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# Project Title: **An Onshore Plastic Waste Detection Framework Using Near-Infrared Images And Yolov5m**

## Background :

Plastic waste pollution is a growing **environmental threat** in ASEAN countries, including Malaysia. The rapid increase in plastic use has led to serious waste accumulation, affecting marine life and ecosystems. With rising urbanization, there is an urgent need for digital tools to monitor and address this issue. However, research has been **limited** in exploring innovative, technology-driven solutions. This framework fills the gap by introducing an AI-powered approach to plastic waste detection using advanced object detection techniques.

## Targets:

Automated plastic waste detection, real-time environmental monitoring and actionable insights for clean-up.

# Proposed Method (Scientific and Technological)

- Utilizes advanced **machine learning** and **computer vision** for plastic waste detection.
- Combines **RGB (Red-Green-Blue)** and **RGNIR (Red-Green-Near Infrared)** images for improved accuracy.
- **YOLOv5** model ensures high-speed and precise detection of various plastic waste types.
- Novel use of **multispectral data** improves the detection of torn or irregularly shaped plastic.

# Proposed Method (Implementation)

- **Data collection**: Images of plastic waste captured via cameras (RGB & RGNIR).
- **Pre-processing**: Resizing and cropping images to suit YOLOv5 input, optimizing detection.
- Dataset split into **training, validation, and testing** sets for model training.
- Real-time, **scalable deployment** using low-cost hardware, suitable for large areas.

# Proposed Method (Experiments and Field Testing)

- **Field setup**: Cameras deployed in areas with high plastic waste pollution.
- Collected images fed into the **YOLOv5** model for detection.
- Evaluated with **precision, recall,** and **mean average precision (mAP)** metrics.

# Impacts (Scientific and Technological)

- **Enhanced** detection accuracy using RGB and RGNIR imaging.
- Real-time detection **capability** with the YOLOv5 model.
- **Introduction** of a multispectral plastic waste dataset.
- **Benchmark** for future research in automated waste detection.

# Impacts (Societal)

- Direct **contribution** to reducing plastic pollution.
- **Supports** environmental policies and waste management strategies.
- **Raises awareness** of plastic pollution among communities and organizations.

# Impacts (Collaborative)

- Potential for interdisciplinary **collaboration** with environmental scientists and policy experts.
- **Partnerships** with technology providers for enhanced data collection.
- Academic and industrial **collaboration** opportunities in machine learning and environmental monitoring.

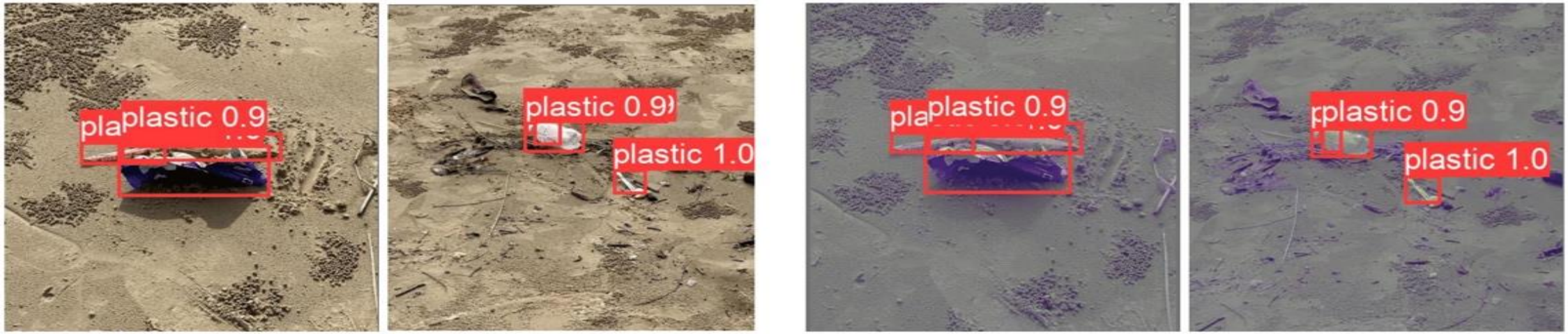
# Output/Outcome

1. Scientific**:**
   - **Development of a high-performance plastic waste detection framework**: The proposed framework demonstrates strong performance with a weighted metric score of 71.82% for both RGB and RGNIR images.

2. Societal:
   - **Public release of a multispectral plastic waste dataset**: The strong performance of the model provides valuable data for future research and applications in waste management.

3. Collaborative:
   - **Opportunity for partnerships with environmental organizations**: The significant improvement of the proposed framework, when compared to the Faster R-CNN model (with a weighted metric score of 46.78%), encourages partnerships with environmental organizations and industries dedicated to advancing plastic waste detection technologies.

# Output/Outcome




(a) (b)

Figure 1: The detection of plastic waste samples by YOLOv5m model for (a) RGB images and (b) RGNIR images

Table 1: Comparison between the proposed model with Faster R-CNN

| Method | mAP@0.5 | mAP@0.5:0.95 | Weighted Metric Score |
|---|---|---|---|
| **Faster R-CNN (ResNet50 as backbone)** | 71.34% | 44.05% | 46.78% |
| **YOLOv5m (Proposed model)** | 92.96% | 69.47% | **71.82%** |

# Conclusion:

1. Targets:
   - To develop a plastic waste detection framework using advanced object detection techniques for effective monitoring and management of plastic pollution.

2. Method:
   - The framework employs both RGB and RGNIR imagery, demonstrating high detection accuracy for various types of plastic waste, including torn and irregularly shaped pieces.

3. Scientific and Societal Impact:
   - The framework significantly outperforms state-of-the-art models like Faster R-CNN, providing a robust solution to plastic waste detection, which can contribute to environmental protection efforts.

4. Future direction:
   - Future work will focus on exploring different YOLOv5 model sizes and extending the spectral range for detection using advanced imaging technologies.

# UN Sustainable Development Goals (SDGs) Impact

**Our research is related to the following UN SDGs:**







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