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Microplastic Identification and Classification from Water Images Using YOLOv10 Architecture

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Abstract: *Microplastics, defined as plastic particles smaller than 5 mm, pose a severe environmental threat to aquatic ecosystems and human health due to their persistence and bioaccumulative nature. Traditional methods for detecting microplastics, such as spectroscopy and manual microscopy, are highly accurate but often involve complex procedures and expensive equipment and are unsuitable for real-time monitoring. To address these limitations, this paper presents PolyScan, a deep learning-based system designed for the automated detection and classification of microplastics in water using image processing techniques. The proposed system employs the state-of-the-art YOLOv10 object detection algorithm, which is optimized for real-time applications and can accurately identify microplastic particles of varying shapes and sizes. The dataset used comprises annotated images of water samples containing different types of microplastics. Image preprocessing, annotation, and data augmentation techniques are applied to enhance detection performance and robustness. Training and validation are conducted using YOLOv10-small on Google Colab, with evaluation metrics including precision, recall, F1-score, and mean average precision (mAP). Experimental results demonstrate the model's effectiveness in detecting microplastics even in visually complex water environments. A user-friendly graphical interface also enables live detection and image upload for testing, making the system accessible to researchers and environmental monitoring teams. PolyScan offers a promising solution for scalable, real-time monitoring of microplastic pollution and can be further integrated into edge devices, drones, or IoT systems for broader deployment.*

Keywords: Microplastic detection, YOLOv10, deep learning, image processing, object detection, real-time monitoring, water pollution, environmental surveillance, CNN, innovative detection systems

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