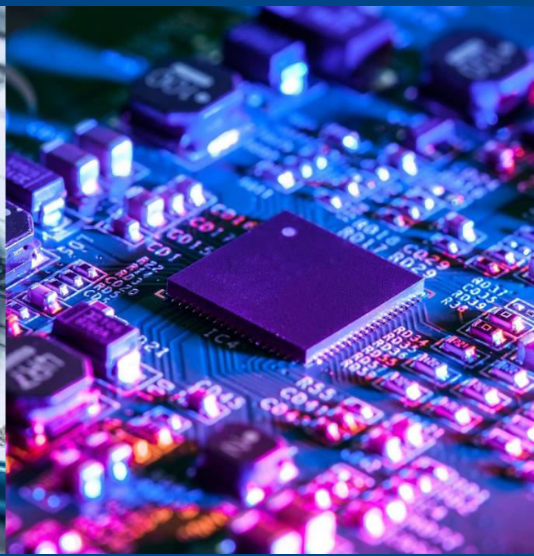
ISSN: 2582-7219

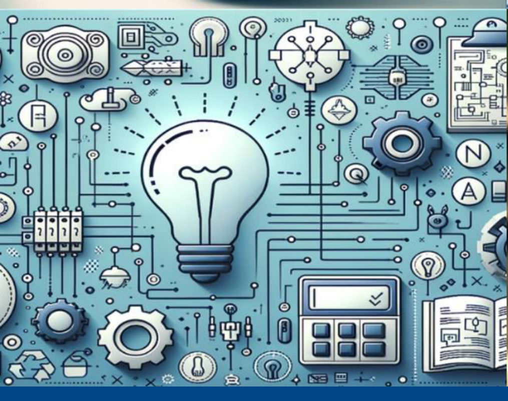




International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206

Volume 8, Issue 4, April 2025

www.ijmrset.com ijmrset@gmail.com +91 6381 907 438 +91 63819 07438

© 2025 IJMRSET | Volume 8, Issue 4, April 2025| DOI: 10.15680/IJMRSET.2025.0804052

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Image Capture and Microplastic Analysis in Water Bodies through Mobile App

Renju Mol.A[1], Ihsana Muhammed[2]

PG Student, Department of Computer Science, Royal College of Engineering and Technology, India[1]

Assistant Professor, Department of Computer Science, Royal College of Engineering and Technology, India[2]

ABSTRACT: The prevalence of microplastics in water bodies has resulted in massive harm to aquatic organisms as well as the environment at large. With water pollution continuing to rise due to human activities, effective ways of monitoring and controlling its impacts must be adopted. Traditional approaches to the identification of microplastics are generally time-consuming, labor-intensive, and less precise. However, recent breakthroughs in deep learning offer promising ways of automating and improving microplastic identification and classification. This paper introduces a deep learning-based approach utilizing various Convolutional Neural Network (CNN) models such as U-Net, ResNet-50, and Faster R-CNN for detecting microplastic particles in water bodies. The proposed model uses mobile camera capture or image upload to detect microplastics based on their chemical composition. Having been trained on a microplastic-specific computer vision dataset, the models demonstrate excellent performance in detecting microplastics from other particles. Among the models experimented on, U-Net was the best performing in detecting microplastics.

KEYWORDS: Image Capture, Microplastics, Detection, Deep Learning Models

I. INTRODUCTION

Microplastic particle contains pieces of smaller plastic in size to 5 mm. Water pollution, a growing global anxiety, is greatly affected by microplastics. These small plastic particles accumulate in aquatic organisms, and even indirectly can find their way into the human body, both induct the risk to aquatic and terrestrial species. As microplastics contribute to the ongoing development of water pollution, it becomes rapidly important to address the issue. Currently, microplastics detection include manual sampling, spectroscopy, filtration and refined laboratory setups with other complex techniques. Existing applications such as sea glass, sea debris tracker and other environment sensors are usually used to address microplastic contamination, but these methods are labor-intensive, special equipment is required, and only researchers and environmental analysts can accessible for. These methods also suffer from time consumption issues, causing delays, limited scalability and potential inaccuracy in predictions or analysis. To address the boundaries of these traditional techniques, an innovative solution is necessary for the future. This study focuses on the identification and analysis of microplastics in various water systems, with the goal of predicting whether the water is contaminated. The proposed solution is a mobile application that uses deep learning techniques to detect microplastic content through mobile cameras, converting it into IOT device. Images captured by the camera are processed in real time by advanced deep learning models to detect microplastics and determine volume. This approach not only increases scalability and accuracy, but also promotes more awareness and responsibility about water pollution within the society.

II. LITERATURE REVIEW

The system appoints an AI-managed camera to detect microplastic particles in water samples, assisting in the preservation of aquatic life. It uses convolutional neural network (CNN) to analyze microplastic levels in water systems through real -time camera feed [1]. Images captured to ensure effective monitoring are processed with preprocessing techniques. CNN classifies and volume microplastic particles based on their visual characteristics. This approach focuses on real -time data collection, rapid detection and identity. Its goal is to improve environmental monitoring capabilities, providing a new tool for accurate predictions to researchers and analysts and reducing microplastic contamination.

Microplastic pollution is a growing concern, which makes innovative identity and analysis methods important to address the issue. This study is a popular way to detect microplastic material in water samples through real-time analysis [2], which uses an IOT-based image captured system powered by an IOT-based image capture system. The high-resolution images captured have been prepared to increase clarity and eliminate the noise of the background. CNN is operated by analyzing features such as size and size. The model is trained and validated using a comprehensive dataset to correct detection of microplastics, reduce delay and increase the accountability of the system. Additionally, the paper introduces a user -friendly interface that allows stakeholders to reach real -time monitoring results.

This paper presents an advanced method to detect and classify microplastic using deep learning techniques, especially the Convolutional Neural Network (CNN) applied to optical microscopy images [3]. Images undergo preprocessing and division to separate microplastic particles from the background for accurate analysis. A large, diverse dataset of labels labeled to train CNN is used, which then different data to increase its accuracy and strength in counting and classifying based on characteristics like size and size Testing and valid on. The study highlights the benefits of this automatic approach to improving environmental monitoring and efficiently addressing plastic pollution in aquatic ecosystems.

The paper presents an innovative framework to automate micro-plastic detection and classification using high-resolution optical microscopy and deep learning[4]. Preprocessing techniques such as filtration and division enhance image quality, while a CNN model is trained on a large dataset to classify particles based on size, color, and size. Additionally, a user-friendly interface supports researchers and environmental managers in monitoring micro-plastic pollution, assists stability efforts and informs decision making.

Similarly, the study on micro-plastic classification and perception in water bodies integrates image processing and machine learning for strong detection[5]. The high-resolution microscopy catches the particles, followed by preprocessing to reduce noise. A CNN model ensures accurate classification, while statistical methods determine particle concentration. A real-time monitoring software further enhances micro-plastic evaluation, supports water quality management and pollution control.

This paper looks into the implementation of machine learning techniques for the analysis of microplastic presence in various environments[6]. The authors analyze different machine learning methods, namely Support Vector Machine, Random Forest, and Decision Tree, which classify the microplastic particles according to their physical and chemical characteristics. They also emphasize the importance of Convolutional Neural Networks for their capacity to automatically recognize and quantify microplastic samples in water, soil, and sediment through their imaging capabilities. The study focuses on the importance of data preprocessing, feature extraction, and other techniques used to improve systems' performance. It also discusses the volume and scope of the dataset and its subsequent impact on accuracy, as well as the possibilities of AI-based real time monitoring for immediate detection and diagnosis during data collection and analysis. The authors review all available literature to assess the application of deep learning models, In particular, convolutional neural networks (CNNs), recurrent neural networks (RNNs), and deep neural networks (DNNs) for microplastic identification[7]. Traditional methods such as FTIR, k-NN, SVM, and Random Decision Forest (RDF) were also analyzed. By shedding light on the advantages as well as the shortcomings of these approaches, the paper suggests the possibility of real-time deep learning assisted microplastic monitoring. It deals with the issue of open sewer microplastic identification and how better detection can lead to better overall waste management and lower water pollution. It intends to outline microplastic monitoring approaches that would contribute to the achievement of public health problems and sustainable environmental solutions.

The goal is to create an effective and novel approach to detect and classify micro-plastics present in water systems by applying deep learning technologies[8]. The author uses Adversial Networks and Generative Adversial Networks to enhance the accuracy accuracy on identifications that are sometimes difficult due to the objects having a high degree of transparency, are small, and their shapes are diverse [8].The model employs a hybrid structure which includes generative and discriminative components. The generator builds images of water in various forms, while the discriminator assigns a label to the image stating whether it is real or not. The adversial learning process increases the model's ability to identify micro-plastics and other contaminants in water. It improves identifications and classifications accuracy. GAN's heavily used for image processing are not only computational disk space demanding. It poses a significant challenge in terms of processing power and memory usage. Hence, it is not practical to use in many situations. The model's entrenched reliance on the quality of dataset prompts worser retention results. Overfitting of data. Realtime implementation tends to be more complex than normally. There is a severe lack of knowledge regarding any aspects that help with these models and it is easy to make a poor collapse of this model.

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

This research looks into the concentration of microplastics in freshwater bodies, as well as the quality of data that is available[9]. It also offers detection methods for microplastics and highlights the risk's microplastics pose to human beings and the environment. This paper aims to classify the sources and the loading and fate of microplastics in the water, structures of water, fresh water bodies, rivers, lakes and even drinking water water sources. The research aims to assess the data quality and consistency in microplastic research and the factors that make microplastic research challenging. In addition, this study reviews the sampling approaches plus the analytic and interpretation of the data components, pointing out that a lack of uniform methodology leads to poor data. CNNs and GANs have been identified as applicable deep learning models, while the former is used for high resolution image classification CNNs are used.

This paper focuses a deep learning approach for automatic detection and classification of micro-plastic particles from environment samples [10]. The proposed system leverages Convolutional Neural Networks to analyze images of micro-plastic samples automatically based on the size ,shape and material properties. The author compares the deep learning approach with the traditional image processing methods for detection and categorization of micro-plastic particles of complex systems. Existing system rely on traditional methods like sampling, manual and automated processes. So it's prone to human errors and interference and time consuming as well. But the deep learning model like CNN provides greater efficiency ,scalability and objectivity, but the limitation with the large labelled dataset training is difficult in some cases. The performance of automated system with deep learning technique is more efficient than the traditional in the case of precision and speed.

III. PROPOSED SYSTEM AND ARCHITECTURE

Water is essential for all living organisms. So water quality has a great role in today's world.
It identify micro-plastic materials with various water samples here. It captures the picture of the water sample through a mobile camera as an IOT device. Those uploads or captured images were then processed using individual deep learning models such as R-CNN, Yolo V8, RES-NET-50 and U-NET. The well -performed model uses for image classification and identification. This provides real -time visual response. Thus the model helps improve the delay and scalability of the model

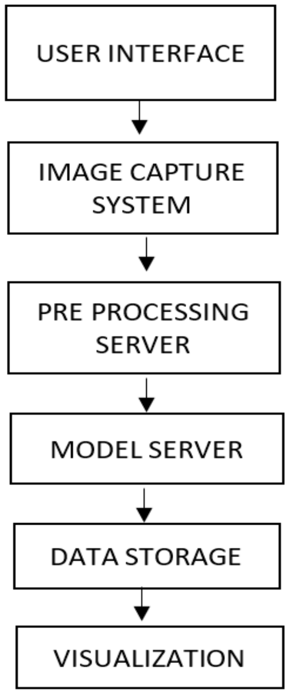


Fig 1: Proposed System Architechture

© 2025 IJMRSET | Volume 8, Issue 4, April 2025| DOI: 10.15680/IJMRSET.2025.0804052

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

In this system, users can capture or upload images using a mobile camera, providing raw data for microplastic analysis. A preprocessing server enhances image quality by resizing, de-noising, and normalizing the images. It also isolates microplastics from non-microplastic particles for more accurate analysis. Trained deep learning models then detect and classify microplastics based on their size, shape, and type. The preprocessed images are stored in a data storage module, while high-computational tasks such as model training and updates can be efficiently managed using cloud storage. The results are then transformed into visually appealing formats, such as graphs, through a visualization module, which presents a clear representation of microplastic content in various water samples.

1. PROBLEM STATEMENT AND OBJECTIVE

Micro-plastic pollution is a significant threat to aquatic life, food chains and human health. Traditional methods to detect micro-plastic content are time consuming, labor intensive, relied on specialized equipments and laboratory industries. Real time monitoring is impractical and large scale assessment is not viable in the existing system. Current monitoring techniques user manual sampling and analysis, which results delayed response. An efficient, accessible and scalable solution for real time analysis and cost effective approach is needed to reduce water contamination.

The objective is to develop a mobile application which leverages different deeplearning techniques for real time detection of micro-plastic particles from different aquatic environments. It provides real time analysis and visual feedback. Comparing with the traditional methods, it will be cost effective and efficient monitoring approach. Deployment of deep learning models on mobile device ensures fast, accurate and power efficient performance.

2. IMAGE CAPTURE SYSTEM

Image capture system is the key module of deep learning based mobile application for microplastic analysis in water systems. It allow users to capture high quality images through a user friendly interface, which includes both captured and uploaded images. The system automatically stores all images taken with camera or uploaded. Once an image is captured, it undergoes basic preprocessing to enhance the quality of the image. It makes the image stores and suits for deeplearning analysis . This model emphasize user experience and reliability.

3. IMAGE PRE PROCESSING

The image preprocessing module is essential to enhance the quality and suitability of the captured images before analysis. It performs a series of automated tasks to improve image clarity, consistency such as resizing to a standard format, adjusting brightness and contrast and applying filters to reduce noise. It also includes the techniques like normalization and histogram equalization to boost features relevant for micro-plastic identification. By qualifying images in this way makes deeplearning model analysis more accurate and efficient leads to reliable results.

4. MODULE ANALYSIS OR DEEPLEARNING MODEL ANALYSIS

The analysis module integrates different deeplearning models such as Faster R-CNN, U-Net, ResNet 50 or YOLO v8 to deliver accurate analysis of water samples. Actually, Faster R-CNN and YOLO v8 mainly used for object detection, helps to detect multiple objects efficiently. U-Net architecture commonly used for segmentation tasks, can easily delineate micro-plastic boundaries. The deeplearning model which provides the best accuracy which chooses for micro-plastic detection.

ResNet 50: ResNet 50(Residual Network with 50 layers) is a deep convolutional neural architecture. It is designed to solve the problem for training very deep neural network. It is also known as Residual connections. It allows for better training and deeper architectures to mitigate the gradient problem. ResNet uses a bottleneck for residual connections. Residual blocks,50 layers, Identify mapping, improved gradient flow, ease of training are the features of ResNet.

U-Net: This is a deeplearning model mainly used for image segmentation tasks, especially it is used in medical image analysis. U-Net lies in U-shaped architecture. It consists of two parts. Contracting path and expansive path. Contracting path or encoder captures the context and reduce the spatial dimensions of the input image through convolutional and pooling layers. Expansive path or decoder restores the spatial resolution to the original input size by using transposed convolutions and combines the low level features from the encoder.

YOLO v8: It is the latest version of YOLO (You Look Only Once) family and primarily used for real time object detection. It is deeplearning based object detection model for real time inference and high speed detection. It uses latest advances and optimization techniques. It uses CSPDarknet as the backbone for feature extraction. YOLO adopts FPN

© 2025 IJMRSET | Volume 8, Issue 4, April 2025| DOI: 10.15680/IJMRSET.2025.0804052
ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|
International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)
(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

(Feature Pyramid Network) and PAN(Path Aggregation Network) as part of neck architecture. Enhanced training strategies and performance improvements are the features of YOLO. Real time inference, high accuracy, flexibility, pre-trained models and cross platform support are the advantages of YOLO.
Faster R-CNN:Faster R-CNN (Region Based Convolutional Neural Network) is a popular and powerful object detection framework created for identifying and localizing objects in images. It helps to improve the speed and accuracy of the system. It helps to ease feature extraction process, these features then used for object detection. It integrates region proposal generation and object detection into a single network. It supports multi scale object detection.

5. DATA STORAGE MODULE

Data storage module is a vital component for micro-plastic detection. It securely managing and organizing all captured images, analysis results and user data. This module facilitates both local and cloud storage options. Users can access their data while maintaining data integrity and privacy. It stores preprocessed images along with analysis results, which facilitates easy data retrieval and comparison. It improves the functionality of the app by implementing efficient data management practices. It helps to monitor the water samples and changes in water quality

6. VISUALIZATION MODULE

This module is an essential part of deeplearning based mobile app for micro-plastic identification, which is designed to present analysis results in a user friendly and informative way. It converts complex data into more attractive visual representations such as graphs, charts and annotated images etc. It allows users to easily interpret the presence of micro-plastics in water samples. It enables users to track changes in micro-plastic concentration. The visualization module empowers users to make informed decisions and great awareness of water quality issues.

IV. RESULT AND DISCUSSION

Fig 1 shows ,how the microplastics visible through camera.We can identify the microplastic particles through camera easily.

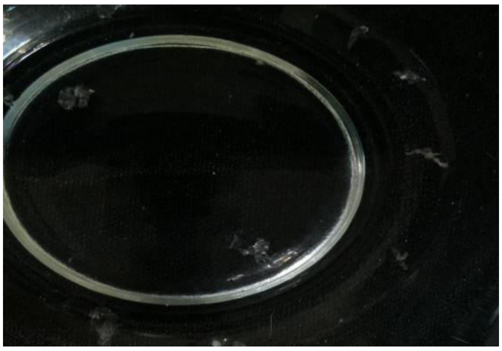


Fig 2: MP Analysis through camera

Result Comparison Table

Model	Task	AP (IoU=0.50: 0.95)	AP50	AP75	Validation Loss	Validation Accuracy
Faster R-CNN	Object Detection	30.47%	68.37%	23.37%	-	-
U-Net	Semantic Segmentation	-	-	-	0.1161	96.03%
ResNet-50	Classification	-	-	-	0.2091	94.02%
YOLOv8	Object Detection	37.6%	78.4%	32.1%	-	-

Fig 3:Result Comparison Table

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

The performance of four models –Faster R-CNN,U-Net,ResNet-50 and YOLOv8 were evaluated for object detection, semantic segmentation and classification tasks. The models were evaluated using accuracy, loss and COCO style average precision for bounding boxes and segmentation masks. Faster R-CNN achieved an AP of 30.47% at IoU=0.50:0.95 with better performance for medium(42.47%) and large objects(65.12%) but lower for small ones(13.86%).U-Net excelled in semantic segmentation with 96.03% accuracy and a loss of 0.1161.While ResNet-50 yielded 94.02% accuracy and a loss of 0.2091 for classification. YOLO v8 demonstrated strong performance with an mAP50 of 78.4% and mAP50-95 of 37.6% making it ideal for real time micro-plastic detection due to its speed and precision.

V. CONCLUSION

This study highlights the ability to integrate advanced technology with environmental monitoring efforts. By taking advantage of deep learning algorithms and mobile functionality, we have developed a user -friendly platform that enables the real -time image capture and identification of microplastic materials in the aquatic environment. Various deep teaching models, including rapid R-CNN, U-Net, Yolo V8, and RESNENT-50, were applied and evaluated on the basis of average accuracy and verification accuracy. Of these, U-Net demonstrated better performance, gaining high accuracy of 96.03% and low verification loss of 0.1161, making it the most suitable model for the accurate identification and division of microplastics at the pixel level. The project not only enhances microplastic monitoring, but also empowering a wide range of users, from researchers to environmental experts to contribute to data collection and awareness efforts. Mobile application provides a versatile and adaptable solution in various settings, promotes environmental protection and encourages active action against microplastic pollution.

REFERENCES

[1] Dr. M.D. Ashfaqul Hasan, Dr.K. Balasubadra,Dr.G. Vadivel, Dr.N. Arunfred, Ishwariya .M.V, S.Murugan ,"IoT-Driven Image Recognition for Microplastic Analysis in Water Systems using Convolutional Neural Networks", International conference on computer 2024.

[2] MAB Sarker, MH Imtiaz, TM Holsen, ABM Baki ,"Real-time detection of microplastics using an ai camera", Sensors, vol no.24, pg no.1-15, 2024

[3] J Lorenzo-Navarro, M Castrillón-Santana, "Deep learning approach for automatic microplastics counting and classification", Science of the Total … Elsevier, vol no.765, pg no.1-8, 2021

[4] Javier Lorenzo-Navarro , Modesto Castrillon-Santhana, Enrico Santesarti ,Maria De Marisco , (Senior Member, IEEE), Ico Martinez , Eugenio Raymond ,May Gomez , And Alicia Herrera , "SMACC: A System for Microplastics Automatic Counting and Classification", IEEE Access, vol no.8, pg no.25249-25260, 2020.

[5] Trisha Karmakar , Reetu Jain , "Microplastic Classification and Quantification in Water Bodies" , International Journal of Enhanced Research in Science, Technology & Engineering, vol no.12, pg no.81-87, 2023.

[6] Adjama Irédon,Dr. Hemen Dave , "Microplastic detection in Environmental Matrix using Artificial Intelligence: Review of Advancement" -NFSU Journal of Law and Artificial Intelligence., vol no.1, pg no.29-37.

[7] Joseph Michael Odhiambo, Dr. Mgala Mvurya, Dr. Anthony Luvanda, Dr. Fullgence Mwakondo , "Deep Learning Algorithm for Identifying Microplastics in Open Sewer Systems: A Systematic Review" -The International Journal of Engineering and Science (IJES)., vol no.11, pg no.11-18, ,2022.

[8] Rajasekar M,Angelina Geetha, "Microplastic Identification in Sea Water using Adversarial Networks" -International conference on Data engineering and Intelligent computing systems., vol no.8, 2024.

[9] Albert A. Koelmans a, Nur Hazimah Mohamed Nor , Enya Hermsen , Merel Kooi , Svenja M. Mintenig , Jennifer De France , "Microplastics in freshwaters and drinking water: Critical review and assessment of data quality" , World Health Organization; licensee Elsevier Inc, vol no.155, pg no.410-422, 2019

[10] Javier Lorenzo-Navarro, Modesto Castrillon-Santana , May Gomez , Alicia Herrera and Pedro , Mar´ın-Reyes , "Automatic Counting and Classification of Microplastic Particles", 7th International Conference on Pattern Recognition Applications and Methods, vol no.2, pg no.646-652, ICPRAM 2018 .

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com