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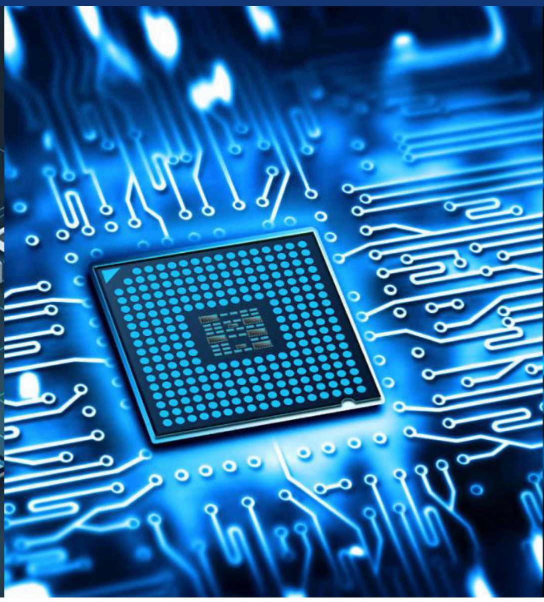

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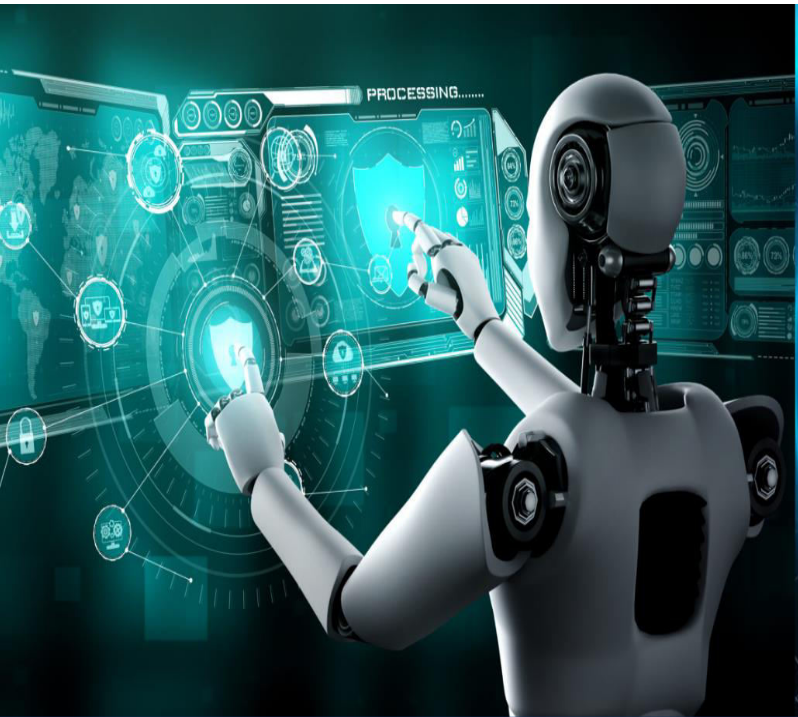

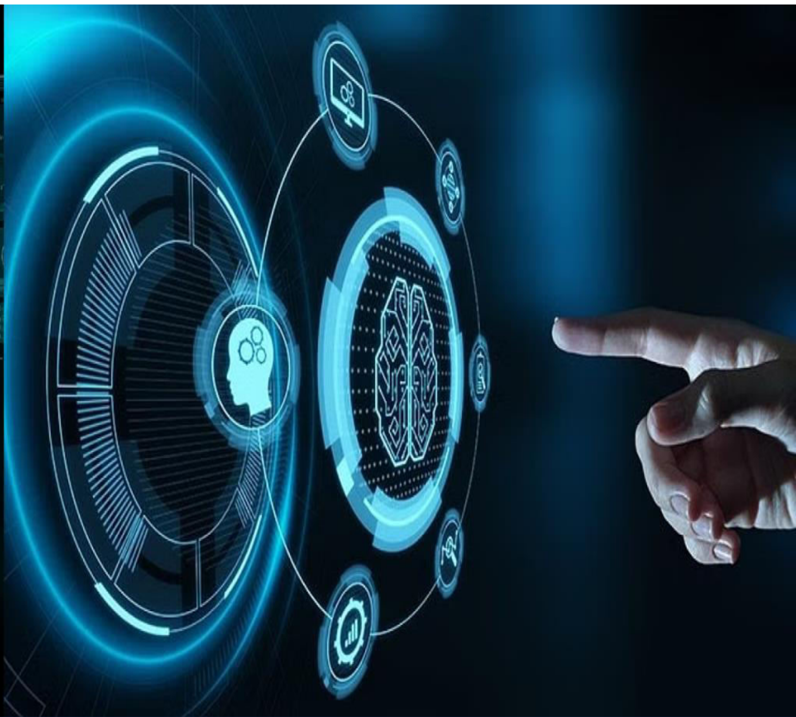

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Garbage Detection on Water Surface using Yolo

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ABSTRACT: The increasing levels of underwater waste pose significant environmental and ecological threats, necessitating advanced detection and monitoring solutions. This project presents an AI-driven approach to detect underwater waste using YOLOv8.The system leverages two datasets—one for underwater waste detection and another for water potability assessment.For waste detection, a denoised dataset is used to train the YOLOv8 model, improving detection accuracy across various types of submerged debris. The trained model is evaluated using a 60-epoch training strategy, optimizing detection performance. For water quality assessment, a structured dataset with multiple physicochemical parameters is analyzed using feature selection techniques and correlation analysis.The integration of deep learning and machine learning enhances detection accuracy, enabling efficient identification of waste materials and unsafe water conditions. This project contributes to marine conservation efforts and public health safety by facilitating proactive waste management and water quality assessment.

KEYWORDS: YOLOv8,Waste Detection, Floating Debris, Water Pollution, Object Recognition.

I. INTRODUCTION

Garbage detection on water surfaces, such as oceans, rivers, and lakes, addresses a pressing environmental challenge affecting marine life, ecosystems, and water quality. Manual methods for monitoring and cleanup are labor-intensive and inefficient. Deep learning, particularly YOLOv8 (You Only Look Once version 8), provides an automated solution to detect and classify floating waste efficiently. This system identifies plastics, metal cans, and other debris, thereby supporting environmental protection efforts. The process begins with dataset acquisition and preprocessing using Roboflow, a platform for managing labeled datasets. Two marine waste datasets, containing labeled images of various garbage types, help the YOLOv8 model learn to recognize and differentiate floating waste. Training the YOLOv8 model for 60 epochs fine-tunes its ability to detect waste with high accuracy, optimizing its parameters for real-world scenarios without overfitting or underfitting the data. Upon completion of training, the model performs real-time inference, analyzing new images of water surfaces to predict, localize, and classify detected garbage. Results are visualized using OpenCV, ensuring clear interpretation for researchers and environmentalists. Feature selection techniques enhance the system's efficiency by eliminating insignificant attributes, and incorporating both original and denoised datasets ensures robust performance in diverse conditions.

This AI-driven system integrates object detection with water quality assessment for comprehensive water pollution monitoring. It enables scalable, automated detection of waste accumulation, supporting marine cleanup efforts, pollution control strategies, and ecosystem conservation. By leveraging AI and computer vision, the project provides a practical and impactful solution for maintaining aquatic environments. Incorporating YOLOv8, Roboflow, and deep learning, this system exemplifies the intersection of technology and environmental sustainability, contributing to cleaner and healthier water bodies. Visualizing results through platforms like Google Colab further improves accessibility and analysis, ensuring practical applicability.

II. RELATED WORK

Water surface garbage detection based on lightweight YOLOv5, Luya Chen & Jianping Zhu, Scientific Reports volume 14, Article number: 6133 (2024), the study highlights a lightweight YOLOv5 algorithm for water surface garbage detection, achieving 4.3% faster detection, 84.9% mAP, 88.7% precision, and reduced parameters for hardware adaptability using the Orca dataset. Trash Detection on Water Channels, December 2021, Lecture Notes in Computer Science, DOI:10.1007/978-3-030-92185-9_31, Neural Information Processing (pp.379-389), Mohbat Tharani, Abdul Wahab Amin, Fezan Rasool, Mohammad Maaz, this study addresses urban water trash detection using deep learning algorithms. A dataset of 48,450 annotated trash objects is created, with IoT camera nodes aiding detection, segmentation, and algorithm modifications. Case Studies in Chemical and Environmental Engineering, Volume 2, September 2020, 100026, AquaVision: Automating the detection of waste in water bodies using deep transfer learning, Harsh Panwar, P.K. Gupta, Mohammad Khubeb Siddiqui, Ruben Morales-Menendez, Prakhar Bhardwaj, Sudhansh Sharma, Iqbal H. Sarker, this study introduces AquaTrash dataset and AquaVision model, achieving 0.8148 mAP for detecting and classifying water pollutants, aiding cleanup efforts and preserving aquatic ecosystems by localizing harmful waste efficiently. Existing systems for underwater waste detection rely on manual methods, such as divers conducting visual inspections, which are time-consuming, labor-intensive, and pose high risks in polluted waters. Traditional image processing techniques, like edge detection and thresholding, perform poorly in complex environments, while statistical models fail to handle non-linear data or provide real-time results. The proposed system integrates deep learning and machine learning for enhanced underwater waste detection and water quality assessment. Using YOLOv8 and a labeled dataset, the system detects and classifies underwater waste, including plastics, cans, fishing nets, and face masks, efficiently. It ensures accuracy, real-time monitoring, and reduced operational costs.

III. METHODOLOGY

The proposed AI-driven underwater waste detection system utilizes YOLOv8 (You Only Look Once, version 8) to identify and classify marine debris in real time. It supports monitoring marine pollution, cleanup efforts, and environmental conservation. The system architecture follows a structured pipeline involving data acquisition, preprocessing, model training, inference, and result visualization. Datasets, curated using Roboflow, consist of labeled images of underwater waste materials such as plastics, metal cans, fishing nets, and glass. These datasets are formatted for YOLOv8 compatibility, ensuring efficient object detection tasks. The YOLOv8 model is trained using GPU acceleration in Google Colab, allowing faster processing. Once trained, the model is deployed to detect and classify underwater waste in real-world images and video feeds. The model predicts waste types and localizes them with high accuracy using the `yolo predict` command. Visualization is achieved with OpenCV, which overlays bounding boxes and confidence scores on the detected objects, enabling detailed analysis of pollution patterns. The system integrates technologies including underwater drones and autonomous robots for real-time waste detection and removal. It proposes enhancements like improved accuracy through diverse datasets and sensors for water quality assessment. Key technologies include Ultralytics YOLOv8, Roboflow, Python, PyTorch, OpenCV, and Google Colab for seamless deployment and efficient performance. The underwater waste detection system is designed to automate the identification of marine debris using deep learning and computer vision. The system is structured into various components and modules, ensuring a seamless flow from data acquisition to waste detection and visualization. Below is a detailed breakdown of the system design, architecture, and components. The Underwater Waste Detection and Water Quality Assessment System is divided into multiple modules to ensure modular development, efficiency, and maintainability. Each module plays a critical role in achieving the system's objectives.

Data Acquisition

The Data Acquisition Module enables users to upload underwater images and water quality data through a React Native interface. Flask API processes inputs efficiently, while external water quality data enhances accuracy. It collects data from Roboflow and real-time sources, including drones, for waste detection and potability assessment, ensuring seamless interaction.

Data Preprocessing

The Preprocessing Module optimizes image and numerical data for model performance. OpenCV resizes, normalizes, and enhances image contrast for accurate YOLOv8 waste detection. Pandas and NumPy manage missing water quality data. Noise reduction, contrast adjustment, and brightness correction improve detection accuracy, while augmentations increase dataset diversity and compatibility.

Waste Detection

The Waste Detection Module identifies and classifies underwater waste using YOLOv8 powered by PyTorch. It processes images to generate labeled outputs, highlighting detected waste. Advanced object detection algorithms enable

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accurate monitoring, providing valuable pollution insights. Deep learning ensures precise detection, supporting environmental conservation and effective underwater waste analysis efforts.

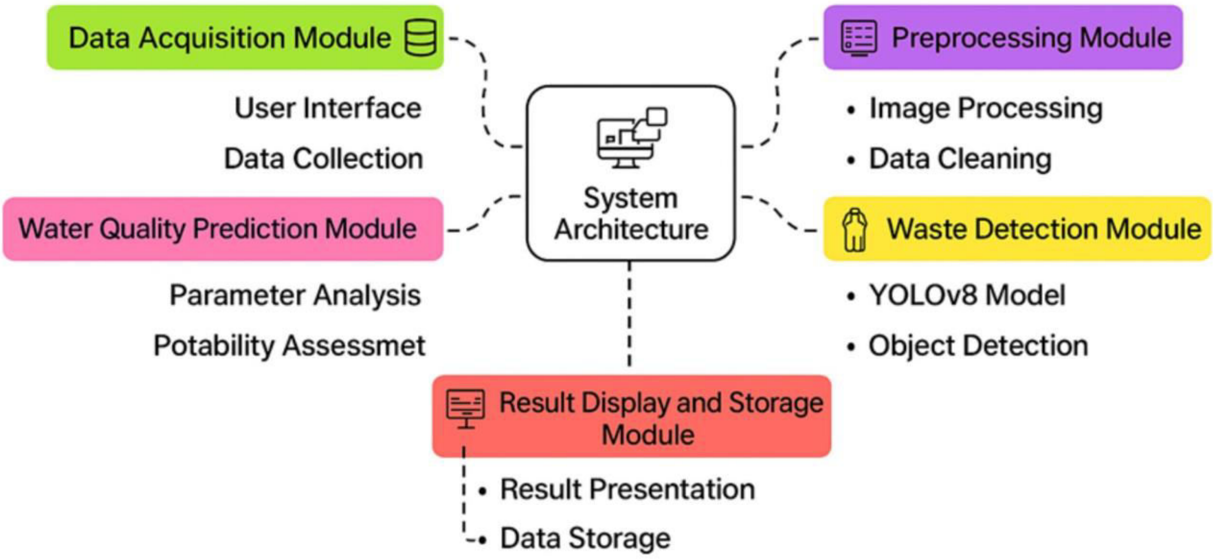

Fig 1: System Architecture

Water Quality Prediction

The Water Quality Prediction Module analyzes parameters like pH and turbidity to assess potability, providing probability scores for water safety. The Result Display Module presents labeled waste detection images and categorizes water as potable or non-potable, ensuring clear outputs and secure data storage for environmental monitoring and resource management.

Model Training and Optimization

The YOLOv8 model is trained using the labeled dataset from Roboflow. Training is performed on Google Colab with GPU acceleration to speed up computation. The model undergoes tuning to achieve the best performance optimizing the rate at which the model updates its weights. Batch Size Optimization balancing memory usage and training speed. Ensuring robustness in varying underwater conditions. The trained model is then saved as 60_epochs_denoised.pt for further deployment.

3.1 System Architecture

The underwater waste detection system is designed with a structured three-layer architecture, ensuring efficient data management, real-time processing, and a user-friendly interface. The two main layers are the Data Layer, Processing Layer.

3.2 Data Layer

The Data Layer is responsible for storing and managing raw and processed data used for training and validation. This includes Underwater Images. Collected datasets containing images of waste materials such as plastic, metal, and glass. The data is maintained using google drive for image storage and firebase or CSV files for structured data, ensuring efficient organization and retrieval.

3.3 Processing Layer

The Processing Layer is the core of the system, responsible for real-time underwater waste detection. The trained YOLOv8 deep learning model is used to detect and classify underwater waste in images. A Flask-based API serves as a

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communication bridge between the detection model and the front-end application, enabling real-time predictions. The system processes images, runs them through the YOLOv8 model, and returns waste detection results with bounding boxes and classifications.

3.4 System Workflow

The system workflow begins when a user uploads an underwater image for waste detection or enters water quality parameters through the web interface. The Flask API processes the request and forwards the data to the appropriate machine learning model for analysis. If an image is uploaded, the YOLOv8 model detects waste within the image and generates visual output. If water quality parameters are provided, the system predicts potability based on predefined conditions. The processed results are then displayed on the web interface with visualizations, allowing users to interpret the findings easily. Finally, the detected results and user-provided data are stored in Firebase, enabling further analysis and future retrieval.

This project employs the YOLOv8 object detection model to identify and classify underwater waste, advancing marine conservation efforts. The implementation follows a structured workflow starting with environment setup, where Google Drive is mounted to access datasets and pre-trained models. Libraries like YOLOv8 and Roboflow ensure seamless data processing. The Underwater Waste Dataset, featuring images of plastics, metals, glass, and organic waste, serves as training data. The YOLOv8 model is trained for 60 epochs, using a pre-trained base model (yolov8s.pt) and 640-pixel resolution to balance detection accuracy and efficiency. The model learns distinguishing features of waste for reliable detection. Trained on this dataset, the model processes new underwater images using command-line scripts or Python inference to detect and classify waste materials. OpenCV visualizes results with bounding boxes, highlighting detected objects. The system evaluates performance based on detection accuracy, adjusting parameters as needed for optimized results in marine waste detection.

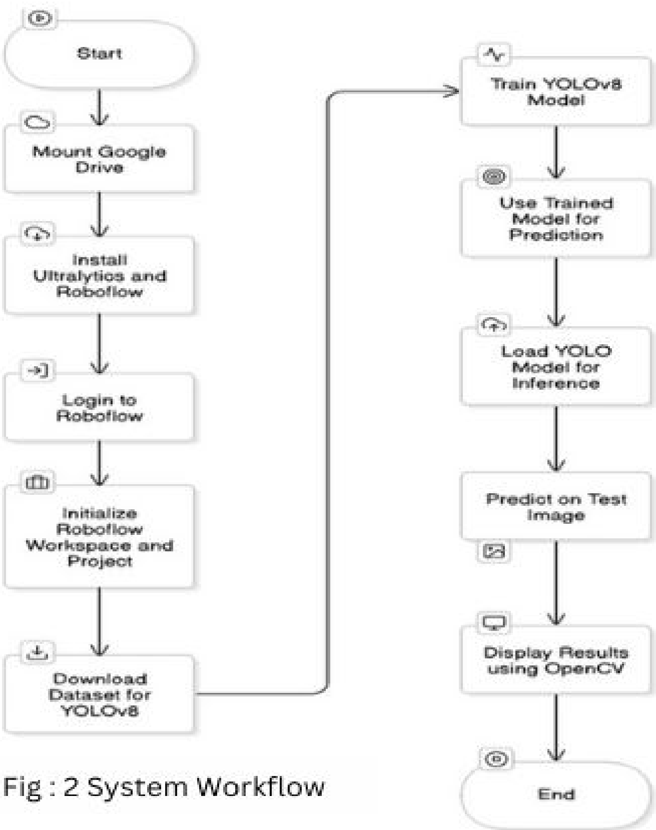

Fig : 2 System Workflow

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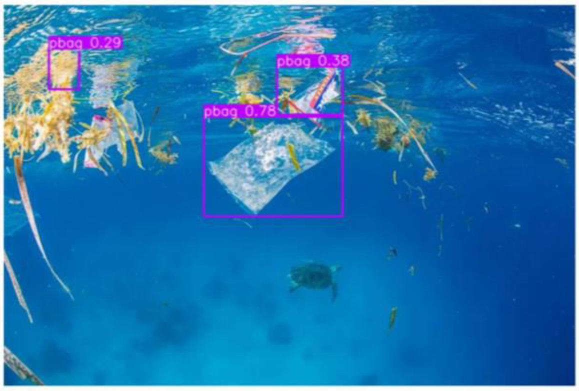
IV. RESULTS AND DISCUSSION

The system integrates advanced solutions for effective water pollution monitoring and environmental conservation. By incorporating YOLOv8 with autonomous drones, it enables large-scale waste detection over extensive water bodies like oceans and rivers. Drones with real-time processing and high-resolution cameras enhance coverage and allow continuous monitoring, improving the efficiency and data-driven nature of cleanup initiatives. The system's real-time garbage detection links to cloud-based platforms, supporting real-time data analysis and alert notifications. Significant waste detections prompt immediate alerts to environmental agencies or local authorities, ensuring prompt action. A cloud infrastructure allows multiple users to access and track pollution data over time, promoting better waste management policies.



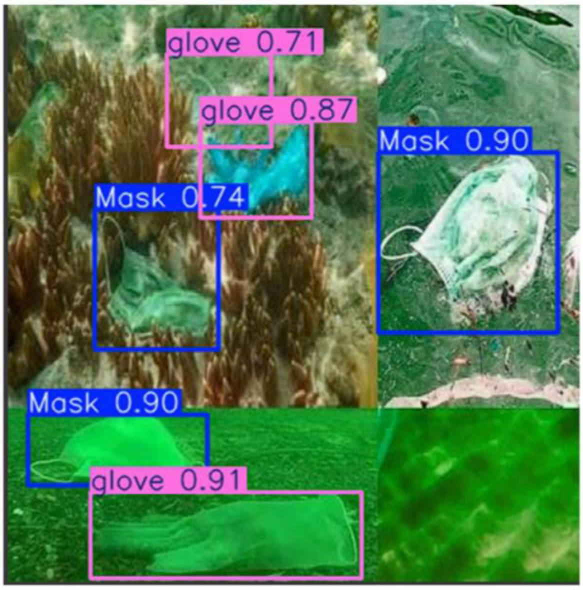


Fig 3: Results

Enhancements include multi-class waste classification, enabling the YOLOv8 model to detect specific waste categories such as plastic, glass, metal, and organic waste. By using a diverse dataset, the system facilitates automated waste segregation and recycling, advancing sustainability. Integrating water quality sensors complements waste detection with parameters like pH, turbidity, and pollutant levels, creating a comprehensive monitoring solution. This integration reveals correlations between waste accumulation and water quality, offering valuable insights for policymakers, researchers, and conservationists. These developments make the system a robust tool for efficient waste management and environmental preservation.

V. CONCLUSION

The Underwater Waste Detection and Water Quality Assessment System was developed to address two critical environmental challenges: marine pollution and water quality monitoring. By integrating YOLOv8 for waste detection the system provides a comprehensive solution for monitoring underwater waste and ensuring water safety. Successfully trained YOLOv8 to detect waste in underwater images with 91.7%. Implemented feature selection techniques to improve prediction efficiency. Conducted performance evaluation and testing, confirming the reliability of the models. Environmental Conditions variations in lighting, turbidity, and visibility can affect detection accuracy. Dataset Constraints the system's effectiveness is limited by the diversity of available training data. Expansion of Waste Categories train the model on a larger dataset to classify more types of underwater waste. Cloud-Based Deployment implement a cloud server for real-time data processing and remote monitoring. This project successfully demonstrates the potential of AI-driven waste detection and water quality assessment. With further improvements, the system can be scaled for large-scale deployment in oceans, rivers, and lakes, aiding in marine conservation and public health safety.

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