Islamia College Peshawar

DIGITAL IMAGE PROCESSING LAB

Deep Learning-Based Mosquito Breeding Site Detection and Segmentation Using YOLO Architectures

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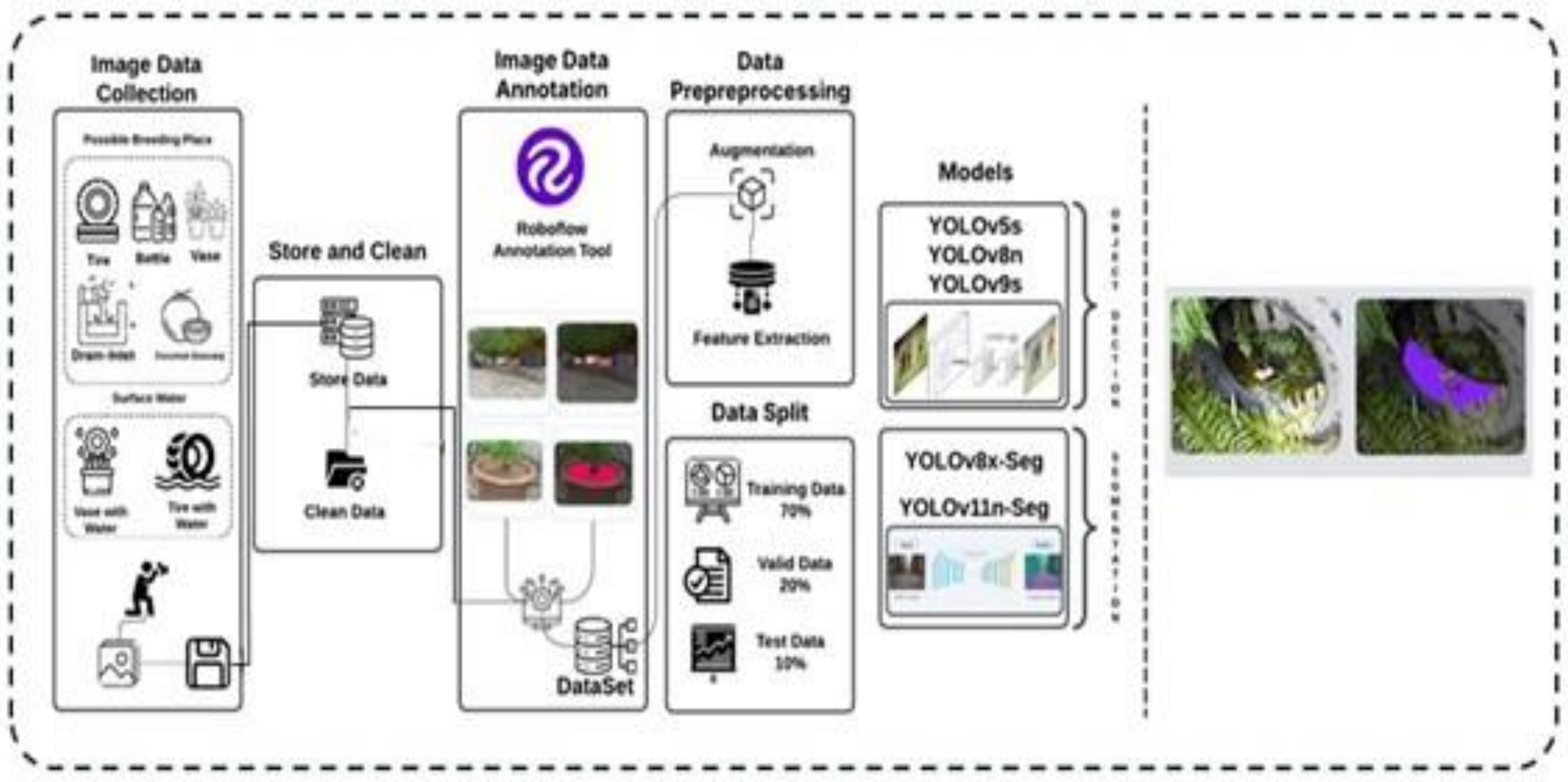
Mosquito-borne diseases such as dengue, malaria, chikungunya, and Zika pose serious threats to global public health, especially in densely populated and tropical regions. These diseases spread through mosquito breeding sites, often found in stagnant water sources and difficult to detect over large or remote areas. Traditional surveillance methods are labor-intensive, time-consuming, and fail to cover vast regions efficiently. To address this, we propose an AI-based mosquito breeding site detection and segmentation system leveraging multiple YOLO architectures. YOLOv5s, YOLOv8n, and YOLOv9s were used for detection, while YOLOv8x-seg and YOLOv11n-seg handled segmentation. The models achieved high accuracy even in cluttered environments, under varying lighting, and with complex backgrounds. This system can integrate with drones to autonomously monitor large or hard-to-reach locations, offering a faster, scalable solution to vector control and aiding in the prevention of mosquito-borne diseases.



Overview of the VisText-Mosquito pipeline, which involves key steps including the collection of image data, annotation, preprocessing, and model training. It supports object detection and water surface segmentation for robust mosquito breeding site analysis.

PROBLEM STATEMENT

- Designing an efficient deep learning-based architecture is challenging due to complex backgrounds and varying conditions in real-world images.
- The goal is to automatically detect, localize, and segment mosquito breeding sites from images.
- Applications include public health monitoring, vector control, early warning systems, and drone-based surveillance for hard-to-reach areas.
- Accurate detection and segmentation are essential as breeding sites are often small, scattered, and surrounded by cluttered environments.

INTRODUCTION

- Mosquito breeding site detection and segmentation is a key area of computer vision research and public health.
- It involves identifying water surfaces or containers that serve as mosquito habitats with distinct visual patterns.
- AI-based systems are needed for accurate detection and segmentation to support effective vector control and disease prevention.
- Applications include public health monitoring, early warning systems, and drone-based surveillance for large or hard-to-reach areas.

Utilized Datasets

- The breeding place detection subset contains 1,828 images with 3,752 annotations across five classes: Coconut-Exocarp (923), Vase (911), Tire (780), Drain-Inlet (585), and Bottle (553).
- The segmentation subset includes 142 images with 253 annotations across two classes: vase_with_water (181) and tire_with_water (72).
- Both subsets are divided into train, test, and validation sets to enable robust model training and evaluation.

CONTRIBUTIONS

We utilize YOLO architectures with convolutional layers, residual blocks, and skip connections to extract robust features from complex aerial imagery, enhancing generalization across varied environments and object scales.

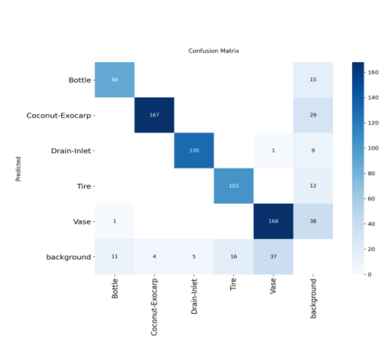
For detection, YOLOv5s, YOLOv8n, and YOLOv9s deliver precise identification of mosquito breeding sites with fast inference, enabling reliable real-time drone-based surveys in diverse settings.

For segmentation, YOLOv8x-seg and YOLOv11n-seg generate detailed pixel-level maps of water surfaces, supporting targeted interventions and large-scale monitoring with reduced manual inspection.

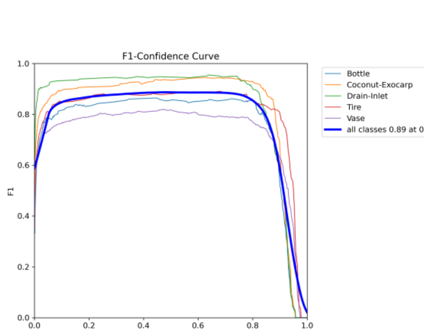
METHODOLOGY

- The proposed model uses YOLO architectures (YOLOv5s, YOLOv8n, YOLOv9s for detection and YOLOv8x-seg, YOLOv11n-seg for segmentation) to selectively focus on salient features in input images, accurately detecting mosquito breeding sites even in complex and cluttered backgrounds.
- The system employs convolutional layers with residual blocks to enhance feature extraction, reduce computational complexity, and maintain high detection and segmentation accuracy, enabling real-time inference and deployment in drone-based surveillance for large or hard-to-reach areas.

RESULTS



Confusion Matrix for Mosquito Breeding Site Detection



F1–Confidence Curve for Mosquito Breeding Site Detection

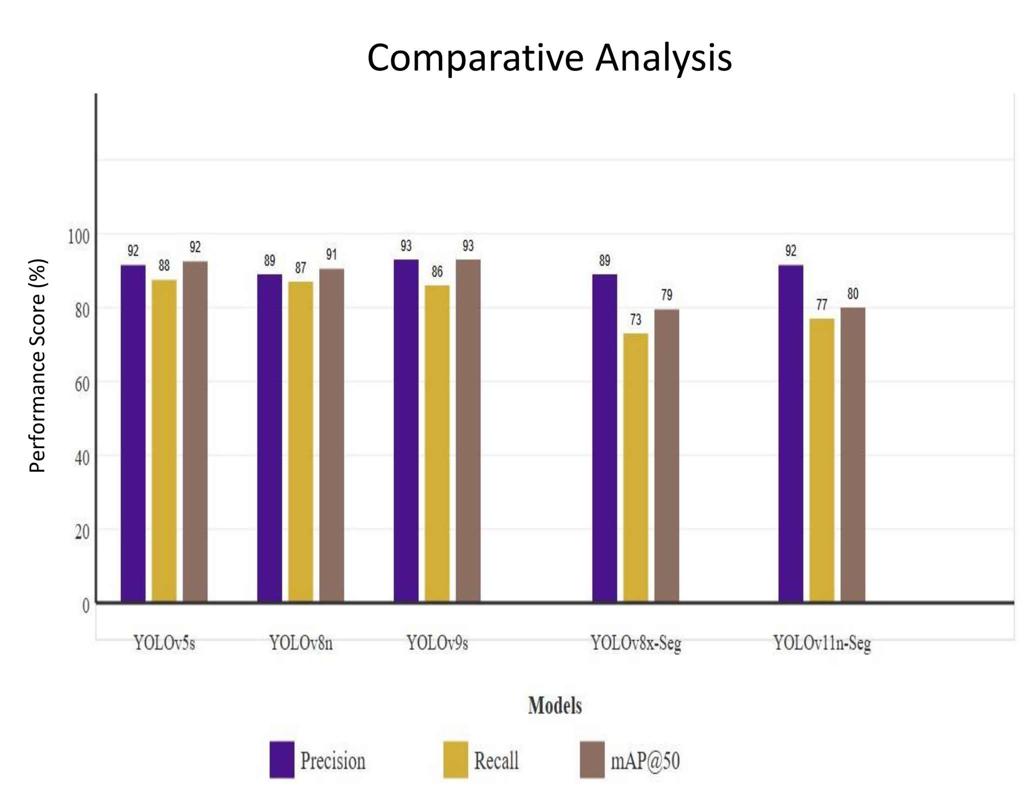
Bounding Box Annotation for Breeding Site Detection

Polygon Annotation for Surface Water Segmentation

BACKGROUND

- Mosquito breeding site monitoring involves large-scale visual data from field images and drone footage.
- Each image or video frame captures potential mosquito habitats like water surfaces, containers, and ponds.
- The collected data is transmitted to backend systems for automated detection and segmentation.
- Challenges include processing, storage, indexing, and accurate analysis of complex and cluttered images.
- Efficient deep learning models enable timely public health interventions and drone-based surveillance in large or hard-to-reach areas.

COMPARISON



CONCLUSION

- YOLO-based deep learning models effectively detect mosquito breeding sites in images.
- Segmentation allows precise mapping of water surfaces where mosquitoes breed.
- The system enables automated monitoring of mosquito habitats.
- Integration with drones allows real-time surveillance in large or hard-to-reach areas.
- The approach supports timely public health interventions and vector control strategies.