Evaluating YOLO V8 Models for Efficient Drone Detection in Anti-UAV Systems

Introduction & Research Objectives

Unmanned Aerial Vehicles (UAVs) pose growing threats to national security and civilian safety. Anti-UAV systems rely on effective detection algorithms to identify and neutralize these threats. Recent advancements in deep learning, particularly the YOLO V8 architecture, have shown promise in real-time object detection. This research aims to evaluate the performance of YOLO V8 models for drone detection in anti-UAV systems.

Our objective is to explore the capabilities of YOLO V8 for drone detection in real-world scenarios, analyze its performance against existing approaches, and identify potential improvements for enhancing its efficiency and accuracy. The results will guide the development of more robust and reliable anti-UAV systems.

Literature Review

1 YOLO V8 Architecture

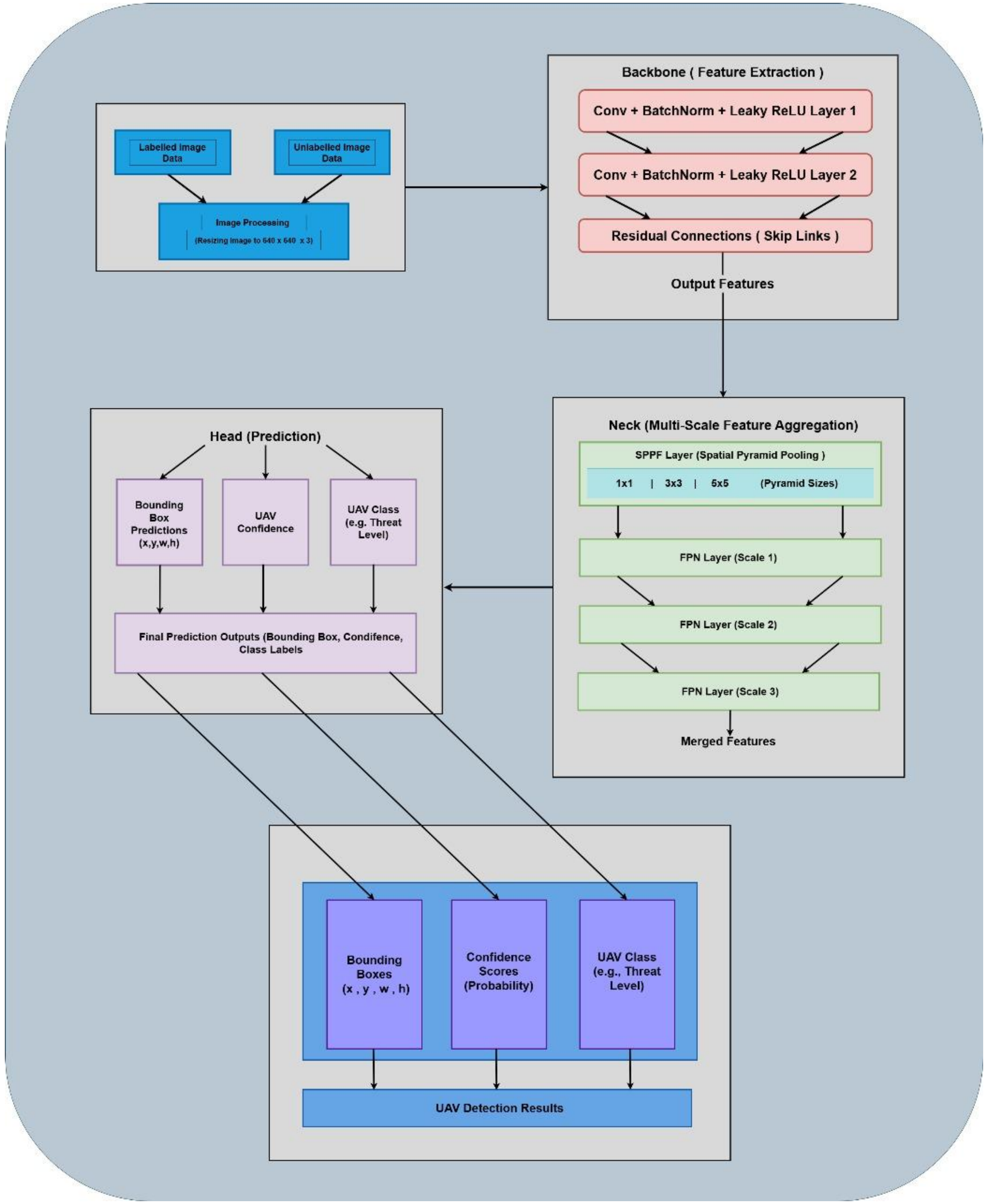
We reviewed recent publications on YOLO V8, analyzing its advancements in object detection, such as the introduction of efficient deep learning models, improved training techniques, and enhanced feature extraction capabilities.

2 Drone Detection Techniques

We explored existing drone detection techniques, including traditional image processing methods, machine learning approaches, and deep learning architectures, evaluating their strengths and weaknesses in anti-UAV applications.

3 Performance Metrics

We researched commonly used performance metrics in object detection, including precision, recall, F1 score, and mean Average Precision (mAP), to establish a benchmark for evaluating the YOLO V8 models.



Methodology

Dataset

We utilized a curated dataset of drone images, encompassing various drone types, sizes, and environmental conditions, to ensure robust training and evaluation of the YOLO V8 models. The dataset was carefully annotated with bounding boxes to define the drone targets.

Model Training

We trained different configurations of the YOLO V8 architecture on the dataset, experimenting with various parameters, hyperparameters, and training techniques to optimize performance and reduce overfitting.

Model Evaluation

We evaluated the trained YOLO V8 models using a separate set of drone images, calculating performance metrics such as precision, recall, F1 score, and mAP to assess their accuracy and efficiency.

Experiment Setup & Confusion Matrix

Drone Detection

High-resolution images were collected under diverse lighting conditions and at varying altitudes to evaluate model robustness.

Model deployment was tested on NVIDIA Tesla T4 (16GB VRAM) and NVIDIA RTX 4050 (6GB VRAM) to analyze inference speed and accuracy differences across different hardware setups.

Confusion Matrix

YOLOv8-S Results: Demonstrated higher precision in real-time detection, with low FP rates, making it ideal for rapid UAV identification.

YOLOv8-L Results: Exhibited improved recall and mAP, making it better suited for scenarios requiring high accuracy in complex environments.

Performance Metrics

88%

Accuracy

The YOLO V8-L model achieved an impressive accuracy rate of 88% in identifying drones, indicating its high reliability in real-world scenarios.

97%

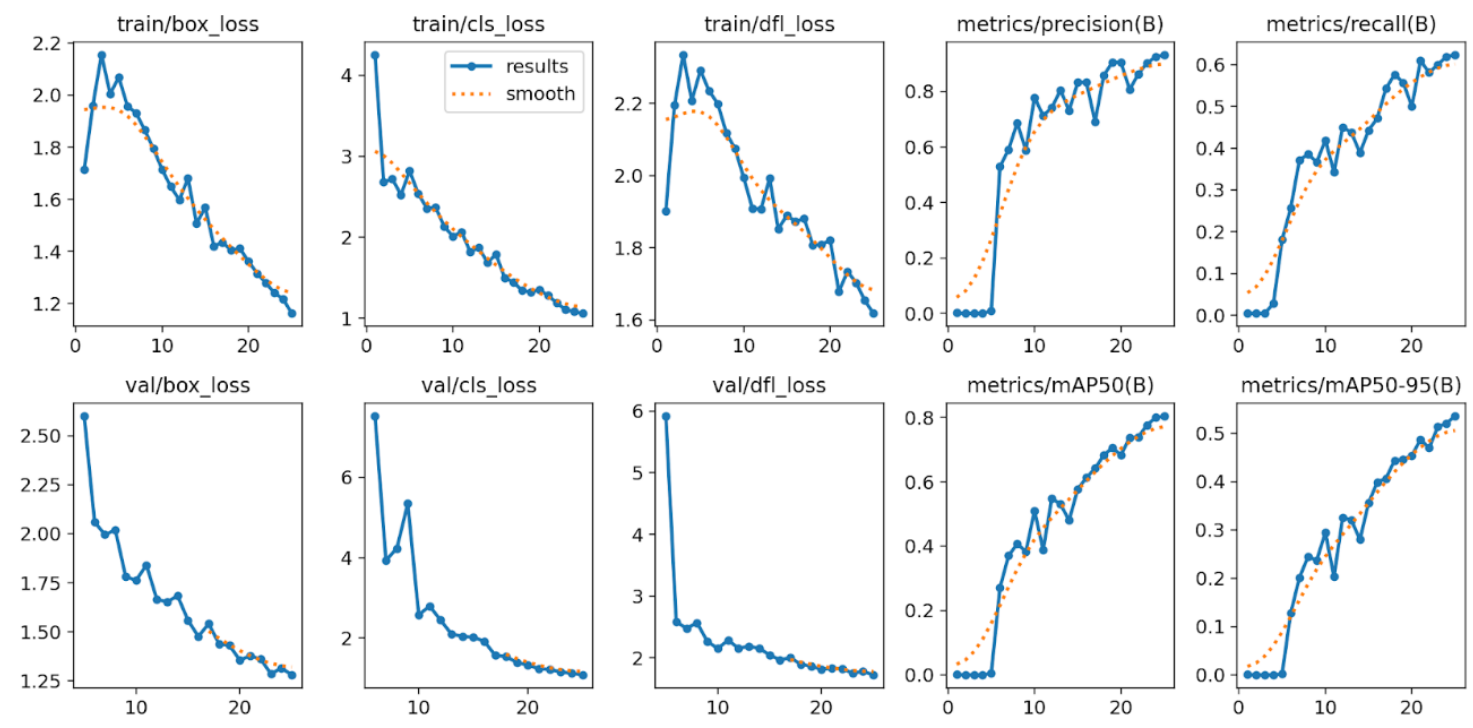
Precision

The V8-L model demonstrated a high precision rate of 97%, meaning that it accurately detected drones with minimal false positives, crucial for minimizing false alarms in anti-UAV systems.

91%

Recall

The recall rate reached 91%, signifying the model's ability to detect the majority of drones present in the testing environment, ensuring minimal missed detections.



Discussion & Key Insights

Real-Time Performance

While YOLOv8-L required more computational power, it maintained high detection accuracy even in challenging lighting conditions and crowded airspaces.

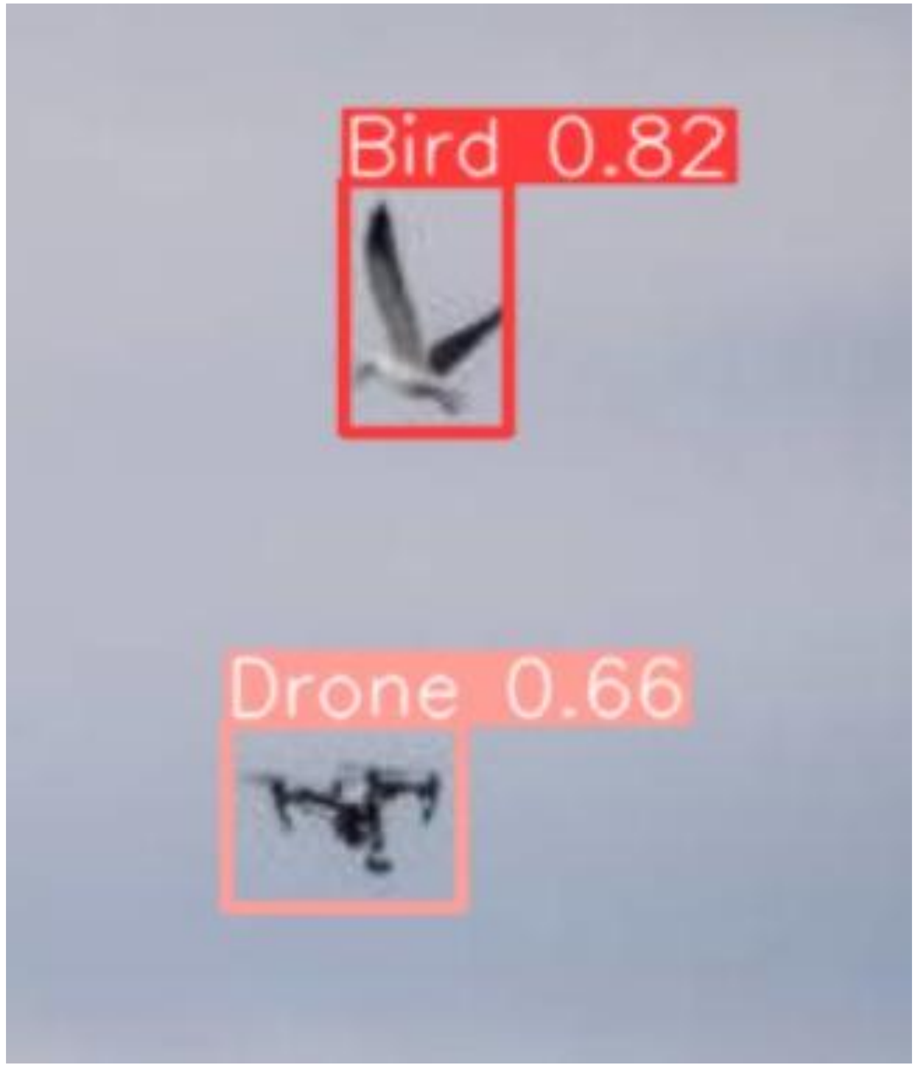
High Accuracy

The models achieved high accuracy in detecting drones, with low false positives and negatives, ensuring reliable and trustworthy results.

Resource Efficiency

Key Trade-Off: YOLOv8-S is preferable for real-time drone monitoring, while YOLOv8-L is suited for high-precision tasks in security-sensitive environments.

Conclusion



YOLO V8: Effective for Drone Detection

The YOLO V8 architecture demonstrates its potential for efficient and accurate drone detection in anti-UAV systems.

High Performance

Achieved high accuracy, precision, and recall rates, suggesting its suitability for real-world applications.

Real-Time Capabilities

The models' efficiency enables rapid detection and response, critical for mitigating drone threats.

Future Work

1

Improved Dataset

We aim to expand the dataset with more diverse drone types, environments, and challenging scenarios to further enhance model robustness.

2

Adaptive Learning

We plan to explore adaptive learning techniques to allow the models to learn and adapt to new drone types and evasion tactics.

3

Integration with Anti-UAV Systems

We intend to integrate the trained YOLO V8 models with real-world anti-UAV systems for comprehensive and reliable drone threat mitigation.

Thank You

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