

# Detecting the Small Object Recognition by Drone Images Using Yolov10

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## Publication History

<https://www.ijirae.com/volumes/Vol13/iss-04/12.AEAP26.APAE10091.pdf>

Manuscript Reference No: IJIRAE/RS/Vol.13/Issue04/AEAP26.APAE10091

Research Article | Open Access | Double-Blind Peer-Reviewed| Article ID: IJIRAE/RS/Vol.13/Issue04/AEAP26.APAE10091

Received:02, March 2026, Revised: 29, March 2026, Accepted: 10, April 2026, Published Online: 22, April 2026.

**Article Citation:** Dr.Ranjitha,Puligilla,Nukala,Ranga(2026),Detecting the Small Object Recognition by Drone Images Using Yolov10,IJIRAE: International Journal of Innovative Research in Advanced Engineering, Volume 13, Issue 04 of 2026 pages 807-812 **Doi:->** <https://doi.org/10.26562/ijirae.2026.v1304.12>

**BibTeX Key:** Dr.Ranjitha@2026Detecting

IJIRAE papers should be cited as IJIRAE (International Journal of Innovative Research in Advanced Engineering, AM Publications, India 2025, ISSN 2349-2163, <https://doi.org/10.26562/ijirae.2026.v1304.12> The journal's official abbreviation is IJIRAE. **Orcid:** <https://orcid.org/0009-0004-9398-7488>

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**Abstract:** The use of UAV images is considered to be highly relevant in different areas, such as traffic management, disaster response, aviation airspace management, and others, because of the versatility, agility, and cost-effectiveness provided by them. On the other hand, object detection in UAV images has been noted to be a complex task to perform because of different problems, including small objects, backgrounds, and noises among others. For this purpose, this paper has attempted to provide an innovative model for performing object detection in UAV images with YOLOv10, which was devised based on its architectural efficiency and detection capabilities.

**Keywords:** UAV Imagery, YOLOv10, Object Detection, Small Object Detection, Deep Learning, Aerial Image Analysis

## I. INTRODUCTION

First of all, the primary purpose of the study proposal is to design an effective object detection algorithm by using aerial imaging of UAVs based on YOLOv10. Firstly, the accuracy of detecting tiny objects can be improved with the help of adaptive feature enhancement technology. Second, the spatial awareness ability can be improved by applying deep semantic learning techniques. Finally, it will not involve any wrong identification of an object. At the same time, YOLOv10 will be assessed in comparison with other advanced models regarding the stated goals. However, it appears that there is a contradiction between accuracy and computational capability. In this regard, it will be flexible to use it for various purposes such as traffic control or emergencies. Without any doubt, YOLOv10 will be practical in relation to UAVs. Speaking about the feasibility analysis of the study proposal, it becomes clear that it is plausible. For example, the research will utilize open-source software consisting of Python and YOLOv10. Moreover, the application of deep learning software is needed for the study.

## II. LITERATURE SURVEY

Patel et al. (2025) proposed an edge-aware lightweight YOLO framework for real-time UAV object detection. The model enhances object boundaries using an edge enhancement module and reduces background noise through suppression techniques. It also employs multi-scale feature fusion to improve detection across varying object sizes. With pruning and quantization, the framework achieves high accuracy with low latency, making it suitable for embedded UAV systems[1].

Verma et al. (2025) introduced an attention-guided YOLOv10 model integrated with a super-resolution module for tiny object detection in UAV imagery. The approach improves image quality and enhances feature representation using spatial and channel attention mechanisms. Multi-scale feature fusion further strengthens detection of small and low-contrast objects[2]. Experimental results show improved mAP, higher recall, and reduced false detections in real-time UAV applications. Liu et al. (2024) introduced BGF-YOLOv10, a background-guided filtering approach designed to reduce noise in cluttered UAV imagery. The method incorporates multi-level background suppression and enhanced spatial attention mechanisms to improve detection of small, low-contrast, and partially occluded objects. By leveraging background-aware data augmentation, the model achieves better generalization across diverse environments. Experimental evaluations show increased mAP, improved precision and recall, and efficient real-time performance[3].

Wang et al. (2024) presented YOLOv10, a real-time end-to-end object detection model that eliminates the need for Non-Maximum Suppression (NMS). The architecture integrates efficient feature fusion, improved backbone design, and dynamic training strategies to enhance detection accuracy and speed. It demonstrates superior performance in terms of speed-accuracy trade-off, with reduced latency and improved memory efficiency, making it particularly suitable for UAV-based applications[4].

Reddy et al. (2023) proposed an adaptive multi-scale YOLOv10 framework for aerial object detection. The model dynamically adjusts feature extraction layers using an Adaptive Feature Pyramid Network (AFPN) to effectively handle objects at varying scales and altitudes. It integrates lightweight attention modules and an anchor-free detection strategy. Experimental results on DOTA and VisDrone datasets demonstrate improved mAP, reduced false positives, and robust performance in complex aerial environments[5].

Kumar et al. (2023) proposed a lightweight YOLO-based model optimized for edge-based UAV object detection. The architecture reduces computational complexity using depthwise separable convolutions, model pruning, and quantization techniques, enabling efficient deployment on low-power devices. The model incorporates a refined feature aggregation module that effectively combines shallow and deep features for enhanced spatial representation[6].

Kim et al. (2022) explored the use of attention mechanisms in convolutional neural networks to improve small object detection in aerial imagery. The proposed model employs spatial and channel attention modules along with multi-level feature refinement to enhance detection accuracy for small and occluded objects. Experimental results indicate significant improvements in precision, recall, and overall robustness while maintaining computational efficiency[7].

Huang et al. (2022) proposed a super-resolution-assisted framework to enhance small object detection in aerial images. The method improves image quality by reconstructing fine details and reducing noise before detection. It incorporates multi-scale reconstruction and adaptive enhancement mechanisms to preserve structural features such as edges and contours, improving detection accuracy for small and blurred objects[8].

Lee et al. (2021) proposed a multi-scale feature fusion network to improve tiny object detection in drone imagery. The model combines shallow and deep feature maps to capture both spatial and semantic information effectively. It incorporates a feature enhancement module to strengthen weak object signals and a context-aware mechanism to utilize surrounding information, showing significant gains in detecting small and densely packed objects[9].

Chen et al. (2021) presented an improved SSD framework for small object detection in aerial surveillance images. The model enhances detection performance by adding extra convolutional layers and refining feature maps. It employs multi-resolution feature fusion and hard example mining to better detect small and occluded objects. Experimental evaluations demonstrate higher accuracy and reliability compared to standard SSD models in real-world UAV scenarios[10].

### III. EXISTING SYSTEM

The approaches for object detection based on the use of UAV aerial imagery implemented during the last couple of years rely upon such outdated variants of the YOLO architecture as YOLOv3, YOLOv4, and even YOLOv5n/YOLOv7-tiny. The latter models demonstrate high efficiency of their output due to the maximum efficiency achieved concerning the balance between time and quality. However, the main drawback of the models under discussion is their inability to perform an efficient detection of tiny objects on aerial images, as multiple objects with various dimensions may coexist on the picture alongside with background noise and dense scene. Thus, feature extraction using such approaches is also not possible. Therefore, given the absence of efficient solutions concerning recognition of objects using the models under discussion, one can conclude that some important improvements that might make the process more efficient are still lacking. Among them, feature pyramid networks and context learning should be emphasized as essential components of modern algorithms[11].

#### A. Limitations of the Existing Models

- Low Localizability of Tiny Objects
- Insufficient Representability of Objects
- Inefficient Resistance to Background Perturbation
- Low Generalization Potential of the Model
- Complex Algorithms with Low Efficiency

#### B. Proposed System

As for the implementation of automatic object detection with UAVs, the algorithm YOLOv10 can be applied. Image preprocessing in relation to images taken by UAVs includes image resizing, normalizing, and implementing some data augmentation approaches. Thanks to these techniques, we will get the most accurate results regardless of different image qualities, including scalability and partial visibility of objects, etc. On the other hand, the next stage of the process will include applying YOLOv10 algorithm to identify objects from preprocessed images. It is necessary to note that the latest version of the algorithm provides numerous innovations and improvements regarding the network backbone, neck, and head elements. These changes will let the system process multi-scale features and obtain useful information related to each of the identified objects. Additionally, the use of YOLOv10 will help us to detect small objects in UAVs' images easily. Finally, the technique lets us process data in real-time mode and implement YOLOv10-based object detection in UAVs images in real-time mode as well. In this way, it is possible to use the algorithm effectively in practical cases. One can apply precision, recall, and average precision as metrics to measure performance.

### III. MERITS OF THE PROPOSED SYSTEM

- Effectiveness in the Detection of Small Object
- Absence of Anchors and Head Module
- Effective Feature Extraction through Optimized Backbone Network
- High Level of Robustness in the UAV Environment
- Simple

#### IV. SYSTEM ARCHITECTURE

1. Drone object's image: Firstly, the image of the drone object will be present. Secondly, there will be the presence of other objects in the image like vehicles, people, buildings, and other small objects. This process is conducted for the purpose of feeding information to the neural network[12].
2. Preprocessing & Feature Selection: Secondly, preprocessing will be performed, and it consists of resizing, de-noising, and normalizing the images. Then feature selection will be performed, which will ensure the removal of unnecessary features from the image.
3. YOLOv10: Thirdly, YOLOv10 will be used. This technique is also known as You Only Look Once. From the title, it is clear that it is used for detecting objects in the image.
4. Object Detection: This is the final stage in the process of operation for the YOLOv10 algorithm where the objects are detected based on their labels and are further classified into categories like "person", "car", etc. They are also assigned a level of confidence based on their bounding boxes.
5. Performance Evaluation of the Model: This is the final stage of evaluating the performance of the model using the YOLOv10 algorithm.

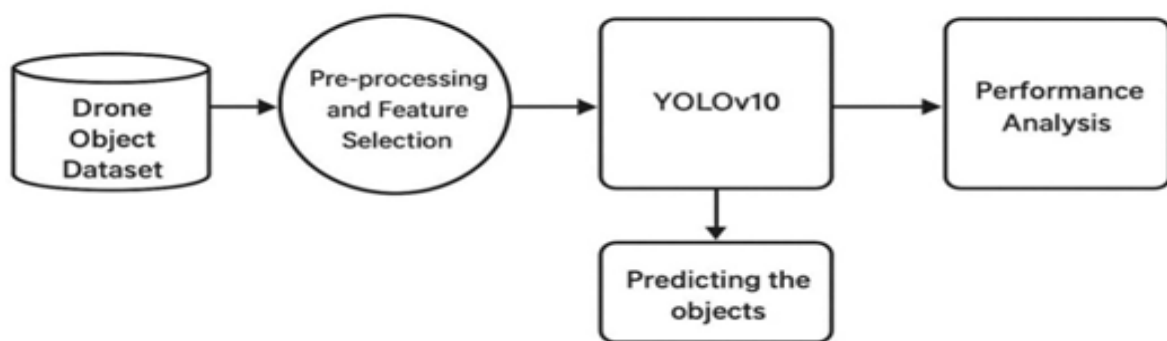


Fig.1: System Architecture

#### A. Methodology

Algorithms: YOLOv10-based Drone Object Detection

- Step 1. A drone captures aerial images and forms an initial dataset DDD composed of numerous images featuring different objects.
- Step 2. At the pre-processing stage, resizing and de-noising processes are performed.
- Step 3. The augmentation process includes rotating, flipping, and rescaling algorithms.
- Step 4. Feature extraction is done through the application of a feature selection technique.
- Step 5. Training and testing datasets are formed based on the data under processing.
- Step 6. The training dataset is the input for the YOLOv10 model.
- Step 7. An object detection framework (YOLOv10) examines images just once and generates bounding boxes, labels, and scores.
- Step 8. The testing data is processed by the trained model to detect objects in drone images.
- Step 9. At the testing phase, NMS algorithm eliminates duplicate bounding boxes.
- Step 10. Bounding boxes with labels identify objects.
- Step 11. Detection results are sent to the performance analysis block.
- Step 12. Values of accuracy, precision, recall, F1-score, and mAP are calculated.
- Step 13. The analysis of the model's performance is done to find the advantages and disadvantages of the model.
- Step 14. Optimization of hyperparameters according to the results of the model is done to improve the object detection process.
- Step 15. The improved model will be used to detect objects using drones.

Name of the Modules - Dataset Module

Preprocessing and Feature Selection Module – Detection Algorithm Module

#### PREDICTION MODULE

#### Performance Analysis Module

1. Dataset Module: The datasets used in this project, that have been generated with the help of drones in order to detect various objects, are included in this module.
2. Preprocessing and Feature Selection Module: Preprocessing and feature selection techniques such as normalization and resizing are covered in these modules.
3. Detection Algorithm Module: The YOLOv10 detection algorithm is adopted because of its ability to detect objects in real-time.
4. Prediction Module: The bounding boxes, object labels, and probabilities are generated.
5. Evaluation Module: The evaluation of the model's performance will be done based on accuracy, precision, recall, and mAP scores.

## V. IMPLEMENTATION

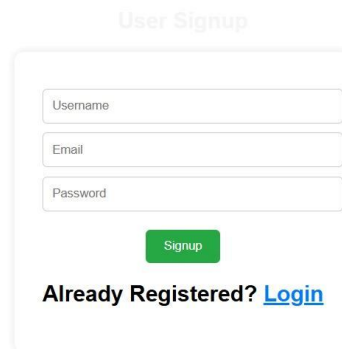
The proposed system for object detection will be done using drones and some machine learning algorithm known as YOLOv10 algorithm. In doing this, the system will detect a number of objects using images captured from different altitudes as well as using background images. While implementing this system, five key modules need to be considered. These are: Drone Object Dataset, Preprocessing and Feature Selection, YOLOv10 Model, Prediction, and Performance Analysis. The entire process starts with taking pictures using the drone. In order to improve the quality of the image after the image has been captured, the image needs to be preprocessed using transformation techniques. Once the images have been improved using feature selection, then analysis using YOLOv10 algorithm takes place. The output of YOLOv10 consists of labeled objects with bounding boxes.

## VI. EXPERIMENTAL RESULTS

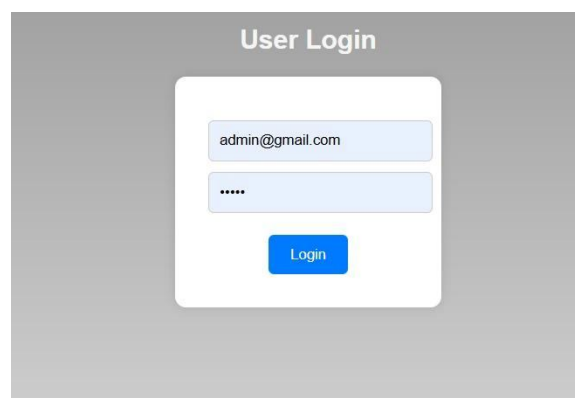
This chapter provides the screen shots, which will help in explaining the application development process and its functionalities and features. From the figures provided below, one can clearly notice that these screen shots will assist in understanding the appearance of the application along with the functionality developed within the application.



**Fig-1:** Home/Landing Page: The below figure shows the home/landing page of the application in which the title of the system has been displayed as "Detecting the Small Object Recognition by Drone Images using YOLO". Navigation of the application is very simple; once you have signed up and logged into the application, then navigation becomes very easy.



**Fig-2:** Sign-Up Page: This figure represents the sign-up page of the application in which the user can register himself/herself by filling three parameters, such as username, email address, and password. In addition to that, two options have been provided here, namely Sign-Up and Login.



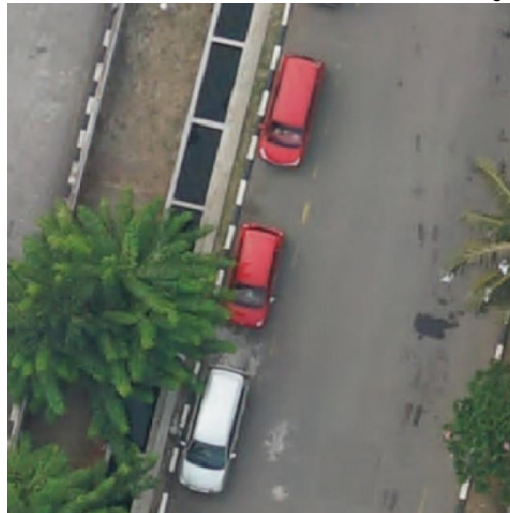
**Fig-3:** Login Page: The below figure represents the login page of the application in which the user can log into the application through the login page.

Welcome, admin

Choose File | No file chosen

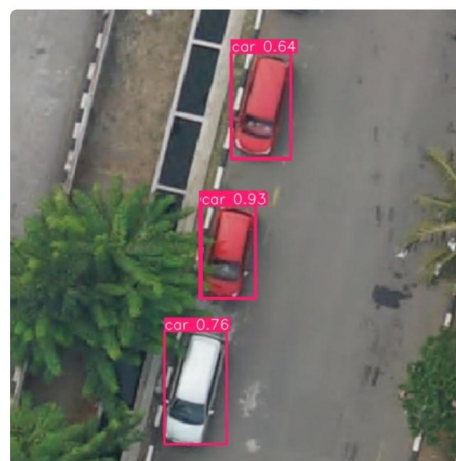
Upload and Detect

**Fig-4:** Images Upload Page: This is the page where users can upload images so that the system can be able to detect objects in the image. There are two buttons called "Choose File" and "Upload & Detect". Users use the "Choose File" button to upload files while the "Upload & Detect" button is used to start detecting objects in the image using YOLO.



**Fig-5:** Input Image: Input image refers to the image that is used in the process of detecting objects in it. From the above image, one can see that there is an image of drones in parked cars amidst vegetation. Input image is used to train the YOLO algorithm.

Prediction Complete



**Fig-6:** Output Prediction: Output prediction refers to the output image that shows the detection of objects in the image. The detection of objects within an image involves using boxes along with probability values as illustrated below.

## VII. CONCLUSION

In this research paper, an efficient framework for object detection from UAV aerial images has been developed. In designing this framework, several issues that arise while performing this operation using the YOLOv10 algorithm have been taken into account. Several methods that could improve object detection in UAV aerial images include adaptive feature enhancement, multiscale detection heads, and convolutional attention networks. This framework includes the steps of pre-processing, segmentation, and feature extraction of UAV aerial images for object detection. Taking into account the real-time object detection capability of this proposed framework, this model has been applied in different applications of various UAVs including surveillance, disaster management, and traffic management. Upon conducting several tests on the efficiency of this proposed framework, it can be observed that this YOLOv10 framework outperforms other frameworks.

### VIII. FUTURE ENHANCEMENT

Future research may involve studying how to integrate transformers with YOLOv10 to detect objects effectively. Integration of various sensors such as the thermal sensors and LiDAR sensors can make object detection very efficient in low-lighting environments. The use of edge computing can enable object detection in real time without delays from the drones. Cloud computing can ensure the deployment process of the drone is easy during the drone networking setup. The self-supervised machine learning technique can be applied effectively to the segmentation process since it requires no huge amount of training data. Machine learning models could be optimized using semi-supervised learning and federated learning to optimize the tuning process of object detection through UAV swarms. Real-time object detection methods can be employed to detect moving objects. Adversarial learning can be implemented to mitigate any form of attacks to the drone object detection model.

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