

A Survey of Object-Detection Datasets Applied to Defense Environments

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Abstract—Object detection has attracted significant attention in defense applications for surveillance, threat assessment, and target identification. Modern defense systems take advantage of computer vision algorithms to achieve situational awareness, yet progress is severely hindered by data accessibility challenges due to classification policies that restrict access to military imagery. Although existing approaches have attempted to leverage civilian datasets, systematic analysis of their defense applicability remains limited. In this paper, we present a comprehensive analysis of publicly available datasets for defense object detection applications. We systematically investigate 10 major civilian datasets across aerial, SAR, and maritime domains, exploring object classes with potential military relevance. Our structured comparison framework evaluates datasets by object coverage, licensing constraints, and defense applicability. The analysis suggests that civilian datasets may contain substantial overlap with defense requirements, potentially encompassing military equipment and infrastructure, while revealing gaps in specialized assets coverage. The findings indicate promising pathways for strategic civilian dataset utilization in defense applications.

Index Terms—Object Detection, Datasets, Defense applications

I. INTRODUCTION

Object detection systems have a rigorous need to advance for defense-based applications, such as surveillance and threat assessment; however, the continued lack of accessibility of military-based datasets is a serious impediment to development. Tight security clearances and inherent secrecy of operational information present major obstacles for researchers and academic institutions, further combined with special tools and military-specific surroundings. This lack of data restricts the development of more advanced object detection models to meet the needs of national security.

One potential solution arises from the widespread availability of modern civilian visual datasets such as MS COCO [1] and ImageNet [2], which have been mostly ignored for defense. Closer inspection reveals a not insignificant synergy: these datasets often include object classes closely related to military requirements, such as vehicles, aircraft, ships, or critical infrastructure. Beyond that, the proliferation of helicopter imagery with finer spatial resolution out of the public domain offers unprecedented, though for the most part unexploited, sources of data suitable for defense.

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Despite this obvious potential, systematic analysis of public datasets for defense applications remains surprisingly limited in defense-oriented research. The gap is hitherto unexamined, which this paper fills by carrying out a systematic review of 10 large public datasets spanning 2011 to 2024. We propose to analyze these datasets systematically by using a formal analytical methodology to assess their appropriateness for military computer vision research, given the constraints of open-source availability and licensing.

We aim to bridge the divide between civilian data abundance and military data scarcity, providing actionable insights for researchers and establishing a foundation for cross-domain dataset utilization in defense applications.

The contributions of our paper are outlined as follows:

- We present a comprehensive survey of 10 public object-detection datasets, thoroughly analyzing their licensing terms and key attributes to enable their strategic repurposing for defense-oriented computer vision research.
- We systematically analyze publicly available civilian object-detection datasets to assess their defense applicability and to outline how open-source data can be leveraged under common operational and licensing constraints.

Outline. The remainder of this article is organized as follows. Section II provides background on object detection in defense applications and details the associated challenges within defense environments. Section III presents a detailed analysis of publicly available datasets across aerial, SAR, and maritime domains and discusses strategies for leveraging these datasets in defense contexts. Section IV reviews related work. Section V outlines the limitations of the present study, emphasizing experimental validation and integration with operational defense environments. Finally, Section VI concludes the paper and summarizes the key contributions.

II. BACKGROUND

A. Object Detection in Defense Applications

Object detection refers to a computer vision technique that identifies and localizes specific objects within images. Modern defense systems utilize sophisticated object detection algorithms to achieve real-time situational awareness for surveillance, threat assessment, and target identification.

TABLE I: Summary of Newly Included Remote Sensing Datasets

Dataset	The # Images	The # Classes	The # Instances	License	Remark
Aerial Optical Datasets					
iSAID	2,806	15	655,451	Academic Use Only	DOTA-based, pixel-level instance segmentation for precise analysis.
FAIR1M	15,000	37	1,000,000+	CC BY-NC-SA 3.0 IGO	Fine-grained aircraft classification
VEDAI	1,250	9	2,807	CC BY 4.0	Vehicle type differentiation, optimized for mixed military/civilian vehicles.
NWPU VHR-10	800	10	Not mentioned	CC BY 4.0	VHR images (0.08 2m), multi-purpose facility detection, military base suitability.
SODA-A	2,513	9	872,069	CC BY-NC 4.0	OBB-based, small/camouflaged targets, various scales/orientations.
MAR20	Approx. 3,800	20	22,341	CC BY 4.0	20 military aircraft classes, for precise aircraft type identification.
RSOD	936	4	Not mentioned	CC BY 4.0	PASCAL VOC format, strategic military facility detection (aircraft, storage tanks).
SAR Datasets					
LS-SSDD-v1.0	9,000	1	Not mentioned	Apache License 2.0	Sentinel-1 SAR, large-area coverage, diverse sea/observation conditions.
SSDD	1,160	1	Not mentioned	Apache License 2.0	SAR images, 1 15m resolution, multi-annotation types (BBox/RBox/Polygon).
Maritime/Ship-Specific Datasets					
ShipRSImageNet	3,435	50	17,573	Apache 2.0 License	Diverse location/sensor, benchmark for maritime traffic/ship classification.

The technology enables accurate recognition of critical assets including vehicles, aircraft, and ships from diverse sensor modalities.

Unlike conventional civilian applications, defense-oriented object detection systems offer enhanced precision and reliability for mission-critical operations. The main advantage is the ability to maintain operational effectiveness in challenging conditions such as camouflage, low visibility, and complex backgrounds while supporting autonomous decision-making requirements.

However, defense object detection systems suffer from significant data accessibility constraints and stringent performance requirements that conventional approaches struggle to address effectively.

B. Challenges in Military Computer Vision Data

Military computer vision data presents inherent complexities that distinguish it from civilian datasets. The main limitation is data scarcity caused by classification policies and security restrictions that severely limit access to operational imagery. Real military datasets remain largely inaccessible to research communities due to national security considerations, creating substantial barriers for algorithm development and validation.

In addition, military imagery exhibits unique characteristics including camouflaged targets, densely packed arrangements, and arbitrary orientations that conventional detection algorithms struggle to handle effectively. The requirement for precise localization of small targets within cluttered backgrounds

makes military computer vision fundamentally different from civilian applications.

C. Leveraging Public Datasets

To mitigate such data constraints, leveraging publicly available civilian datasets offers a practical solution. Public datasets like MS COCO and ImageNet frequently include object classes closely related to military requirements, providing valuable foundation for cross-domain transfer learning. While these datasets contain relevant categories such as vehicles, aircraft, and ships, the object class coverage does not completely align with specialized military assets including tactical equipment, weapon systems, and mission-specific infrastructure. The main advantage is immediate accessibility with millions of annotated samples for comprehensive model pre-training without security clearance requirements.

Unfortunately, civilian datasets create domain shift challenges when applied to military contexts due to differences in imaging conditions, target appearances, and environmental factors. The proliferation of high-resolution aerial imagery from public sources presents unprecedented opportunities for defense applications, though domain adaptation techniques remain essential for bridging the gap between civilian and military visual characteristics.

III. METHODOLOGY

A. Dataset Overview

To identify public datasets with potential defense applications, we conduct a systematic survey of publicly available

object detection datasets. Our investigation focuses on three primary domains: Aerial Optical, SAR-based, and Maritime datasets. We examine each dataset’s characteristics, including object classes, spatial resolution, and licensing terms to assess their relevance to military requirements. The survey process involves reviewing dataset documentation, analyzing sample imagery, and evaluating the overlap between civilian object categories and defense-relevant targets such as vehicles, aircraft, ships, and infrastructure.

We investigate 10 major datasets across the three domains, documenting their technical specifications and potential military applications. For each dataset, we record key parameters including image count, object class coverage, and license. The datasets demonstrate varying levels of defense applicability, with some containing direct military relevance (e.g. aircraft classification, vehicle detection) while others provide foundational capabilities transferable to defense contexts.

The finding of our survey is summarized in Table I, which presents the fundamental characteristics of each analyzed dataset. The investigation reveals that civilian datasets frequently include object classes directly relevant to defense operations, although coverage of specialized military assets remains limited. The survey demonstrates that while civilian datasets cannot fully replace military-specific data, they provide valuable resources for preliminary model development and cross-domain transfer learning in defense computer vision research.

B. Aerial Optical Datasets

Aerial optical datasets consist of high-resolution imagery captured by airborne or satellite platforms operating in the visible spectrum. These datasets typically contain annotated objects like vehicles, aircraft, and infrastructure, and are widely used in civilian applications. While most datasets primarily include general-purpose objects such as civilian vehicles and commercial aircraft, some also cover object types relevant to defense tasks such as small aircraft, ships, and ground vehicles. However, explicitly military-specific assets, including tanks, armored vehicles, or military jets, are rare.

This study examines six publicly available aerial optical datasets: iSAID [3], FAIR1M [4], VEDAI [5], NWPU VHR-10 [6], SODA-A [7], MAR20 [8], and RSOD [9]. Each provides high-resolution imagery and annotations for detection, classification, or segmentation. Common characteristics across these datasets include diverse object categories, varied image scales and resolutions, and advanced annotation formats such as oriented bounding boxes (OBBs, e.g., in FAIR1M, iSAID, SODA-A) and segmentation masks (present in iSAID and some others), enabling robust multi-class detection models.

For instance, FAIR1M consists of over 15,000 high-resolution aerial images with fine-grained annotations for more than 1,000,000 aircraft instances across 37 categories. While the dataset was originally designed for civilian applications such as airport management and air-traffic monitoring, its detailed categorization of Boeing, Airbus, and other airplanes provides strong relevance for defense-oriented research on

aerial surveillance and aircraft recognition. However, the dataset does not explicitly include military-specific aircraft types such as fighter jets or transport aircraft, which limits its direct applicability to operational scenarios.

Aerial optical datasets hold strong potential for defense-related applications by providing detailed imagery of military-relevant objects under various conditions. High-resolution sensors and advanced annotations support detecting small or arbitrarily oriented targets, which are frequent in military reconnaissance scenarios. However, true camouflaged or purposefully concealed military assets remain underrepresented. Given restricted access to classified military aerial data, these open-source datasets offer a practical alternative for training and benchmarking object detection models for battlefield surveillance and intelligence gathering. [10]

C. SAR Datasets

Synthetic Aperture Radar (SAR) datasets are vital for object detection in operational environments where optical imagery suffers limitations, such as poor lighting or adverse weather. Unlike electro-optical sensors, SAR’s ability to capture imagery regardless of illumination or climatic conditions enables persistent, all-weather, day-and-night monitoring—capabilities that are essential for critical military operations.

We include LS-SSDD-v1.0 [11] and SSDD [12] as representative SAR datasets for ship detection and maritime monitoring. Both deliver satellite SAR images of maritime scenes exhibiting wide variation in scale, sea state, and ship appearance. Most targets are civilian vessels; explicitly labeled military ships are infrequent or missing, making direct use for military threat detection less effective without further adaptation or relabeling.

The LS-SSDD-v1.0 dataset contains approximately 9,000 SAR images collected from Sentinel-1, annotated primarily for ship detection. Its large-scale backgrounds and small ship detection make it particularly valuable for developing algorithms capable of all-weather and day-night surveillance, a core requirement in maritime defense operations.

Similarly, SSDD provides 1,160 SAR images at resolutions between 1 and 15 meters, annotated using multiple formats including bounding boxes and polygons. Although these datasets support flexible model training, the restricted diversity of vessel types and the absence of military-purpose ships, such as warships, constitute a critical limitation in reflecting the characteristics of defense environments.

Owing to their all-weather imaging and detailed annotation, SAR datasets are well-suited for developing robust AI models for surveillance and coastal defense. They support model training for situations involving occlusions, complex backgrounds, and varying object orientations—scenarios frequently encountered in military reconnaissance. In the absence of classified data, these public resources are invaluable for developing and benchmarking defense-relevant detection systems.

D. Maritime/Ship-Specific Datasets

Maritime-object detection datasets address the distinct visual and operational challenges of naval and shipping envi-

ronments, including sea clutter, vessel diversity, and object scaling. These datasets provide annotated imagery focused on ships and maritime scenes, supporting applications in surveillance, traffic monitoring, and maritime security. Specialized datasets are necessary to realistically train and evaluate models for defense-related naval operations.

ShipRSImageNet [13] is one of the largest open-source maritime datasets, comprising about 3,400 satellite images and 17,500 annotated ships across 50 vessel categories. The dataset's extensive coverage of maritime environments, high image quality, and environmental diversity provide a valuable foundation for maritime surveillance research. While predominantly featuring civilian and commercial vessels, it also notably includes specific categories such as warships, which are further subdivided into types like Submarine, Aircraft Carrier, Destroyer, and Frigate, thus offering enhanced utility for defense-oriented applications involving diverse ship types.

The maritime domain is vital for national defense operations such as coastal surveillance, threat detection, and maritime domain awareness. Datasets like ShipRSImageNet facilitate development of models that can operate under real maritime conditions, allowing for changing sea states, complex coastlines, and vessel overlap. Their diversity in ship types, observation geometries, and environments approximates real-world military settings, making them valuable resources for developing and benchmarking naval detection algorithms.

E. Defense Applications Strategies

Building upon the systematic analysis of publicly available civilian datasets, several practical strategies can be proposed for their effective utilization in defense object detection applications. These strategies aim to take advantage of the strengths of open source data while acknowledging and mitigating the inherent limitations for military contexts. The overarching goal is to accelerate the development of defense AI capabilities despite the persistent scarcity of classified operational imagery.

A foundational strategy involves a phased approach to model development. This entails an initial stage of pre-training on large civilian datasets to acquire robust general features. This initial phase can be followed by targeted fine-tuning using limited military-specific data or synthetically generated samples for specialized assets not present in civilian corpora. This hybrid training paradigm allows for leveraging the vastness of public data while addressing the critical need for domain-specific knowledge, thereby optimizing the use of scarce military resources. [14]

Furthermore, the implementation of advanced domain adaptation and data augmentation techniques is crucial to bridge the significant domain gap between civilian and military imagery. Strategies could include adversarial domain adaptation to learn domain-invariant features, or style transfer methods to transform civilian images to mimic military sensor characteristics and environmental conditions (e.g., low light, adverse weather). Furthermore, intelligent data augmentation techniques, informed by military operational scenarios, can be

applied to civilian data to simulate conditions like partial occlusion, varied viewpoints, and different levels of camouflage, enhancing model robustness without requiring extensive new military data collection.

IV. RELATED WORK

A. Single-stage Detection Frameworks.

To address computational limitations, Redmon et al. [15] presented YOLO, a novel framework that predicts object bounding boxes and categories directly from entire images in a single inference pass. The approach dramatically reduced inference time while maintaining competitive accuracy for real-time applications. Similarly, Carion et al. [16] introduced DETR using Transformer architectures to create fully end-to-end detection systems. Unlike previous approaches, DETR eliminates separate post-processing modules by optimizing detection holistically from input to output.

B. Two-stage Detection Systems.

Girshick et al. [17] proposed R-CNN, the first approach that combined selective region generation with deep feature extraction for object classification. The method achieved unprecedented accuracy improvements over traditional sliding window approaches by efficiently focusing on regions likely to contain relevant targets. However, R-CNN suffers from computational inefficiency due to separate proposal and classification stages that limit real-time deployment capabilities.

C. Domain Adaptation Techniques.

The challenge of domain shift has been addressed through various adaptation methodologies. Ganin et al. [18] presented adversarial domain adaptation, where domain discriminator networks guide feature extractors toward learning domain-invariant representations for enhanced cross-dataset transferability. The method demonstrates effectiveness for modest domain discrepancies when representative labeled data are available for fine-tuning. However, adversarial adaptation approaches create limitations when applied to military contexts due to unique sensor types, atypical viewpoints, and severe label scarcity that characterize defense scenarios.

D. Public Dataset Utilization.

Previous studies have focused on leveraging large-scale public datasets for specialized applications. Lin et al. [1] developed MS COCO as a comprehensive benchmark that propelled computer vision progress by providing millions of annotated images for model evaluation. Torralba et al. [19] analyzed the limitations of public datasets, revealing intrinsic biases in object categories and imaging conditions that critically limit generalization to specialized domains. The main reason for this is that public datasets often lack domain-specific entities and operational backgrounds essential for real-world defense applications. Despite the importance of systematic dataset analysis for defense contexts, few studies comprehensively evaluate civilian dataset applicability to military object detection requirements.

V. LIMITATIONS

While this survey provides a structured and comprehensive analysis of publicly available datasets for defense-related object detection, several limitations remain. The most significant constraint lies in the absence of experimental validation and real-world defense case studies, primarily due to the restricted accessibility of classified imagery. Consequently, the present analysis remains conceptual and comparative rather than empirical.

To bridge this gap, a key priority for future work is the empirical validation of the identified datasets capabilities. A crucial direction involves leveraging prior research that has successfully demonstrated the utility of these datasets within related civilian contexts. For example, FAIR1M has been effectively applied to fine-grained aircraft classification and airport management.

Similarly, LS-SSDD and SSDD have supported advancements in ship detection and maritime traffic monitoring, whereas ShipRSImageNet has enabled fine-grained vessel categorization and incorporates specific categories such as warships, thereby providing greater relevance for defense-related research. Building upon these established precedents, future research can directly extend such proven applications to defense-relevant domains.

VI. CONCLUSION

In this paper, we present a comprehensive analysis of publicly available datasets and their potential applicability to defense-oriented object detection systems. We systematically explored 10 major civilian datasets across aerial optical, SAR, and maritime domains, investigating possible object class overlap with military requirements. Our structured comparison framework facilitates dataset evaluation by object relevance, licensing constraints, and defense applicability considerations, contributing to defense-focused computer vision research.

Our analysis suggests that civilian datasets may encompass significant coverage of defense-relevant object classes, potentially including military equipment, critical infrastructure, and operational scenarios. We explored possible utilization pathways for defense applications, including perimeter security through vehicle detection datasets, infrastructure monitoring via high-resolution aerial imagery, and maritime surveillance systems using ship-specific datasets. The compiled comparison framework provides researchers with systematic guidance for dataset selection based on specific defense requirements and operational considerations.

The main contributions of this work include systematic investigation of defense-applicable civilian datasets, development of a structured evaluation framework, and exploration of potential application strategies for military computer vision systems. We have established foundational insights for leveraging civilian datasets in defense contexts while maintaining compliance with licensing and accessibility requirements.

Future work will focus on empirical validation through comprehensive experiments using the identified datasets to quantitatively assess their effectiveness in defense environments.

We believe that systematic utilization of civilian datasets will continue to play a crucial role in advancing defense computer vision capabilities while addressing fundamental data scarcity challenges in military applications.

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