Small-Object Detection in Remote Sensing Images and Video

Stamatios Orfanos

University of Piraeus   NCSR Demokritos

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Introduction

Remote sensing imaging is a process used to gather information about objects or areas from a distance, typically using aircraft or satellites. Remote sensing imaging has applications across a broad spectrum of fields.

- Environmental monitoring
- Agriculture monitoring
- Disaster management
- Urban planning
- Military and intelligence

Urban Planning

Introduction

In remote sensing images the objects are small fraction of the pixels of the image, qualifying this process as Small Object Detection.

Compared with large and medium objects, small objects are more difficult to detect accurately for the following reasons:

- Small objects have low resolution and insufficient features
- The span of object-scale is large and multiple scales coexist
- The examples of small objects are scarce
- Categories for small objects are imbalanced for the majority of datasets

Introduction

There are two ways to define small objects in the context of object detection.

- Relative size: the bounding box of a small object should cover less than 1% of the original image
- Absolute size: a small object has size less than 32x32 pixels defined in MS-COCO dataset or 16x16 pixels defined in USC-GRAD-STDdb

Data and Data Preprocessing

The selected datasets cover a wide range of applications, from real-life scenarios to military and intelligence uses, ensuring a comprehensive evaluation of the detection models.

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COCO2017 Dataset

The COCO2017 dataset includes complex everyday scenes with common objects in their natural context. It features:

- Over 200,000 images
- 1.5 million object instances
- 80 object categories

Used for object detection, segmentation, and captioning tasks.

Vis-Drone Dataset

Vis-Drone is designed for drone-based image analysis and includes:

- Around 10,209 images
- Images captured from various drones
- Focus on urban scenes and traffic monitoring

It is used for object detection and tracking.

UAV-SOD Dataset

The UAV-SOD dataset is targeted at small object detection from aerial perspectives, featuring:

- High-resolution images
- Challenges due to small object scales
- Annotations for object detection tasks

Essential for research in drone-based surveillance and remote sensing.

Data Preprocessing Steps

Preprocessing is crucial for normalizing data and improving model training efficiency. Steps include:

- Resizing images and annotations to a uniform size (e.g., 600×600 pixels).
- Image padding to maintain aspect ratio without distortion.
- Annotation format standardization for consistency across datasets.
- Normalization of image pixel values using dataset-specific mean and standard deviation.

Object Detection Metrics

Proposed Method

Experiments

Conclusion