Bottle Detection in the Wild Using Low-Altitude Unmanned Aerial Vehicles

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Outline

Introduction

Motivation

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The sanitation workers on the Huashan Mountain.

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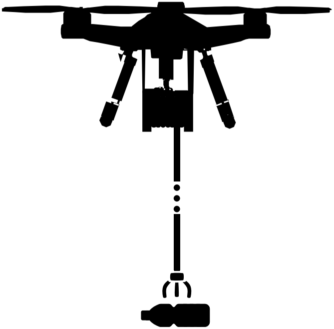
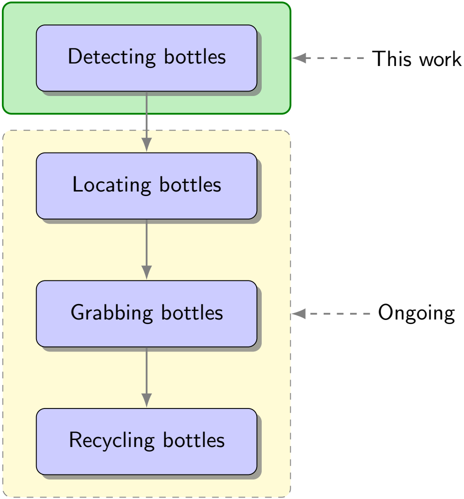


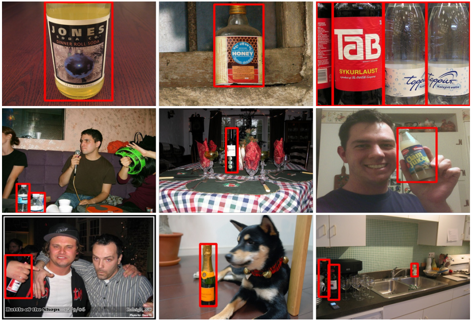
UAVs can help them!

Pipeline


Detecting bottles
This work
Locating bottles
Grabbing bottles
Ongoing
Recycling bottles

challenges

In UAV images, the bottles look completely different from the bottles in datasets such as PASCAL VOC, Microsoft COCO, etc.



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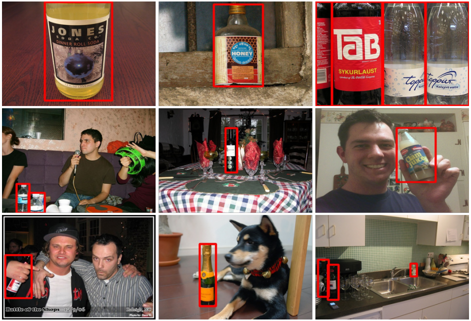

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- Backgrounds are very complex.
- Arbitrary orientations.
- Plastic bottles are often transport, increaseing the difficulty of detection.

UAV-Bottle Dataset

Dataset

To build a baseline for bottle detection in UAV images, we establish a large scale bottle detection dataset, we call UAV-Bottle Dataset(UAV-BD) and benchmark.

We used DJI Phantom 4 Pro to collect images. The resolution of the captured images are 5472×3078 pixels. At the same time, we follow four key suggestions:

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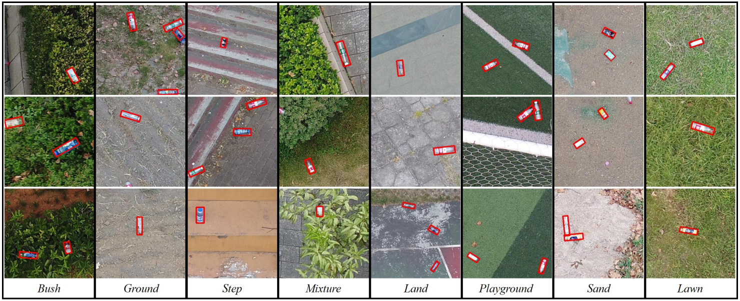
- Wide range of scale and aspect ratios.
- Different backgrounds.
- Different orientation.
- As many types of bottles as possible.

Dataset Collection

8 background scenes are chosen and annotated in our UAV-BD:

- Bushforest land
- Waste land
- Step
- Forest land
- Flat land
- Plastic stadium
- Sand land
- Grassland



Annotation Method

A common description of horizontal bounding boxes is (c_x, c_y, h, w) , where (c_x, c_y) is the center location, h, w are the height and width.

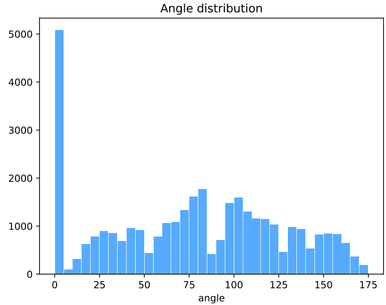
However, horizontal bounding box cannot accurately or compactly outline oriented instances such as the bottles in UAV images. So we use (c_x, c_y, h, w, θ) to describe bounding boxes, where θ is the angle from the horizontal direction of the horizontal bounding box.

Dataset Statistics

The size of original image(OI) in UAV-BD is 5472×3078 pixels, they are too large to be trained for CNN-based algorithms. So we segment each OI into 144 small subimages(SIs), and the size of SIs is 342×342 pixels. Images and instances number in UAV-BD are shown in the table below.

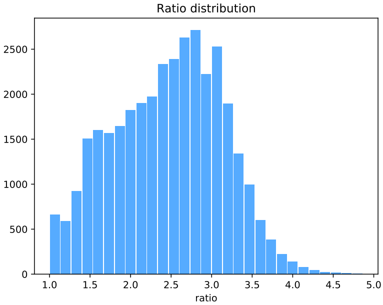
Scenes	**OI**	**SI**	**Instances in OI**	**Instances in SI**
Bushforest land	230	4134	1812	3047
Wasteland	379	7598	4355	5800
Step	135	2691	1325	2106
Forest land	285	5724	3702	4891
Flat land	134	2803	1538	2142
Plastic stadium	336	6807	4180	4998
Sand land	249	5570	2704	4008
Grassland	456	9029	5778	7787
Total	2204	44356	25394	34779

Dataset Statistics



Angle distribution of UAV-BD. The angle ranges from 0 to $180°$.

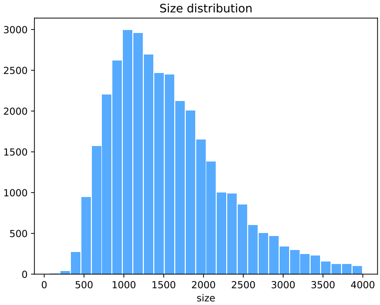
Dataset Statistics



Ratio distribution of UAV-BD.

The ratio ranges from 1.0 to 5.0.

Dataset Statistics



Size distribution of UAV-BD. The size ranges from 0 to 4000.

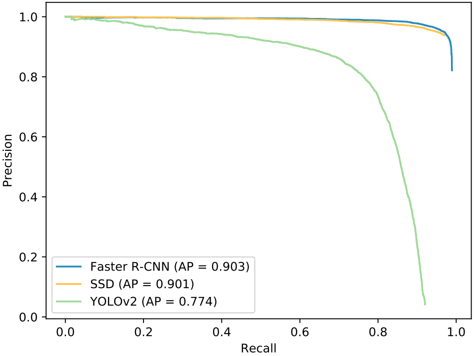
Baselines and Methods

Dataset Split

We randomly select 64%, 16% and 20% of the UAV-BD as the training, validation and testing data. So the whole UAV-BD contains $16,258$ images with $22,211$ instances for training, $4,055$ images with $5,624$ instances for validation and $5,081$ images with $6,944$ instances for testing.

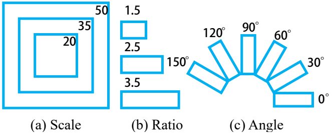
Baselines with Horizontal Bounding Boxes(HBB)

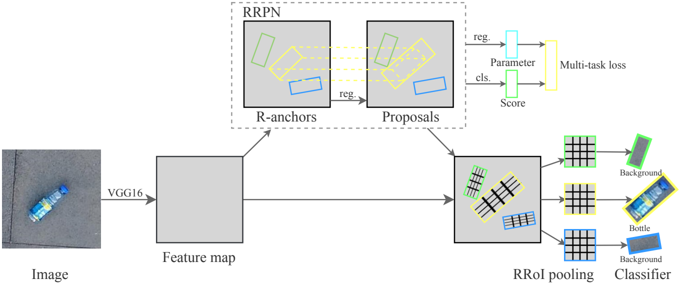
We select Faster R-CNN, SSD, YOLOv2 as our baseline for horizontal object detection. The experimental results of HBB prediction are shown in figure below.



Baseline with Oriented Bounding Boxes(OBB)

For oriented object detection, wo modify the original Rotation Region Proposal Network(RRPN) algorithm to predict properly oriented bounding boxes. RRPN's network structure is shown in figure below.





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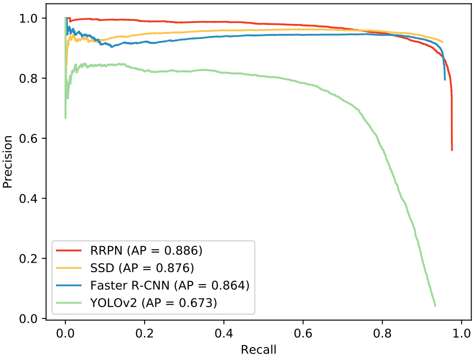
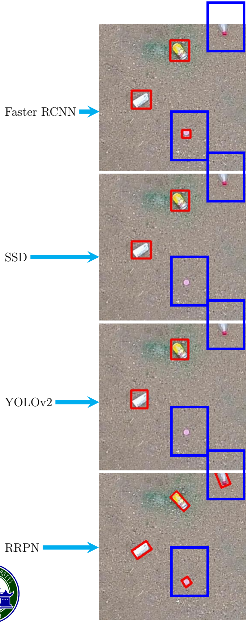
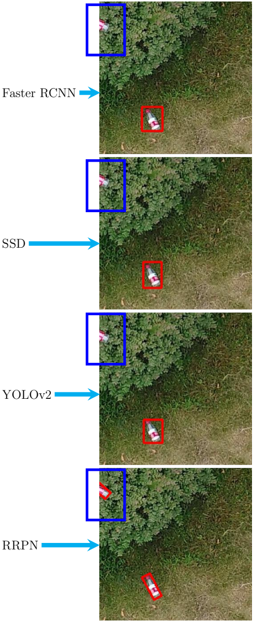


Experimental Analysis

Some Details





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- ◎ Built a large-scale dataset for bottle detection in UAV images named UAV-BD.

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Future Work

- We will focus on locating and recycling bottles in the real-world using UAV.

Get UAV-Bottle Dataset

UAV-Bottle Dataset and Development Kit can be downloaded on Google Drive and Github.

UAV-Bottle Dataset

https://jwwangchn.github.io/UAV-BD/

Development Kit

https://github.com/jwwangchn/UAV-BD.git

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Thanks!