# EAGLE: Large-scale Vehicle Detection Dataset in Real-World Scenarios using Aerial Imagery

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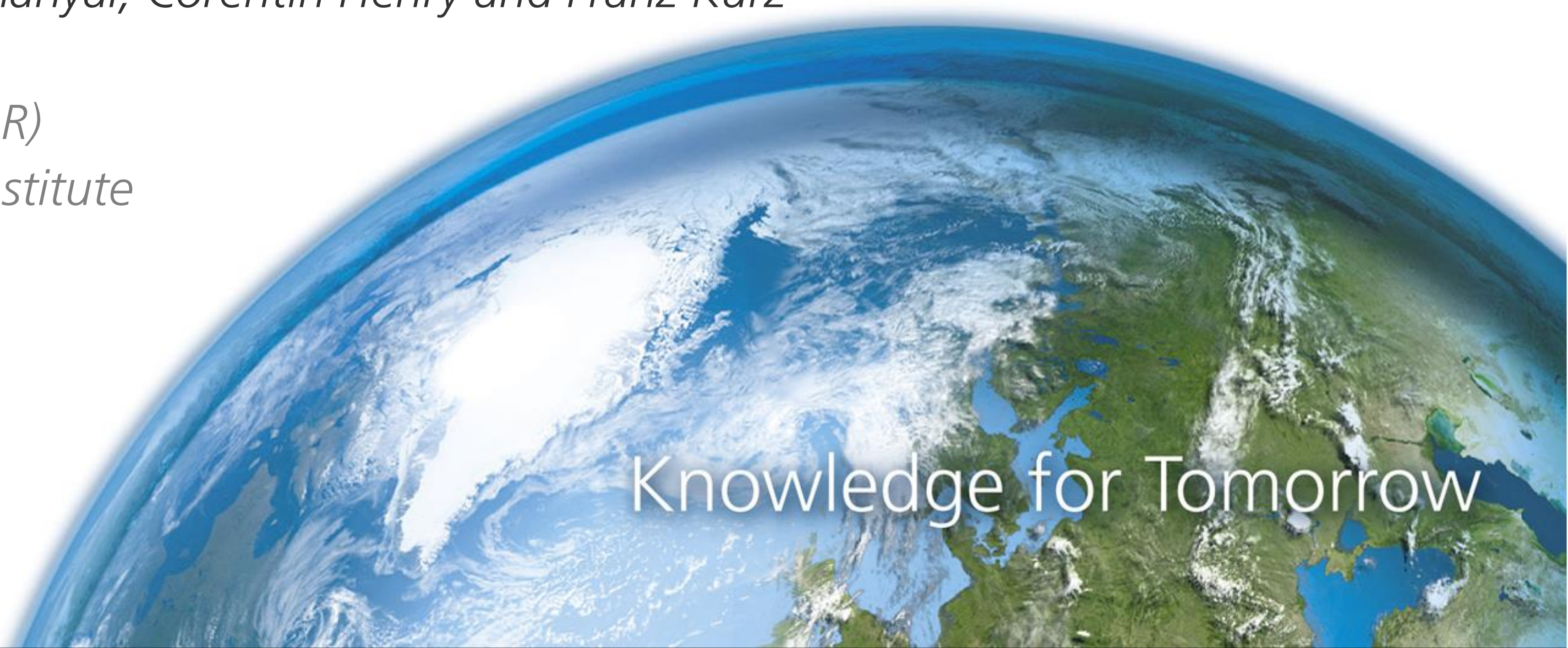



DLR

# Robust Vehicle Detection for the Real-World Applications

## Disaster Management, Traffic Monitoring, Search & Rescue Missions, etc

Source: DLR

Source: DLR

*An algorithm suitable for such scenarios should be very accurate with high accuracy and robust to*

- ***Weather conditions: clouds, fog, haze, shadow, …***
- ***Minor and major occlusions, different backgrounds, tiny object size, different scales, etc***

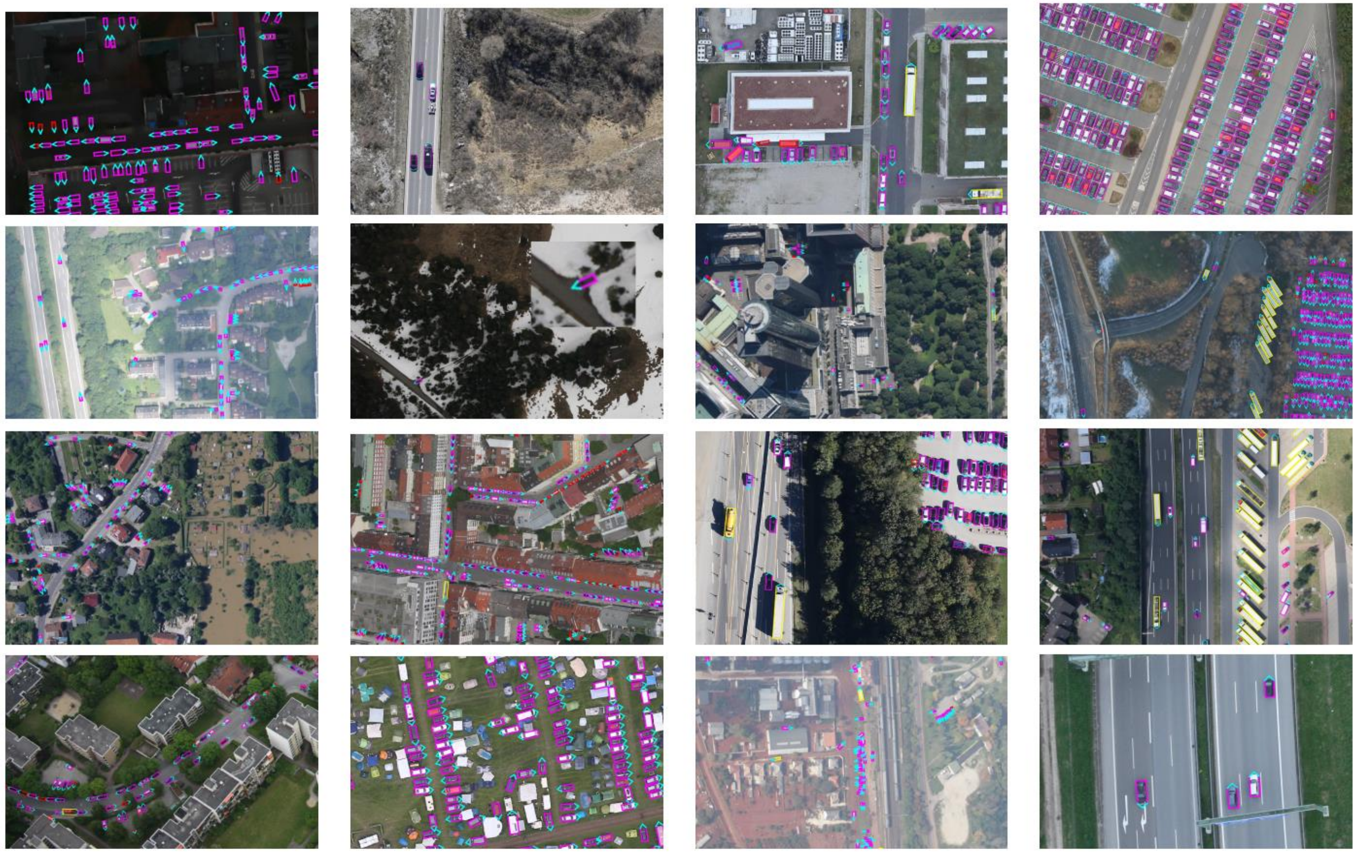
# Large-scale Vehicle Detection Datasets in Remote Sensing are Scarce!

| Datasets | # Vehicle Instances | # Vehicle Categories | # All Categories | # Images | # All Instances | Image Width (px) | Annotation Approach | Year |
|---|---|---|---|---|---|---|---|---|
| TAS | 1,319 | 1 | 1 | 30 | 1,310 | 792 | HBB | 2008 |
| NWPU-VHR-10 | 232 | 1 | 10 | 800 | 3,775 | 1000 | HBB | 2014 |
| VEDAI | 3,270 | 6 | 9 | 1,210 | 3,640 | 1024 | OBB | 2015 |
| UCAS-AOD | 2,819 | 1 | 2 | 910 | 6,029 | 1280 | HBB | 2015 |
| DLR-3K-Vehicle | 14,232 | 2 | 2 | 20 | 14,235 | 5616 | OBB | 2015 |
| COWC | 32,716 | 1 | 1 | 53 | 32,716 | 2000-19,000 | One-Dot | 2016 |
| HRSC2016 | 0 | 0 | 1 | 1,070 | 2,976 | 1000 | OBB | 2016 |
| RSOD | 0 | 0 | 4 | 976 | 6,950 | 1000 | HBB | 2017 |
| DOTA | 43,462 | 2 | 15 | 2,806 | 188,282 | 300-4000 | RBB | 2017 |
| **EAGLE (ours)** | **215,986** | 2 | 2 | **8,280** | **215,986** | 936 | OBB | 2020 |

*Current datasets for vehicle detection not only lacks high number of instances, but also they lack*

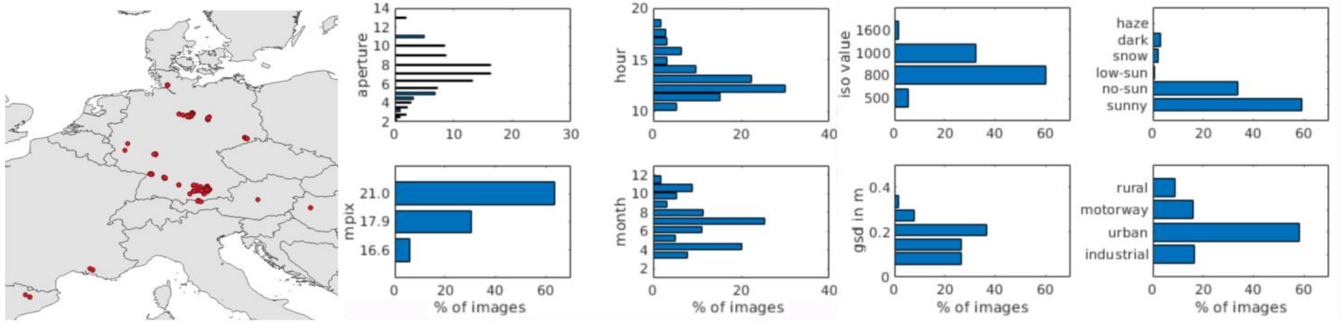
- ***High-quality annotation esp. occluded vehicles***
- ***Scenarios with poor visibility and weather condition***
- ***Large-scale for #images, resolution variation, location, time, camera angle***
- ***Real disasters***

# Addressing Current Issues with the Introduction of EAGLE

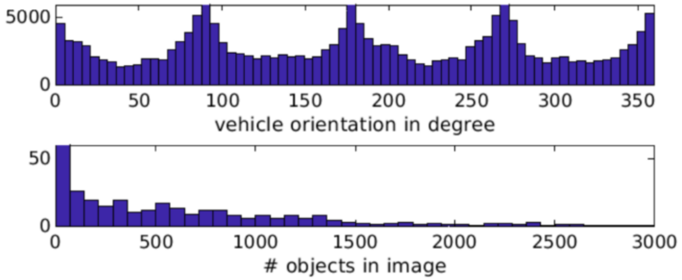


Sample Images

Comparison with the state-of-the-art Dataset DOTA




Distribution and Variation




Statistic

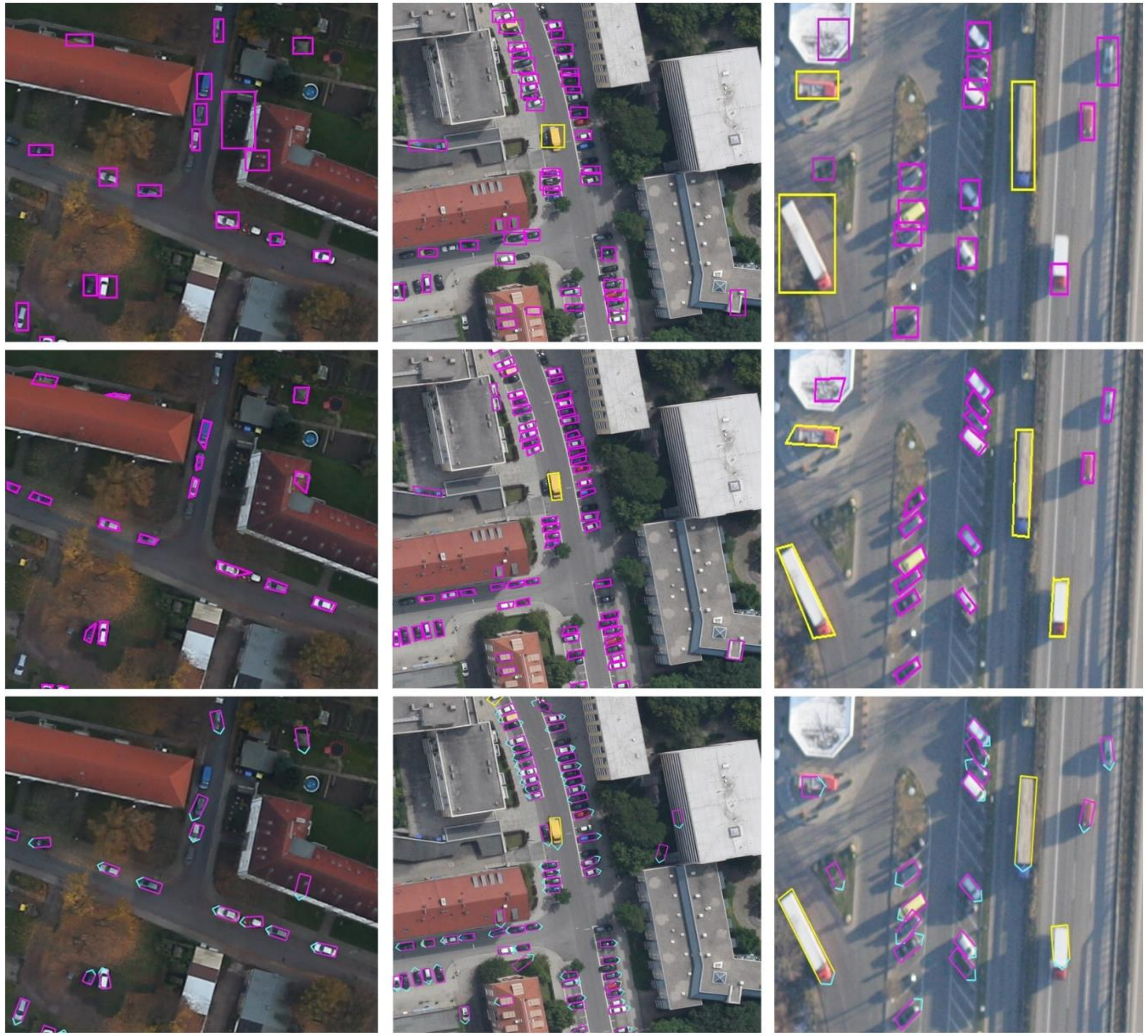
# Benchmark Results

| Method | Backbone | AP [%] (HBB) | | | AP [%] (RBB) | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SV | LV | Mean | SV | LV |
| Yolov3 | Darknet-53 | 20.29 | 30.45 | 10.13 | 13.28 | 21.34 | 5.23 |
| SSD | InceptionV2 | 12.06 | 20.67 | 3.45 | 7.31 | 12.34 | 2.28 |
| RefineDet | VGG16 | 22.23 | 32.25 | 12.21 | 14.78 | 22.67 | 6.89 |
| R-FCN | ResNet101 | 30.61 | 46.85 | 14.37 | 21.06 | 35.56 | 6.56 |
| Faster-RCNN | ResNet101 | 31.84 | 48.34 | 15.34 | 23.15 | 39.29 | 7.02 |
| Mask-RCNN | ResNet101 | 30.81 | 46.51 | 15.11 | 22.54 | 36.65 | 8.43 |
| Cascade-RCNN | ResNet101 | 33.49 | 49.65 | 17.34 | 23.58 | 38.97 | 8.19 |
| SNIPER | ResNet101 | 30.74 | 48.34 | 13.14 | 21.97 | 38.23 | 5.72 |
| FPN | ResNet101 | 37.10 | 50.76 | 23.45 | 27.11 | 39.78 | 14.45 |
| TridenNet | ResNet101 | 30.53 | 47.16 | 13.91 | 22.53 | 37.16 | 7.91 |
| FCOS | ResNeXt101 | 38.80 | 52.94 | 24.67 | 27.67 | 41.24 | 14.10 |
| Cascade Mask-RCNN-H | Triple-ResNeXt152 | **39.29** | **53.45** | **25.14** | 30.22 | 43.84 | 16.60 |
| Cascade Mask-RCNN-R [Ours] | Triple-ResNeXt152 | - | - | - | **37.23** | **51.27** | **23.19** |

| Method | Task | mAP [%] | AP [%] | |
|---|---|---|---|---|
| | | | small-vehicle | large-vehicle |
| Cascade Mask-RCNN-H | HBB | 33.54 | 50.16 | 16.92 |
| Cascade Mask-RCNN-R | RBB | 30.18 | 46.82 | 13.54 |
| Cascade Mask-RCNN-O | OBB | 32.02 | 48.13 | 15.91 |

| Training set | Test set | Avg. | SV | LV |
|---|---|---|---|---|
| DOTA | DOTA | 59.95 | 61.23 | 58.67 |
| DOTA | EAGLE | 28.23 | 38.89 | 17.57 |
| EAGLE | DOTA | 53.25 | 57.34 | 49.16 |
| EAGLE | EAGLE | 39.29 | 53.45 | 25.14 |

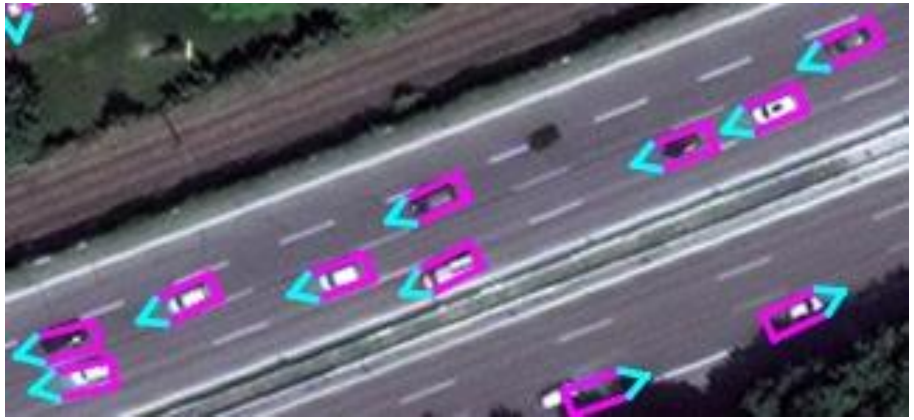
# Qualitative Performance



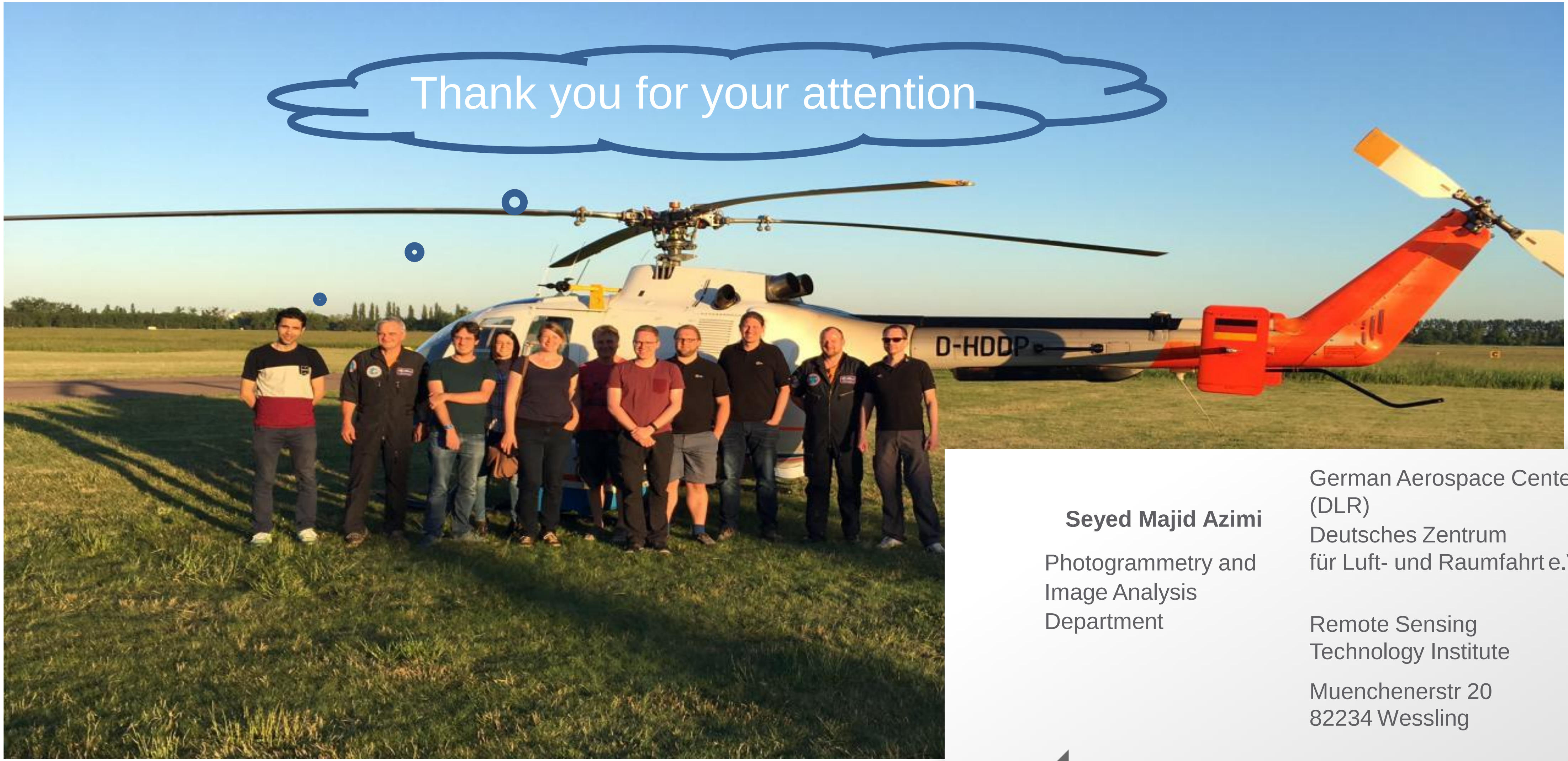
Horizontal Bounding Box

Quadrilateral Rotated Bounding Box

Oriented Bounding Box



Generalization on Satellite imagery

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