Ahmedabad University

CSE541: Computer Vision

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Group: 7

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Problem Statement

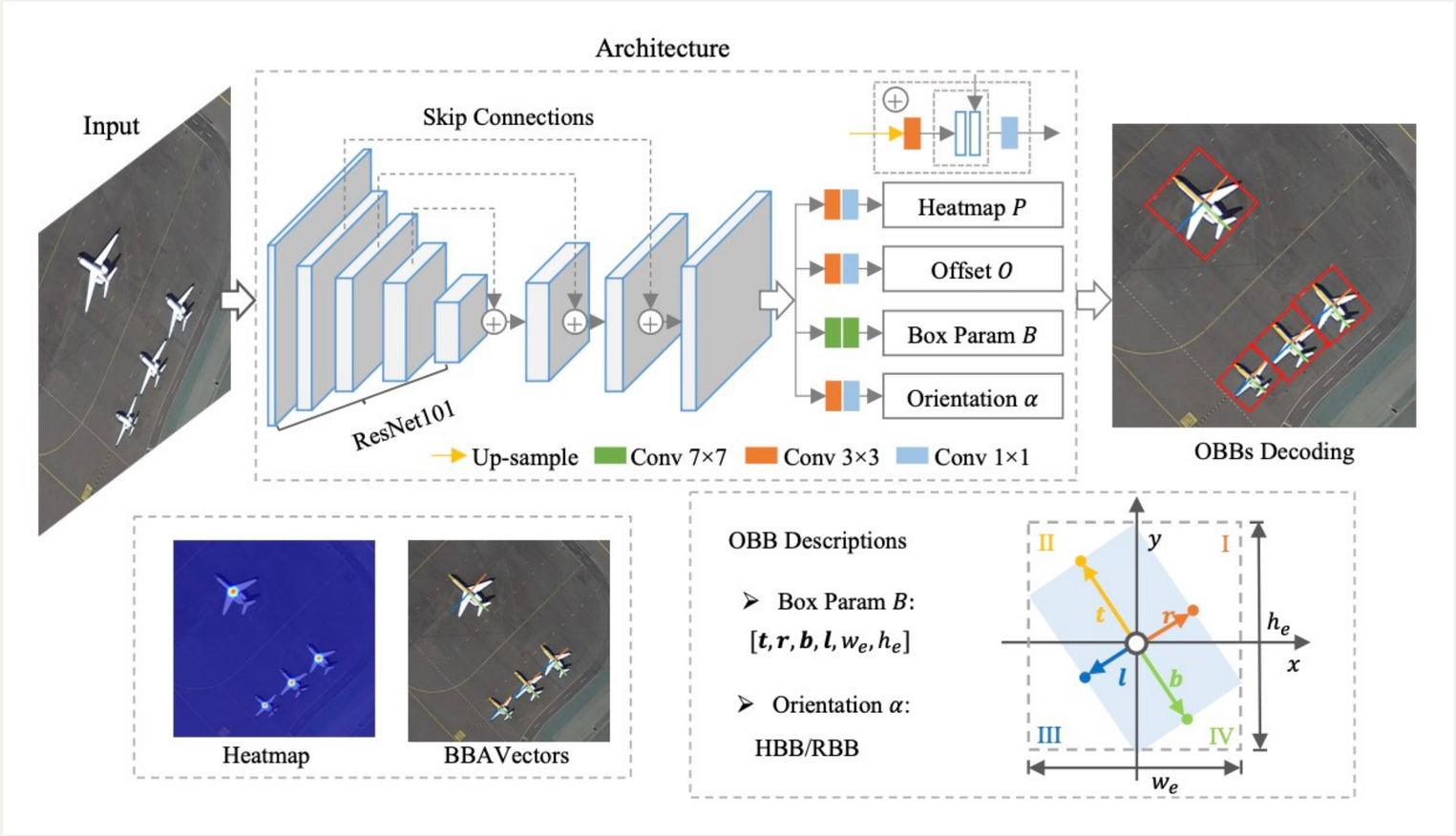
Oriented Object Detection (OOD) for AU Drone Dataset

- Oriented Object Detection: A Challenging Task
- Current Methods Rely on Two-Stage Anchor-Based Detectors
- Severe Imbalances Between Positive and Negative Anchor Boxes
- Proposal: Center Key Points Detection and Regression of Box Boundary-Aware Vectors (BBAVectors)
- Aim: Capture Oriented Bounding Boxes Across the Cartesian Plane
- Approach Outperforms Two-Stage Anchor-Based Detectors
- Direct Prediction of Box Parameters

Methodology

- Pre-trained ResNet101 Conv1-5 is used as the base for feature extraction.
- Image is up-sampled to increase the size of extracted features by four times.
- Up-sampled feature map is refined with a 3x3 Conv layer.
- Refined feature map is concatenated with a shallow layer and refined further with a 1x1 convolutional layer.
- Output feature map is divided into four branches:

Methodology



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*[1] J. Yi, P. Wu, B. Liu, Q. Huang, H. Qu, and D. Metaxas, “Oriented Object Detection in Aerial Images with Box Boundary-Aware Vectors.” Accessed: Mar. 16, 2024. https://arxiv.org/pdf/2008.07043v2.pdf

Methodology

- Heat maps detect oriented objects' centre points, trained with focal loss using 2D Gaussian from the ground truth to reduce noise reduction.
- Offset map predicts offsets to compensate for differences between floating centre points and integer centre points.
- Box parameters predict parameters for box boundary aware (BBA) vectors distributed in four quadrants of the Cartesian coordinate system.
- Orientation categorises objects into horizontal bounding boxes (HBB) and rotated bounding boxes (RBB) to address detection failures in corner cases.

Results

- With the orientation classification and additional external Oriented Bounding Box (OBB) size parameters, method achieves 72.32% accuracy. With the larger training batch size, it achieves 75.36% accuracy. Moreover, this method is robust enough to capture objects even in tiny, crowded vehicles.

Method	mAP	Plane	BD	Bridge	GTF	SV	LV	Ship	TC	BC	ST	SBF	RA	Harbor	SP	HC
YOLOv2 [18]	25.49	52.75	24.24	10.6	35.5	14.36	2.41	7.37	51.79	43.98	31.35	22.3	36.68	14.61	22.55	11.89
FR-O [22]	54.13	79.42	77.13	17.7	64.05	35.3	38.02	37.16	89.41	69.64	59.28	50.3	52.91	47.89	47.4	46.3
R-DFPN [24]	57.94	80.92	65.82	33.77	58.94	55.77	50.94	54.78	90.33	66.34	68.66	48.73	51.76	55.10	51.32	35.88
R^2CNN [7]	60.67	80.94	65.75	35.34	67.44	59.92	50.91	55.81	90.67	66.92	72.39	55.06	52.23	55.14	53.35	48.22
Yang *et al.* [25]	62.29	81.25	71.41	36.53	67.44	61.16	50.91	56.60	90.67	68.09	72.39	55.06	55.60	62.44	53.35	51.47
ICN [1]	68.16	81.36	74.30	47.70	70.32	64.89	67.82	69.98	90.76	79.06	78.20	53.64	**62.90**	**67.02**	64.17	50.23
ROI Trans. [2]	67.74	88.53	77.91	37.63	**74.08**	66.53	62.97	66.57	90.5	79.46	76.75	**59.04**	56.73	62.54	61.29	55.56
ROI Trans.+FPN [2]	69.56	**88.64**	78.52	43.44	**75.92**	68.81	73.68	83.59	90.74	77.27	81.46	**58.39**	53.54	62.83	58.93	47.67
BBAVectors+r	71.61	88.54	76.72	49.67	65.22	75.58	**80.28**	87.18	90.62	**84.94**	**84.89**	47.17	60.59	65.31	63.91	53.52
BBAVectors+rh	**72.32**	88.35	**79.96**	**50.69**	62.18	**78.43**	78.98	**87.94**	**90.85**	83.58	84.35	54.13	60.24	65.22	**64.28**	**55.70**
BBAVectors+rh^*	**75.36**	**88.63**	**84.06**	**52.13**	69.56	**78.26**	**80.40**	**88.06**	**90.87**	**87.23**	**86.39**	56.11	**65.62**	**67.10**	**72.08**	**63.96**

Table 1. Detection results on the testing set of DOTA-v1.0. The performances are evaluated through the online server. Symbol $*$ shows the result with a larger training batch size (i.e., 48 on 4 Quadro RTX 6000 GPUs). Red and Blue colors label the best and second best detection results in each column.

*[1] J. Yi, P. Wu, B. Liu, Q. Huang, H. Qu, and D. Metaxas, “Oriented Object Detection in Aerial Images with Box Boundary-Aware Vectors.” Accessed: Mar. 16, 2024. https://arxiv.org/pdf/2008.07043v2.pdf

Future Work

Improvement of Model

- Significant improvement required with the accuracy of the bounding box formation, and our model
- Make the code efficient and operatational as many issues are faced due incompatible versions of dependencies in the model, it cannot run in the local environment.

Looking for different approaches than BBA Vectors

- The current approach includes use of BBA vectors with is fairly efficient. Various new approaches can be referred or found for improvement of the accuracy in detecting oriented objects.

References

[1] J. Yi, P. Wu, B. Liu, Q. Huang, H. Qu, and D. Metaxas, “Oriented Object Detection in Aerial Images with Box Boundary-Aware Vectors.” Accessed: Mar. 16, 2024. https://arxiv.org/pdf/2008.07043v2.pdf

[2] S. Lang, F. Ventola, and K. Kersting, “DAFNe: A One-Stage Anchor-Free Approach for Oriented Object Detection,” arXiv.org, May 30, 2022. https://arxiv.org/abs/2109.06148v4

THANK YOU

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