Forground-Guided Vehicle Perception Framework

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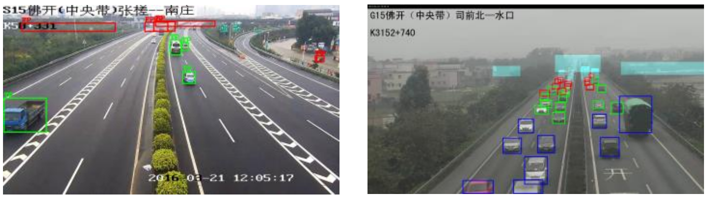
Definition of Vehicle Detection

Input surveillance scene images

Output detected results

Challenges of Vehicle Detection

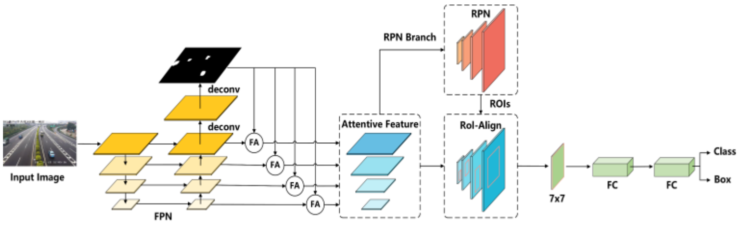


(a) (b)

(a) False positive: vegetation on the left, distant road areas and fuzzy non-motorized vehicles have been detected as targets, which are actually FP and drawn in red rectangles.

(b) Scale difference: small, medium, large and ignored objects are shown in red, green, blue and cyan bounding boxes.

Our Method



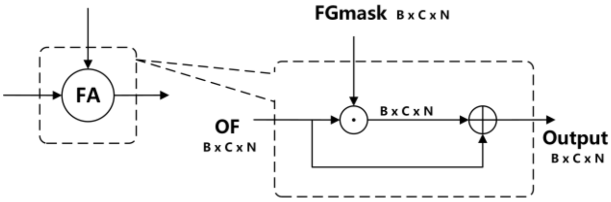
$$L = L_{seg} + L_{det} \quad (1)$$

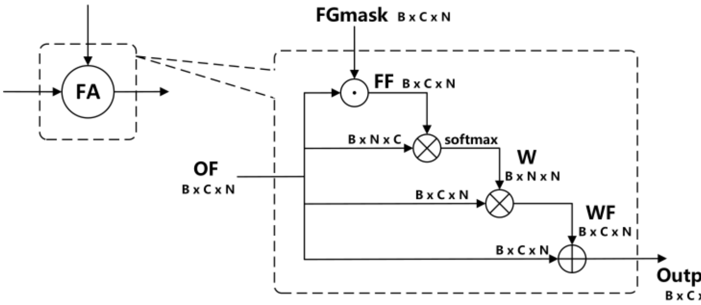
$$L_{seg} = -\frac{1}{N}\sum_{i=1}^{N} y_i \cdot \log\left(p\left(y_i\right)\right) + \left(1 - y_i\right) \cdot \log\left(1 - p\left(y_i\right)\right) \quad (2)$$

$$L_{det} = L_{cls} + L_{reg} \quad (3)$$

Our framework consists of backbone, segmentation branch and detection branch. With the proposed attention module (FA), the features can be further modified and enhanced.

Two Kinds of Attention Modules

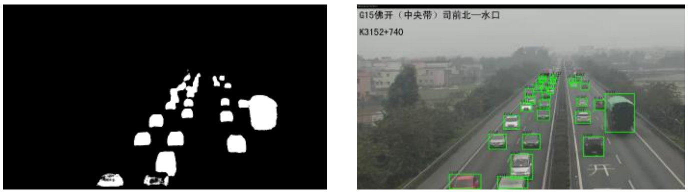




Experimental Results

Model	Time/Image	Mean	Sparse			Crowded		
			car	bus	van	car	bus	van
FPN-base	0.09	72.61	84.57	86.47	80.45	59.61	55.55	69.01
+FA(a)	0.11	74.35	85.19	87.06	82.98	59.00	59.43	72.45
+FA(b)	0.11	74.57	84.96	88.77	81.03	59.76	59.12	73.80
RetinaNet	0.07	69.67	83.89	87.75	78.69	51.42	52.67	63.60
+FA(a)	0.09	70.89	84.07	87.97	80.17	53.43	52.52	67.21
+FA(b)	0.09	70.98	84.23	87.33	80.30	52.71	55.23	66.09
Cascade R-CNN	0.13	72.70	85.07	87.50	80.04	60.05	55.16	68.42
+FA(a)	0.15	73.48	85.28	86.37	80.00	60.47	59.05	69.75
+FA(b)	0.15	73.73	85.52	87.42	82.12	60.28	57.00	70.09

Model	Time/Image	Mean	Sparse			Crowded		
			car	bus	van	car	bus	van
YOLO	0.03	16.52	23.06	31.13	22.44	3.87	8.35	10.32
YOLOv2	0.03	43.82	59.71	65.51	58.35	17.39	21.55	40.42
RetinaNet	0.07	69.67	83.89	87.75	78.69	51.42	52.67	63.60
Faster R-CNN	0.31	46.43	60.93	66.68	60.14	26.08	24.55	40.24
MS-CNN	0.23	63.23	79.94	83.71	76.79	51.74	32.95	54.26
SINet	0.20	70.17	81.82	85.60	78.65	56.80	55.78	62.38
FPN	0.09	72.61	84.57	86.47	80.45	59.61	55.55	69.01
VPNet	0.11	74.57	84.96	88.77	81.03	59.76	59.12	73.80



Conclusion

1. We first put forward using segmentation branch to assist detection task training, which can sense pixel position of the foreground vehicles in advance.

2. Two attention mechanisms are designed to suppress the classification confidence scores of background regions, thus alleviating the impact of false alarms.

3. We verify the compatibility of our method on several classic single-stage and two-stage detection models.