Nighttime Pedestrian Detection Based on Feature Attention and Transformation

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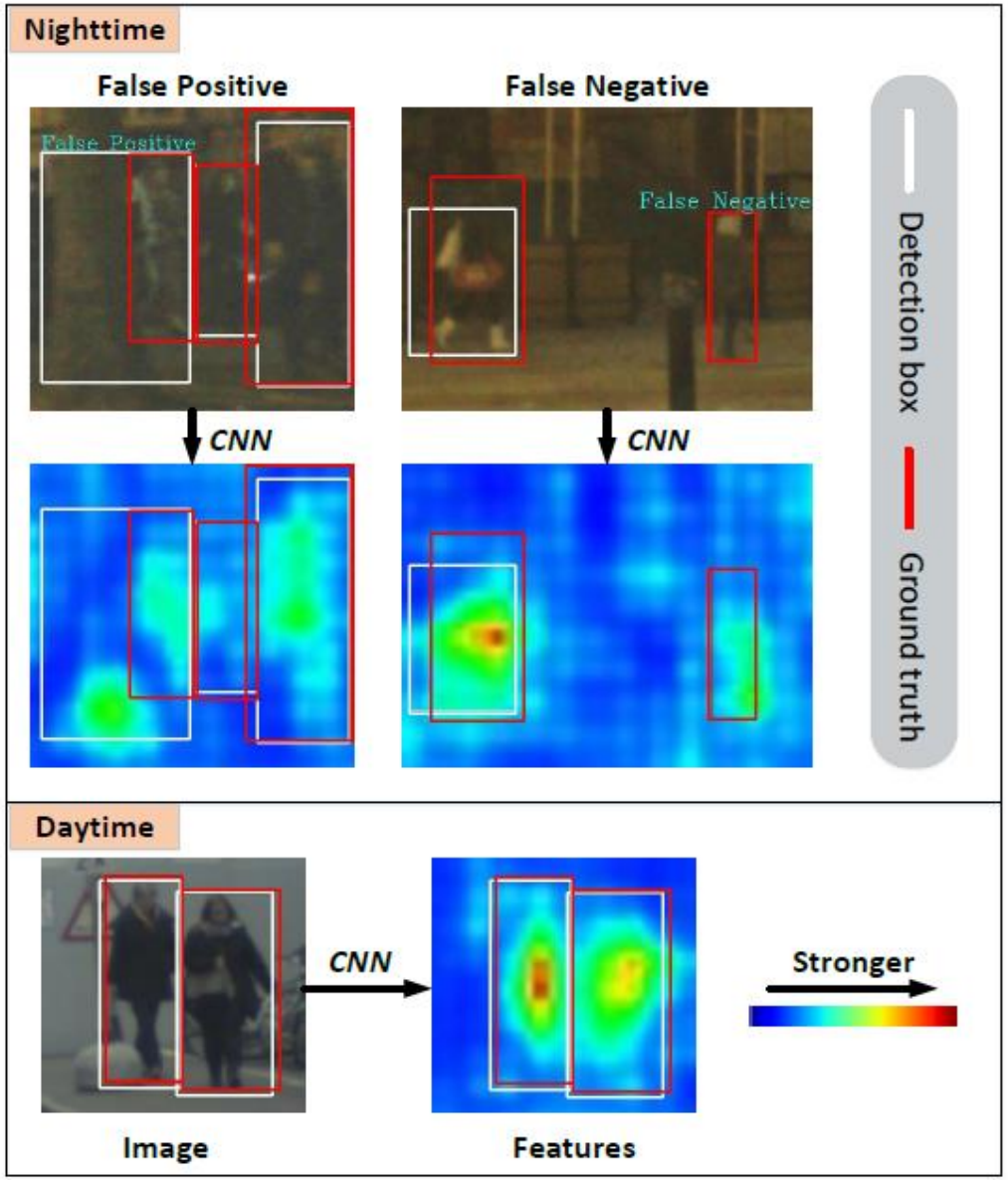
Problem

Nighttime pedestrian detection is a fundamental task for many practical applications, such as autonomous driving. Some works propose to detect pedestrians at night by multi-modal data (e.g. thermal and RGB), but the thermal sensor is expensive and not widely available in robotics or surveillance systems.

Thus detecting only with RGB images is important, and it is also seldom explored in previous literatures.

Motivation

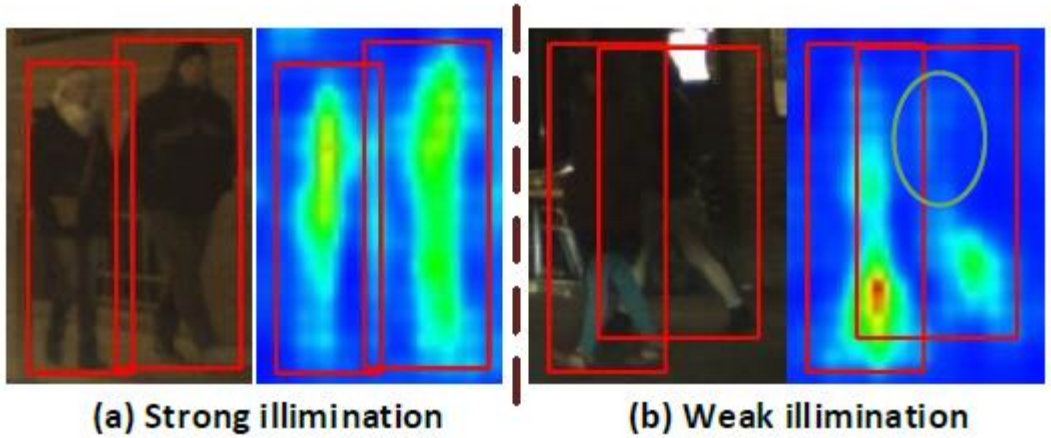


At daytime, CNN features at pedestrian region show high responses at pedestrian regions, with minimal noise at the background.

In contrast, at nighttime, CNN features fail to trigger high responses at pedestrian regions while contain much noise at the background, **resulting in false negatives and positives**, respectively.

To improve feature discrimination, we propose feature attention module.

Motivation



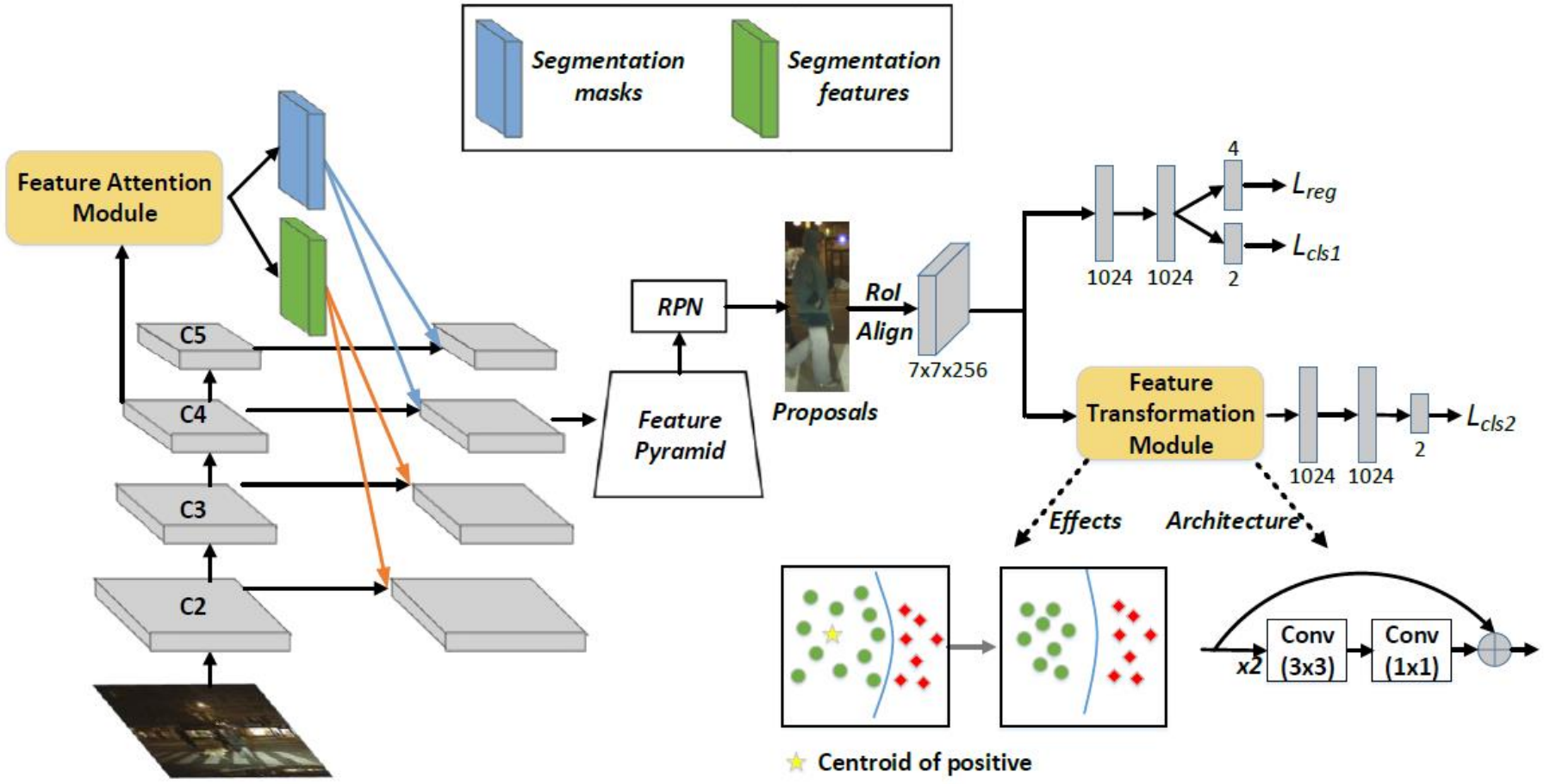
Compared to daytime, pedestrians under adverse illumination trigger **weaker responses**.

These examples are hard positive examples and close to the classification boundary.

We propose **feature transformation module** to push dark examples to approach bright ones.

Methods

Overall Architecture



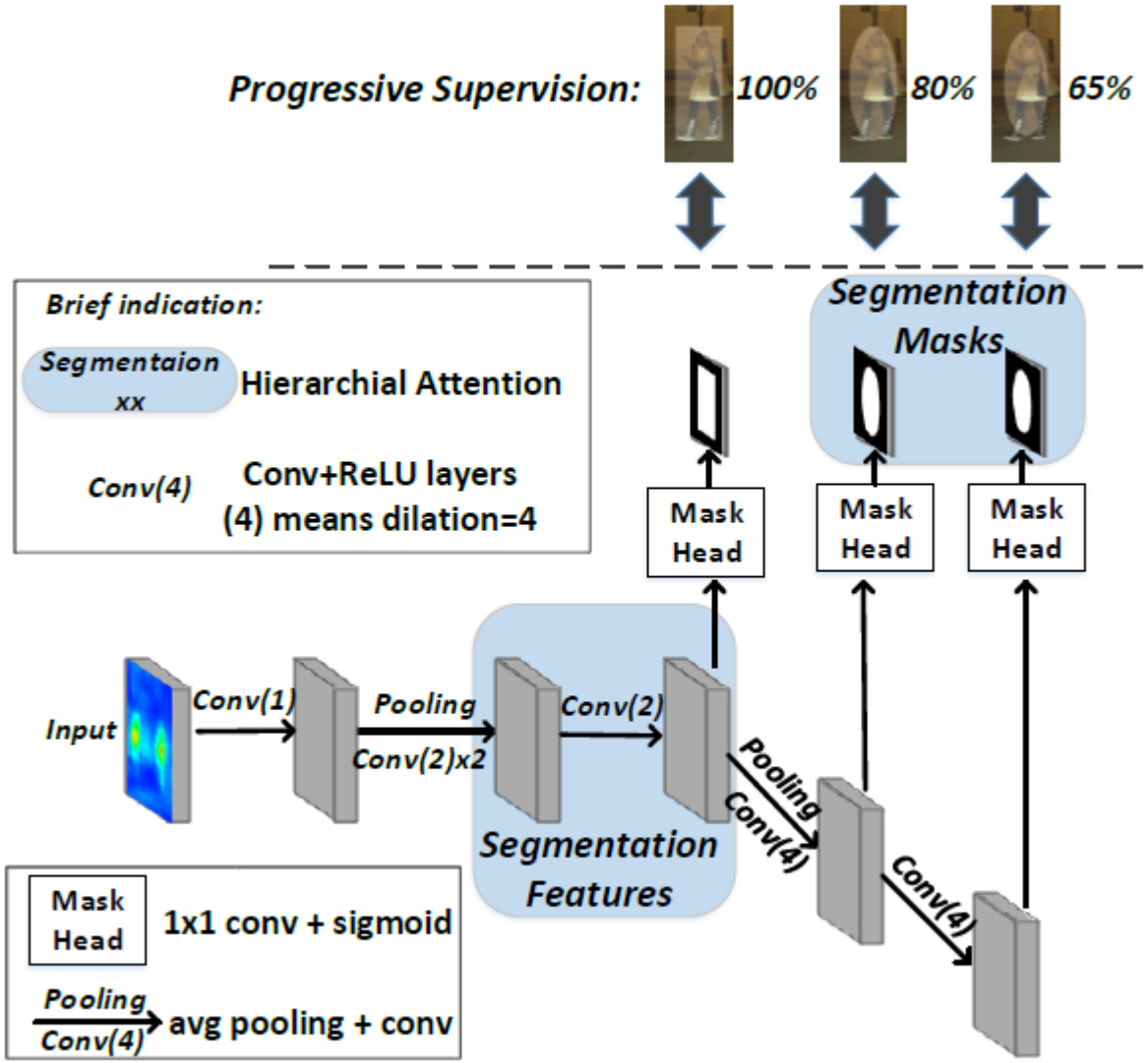
Methods

Feature Attention Module

Low- and high- level features usually carry different levels of semantic information. Applying the same attention map to different level features is sub-optimal.

Thus we use a light-weight segmentation module to produce two attention maps:
- segmentation masks
- segmentation features

Segmentation masks can effectively suppress background noises. And segmentation features can enhance the pedestrian region.



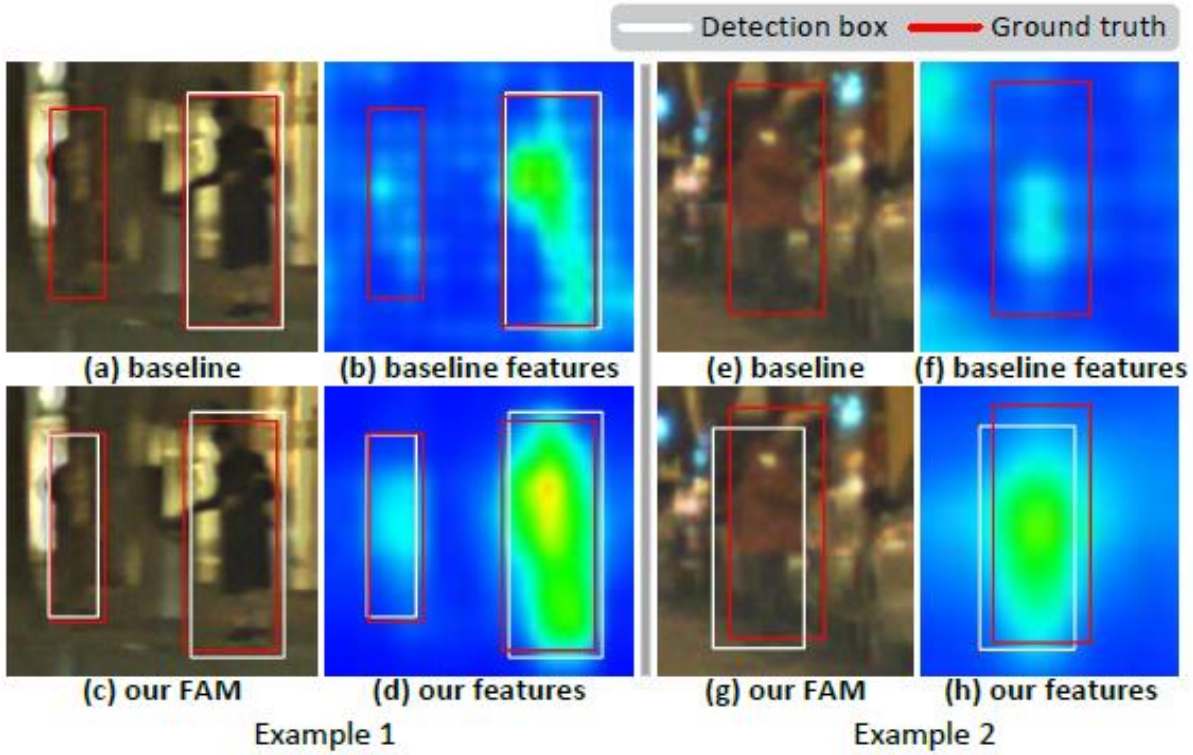
Results

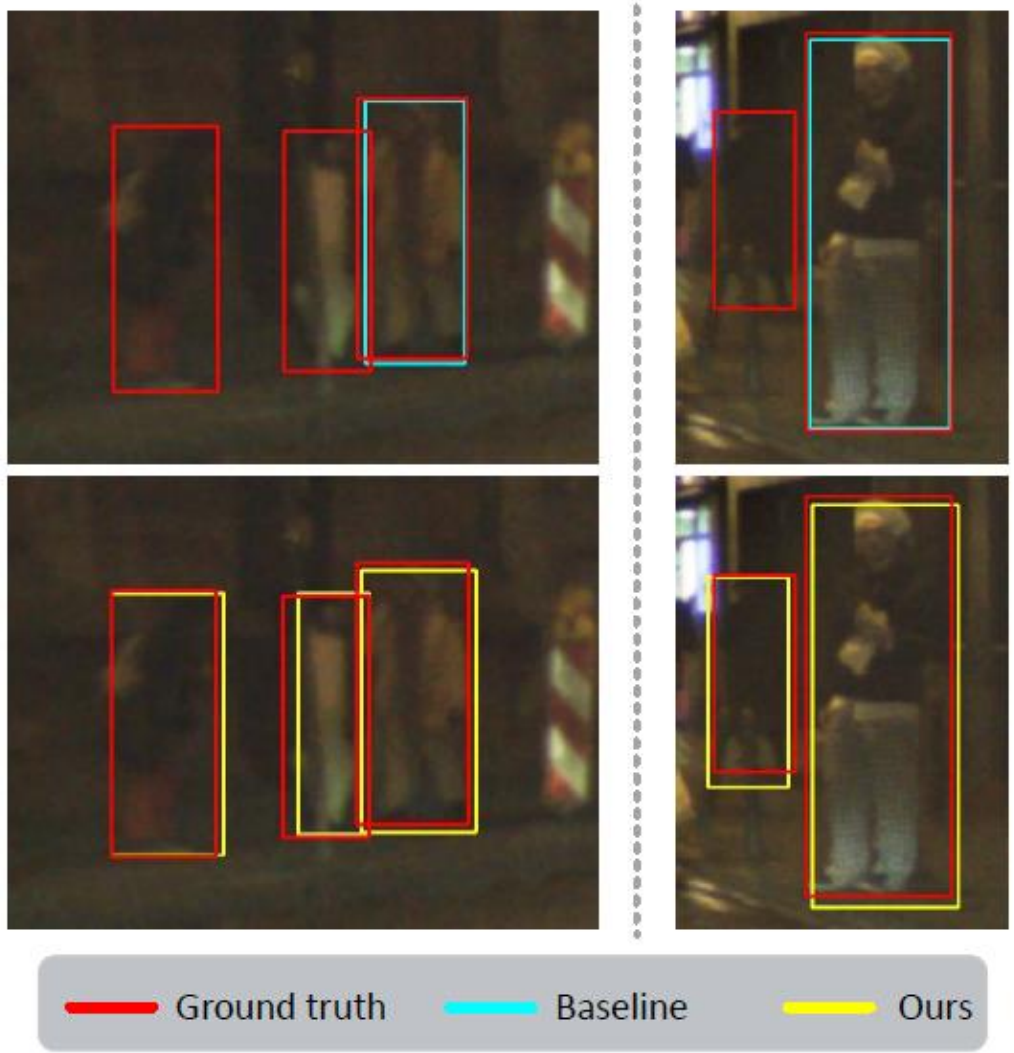
Ablation Study

Baseline	FAM		FTM	EuroCity Persons (Night)				Nightowls			
	Seg features	Seg masks		Rea	Small	Occ	All	Rea	Small	Occ	All
✓				15.36	27.95	69.07	32.53	16.56	26.26	46.53	25.98
	✓			13.84	21.21	63.20	29.26	16.08	27.05	44.21	24.96
		✓		14.29	21.69	64.06	29.59	16.22	24.83	45.98	25.46
	✓	✓		12.71	19.74	60.82	27.76	14.57	23.51	44.47	23.70
	✓	✓	✓	**12.35**	**19.52**	**60.60**	**27.35**	**14.02**	**22.43**	**43.32**	**23.28**
	Overall Improvement			**+3.01**	**+8.43**	**+8.47**	**+5.18**	**+2.54**	**+3.83**	**+3.21**	**+2.7**

Results

Qualitative Results





Motivation

Comparison with SOTA

COMPARISON WITH STATE-OF-THE-ART METHODS ON THE NIGHTOWLS VALIDATION SET. NUMBERS ARE MISS RATES, LOWER IS BETTER.

Method	Rea	Small	Occ	All
A-FRCNN [5]	18.44	30.17	54.41	30.16
CSP [37]	21.44	29.85	59.05	32.88
ALFNet [7]	21.01	33.09	61.06	32.18
FATNet(ours)	**14.02**	**22.43**	**43.32**	**23.28**

COMPARISON WITH STATE-OF-THE-ART METHODS ON THE ECPN VALIDATION SET. NUMBERS ARE MISS RATES, LOWER IS BETTER.

Method	Rea	Small	Occ	All
A-FRCNN [5]	16.77	36.49	70.91	34.79
CSP [37]	17.44	21.85	66.81	33.16
ALFNet [7]	16.66	30.83	66.25	32.65
FATNet(ours)	**12.35**	**19.52**	**60.60**	**27.35**

THANKS