

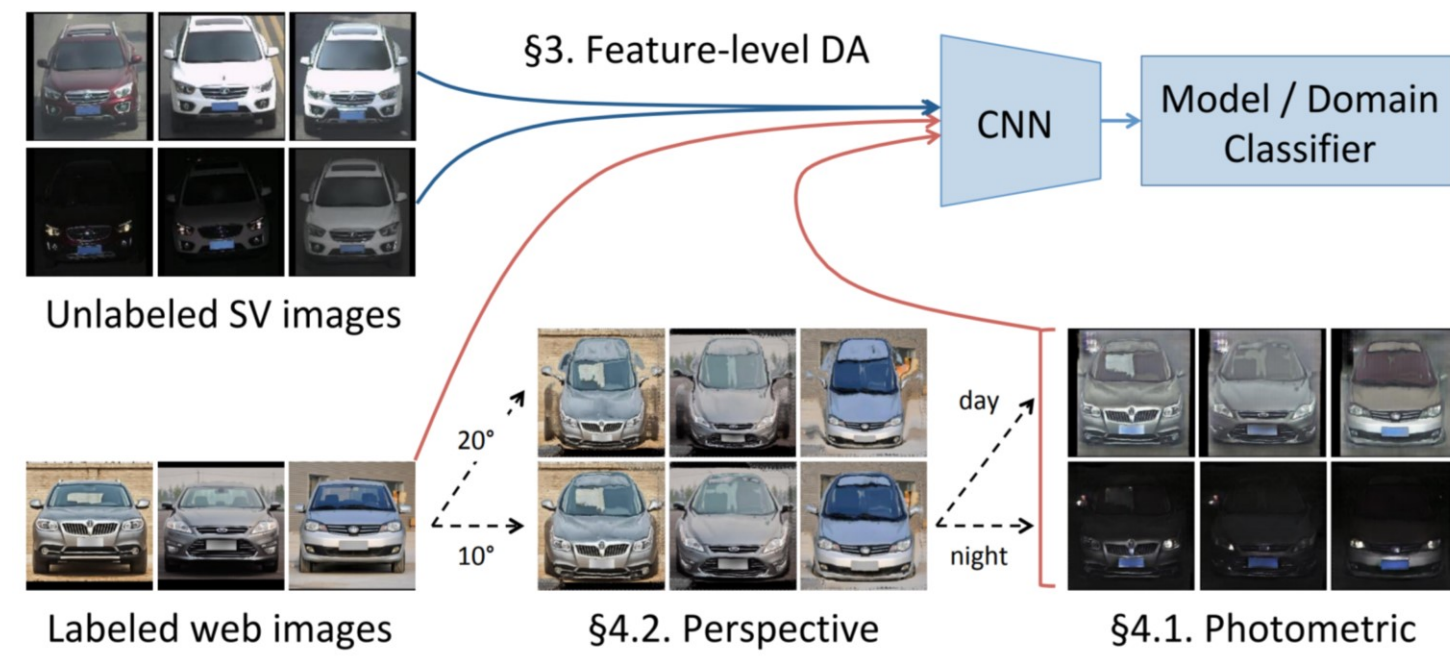


Gotta Adapt 'Em All: Joint Pixel and Feature-Level Domain Adaptation for Recognition in the Wild

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Problem & Contributions



Problem

- Car recognition in surveillance domain with labeled training images from web domain which different in camera view-angle, lighting, weather condition, etc.

Contribution

- Certain challenges are better handled in the image space, while others are better handled in the feature space.
- A novel UDA framework that adapts at multiple levels from pixel to feature, with complementary insights for each type of adaptation.
- Feature-level DA: classification-aware domain adversarial neural network.
- Pixel-level DA, attribute-conditioned CycleGAN & warping-based pose translations.
- A new experimental protocol on car recognition in surveillance domain.

Related Works

Unsupervised Domain Adaptation

- Domain adversarial neural network: *Ganin et al.*
- Maximum mean discrepancy: *Saito et al.*

Perspective Transformation

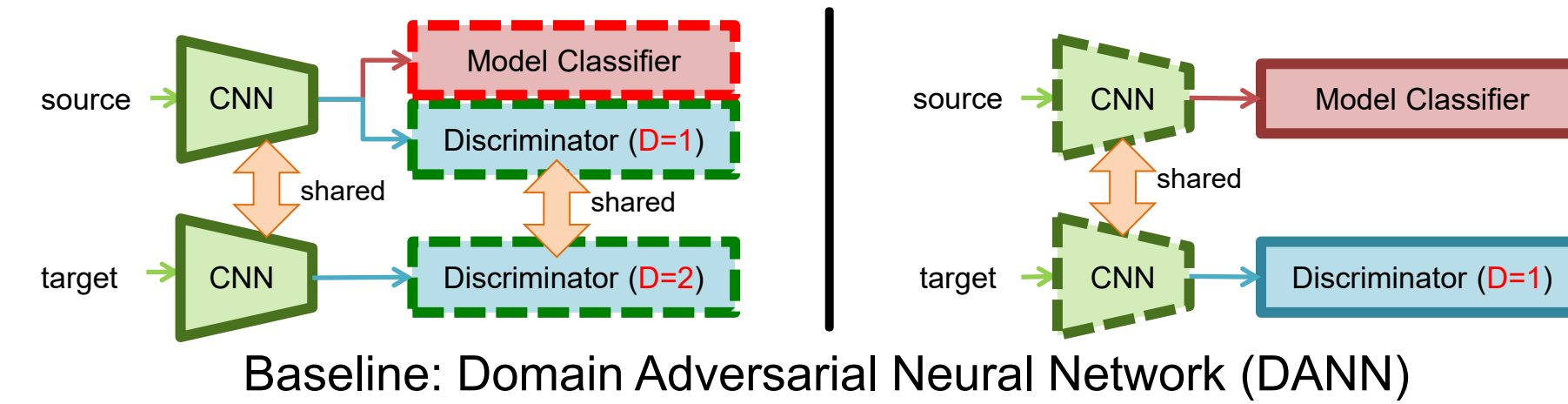
- Direct image generation: *Tatarchenko et al.*
- Warping-based: *Zhou et al.*

Image-to-image Translation

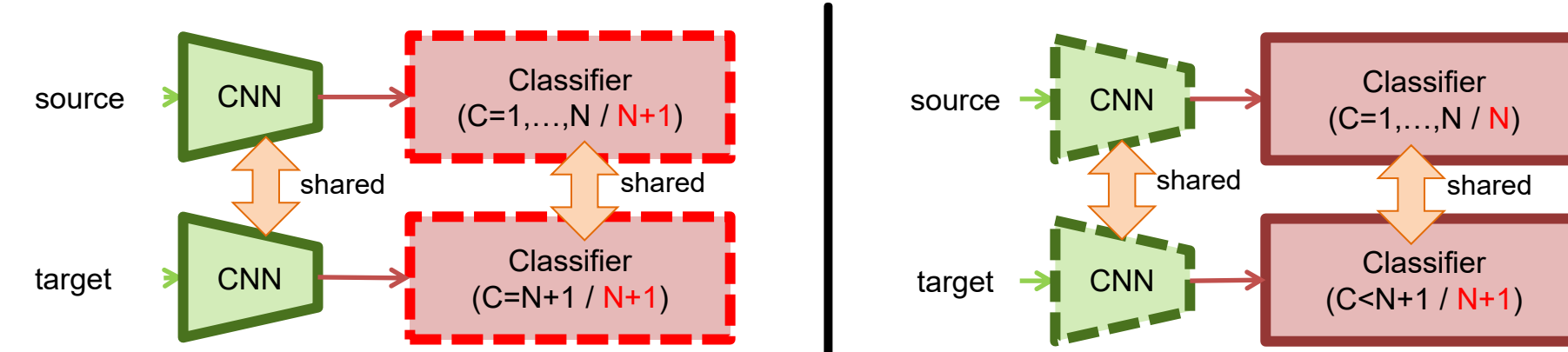
- Image translation with perspective transformation: CycleGAN - *Zhu et al.*

Pixel and Feature-level Domain Adaptation

Domain Adversarial Feature Learning



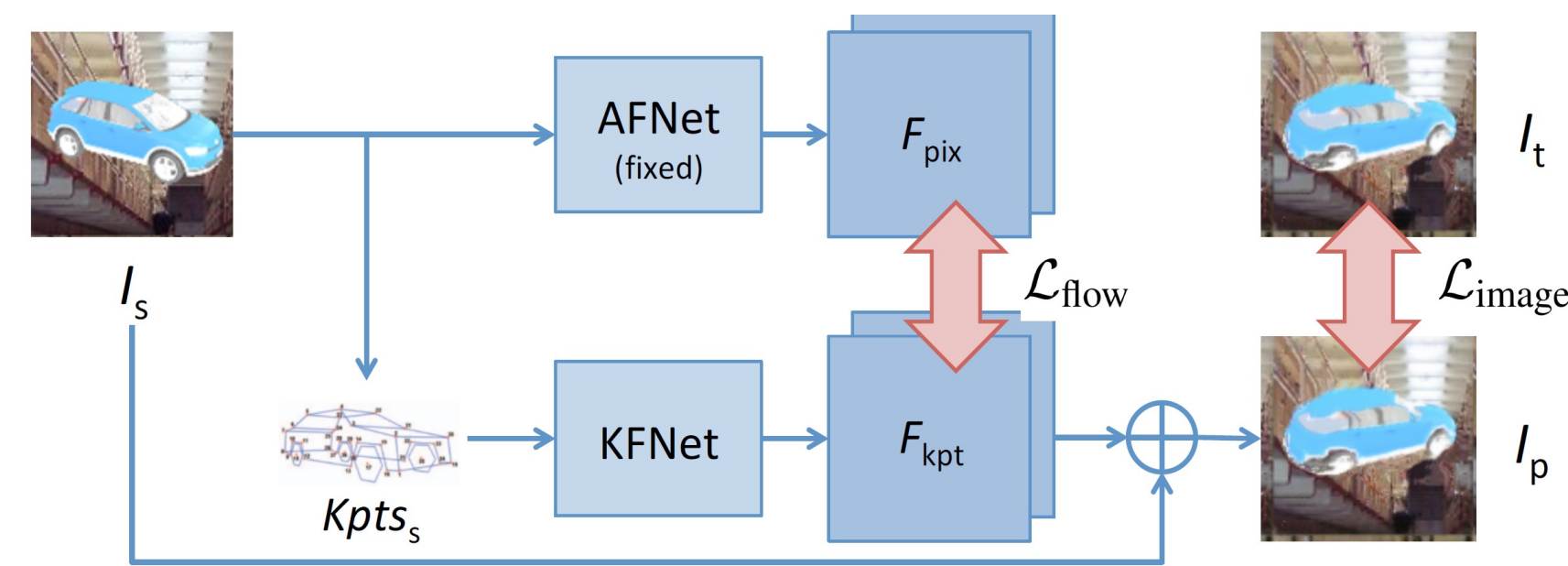
Baseline: Domain Adversarial Neural Network (DANN)



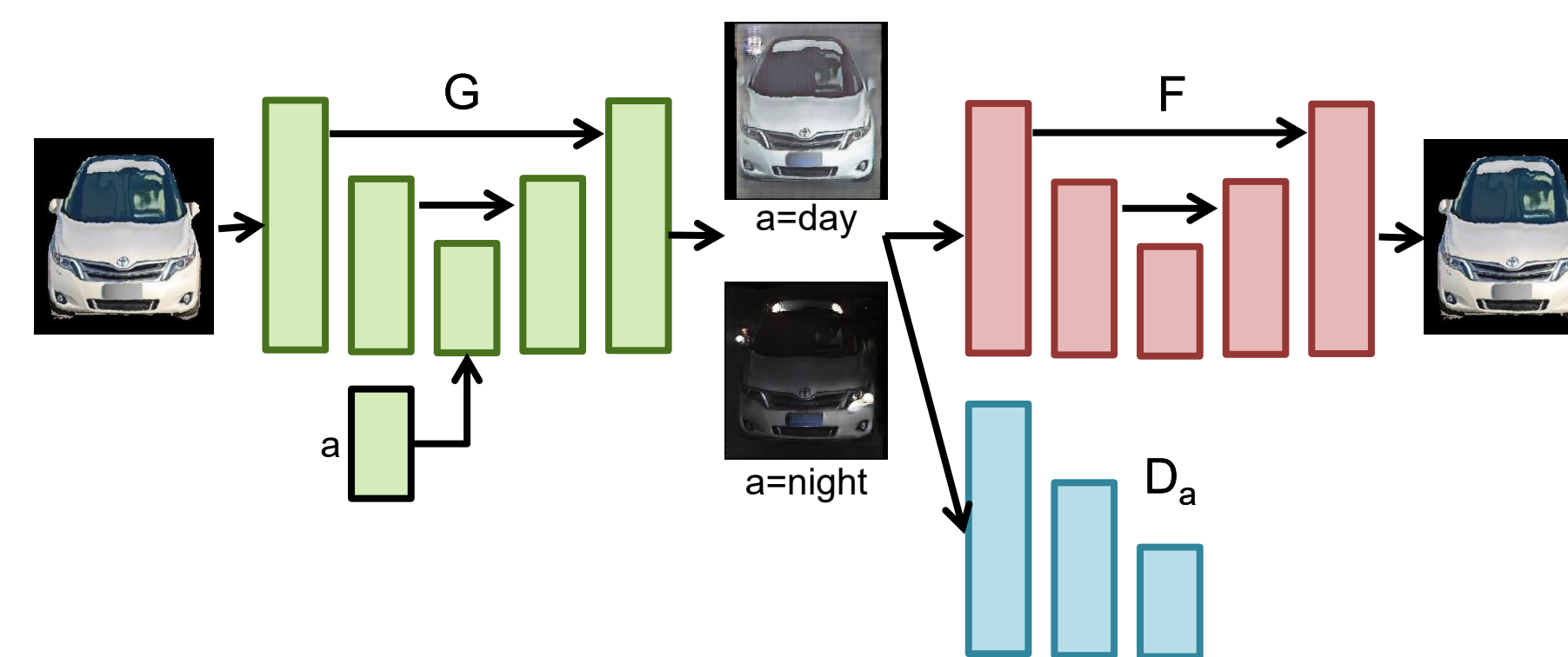
Classification-Aware Adversarial Learning (DANN-CA)

Pixel-level Cross-Domain Image Translation

- Perspective Synthesis by Appearance Flow

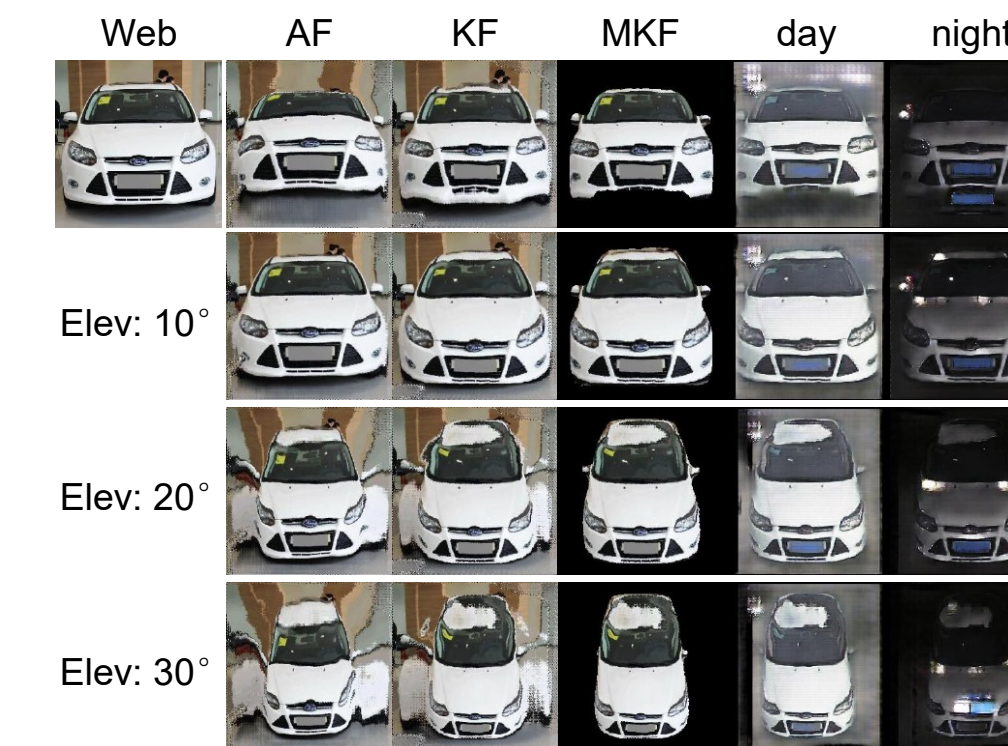


- Photometric Transformation by CycleGAN



Experimental Results

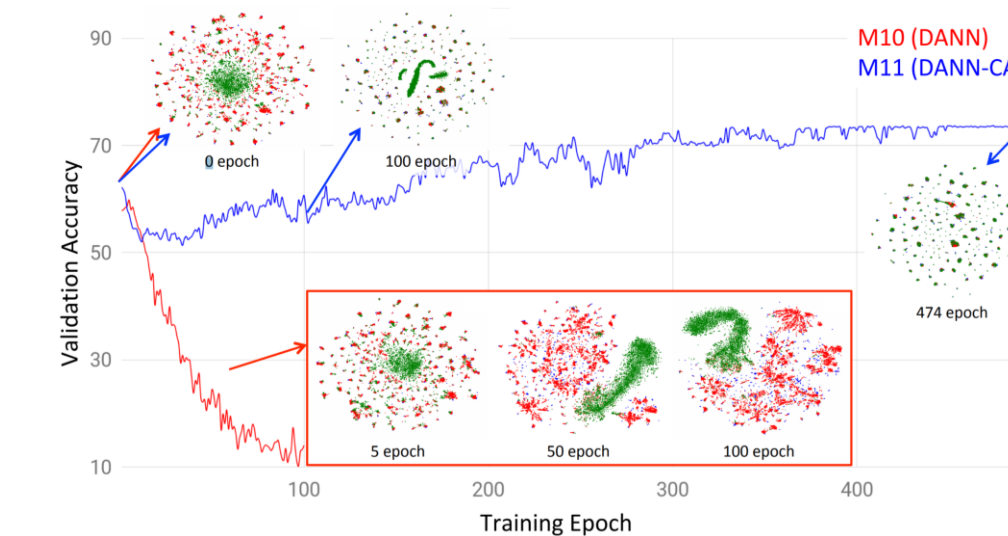
Analysis on Pixel-level Adaptation



Perspective Transf.	SV	Day	Night
Baseline (web only)	54.98	72.67	19.87
Supervised (web+SV)	98.63	98.92	98.05
Appearance Flow (AF)	59.73	75.78	27.87
Keypoint-based AF (KF)	61.55	77.98	28.92
KF with mask (MKF)	64.30	78.62	35.87

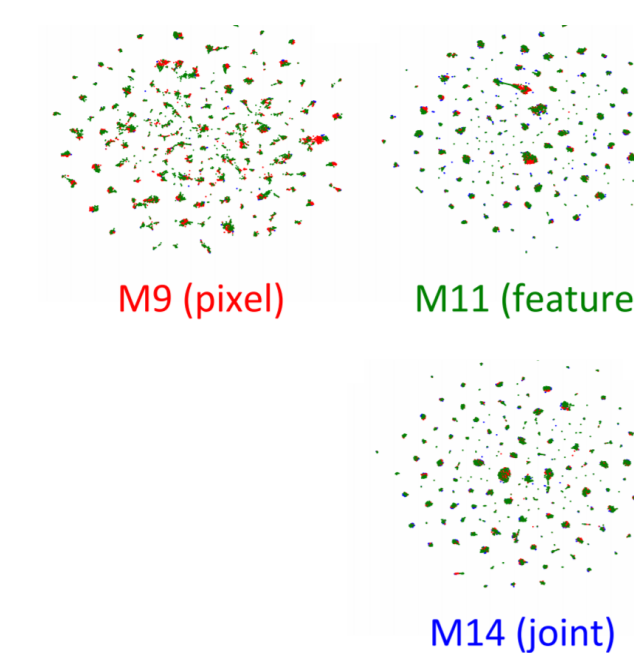
Photometric Transf.	SV	Day	Night
CycleGAN	64.32	77.01	39.12
AC-CGAN	67.30	78.20	45.66
MKF + CycleGAN	71.21	81.54	50.68
MKF + AC-CGAN	79.71	84.10	70.99

Analysis on Feature-level Adaptation

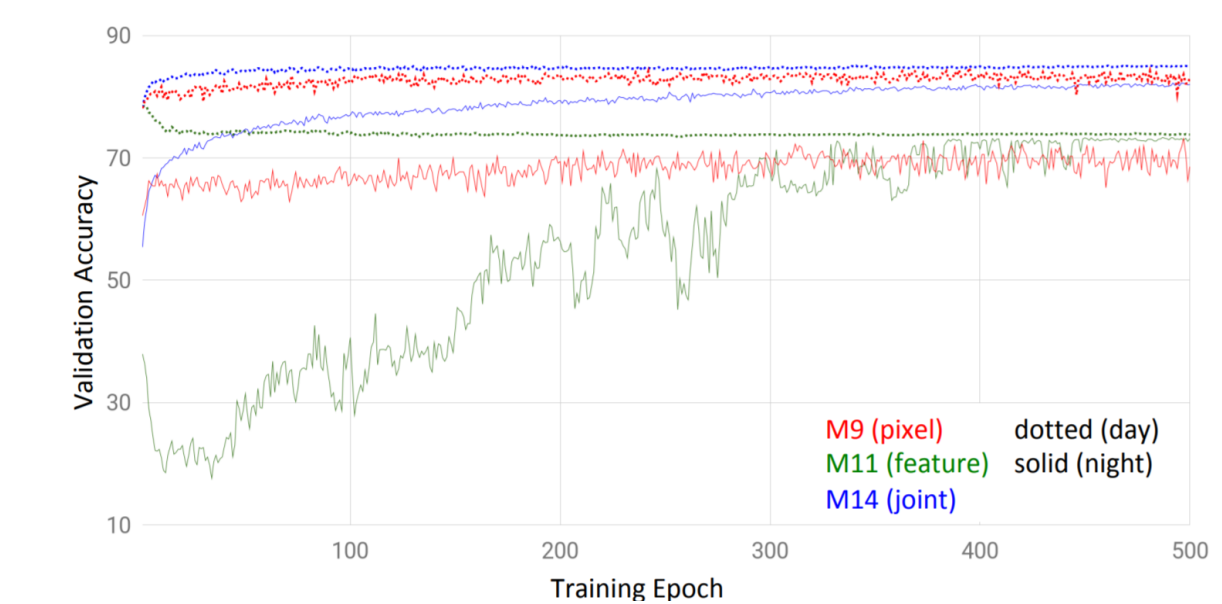


Pixel	Feature	SV	Day	Night
Baseline (web only)		54.98	72.67	19.87
Supervised (web+SV)		98.63	98.92	98.05
-	DANN	60.40	75.56	30.31
-	DANN-CA	75.83	76.73	74.05
MKF	DANN-CA	80.40	82.50	76.22
AC-CGAN	DANN-CA	80.24	82.15	76.44
Both	DANN-CA	84.20	85.77	81.10

Analysis on Joint Pixel and Feature (PnF)



F: Improve Domain Alignment



P: Improve Training Stability

Conclusions

- We propose a joint UDA framework by leveraging complementary tools that are better-suited for each type of adaptation challenge.
- Importance & complementarity of each component are demonstrated through experiments on an application of car recognition in surveillance domain.