ICCV23
PARIS

Single Image Deblurring with Row-dependent Blur Magnitude

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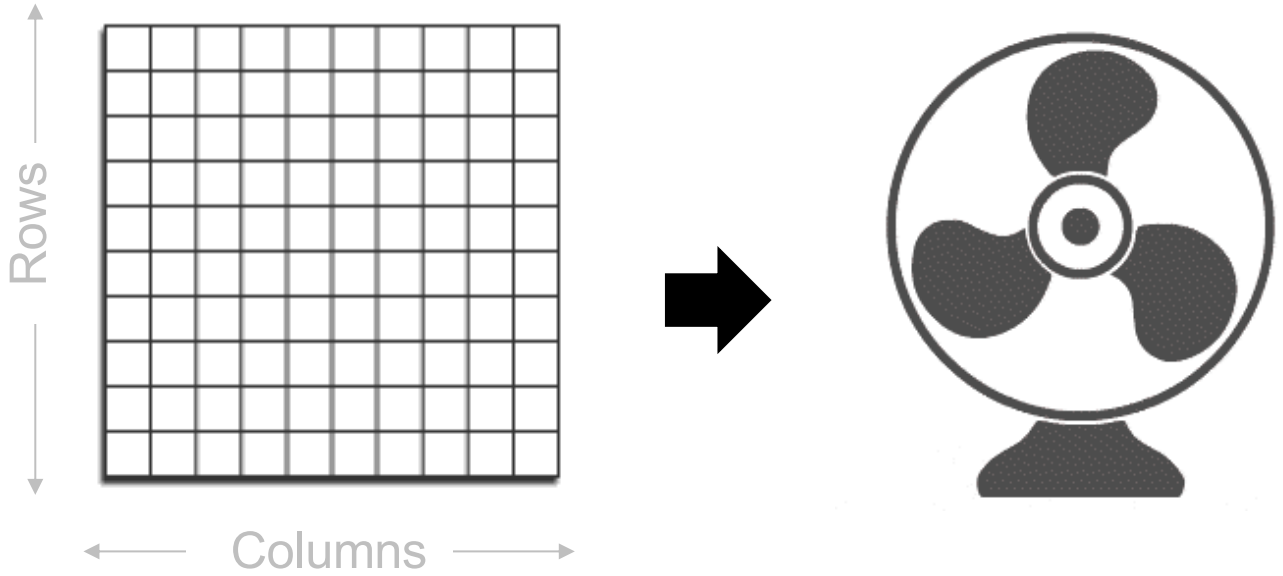
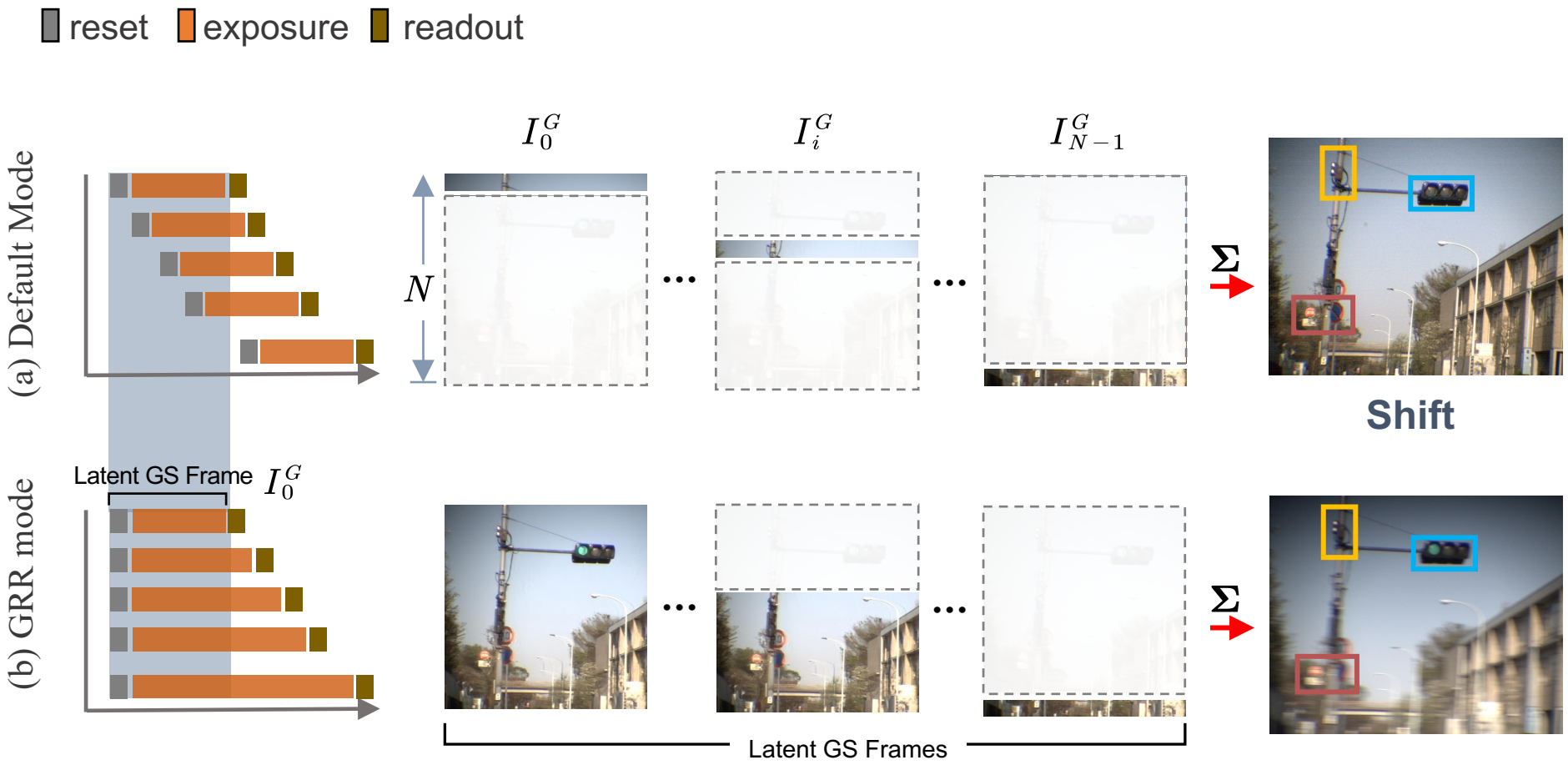
Rolling Shutter

- Widely used in our imaging devices
- Row-by-Row exposure manner cause motion degradations



Motion Degradations of Two Rolling Shutter Modes



Row-dependent Blur Magnitude

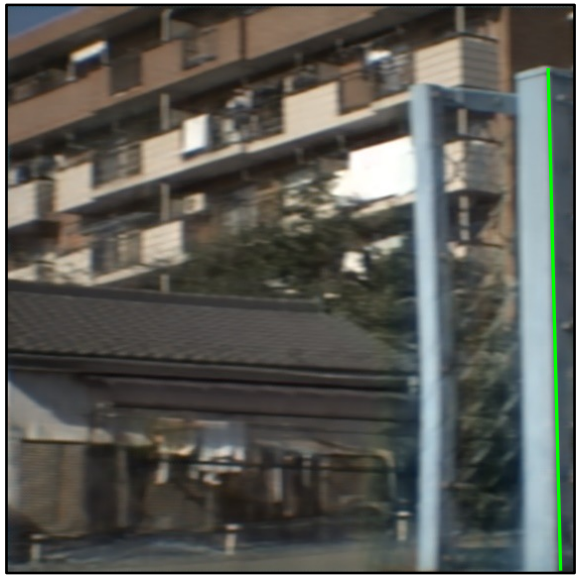
Wang et al, Neural Global Shutter, CVPR 2022

Removing Blur is Easier than Correcting Pixel Shift

Default RS mode Input

Default RS + DSUR

GRR mode Input

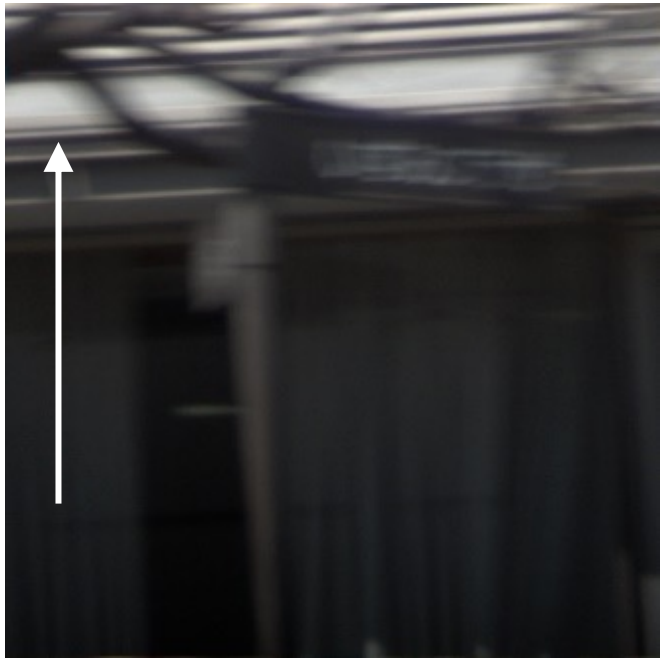


GRR + NGS

Liu et al, DSUR, CVPR'20

Wang et al, Neural Global Shutter, CVPR 2022

However, Unsatisfactory Performance for Single-Image Input



Input

NGS_1
Single Image

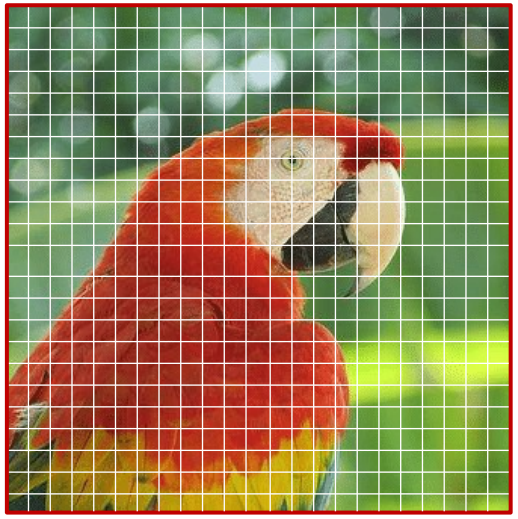
NGS_8
Multiple Images

Wang et al, Neural Global Shutter, CVPR 2022

Our Idea

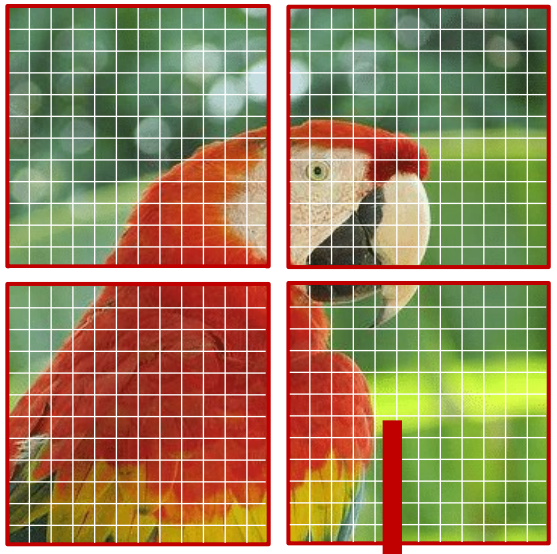
- Introducing (swin) transformer for better ***spatial-varying*** correction

ViT, ICLR'20



$\mathcal{O}(N^2)$

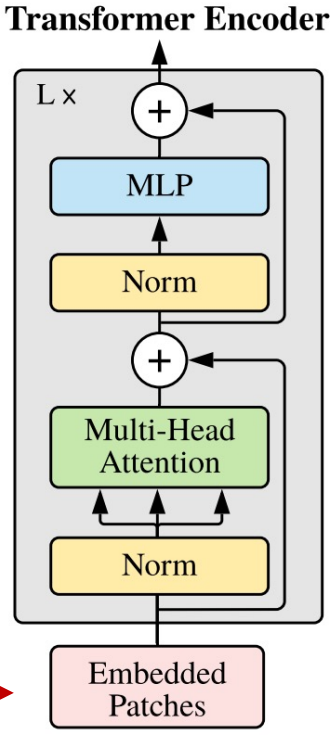
Swin Transformer, ICCV'21



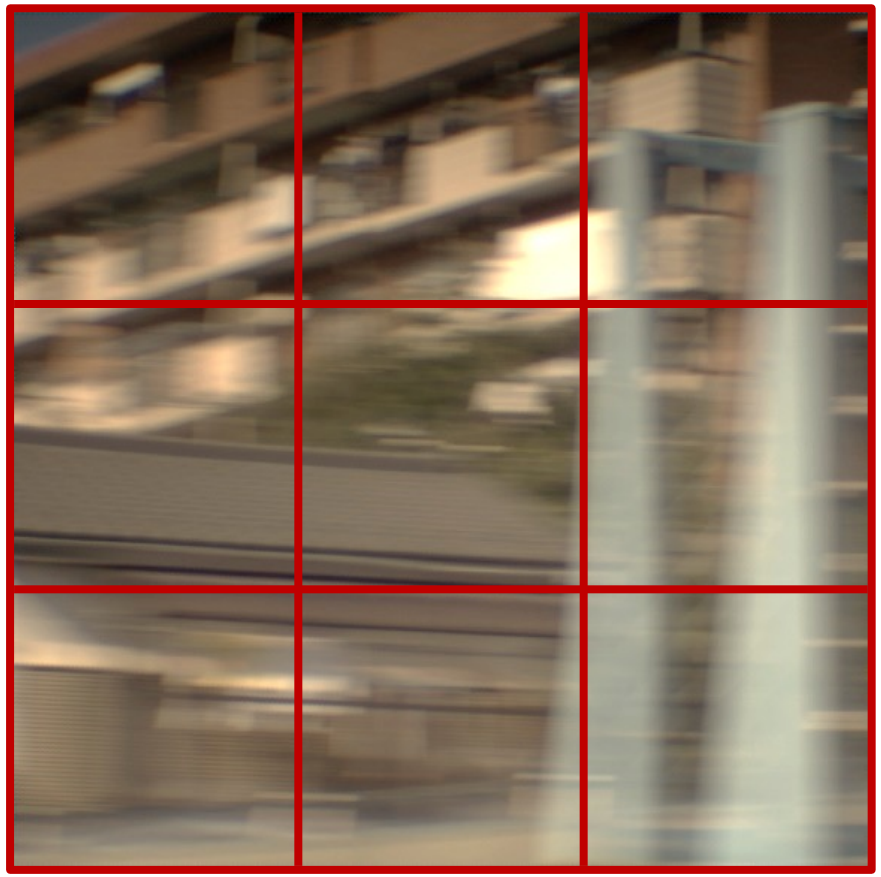
$\mathcal{O}(N)$

A patch

A local window to perform self-attention

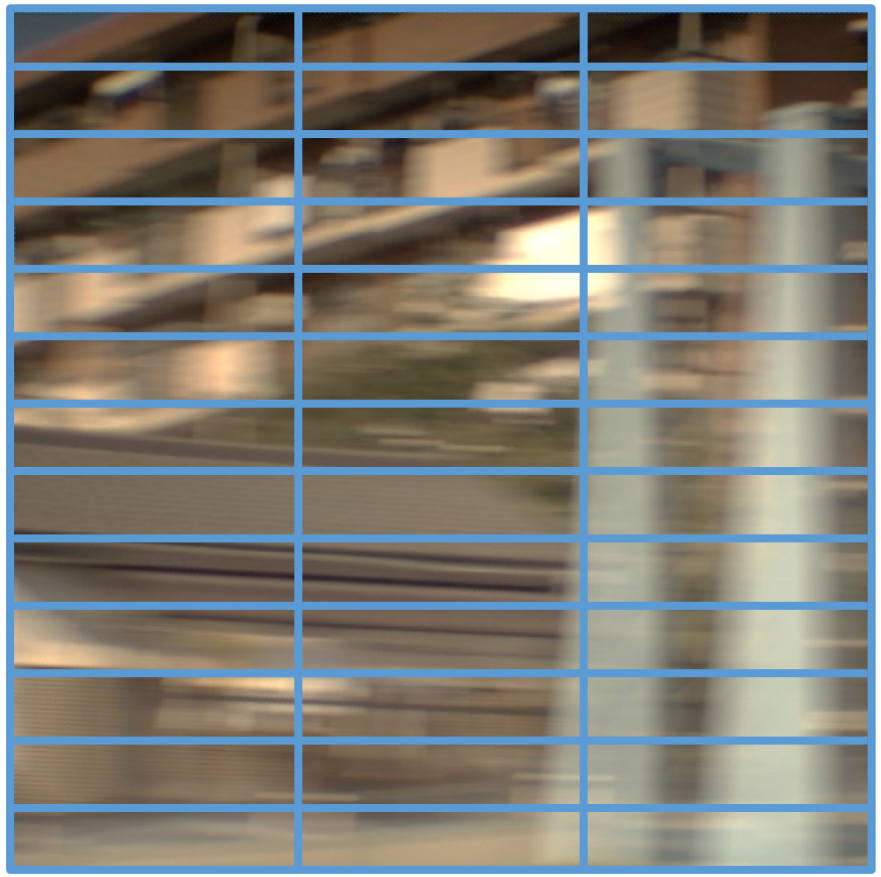


Challenge I: Row-wise Blur



Squared Window Partition

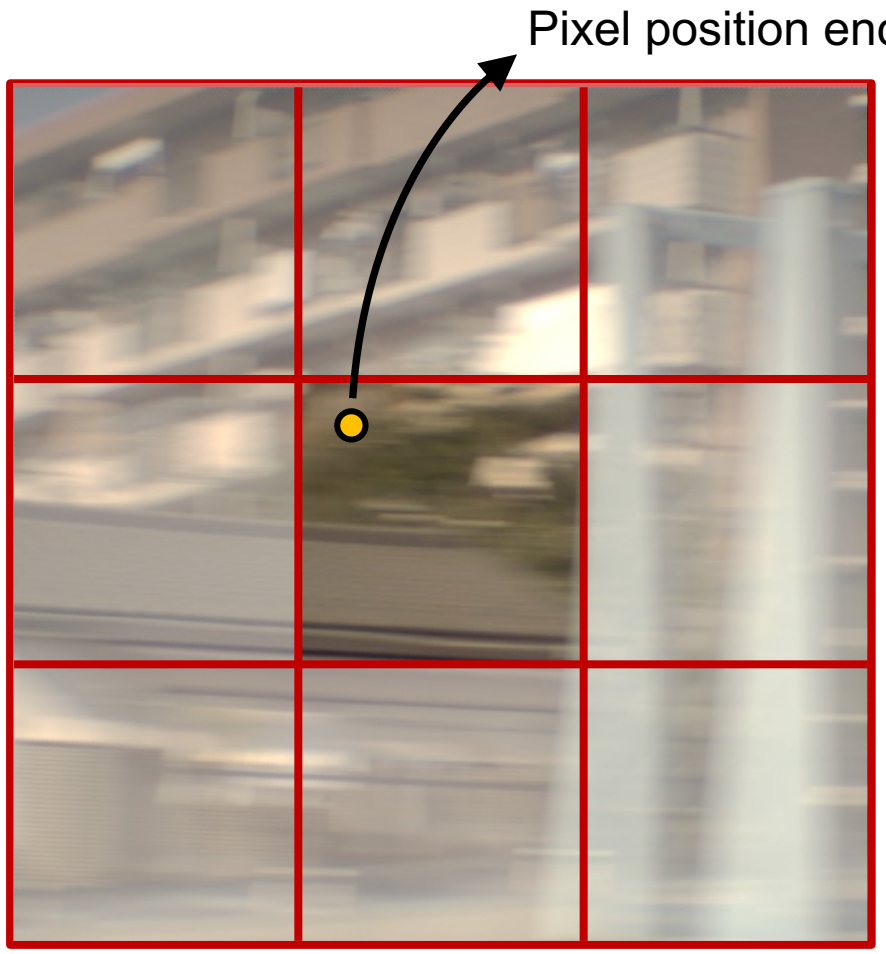
SwinTransformer, ICCV'21



Horizonal Window Partition for Row-wise Blur

Ours

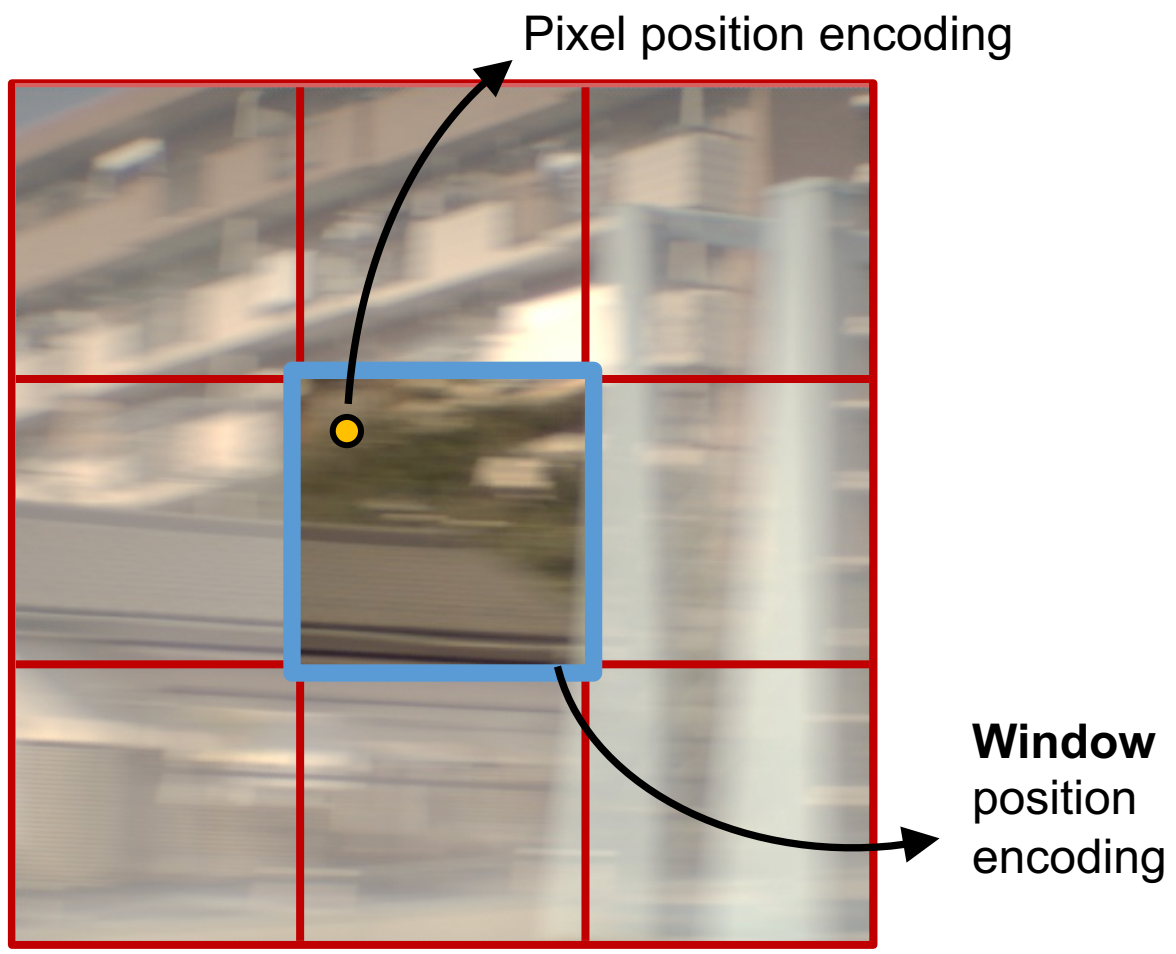
Challenge II: Missing Absolute Position



Only Pixel Position Encoding

SwinTransformer, ICCV'21

spatial context corrupted by window partition

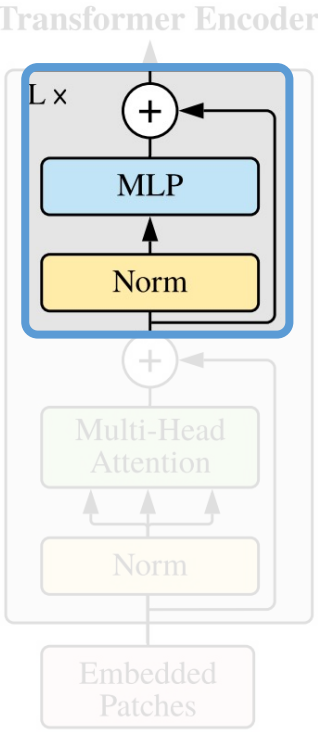


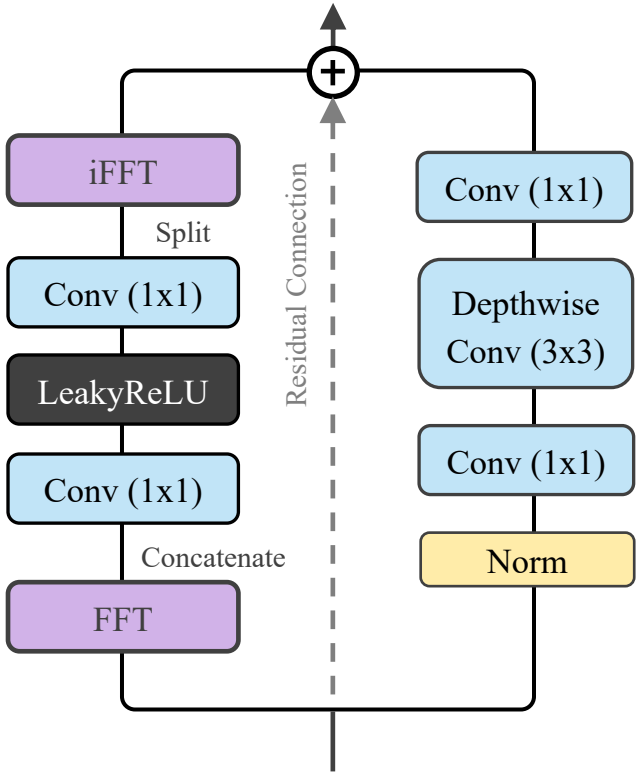
Hierarchical Position Encoding

Ours

Challenge III: Reduced Receptive Field

Modification in spectral space change global information
Enhance long-range dependency modeling

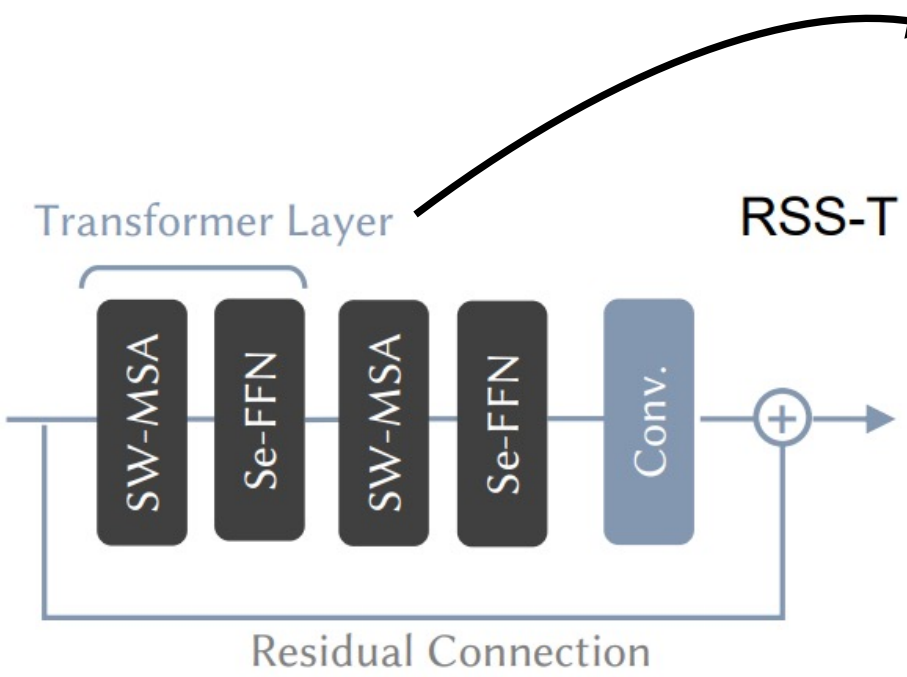


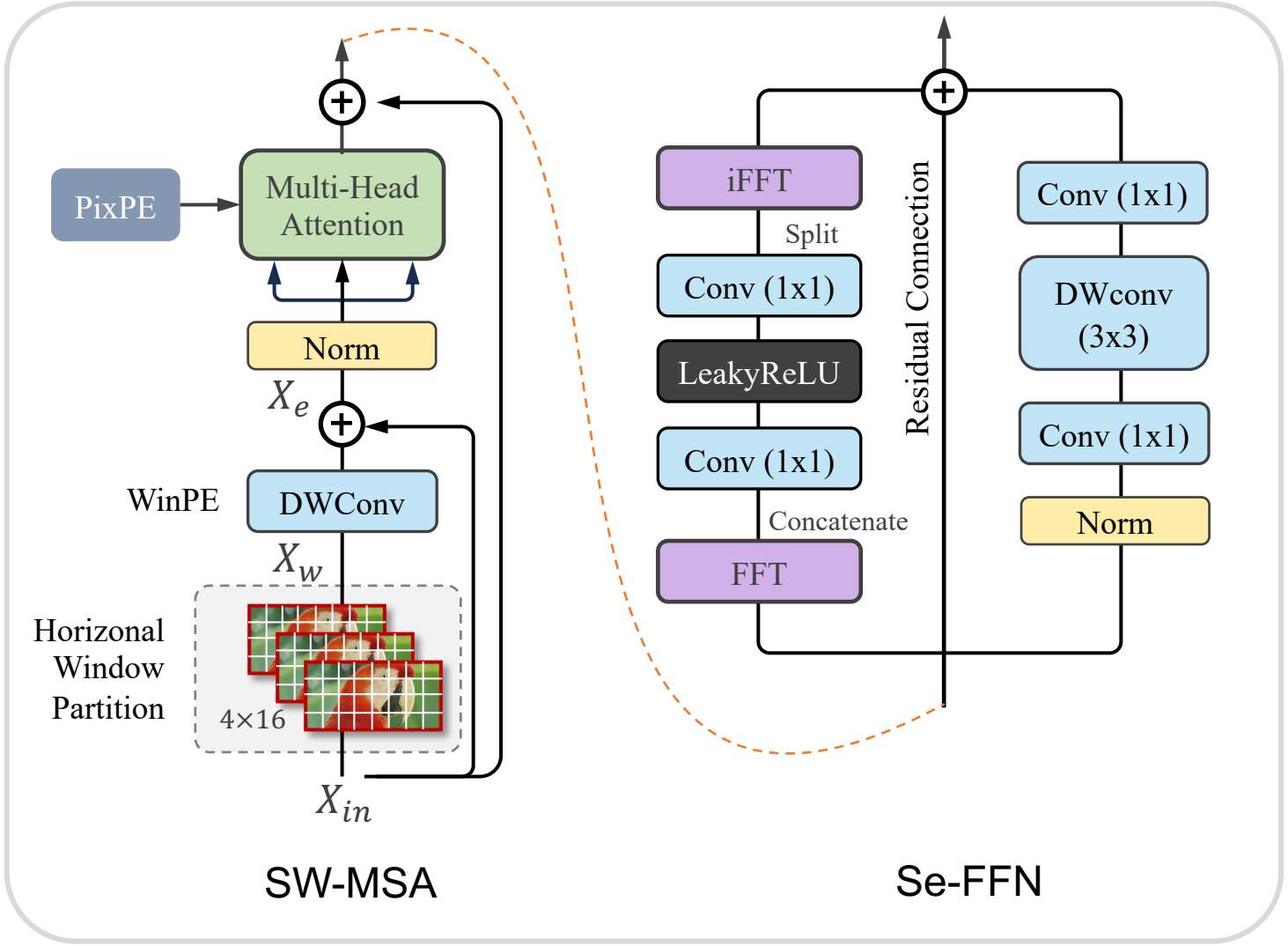


Feed-forward Network
SwinTransformer, ViT, …

Spectral-enhanced Feed-forward Network
Ours

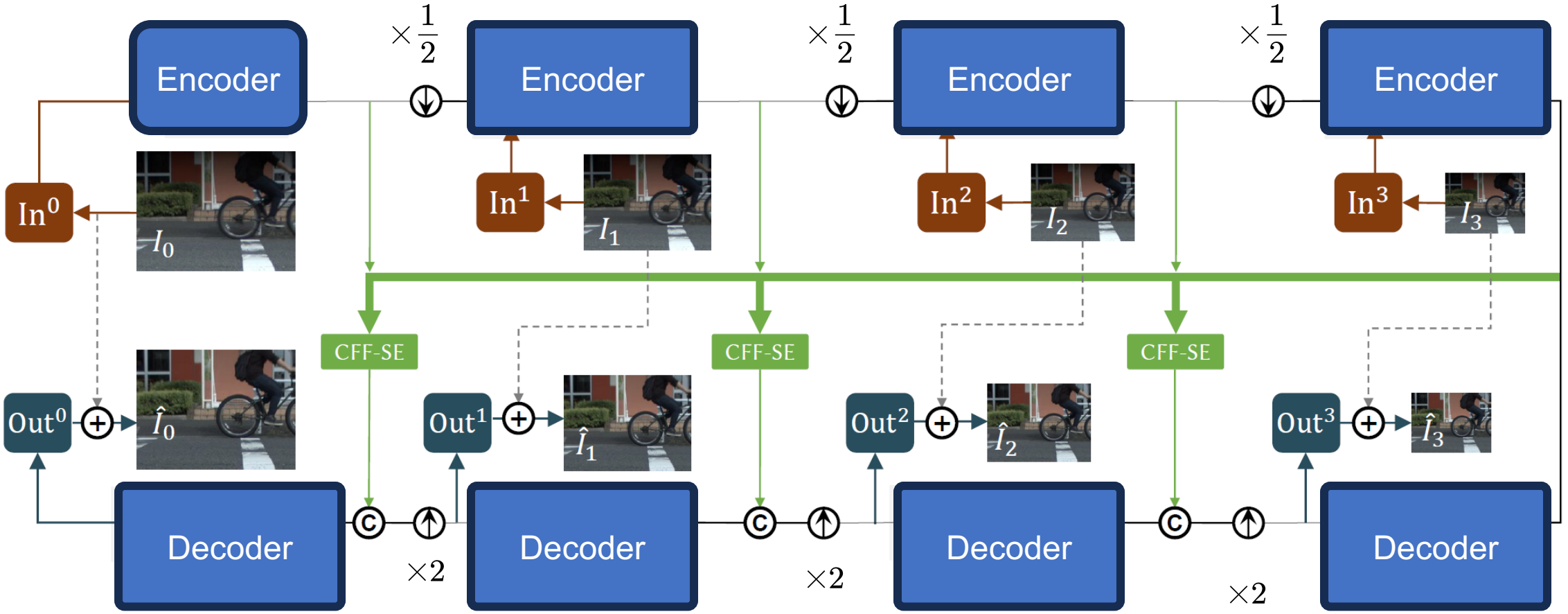
Put Them Together:
Tailored Transformer Block





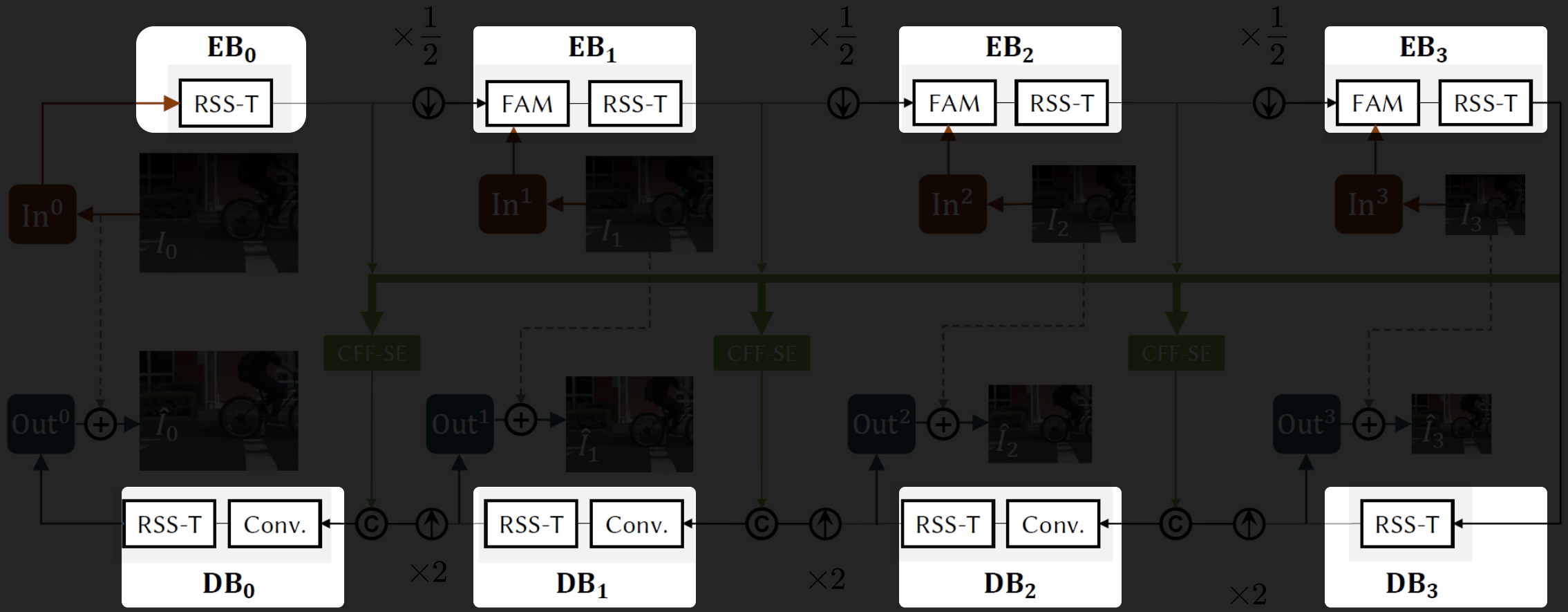
Our Full Method

Basic Framework: Cross-Scale Information Fusion



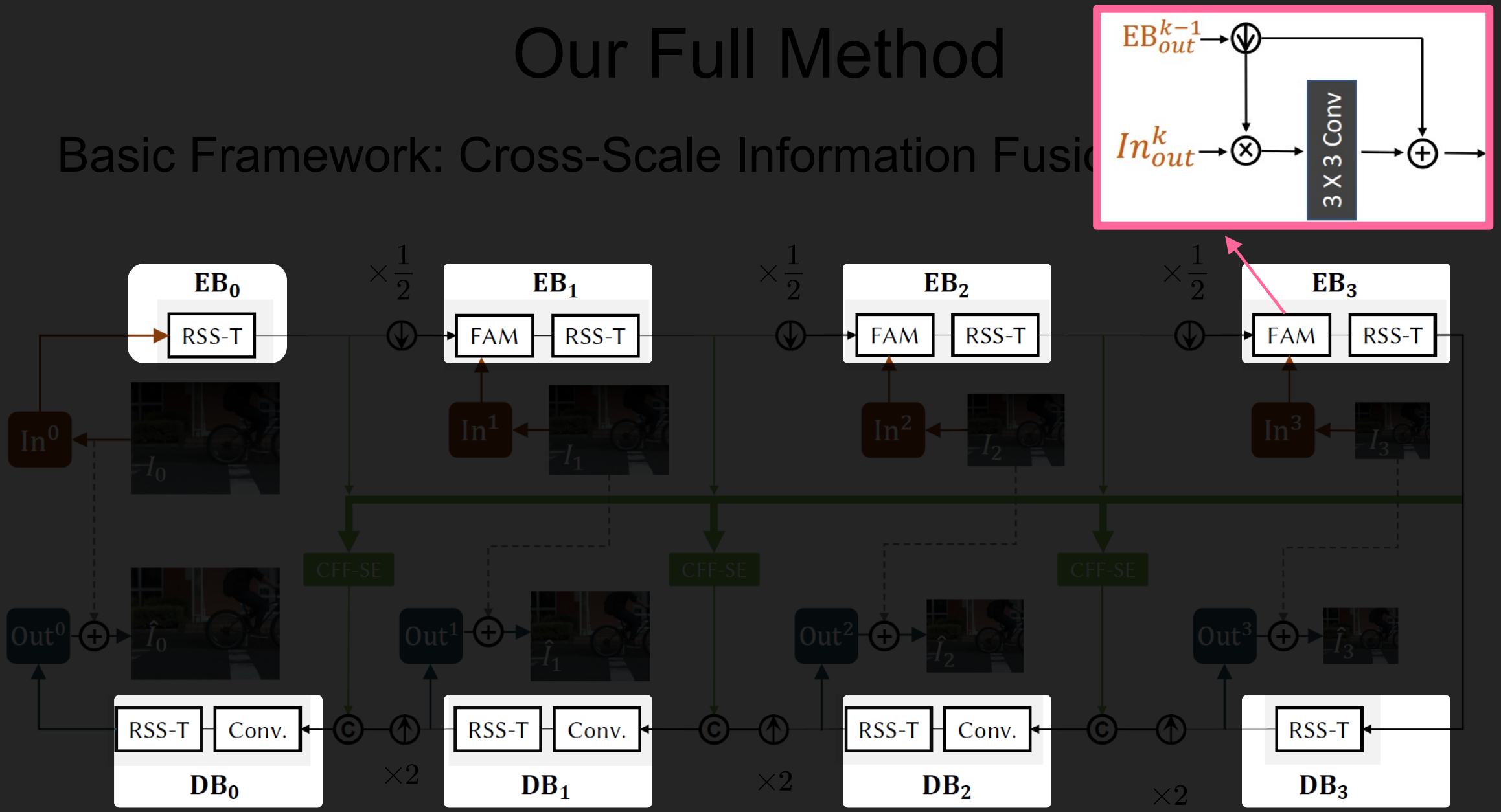
Our Full Method

Basic Framework: Cross-Scale Information Fusion



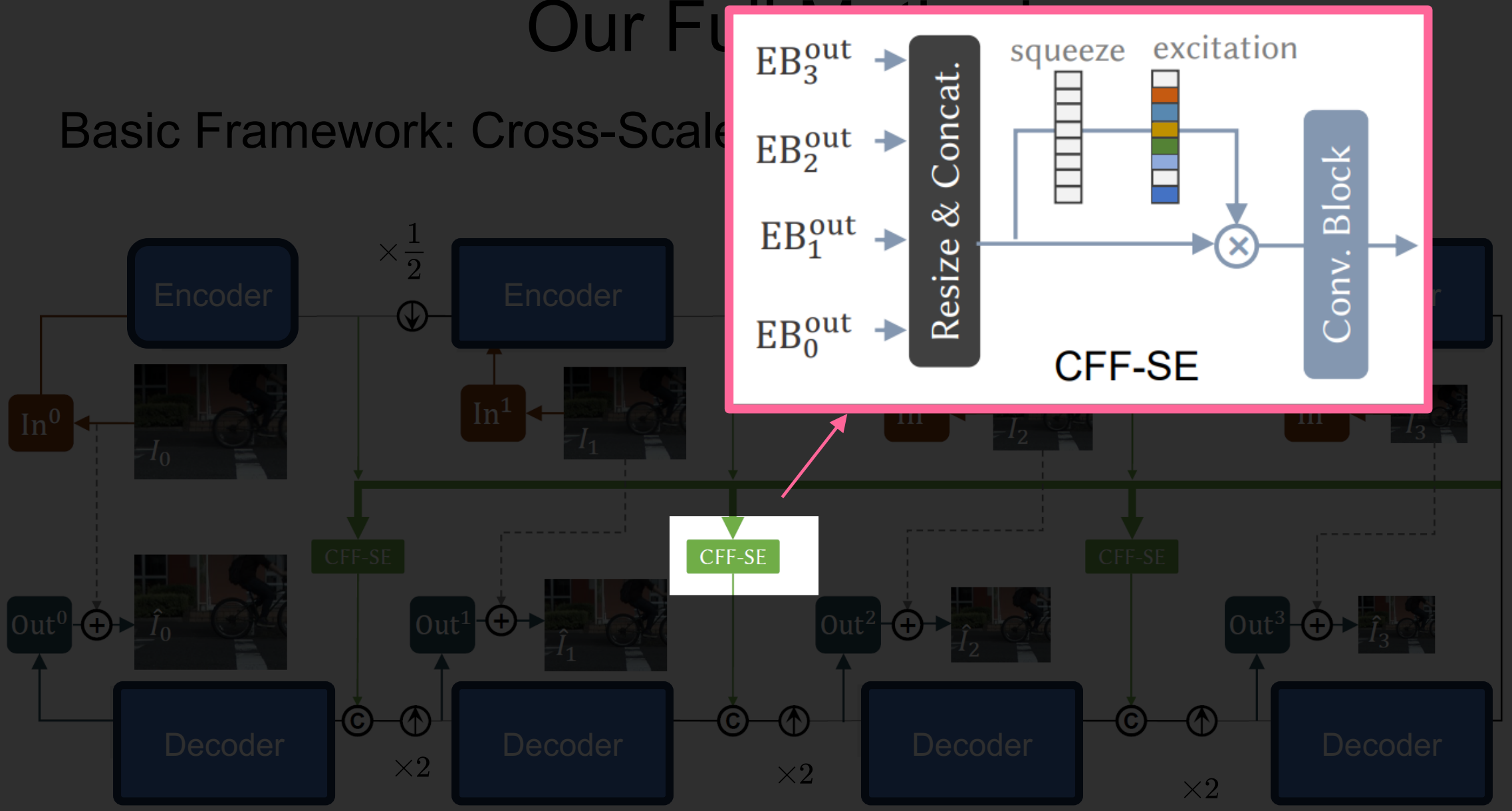
Our Full Method

Basic Framework: Cross-Scale Information Fusio



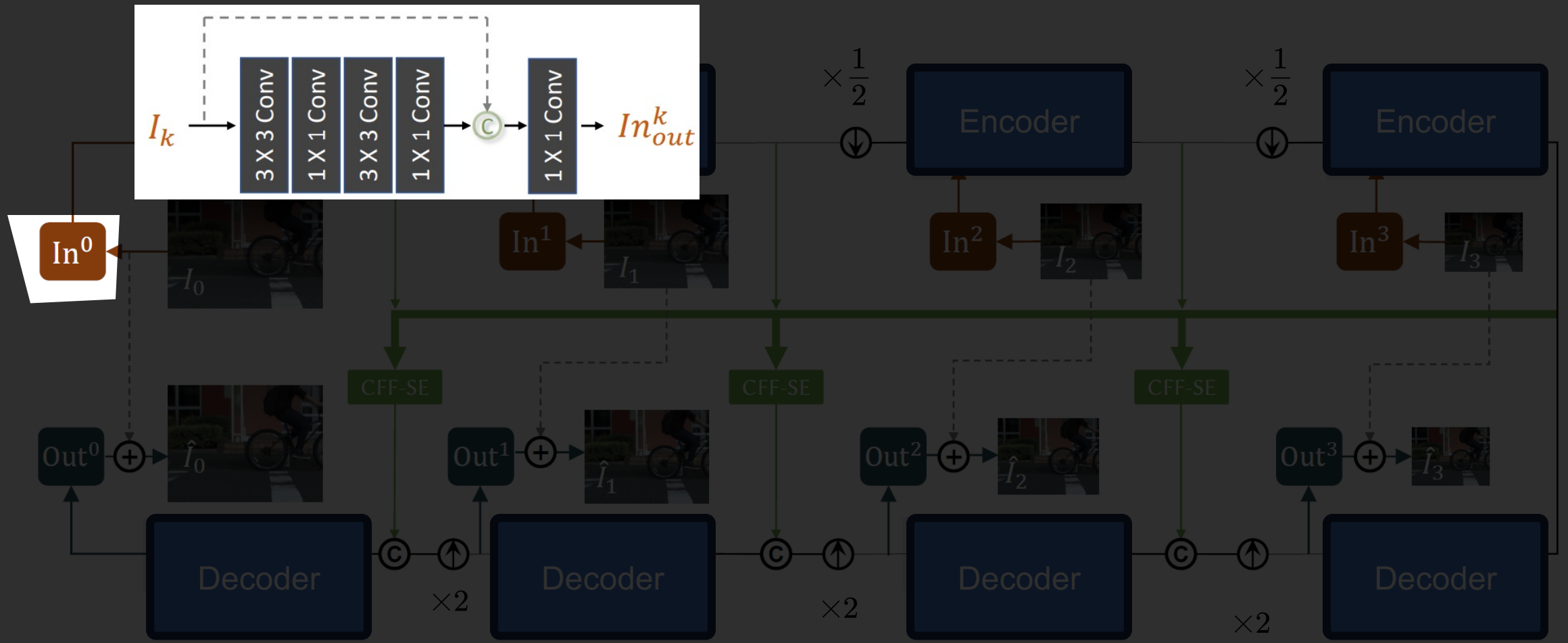
Our Fu

Basic Framework: Cross-Scale



Our Full Method

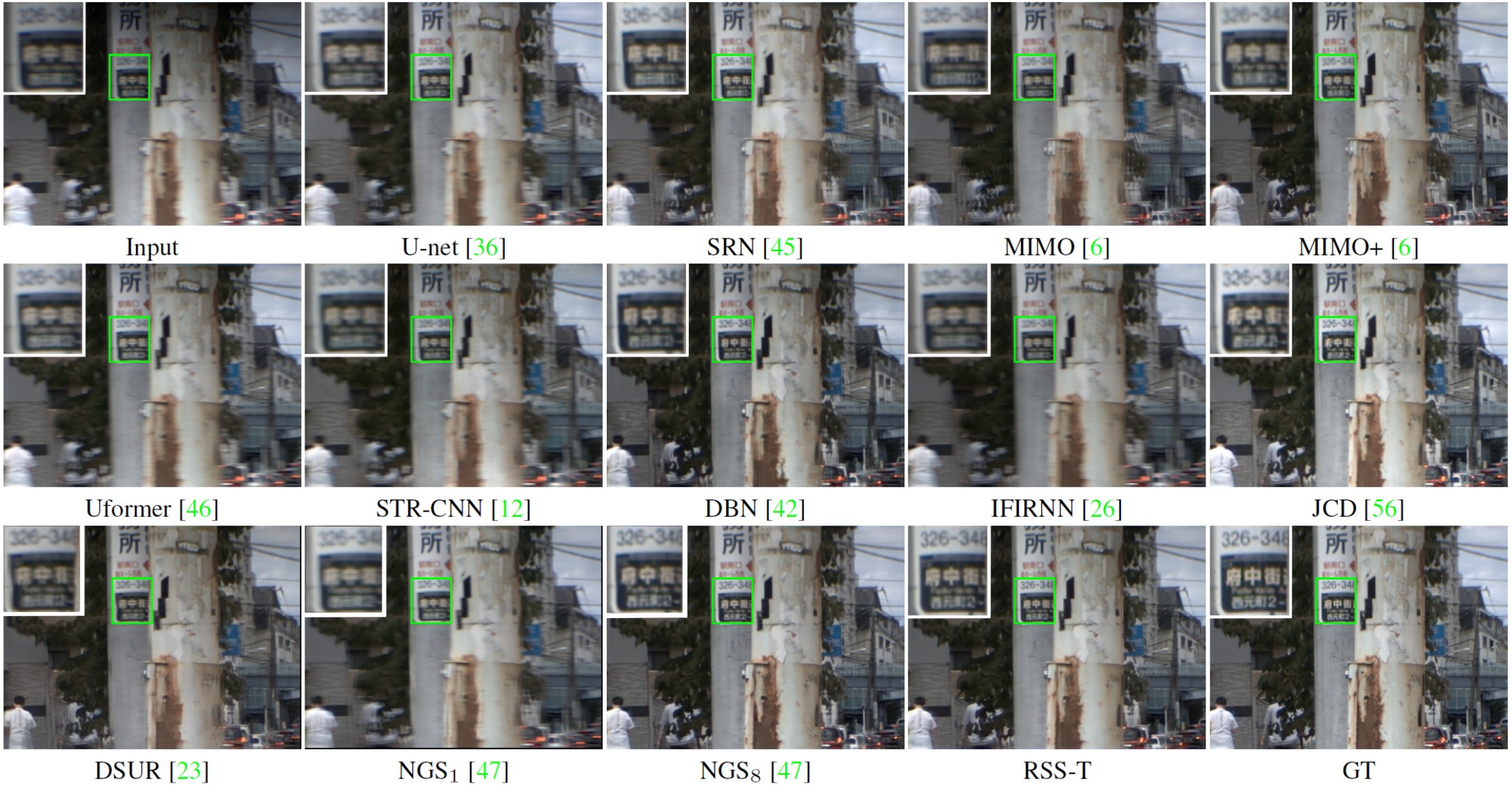
Basic Framework: Cross-Scale Information Fusion



Comparison on GRR Deblurring

Method	Mode / Input	Effectiveness				Efficiency		
		Top	Middle	Bottom	Full	Time (s)	Params (M)	FLOPs (T)
Input	–	15.12 / 0.67	21.83 / 0.78	20.08 / 0.76	17.61 / 0.74	–	–	–
U-net [36]	GS / Single	26.34 / 0.92	23.83 / 0.85	22.74 / 0.83	23.57 / 0.87	0.0062	9.50	0.072
SRN [45]		25.11 / 0.78	24.34 / 0.72	24.08 / 0.72	23.84 / 0.74	0.0140	10.25	0.509
MIMO [6]		27.16 /0.90	24.55 / 0.82	24.04 / 0.79	24.48 / 0.84	0.0123	6.81	0.315
MIMO+ [6]		28.46 / 0.91	26.31 / 0.85	25.78 / 0.83	26.12 / 0.86	0.0249	16.11	0.724
Uformer [46]		25.04 / 0.93	23.70 / 0.86	22.20 / 0.84	22.92 / 0.87	0.2147	20.63	0.257
STR-CNN [12]	GS / Multi	20.88 / 0.83	23.28 / 0.77	22.60 / 0.75	21.39 / 0.78	0.0194	0.93	0.367
DBN [42]		25.11 / 0.90	25.90 / 0.85	25.87 / 0.82	24.97 / 0.85	0.0229	15.31	1.046
IFIRNN [26]		27.19 / 0.90	23.85 / 0.78	23.21 / 0.77	23.97 / 0.81	0.0135	1.64	0.581
JCD [56]	RS / Multi	27.64 / 0.90	23.65 / 0.80	19.76 / 0.77	22.31 / 0.82	0.2625	8.67	0.326
DSUR [23]		24.81 / 0.87	23.87 / 0.78	23.39 / 0.76	23.35 / 0.80	0.3018	3.90	0.225
NGS_8 [47]	GRR / Multi	31.71 / 0.93	30.54 / 0.90	29.12 / 0.87	30.03 / 0.90	0.0233	8.67	1.266
NGS_1 [47]	GRR / Single	26.61 / 0.89	23.53 / 0.78	22.83 / 0.76	23.67 / 0.81	0.0187	4.56	0.083
RSS-T		30.90 / 0.93	28.60 / 0.88	27.86 / 0.86	28.64 / 0.90	0.1479	11.34	0.176

Comparison on GRR Deblurring

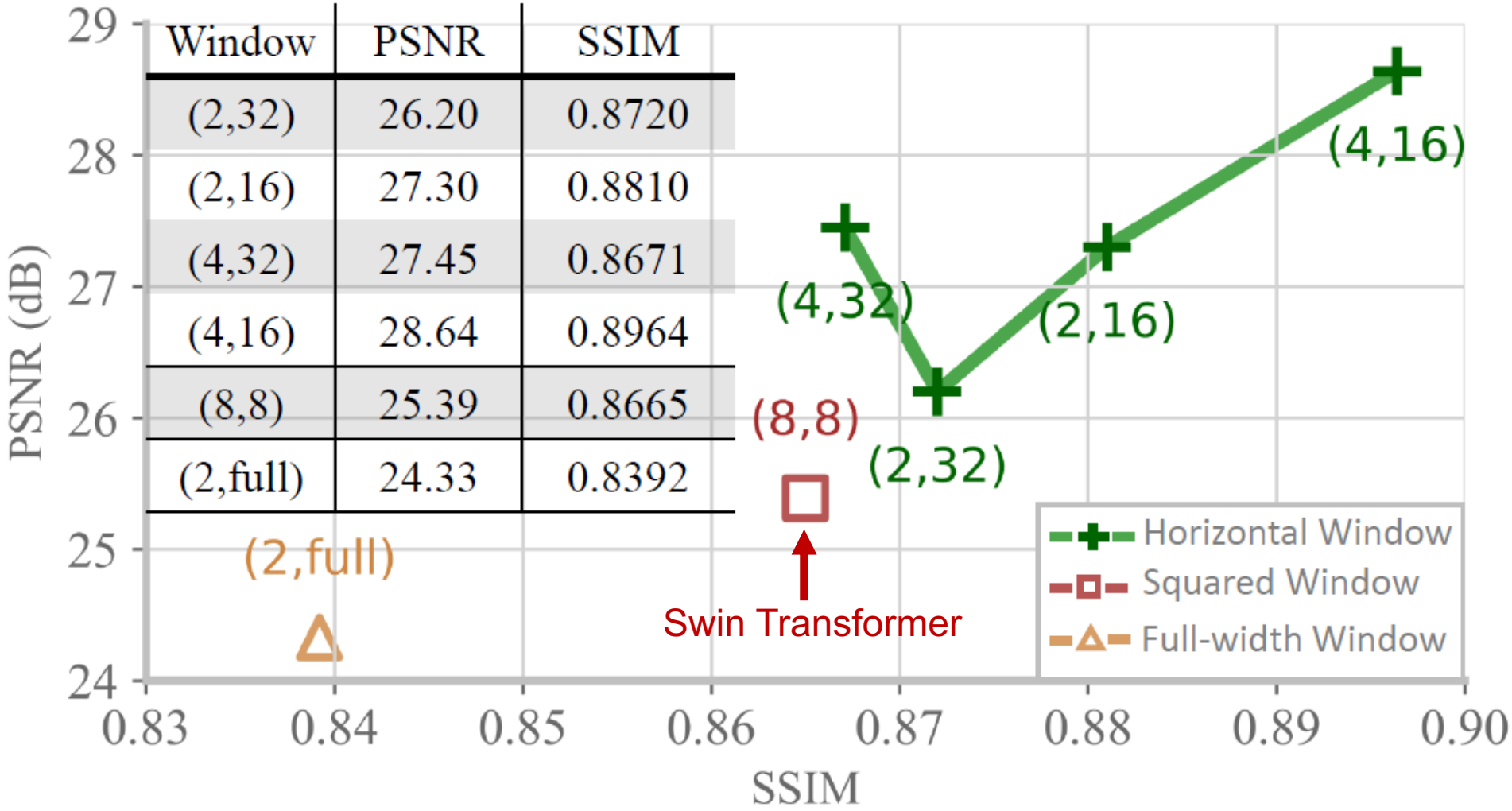


Ablation Study

	PE		FFN		Fusion		PSNR / SSIM
	WinPE	PixPE	LeFNN	Se-FNN	AFF	CFF-SE	
v1			✓		✓		25.69 / 0.85
v2	✓		✓		✓		26.50 / 0.86
v3		✓	✓		✓		26.10 / 0.86
v4	✓	✓	✓		✓		26.83 / 0.87
v5	✓	✓	✓			✓	27.24 / 0.87
RSS-T	✓	✓		✓		✓	28.64 / 0.90

Analysis on Window Partition

Window	PSNR	SSIM
(2,32)	26.20	0.8720
(2,16)	27.30	0.8810
(4,32)	27.45	0.8671
(4,16)	28.64	0.8964
(8,8)	25.39	0.8665
(2,full)	24.33	0.8392



Thank you!

Questions and Comments?