Edge-enhanced Feature Distillation Network for Efficient Super-Resolution

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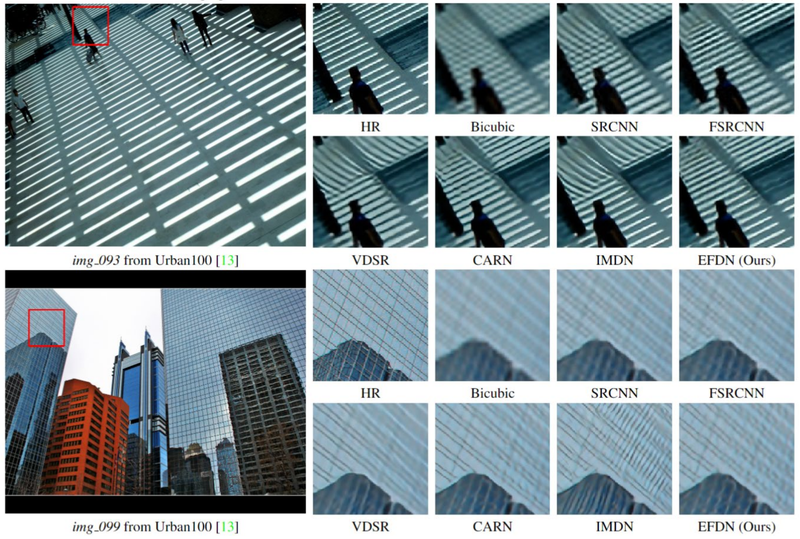
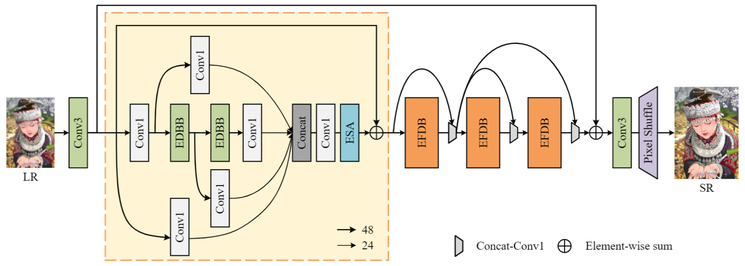
Contribution:

- ✓ A plug-in edge-enhanced diverse branch block (EDBB) by revisiting existing reparameterization technologies.
- ✓ A novel gradient-variance loss function for edge information preserve.
- ✓ Combining block composing, NAS, and loss design into one framework.

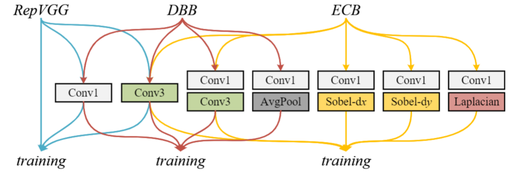


Method:

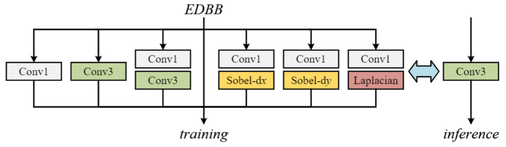
✓ Network architecture



✓ EDBB



(a) Revisiting re-parameterizable typology.



(b) Proposed edge-enhanced diverse branch block.

✓ Loss design

$$v_x^{HR} = \frac{\sum_{j=1}^{n^2}\left(G_{i,j} - \overline{G_i}\right)}{n^2 - 1} \Rightarrow \mathcal{L}_x = \mathbb{E}_{I^{SR}} \| v_x^{HR} - v_x^{SR} \|$$

$$\mathcal{L} = \mathcal{L}_1 + \lambda_x \mathcal{L}_x + \lambda_y \mathcal{L}_y + \lambda_z \mathcal{L}_z$$

Results:

✓ Ablation study

	Block	3×3 Conv	1×1 Conv	Identity	Expand-Squeeze	Scaled Filter	Set5	Set14	B100	Urban100
FSRCNN [10]	Baseline-$\mathcal{L}_1$	✓					37.09/0.9569	32.75/0.9098	31.56/0.8913	30.00/0.9037
	Baseline-$\mathcal{L}_{EG}$	✓					37.14/0.9571	32.77/0.9103	31.58/0.8917	30.00/0.9040
	RepVGG [8]	✓	✓	✓			37.15/0.9571	32.78/0.9102	31.59/0.8916	30.06/0.9045
	DBB [7]	✓	✓		✓	Avgpool	37.18/0.9572	32.77/0.9103	31.60/0.8918	30.11/0.9050
	ECB [37]	✓			✓	Laplacian & Sobel	37.17/0.9572	32.80/0.9103	31.59/0.8915	30.09/0.9044
	EDBB-$\mathcal{L}_1$	✓	✓	✓	✓	Laplacian & Sobel	37.19/0.9573	32.80/0.9104	31.61/0.8919	30.14/0.9052
	EDBB-$\mathcal{L}_{EG}$	✓	✓	✓	✓	Laplacian & Sobel	**37.27/0.9576**	**32.86/0.9109**	**31.65/0.8926**	**30.25/0.9069**
VDSR [16]	Baseline-$\mathcal{L}_1$	✓					37.69/0.9593	33.24/0.9142	31.99/0.8970	31.30/0.9198
	Baseline-$\mathcal{L}_{EG}$	✓					37.72/0.9595	33.30/0.9147	32.02/0.8978	31.40/0.9215
	EDBB-$\mathcal{L}_1$	✓		✓	✓	Laplacian & Sobel	37.73/0.9594	33.26/0.9143	31.99/0.8968	31.32/0.9205
	EDBB-$\mathcal{L}_1$	✓	✓		✓	Laplacian & Sobel	37.73/0.9596	33.33/0.9145	32.02/0.8973	31.38/0.9205
	EDBB-$\mathcal{L}_1$	✓	✓	✓	✓	Avgpool	37.68/0.9593	33.28/0.9142	32.00/0.8971	31.27/0.9190
	EDBB-$\mathcal{L}_1$	✓	✓	✓	✓	Laplacian & Sobel	37.76/0.9595	33.33/0.9147	32.03/0.8975	31.41/0.9207
	EDBB-$\mathcal{L}_{EG}$	✓	✓	✓	✓	Laplacian & Sobel	**37.85/0.9600**	**33.41/0.9158**	**32.10/0.8987**	**31.65/0.9237**
*	Baseline-$\mathcal{L}_1$	✓					37.91/0.9601	33.44/0.9168	32.12/0.8990	31.82/0.9253
	EDBB-$\mathcal{L}_{EG}$	✓	✓	✓	✓	Laplacian & Sobel	**38.00/0.9604**	**33.57/0.9179**	**32.18/0.8998**	**32.05/0.9275**

✓ Quantitative Result

Dataset	Scale	Bicubic Para/MAdds	FSRCNN [10] 12K/4.6G	VDSR [16] 665K/612.6G	IDN [15] 553K/31.1G	CARN [3] 1592K/90.9G	IMDN [14] 715K/41.0G	PAN [40] 272K/28.2G	**EFDN** (Ours) 276K/14.7G
Set5	×2	33.66/0.9299	37.00/0.9558	37.53/0.9587	37.83/0.9600	37.76/0.9590	**38.00/0.9605**	**38.00/0.9605**	**38.00**/0.9604
	×4	28.42/0.8104	31.35/0.8838	31.82/0.8903	32.13/0.8937	**32.21/0.8948**	32.13/**0.8948**	32.13/**0.8948**	32.08/0.8931
Set14	×2	30.24/0.8688	32.63/0.9088	33.03/0.9124	33.30/0.9148	33.52/0.9166	**33.63**/0.9177	33.59/**0.9181**	33.57/0.9179
	×4	26.00/0.7027	27.61/0.7550	28.01/0.7674	28.25/0.7730	**28.60**/0.7806	28.58/0.7811	**28.60/0.7822**	28.58/0.7809
B100	×2	29.56/0.8403	31.53/0.8920	31.90/0.8960	32.08/0.8985	32.09/0.8978	**32.19**/0.8996	32.18/0.8997	32.18/**0.8998**
	×4	25.96/0.6675	26.98/0.7150	27.29/0.7251	27.41/0.7297	27.58/0.7349	27.56/0.7353	**27.59/0.7363**	27.56/0.7354
Urban100	×2	26.88/0.8403	29.88/0.9020	30.76/0.9140	31.27/0.9196	31.92/0.9256	**32.17/0.9283**	32.01/0.9273	32.05/0.9275
	×4	23.14/0.6577	24.62/0.7280	25.18/0.7524	25.41/0.7632	26.07/0.7837	26.04/0.7838	**26.11/0.7854**	26.00/0.7815

✓ Running-time Result

Method	Time on 2070-maxQ	Time on 3090
IMDN [14]	0.158s	0.092s
EFDN (Ours)	**0.089**s	**0.019**s

Project: