Blueprint Separable Residual Network for Efficient Image Super-Resolution

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INTRODUCTION

The main contributions of this paper are:

- ✓ We introduce **BSConv** to construct the basic building block and show its effectiveness for SR.
- ✓ We utilize two effective **attention modules** with limited extra computation to enhance the model ability.
- ✓ The propose **BSRN**, which integrates BSConv and two effective attention modules, demonstrates superior performance for efficient SR.

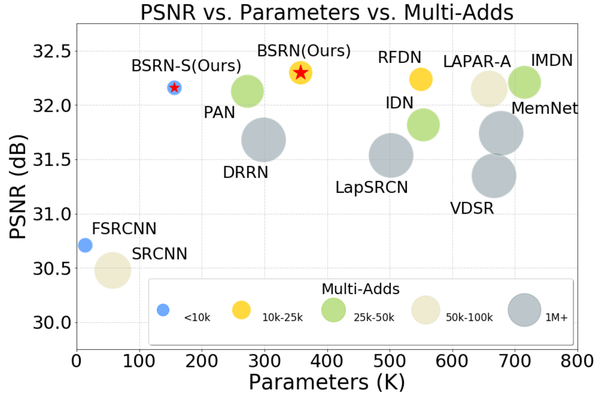

Figure 1. Performance and model complexity comparison for upscaling factor ×4.

- ➢ As show in Fig.1, our proposed BSRN obtains better performance with fewer parameters and Multi-Adds among existing efficient SR methods.
- ➢ A smaller variant, BSRN-S, can achieve the comparable performance with only about **28.4%** parameters and **34.7%** Multi-Adds compared to RFDN.
- ➢ BSRN-S won the **championship** in model complexity track of NTIRE 2022 efficient super-resolution challenge.

METHOD

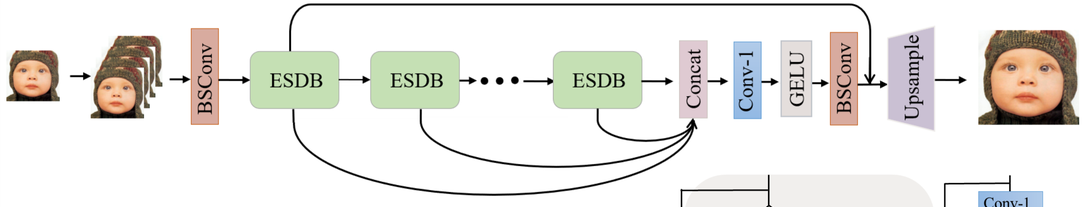

Figure 2. The architecture of Blueprint Separable Residual Network (BSRN).

- ➢ The overall architecture of BSRN is shown in Fig.2, consisting of shallow feature extraction, deep feature extraction, multi-layer feature fusion and reconstruction.
- ➢ Inspired by the RFDB from RFDN, we design the efficient separable distillation block (ESDB) as the basic block in our method, shown in Fig.3 (a).
- ➢ The basic module of ESDB is BSRB, as shown in Fig.3 (b), which consists of a BSConv as shown in Fig3. (e), an identity connection and a GELU activation unit.
- ➢ We also introduce effective attention modules of ESA block and CCA block to the designed ESDB, of which the specific structures are shown in Fig.3 (c) and (d).

Team

Code

Paper

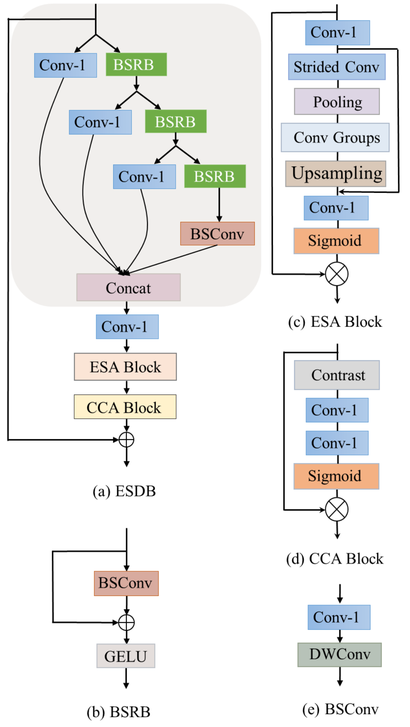

Figure 3. Modules in BSRN.

EXPERIMENTS

➢ Ablation Study

Table 1. Quantitative comparison of two BSRN variants with RFDN. BSRN-1 has the same depth and width as RFDN, while BSRN-2 has close computational complexity to RFDN.

Method	Param[K]	Multi-Adds[G]	Set5		Set14		BSD100		Urban100		Manga109	
			PSNR	SSIM	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM
RFDN	443	23.9	32.04	0.8934	28.52	0.7799	27.53	0.7344	25.92	0.7810	30.30	0.9063
BSRN-1	209	11.5	32.14	0.8942	28.57	0.7811	27.55	0.7352	25.95	0.7815	30.35	0.9068
BSRN-2	438	24.2	32.22	0.8954	28.62	0.7827	27.60	0.7369	26.08	0.7855	30.61	0.9096

Table 2. Ablation study of ESA and CCA.

Method	Param[K]	Multi-Adds[G]	Set5		Set14		BSD100		Urban100		Manga109	
			PSNR	SSIM	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM
BSRN	352	19.4	32.25	0.8956	28.62	0.7822	27.60	0.7367	26.10	0.7864	30.58	0.9093
BSRN-woESA	320	18.2	32.1407	0.8943	28.5551	0.7807	27.5581	0.7352	25.9697	0.7816	30.3931	0.9071
BSRN-woCCA	348	19.4	32.1999	0.8947	28.6500	0.7824	27.5968	0.7368	26.0454	0.7854	30.5274	0.9087

➢ Visual Comparison

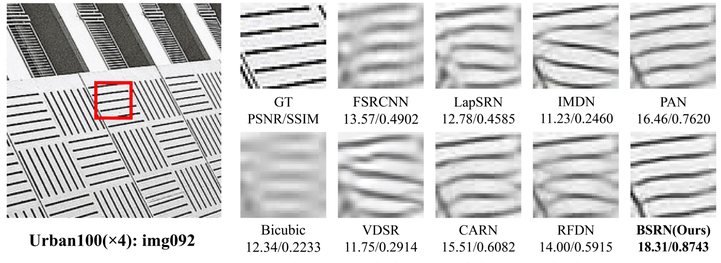

Figure 4. Visual comparison of BSRN with the state-of-the-art methods on ×4 SR.

➢ Quantitative Comparisons.

Table 3. Quantitative comparison with state-of-the-art methods on ×4 benchmark datasets. The best and second-best performance are in red and blue colors.

Method	Param[K]	Multi-Adds[G]	Set5		Set14		BSD100		Urban100		Manga109	
			PSNR	SSIM	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM
Bicubic	-	-	28.42	0.8104	26.00	0.7027	25.96	0.6675	23.14	0.6577	24.89	0.7866
MemNet	678	2,662.4	31.74	0.8893	28.26	0.7723	27.40	0.7281	25.50	0.7630	29.42	0.8942
IDN	553	32.3	31.82	0.8903	28.25	0.7730	27.41	0.7297	25.41	0.7632	29.41	0.8942
CARN	1592	90.9	32.13	0.8937	28.60	0.7806	27.58	0.7349	26.07	0.7837	30.47	0.9084
IMDN	715	40.9	32.21	0.8948	28.58	0.7811	27.56	0.7353	26.04	0.7838	30.45	0.9075
PAN	272	28.2	32.13	0.8948	28.61	0.7822	27.59	0.7363	26.11	0.7854	30.51	0.9095
LAPAR-A	659	94.0	32.15	0.8944	28.61	0.7818	27.61	0.7366	26.14	0.7871	30.42	0.9074
RFDN	550	23.9	32.24	0.8952	28.61	0.7819	27.57	0.7360	26.11	0.7858	30.58	0.9089
BSRN-S(Ours)	156	8.3	32.16	0.8949	28.62	0.7823	27.58	0.7365	26.08	0.7849	30.53	0.9089
BSRN(Ours)	352	19.4	32.35	0.8966	28.73	0.7847	27.65	0.7387	26.27	0.7908	30.84	0.9123