FAST AND LIGHTWEIGHT IMAGE SUPER-RESOLUTION BASED ON DENSE RESIDUALS TWO-CHANNEL NETWORK

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Introduction

we propose a fast and lightweight two-channel end-to-end network with fewer parameters and low computational complexity in this paper.

The main contributions are as follows:

a) **Speed:** Our model not only has good reconstruction accuracy, but also provides fast processing speed.

b) **Computational complexity:** The proposed FLSR and FLSR-G model have lower computational complexity and higher reconstruction accuracy compared .

c) **Combination of dense and residual:** FLSR with dense and residual connection is chosen to weaken the gradient vanishing or exploding phenomenon, which shows excellent performance in SR task.

Our Algorithm

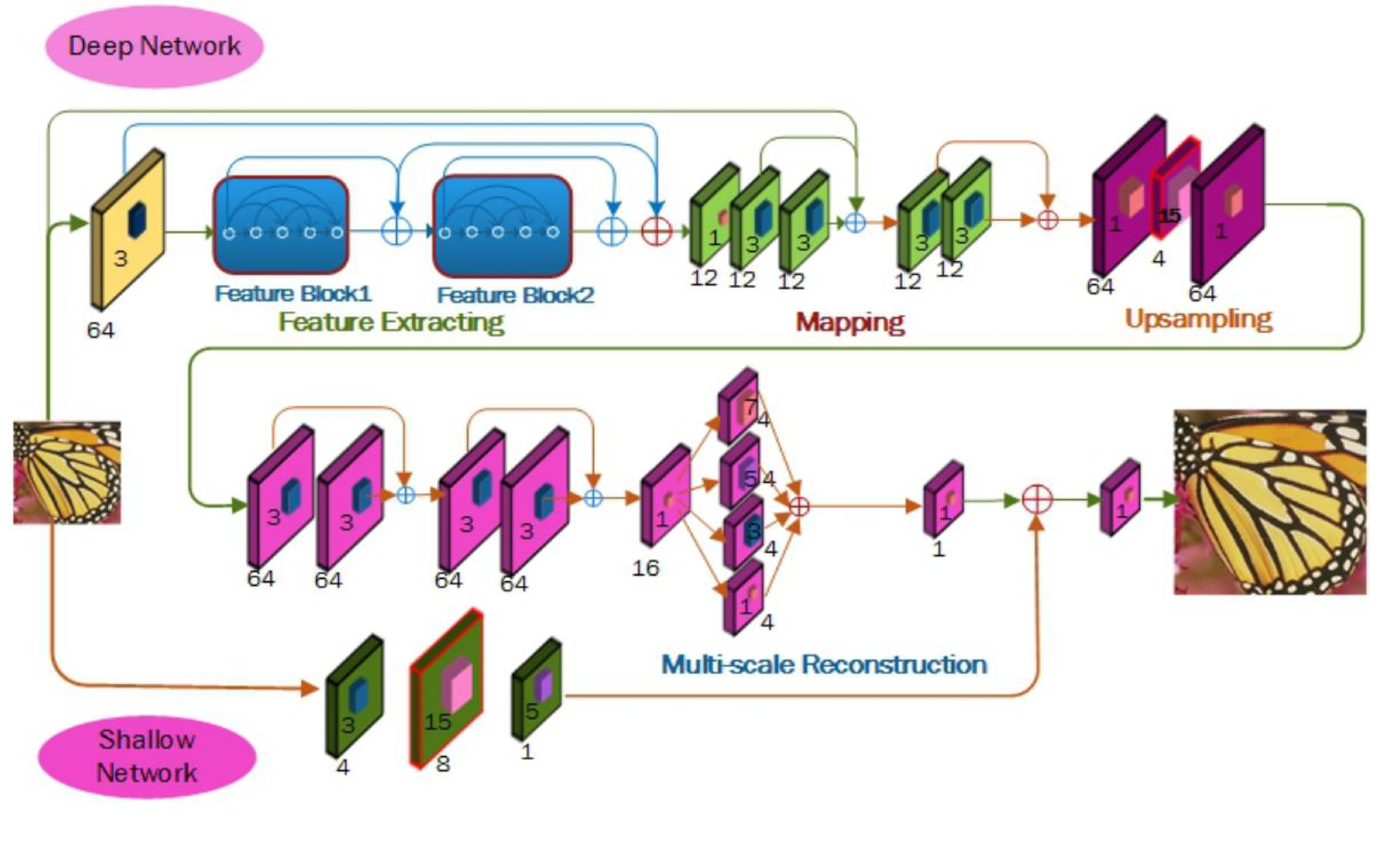

Fig.1 Architecture of the proposed network. The ⊕ operations in network are element-wise addition for residual learning, and ⊕ is densely skip connection. The small white circle is convolution operation.

a) **The shallow channel :** mainly restores the general outline of the image, while the deep channel mainly learns the high-frequency texture information.

b) **The deep channel :** combines the dense block and residual connection. The dense block increases data flow of network, while the residual connection reduces the number of parameters and speeds up the convergence of network.

c) **Enhanced network :** uses group convolution, which significantly reduces the parameters and computational complexity with slight performance loss.

Fig.2 Speed and accuracy trade-off. The average PSNR and the average inference time for upscaling 2 on Urban100.

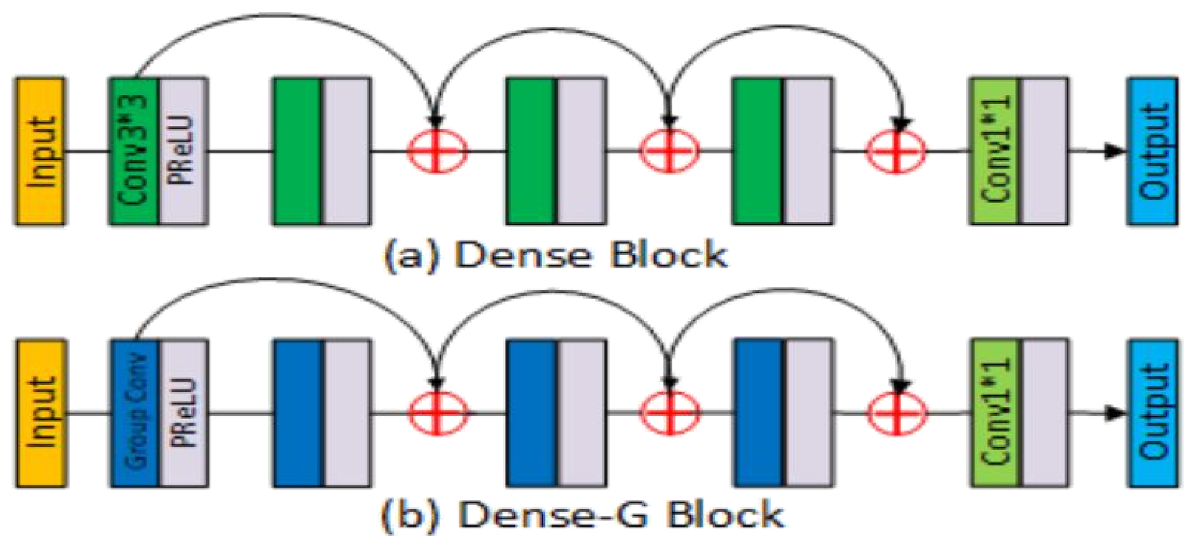

Fig.3 The structure of feature block. The half green rectangle represents convolutional layer, the half blue rectangle represents group convolution.

Experiments

Model	Layer	Params	Scale	MultAdds	Set5 PSNR (SSIM)	Set14 PSNR (SSIM)	BSD100 PSNR (SSIM)	Urban100 PSNR (SSIM)
SRCNN[1]	3	57k	2x	52.7G	36.66 (0.9542)	32.42 (0.9063)	31.36 (0.8879)	29.50 (0.8946)
VDSR[4]	20	665k		612.6G	37.53 (0.9587)	33.03 (0.9124)	31.90 (0.8960)	30.76 (0.9140)
DRCN[3]	20	1774k		9788.7G	37.63 (0.9588)	33.04 (0.9118)	31.85 (0.8942)	30.75 (0.9133)
LapSRN[22]	27	813k		29.9G	37.52 (0.9590)	33.08 (0.9130)	31.80 (0.8950)	30.41 (0.9100)
DRRN[7]	52	297k		6796.9G	37.74 (0.9591)	33.23 (0.9136)	32.05 (0.8930)	31.23 (0.9188)
MemNet[21]	80	677K		623.9G	37.78 (0.9597)	33.28 (0.9142)	32.08 (0.8980)	31.31 (0.9195)
SRDenseNet [24]								
MS-LapSRN -D5R2[23]	24	222k			37.62 (0.9600)	33.13 (0.9130)	31.93 (0.8970)	30.82 (0.9150)
IDN[8]	31	715.3K		138.3G	37.83 (0.9600)	33.30 (0.9148)	32.08 (0.8985)	31.27 (0.9196)
SDSR[6]	19	300.87k		175.5G	37.07 (0.9564)	32.64 (0.9093)	31.52 (0.8911)	
FLSR (Ours)	33	717.28K		271.35G	37.79 (0.9595)	33.16 (0.9143)	32.06 (0.8979)	31.23 (0.9183)
FLSR-G+ (Ours)	33	330.21K		182.17G	37.73 (0.9594)	33.17 (0.9142)	31.99 (0.8971)	31.07 (0.9138)
FLSR+ (Ours)	33	717.28K		271.35G	37.87 (0.9599)	33.29 (0.9152)	32.11 (0.8985)	31.35 (0.9196)

Model	Scale	MultAdds	Set5 PSNR (SSIM)	Set14 PSNR (SSIM)	BSD100 PSNR (SSIM)	Urban100 PSNR (SSIM)
SRCNN[1]	3x	52.7G	32.75 (0.9090)	29.28 (0.8209)	28.41 (0.7863)	26.24 (0.7989)
VDSR[4]		612.6G	33.66 (0.9213)	29.77 (0.8314)	28.82 (0.7976)	27.14 (0.8279)
DRCN[3]		9788.7G	33.82 (0.9226)	29.76 (0.8311)	28.80 (0.7963)	27.15 (0.8276)
LapSRN[22]						
DRRN[7]		6796.9G	34.03 (0.9244)	29.96 (0.8349)	28.95 (0.8004)	27.53 (0.8378)
MemNet[21]		623.9G	34.09 (0.9248)	30.00 (0.8350)	28.96 (0.8001)	27.56 (0.8376)
SRDenseNet [24]						
MS-LapSRN -D5R2[23]			33.88 (0.9230)	29.89 (0.8340)	28.87 (0.8000)	27.23 (0.8310)
IDN[8]		30.8G	34.11 (0.9253)	29.99 (0.8354)	28.95 (0.8013)	27.42 (0.8359)
SDSR[6]		156.64G	33.42 (0.9181)	29.47 (0.8288)	28.65 (0.7933)	
FLSR (Ours)		196.02G	34.02 (0.9229)	29.76 (0.8342)	28.89 (0.7991)	27.31 (0.8314)
FLSR-G+ (Ours)		157.01G	34.06 (0.9247)	29.92 (0.8355)	28.95 (0.8007)	27.47 (0.8352)
FLSR+ (Ours)		196.02G	34.14 (0.9249)	29.94 (0.8353)	28.97 (0.8012)	27.47 (0.8359)

Model	Scale	MultAdds	Set5 PSNR (SSIM)	Set14 PSNR (SSIM)	BSD100 PSNR (SSIM)	Urban100 PSNR (SSIM)
SRCNN[1]	4x	52.7G	30.48 (0.8628)	27.49 (0.7503)	26.90 (0.7101)	24.52 (0.7221)
VDSR[4]		612.6G	31.35 (0.8838)	28.01 (0.7674)	27.29 (0.7251)	25.18 (0.7524)
DRCN[3]		9788.7G	31.53 (0.8854)	28.02 (0.7670)	27.23 (0.7233)	25.14 (0.7510)
LapSRN[22]		149.4G	31.54 (0.8850)	28.19 (0.7720)	27.32 (0.7280)	25.21 (0.7560)
DRRN[7]		6796.9G	31.68 (0.8888)	28.21 (0.7720)	27.38 (0.7284)	25.44 (0.7638)
MemNet[21]		623.9G	31.74 (0.8893)	28.26 (0.7723)	27.41 (0.7290)	25.54 (0.7666)
SRDenseNet [24]		389.9G	32.02 (0.8934)	28.50 (0.7782)	27.53 (0.7337)	26.05 (0.7819)
MS-LapSRN -D5R2[23]			31.62 (0.8870)	28.16 (0.7720)	27.36 (0.7290)	25.32 (0.7600)
IDN[8]		34.6 G	31.82 (0.8903)	28.25 (0.7730)	27.41 (0.7297)	25.41 (0.7632)
SDSR[6]		149.68G	31.01 (0.8744)	27.73 (0.7614)	27.10 (0.7186)	
FLSR (Ours)		173.66G	31.41 (0.8829)	27.98 (0.7688)	27.30 (0.7243)	25.33 (0.7574)
FLSR-G+ (Ours)		151.37G	31.62 (0.8875)	28.24 (0.7722)	27.39 (0.7284)	25.26 (0.7565)
FLSR+ (Ours)		173.66G	31.57 (0.8848)	28.20 (0.7713)	27.37 (0.7267)	25.33 (0.7574)

Table 1. Average PSNR/SSIM for upscaling factors 2×, 3× and 4× on benchmark datasets.

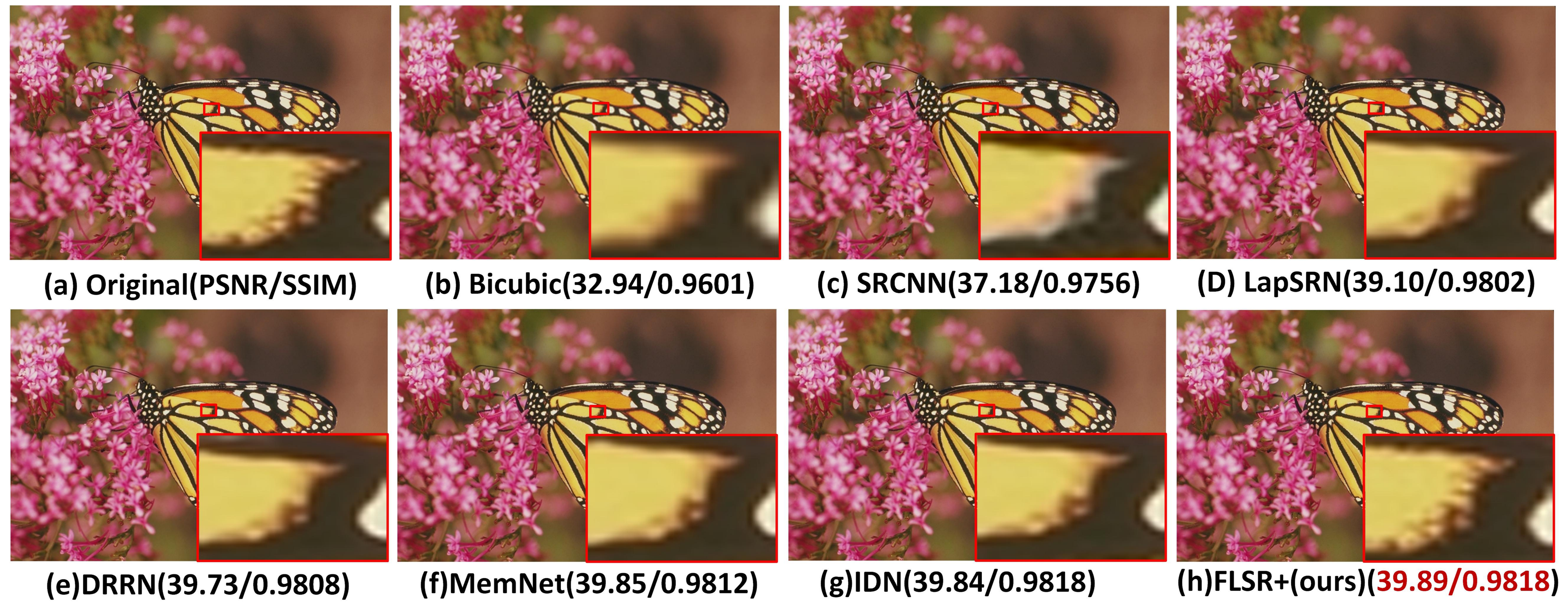

Fig.4 The "monarch" image from the Set14 dataset with an upscaling factor 2. Red color indicates the best performance.

References

[8] Z. Hui, X. Wang, and X. Gao, " Fast and Accurate Single Image Super-Resolution via Information Distillation Network," IEEE Conference on Computer Vision and Pattern Recognition, pp. 723-731, 2018.

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