BILATERAL RECURRENT NETWORK FOR SINGLE IMAGE DERAINING

Wei Shang, Pengfei Zhu, Dongwei Ren*, Hong Shi

College of Intelligence and Computing, Tianjin University, Tianjin, China

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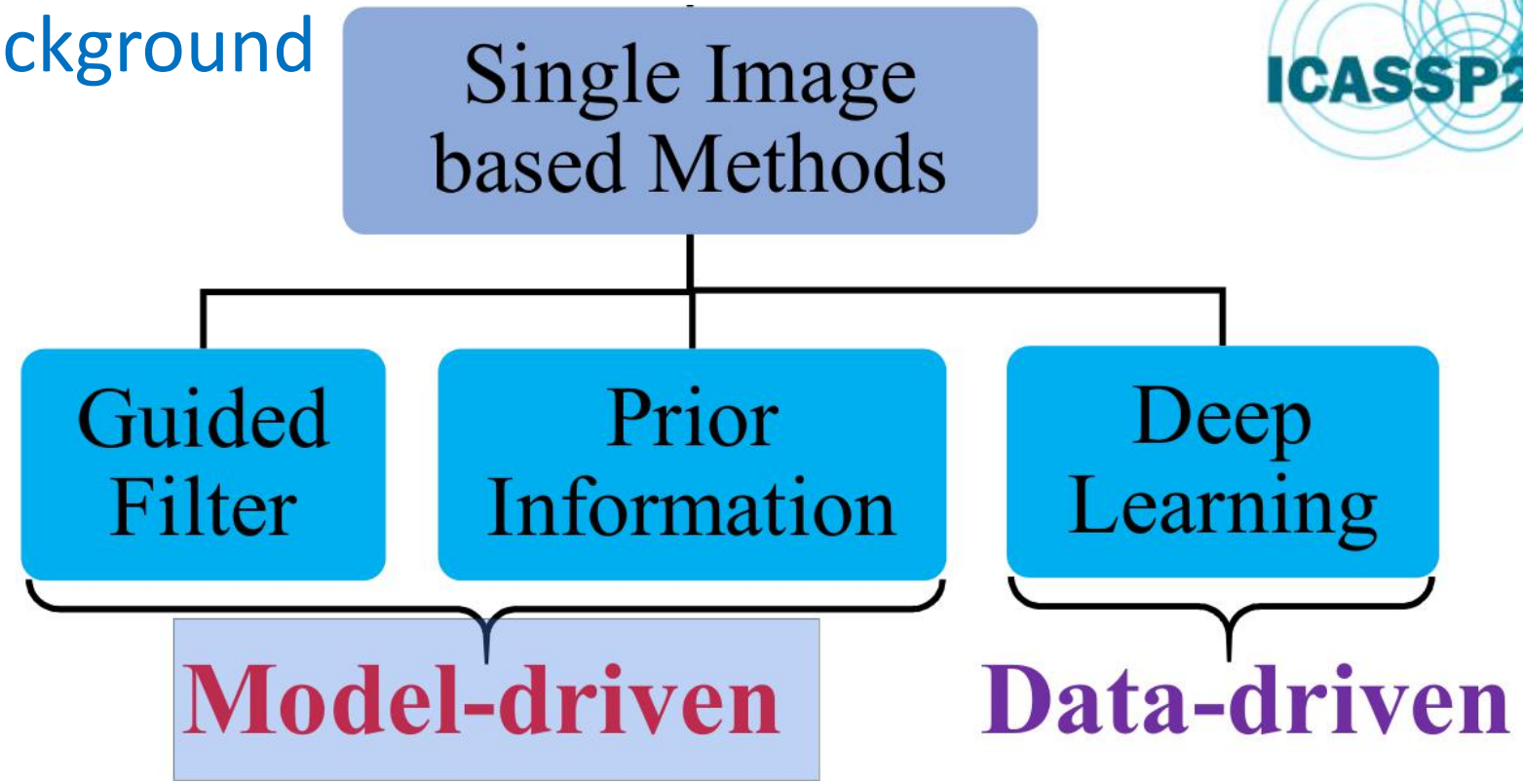
Background

Removing rain streaks from a single image is a crucial task in computer vision systems, e.g., surveillance, object detection and recognition in rainy outdoor scenes. Single image deraining is a very challenging ill-posed problem, and has received considerable research attention in recent years.

y = x + r

1

Background



There are several conventional optimization based deraining methods by studying the composition pattern of the rainy image and designing proper regularization priors.

With the great success of deep learning in low-level vision tasks, deep convolutional neural network (CNN)-based deraining methods also achieve significant performance improvements against conventional optimization based methods.

2

Motivation

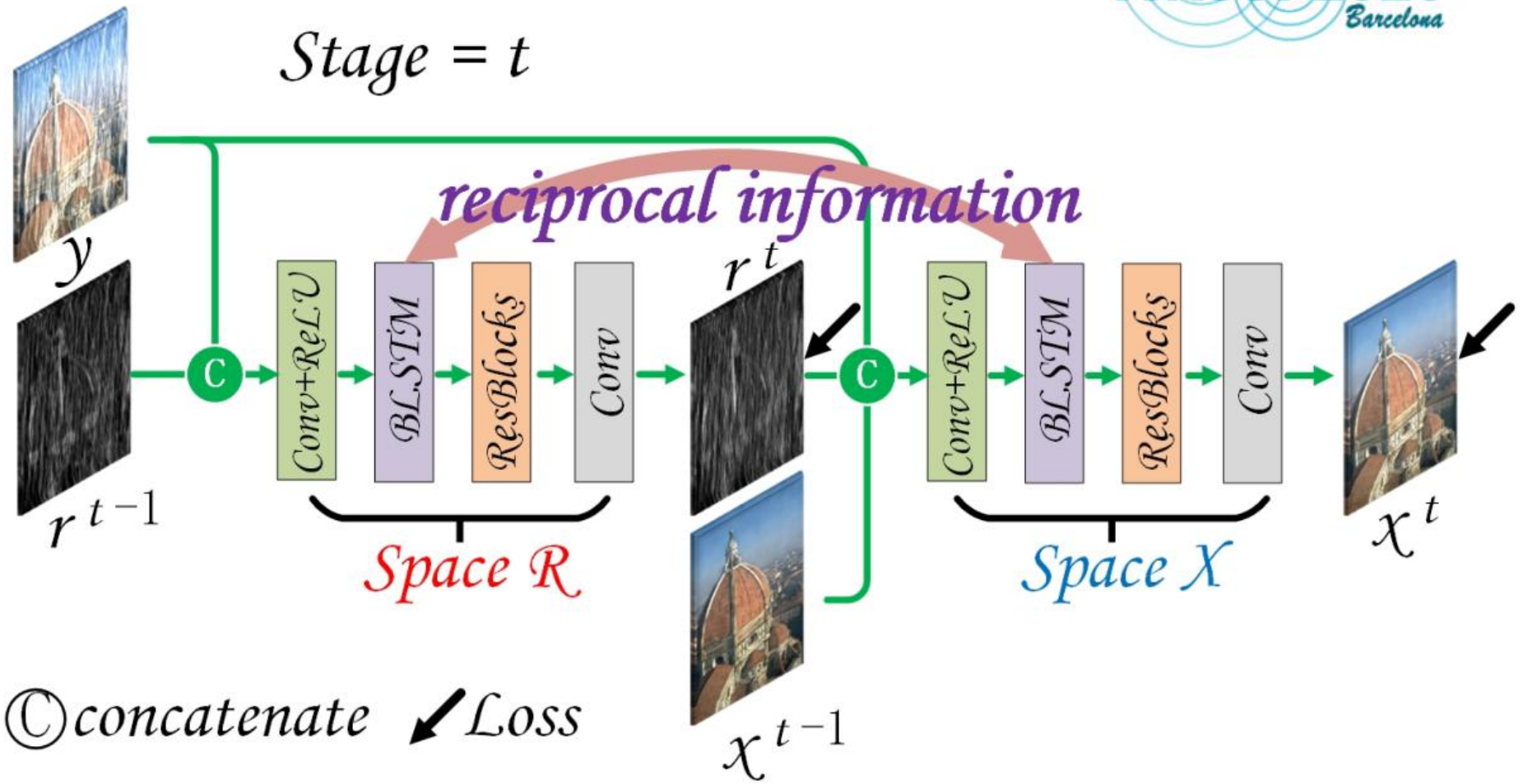
Despite of various network architectures and training strategies, these methods use deep network to learn a residual mapping from rainy image to rain streak layer.

However, for real world rainy images the composition of rain streak layers and background images become more complicated. Thus, rain streaks are very likely to be over-subtracted to yield visual artifacts.

To address this issue, we propose a bilateral recurrent network (BRN) to jointly exploit rain streak layer and clean background image layer.

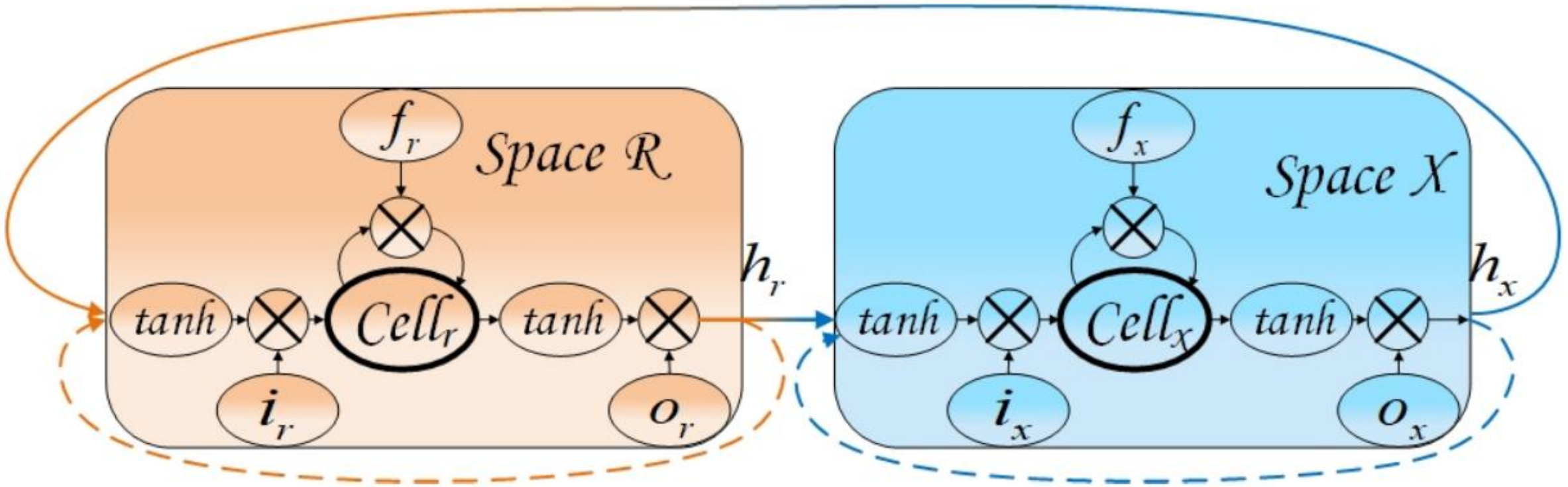
3

Method


Stage = t
reciprocal information
y
r t −1
C
Conv+ReLU
BLSTM
ResBlocks
Conv
r t
Space R
C
Conv+ReLU
BLSTM
ResBlocks
Conv
x t
Space X
x t −1
Ⓒ concatenate
Loss

3

Method



The architecture of BLSTMs, where the hidden state h is not only respectively propagated through space X and space R (dashed lines), but also brings the interplay between space R and space X (solid lines).

4

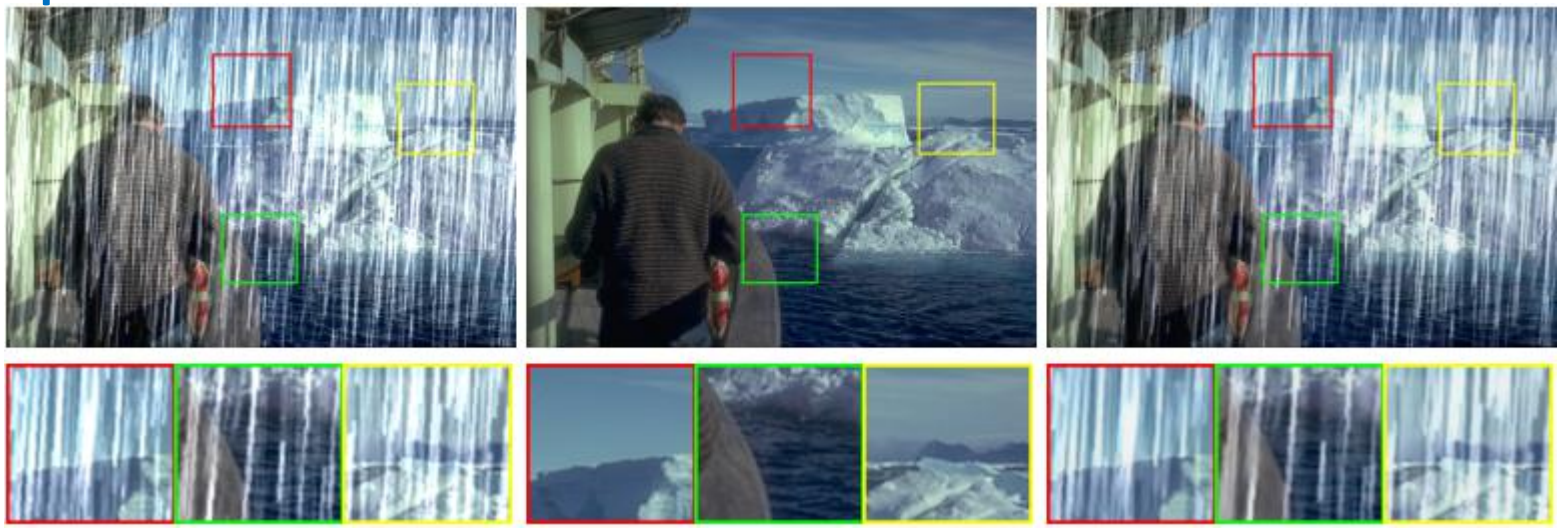
Experiment

Average PSNR and SSIM comparison on synthetic datasets, including Rain100H, Rain100L and Rain12. Red, blue and purple colors are used to indicate top 1 st , 2 nd and 3 rd rank, respectively.

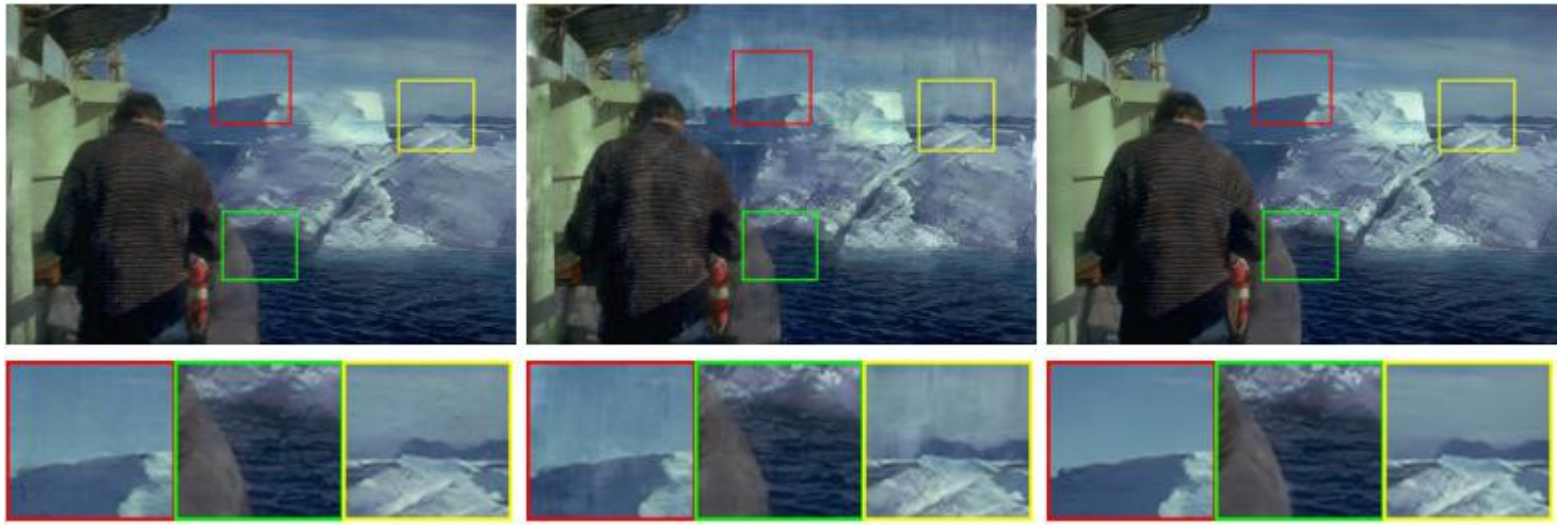
Method	GMM	DDN	ResGuideNet	JORDER	RESCAN	CRN	$BRN_{x\rightarrow r}$	$BRN_{r\rightarrow x}$	BRN
Rain100H	15.05/0.425	21.92/0.764	25.25/0.841	26.54/0.835	28.64/0.864	29.10/0.897	29.50/0.901	29.16/0.898	29.58/0.902
Rain100L	28.66/0.865	32.16/0.936	33.16/0.963	36.61/0.974	—	37.52/0.980	37.65/0.980	37.40/0.979	37.82/0.981
Rain12	32.02/0.855	31.78/0.900	29.45/0.938	33.92/0.953	—	36.58/0.959	36.63/0.959	36.54/0.959	36.70/0.959

4

Experiment



Rainy image | Ground-truth | GMM



RESCAN | JORDER | BRN(ours)

4

Experiment

Rainy image | DDN | RESCAN | BRN(ours)

5 Conclusion

We proposed a novel bilateral recurrent network for effective single image deraining, where the proposed BLSTMs are effective in propagating reciprocal information between rain streak layer and clean background image layer. Benefiting from bilateral recurrent network, both rain streak layer and clean background image layer can be well exploited, leading to visually favorable deraining results. Extensive experimental results validate the superiority of BRN against state-of-the-art deep deraining networks. Moreover, the proposed bilateral modeling for dual layers can be applied to other two-layer image decomposition problems in the future work.


ICASSP2020
Barcelona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Thank you!