BILATERAL RECURRENT NETWORK FOR SINGLE IMAGE DERAINING

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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.

\[
y = x + r
\]
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.
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.
Method

Stage = t

reciprocal information

concatenate

loss

Space R

Space X

\(x_t\)

\(x_{t-1}\)

Conv + ReLU

BLSTM

ResBlocks

Core

Conv + ReLU

BLSTM

ResBlocks

Core

Presentation

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Barcelona
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).
Experiment

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

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

Rainy image

Ground-truth

GMM

RESCAN

JORDER

BRN(ours)
Experiment

Rainy image  DDN  RESCAN  BRN(ours)
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.
Thank you!