Multi-scale Processing of Noisy Images using Edge Preservation Losses

Nati Ofir and Yosi Keller
BIU
Deep Processing of Noisy Images

• Faint edge detection
• Noisy image classification
• Natural image denoising
Architecture
Faint Edge Detection

Fig. 1. Example of a medical image with many curved edges. (a) The original image. (b) The proposed FED-CNN approach results. (c) FastEdges [22] results. Both methods achieve high quality of detection while ours run in milliseconds and FastEdges runtime is more than seconds.
Dice Coefficients Loss

\[ Di(y, y') = -\frac{\sum_p y'(p) \cdot y(p)}{\sum_p y'(p) + \sum_p y(p)} \]

\[ y' = \text{network output} \]
\[ y = \text{ground truth label} \]
Quantitative Results
Visual Results

Fig. 8. Result on image from the binary images dataset [16] that we used to train and test our network. Left: the input noisy images with a binary pattern. Middle: the ground truth labels. Right: our directions. FED-CNN result is very similar to the ground truth and we manage to detect and track edges even at high curvatures.

Fig. 9. Examples of real images. Left: the original gray scale images. Middle: our results. Right: FastEdges [22] results. Both methods achieve high quality of detections.
Noisy image classification
Classification Results

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>CIFAR10</th>
<th>CIFAR100</th>
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<tbody>
<tr>
<td>resnet(IDCNN)</td>
<td>82.7</td>
<td>53.3</td>
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<tr>
<td>resnet noisy</td>
<td>77.5</td>
<td>46.0</td>
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<tr>
<td>resnet_clean</td>
<td>34.1</td>
<td>16.9</td>
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Natural Image Denoising Method

\[ L_E = \| \frac{\partial}{\partial x} I_c - \frac{\partial}{\partial x} IDCNN(I_n) \|_2^2 \]
Image Denoising Results

Fig. 2. Denoising result at additive noise of 50 standard deviation, of the proposed multi-scale network trained by our edge preservation loss. (a) The noisy input image. (b) The results of the proposed scheme. (c) Denoising results of the state-of-the-art DnCNN [34] approach. Our method achieves the highest SSIM [31] scores in our experiments at all the noise levels.
Conclusions and Summary

• We introduced methods for multiscale processing of noisy images using edge preservation loss.
• FED can be carried out by deep CNN.
• Noisy image classification can be improved by CNN preprocessing.
• Edge preservation loss improves the quality of natural image denoising by a multiscale CNN.