Cycle-Consistent Super Resolution Generative Adversarial Network

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Motivation

This project aims to use Cycle-Consistent Generative Adversarial Networks (CycleGANs) and perceptual loss to improve the state-of-the-art for the Super Resolution (SR) task.

This approach is based on the idea that if a network can learn how to compress an image, it can learn how to enhance an image.

The model has no prior information about the data other than the input, so unpaired data is used as opposed to paired data.

Related Work

Ledig et al. has developed SRGAN, which produces 4x upscaling while maintaining photo-realistic qualities, but uses paired samples.

Zhu et al. shows that photos can be generated with shallower depth of field, which suggests photo enhancement is a suitable area for CycleGAN, but has not applied it to super resolution.

References


CycleSRGAN

\[ L_{\text{LSGAN}} = E_{x \sim p_{data}} [D_x(G(x))^2 + (D_y(x) - 1)^2] + E_{y \sim p_{data}} [D_y(F(y))^2 + (D_x(y) - 1)^2] \]

\[ L_{\text{CYC}} = E_{x \sim p_{data}} \| F(G(x)) - x \| + E_{y \sim p_{data}} \| G(F(y)) - y \| \]

\[ L_{\text{SR}} = E_{x \sim p_{data}} \| \phi(x) - \phi(G(G(x))) \|^2 + E_{y \sim p_{data}} \| \phi(y) - \phi(G(F(y))) \|^2 \]

Experimental Results

<table>
<thead>
<tr>
<th>Image</th>
<th>MSE</th>
<th>SSIM</th>
<th>PSNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image 1</td>
<td>0.07</td>
<td>0.75</td>
<td>11.48</td>
</tr>
<tr>
<td>Image 2</td>
<td>0.02</td>
<td>0.64</td>
<td>16.67</td>
</tr>
<tr>
<td>Image 3</td>
<td>0.14</td>
<td>0.44</td>
<td>8.47</td>
</tr>
<tr>
<td>Image 4</td>
<td>0.02</td>
<td>0.77</td>
<td>17.66</td>
</tr>
<tr>
<td>Image 5</td>
<td>0.03</td>
<td>0.47</td>
<td>15.03</td>
</tr>
<tr>
<td>Image 6</td>
<td>0.07</td>
<td>0.75</td>
<td>11.42</td>
</tr>
<tr>
<td>Image 7</td>
<td>0.06</td>
<td>0.71</td>
<td>12.36</td>
</tr>
</tbody>
</table>

Figure 1: SR example, where \( \alpha \) is the depth of field.

Figure 2: Paired vs. Unpaired data.

Figure 3: SRGAN Results.

Figure 4: CycleGAN Results.

Table 1: Parameter values of CycleSRGAN.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning rate</td>
<td>0.0002</td>
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<tr>
<td>Epochs</td>
<td>100</td>
</tr>
<tr>
<td>Train set size</td>
<td>1600</td>
</tr>
<tr>
<td>( \lambda_1 )</td>
<td>10</td>
</tr>
<tr>
<td>( \lambda_2 )</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2: Evaluation metrics for generated image compared to "ground truth."