D³Net: Joint Demosaicking, Deblurring and Deringing

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The path to a white-box network

1. joint three restoration tasks
2. light-weight architecture
3. transparent CNN
Image degradation model

Degraded data by blur, CFA pattern and noise

\[ g = S H u + n \]

Intrinsic camera blur

Blurred image

Original image
Model-based solution

Optimization problem with total variation regularization

\[ \hat{u} = \arg \min_u \frac{\gamma}{2} \|SHu - g\|_2^2 + \phi^1(\{D_ju\}) \]

Using ADMM leads to an iterative solution

IWFT: Sroubek 2019
Model-based solution

Optimization problem with total variation regularization

\[ \hat{u} = \arg \min_u \frac{\gamma}{2} \| SHu - g \|_2^2 + \phi^1 (\{D_j u\}) \]

\[ \hat{u}_0 = P(r \ast g) \]
\[ \tilde{v}_i = d \ast \hat{u}_{i-1} \]
\[ v_i = \text{SoftThr} (\tilde{v}_i - a_{i-1}) \]
\[ a_i = a_{i-1} + (v_i - \tilde{v}_i) \]
\[ \hat{u}_i = \hat{u}_0 + w \ast (v_i + a_i) \]

Initial restoration

only filtering and element-wise operations
D³Net is inspired by model-based optimization algorithm.
Joint vs. sequential approach

Real data

Phone demosaicking

JointADMM

DeepJoint

FlexISP

Wiener

IWFT

Ground-truth

DeepJoint

FlexISP

D^2Net v1

D^2Net v2

Real data

<table>
<thead>
<tr>
<th>Method</th>
<th>PSNR [dB]</th>
<th>SSIM</th>
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<tr>
<td>JointADMM</td>
<td>23.06</td>
<td>0.742</td>
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<td>DeepJoint</td>
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<td>Wiener</td>
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<td>JointADMM^*</td>
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<td>DeepJoint^*</td>
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<td>FlexISP^*</td>
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<td>D^2Net v1</td>
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<td>0.887</td>
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<tr>
<td>D^2Net v2</td>
<td>28.91</td>
<td>0.912</td>
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</tbody>
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Conclusion

1. joint three restoration tasks
   - Demosaicking
   - Deblurring
   - Deringing

2. light-weight architecture

3. transparent CNN
Thank you for your attention

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