Introduction

Problems:
- Real-world image/video capturing introduces low-frequency or grainy noise.
- High-frequency details of the image cannot be seen on a small display.
- Conventional noise reduction methods are designed to remove white or all-frequency noise.

Solution:
- We propose an approach for a coarse-grain removal using existing white noise filters.

Conventional Removal of Low Frequency Noise

Our Algorithm:
1. Anti-aliasing (Low-pass) filter: \( I_h = I * h_\sigma \)
2. Downscale and filter image using a white noise filter
   \[ A'_h = I_h(0 : 2^r : e, 0 : 2^r : r) \]
   \[ A'_w = WGF(A'_h, \sigma_w) \]
3. Upscale filtered image and compute the residual image
   \[ z = I_h - U_l(A'_w) \]
4. Filter the decoupled residual image using DCT shrinkage
   \[ \tilde{z} = FDC(I_h) \]
   \[ \tilde{z}_a = \tilde{z}_a [1 - \exp(-p)], p = \max \left( \frac{|\tilde{z}_a|}{\sigma_w}, 1, 0 \right) \]
5. Inverse decouple
   \[ I = z + \tilde{z}_a, \tilde{z}_a = IDC(\tilde{z}_a) \]

Decoupling makes the low-frequency noise less spatially correlated

System Architecture

Experimental results

Synthetic noise
\[ I = I + n * h \]
- \( n \) Gaussian noise with \( \sigma_n = 15 \)
- \( h \) Gaussian filter with \( \sigma_{cov} = 0.6 \)

PSNR averaged over the TID2013 dataset degraded with LF noise, comparing proposed and related decomposition methods

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Real filtered and compressed noise

Synthetic low-frequency noise