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Interpretable Learned Image Compression: A Frequency Transform Decomposition Perspective

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2022.3

Data Compression Conference

Problem

- Lossy Image Compression
  - Trade-off between rate and distortion

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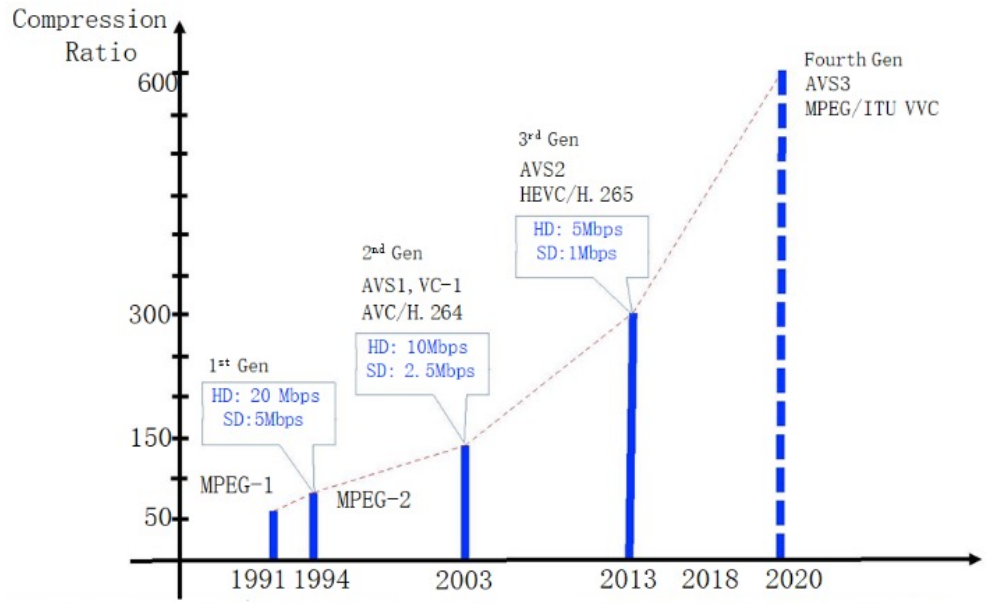
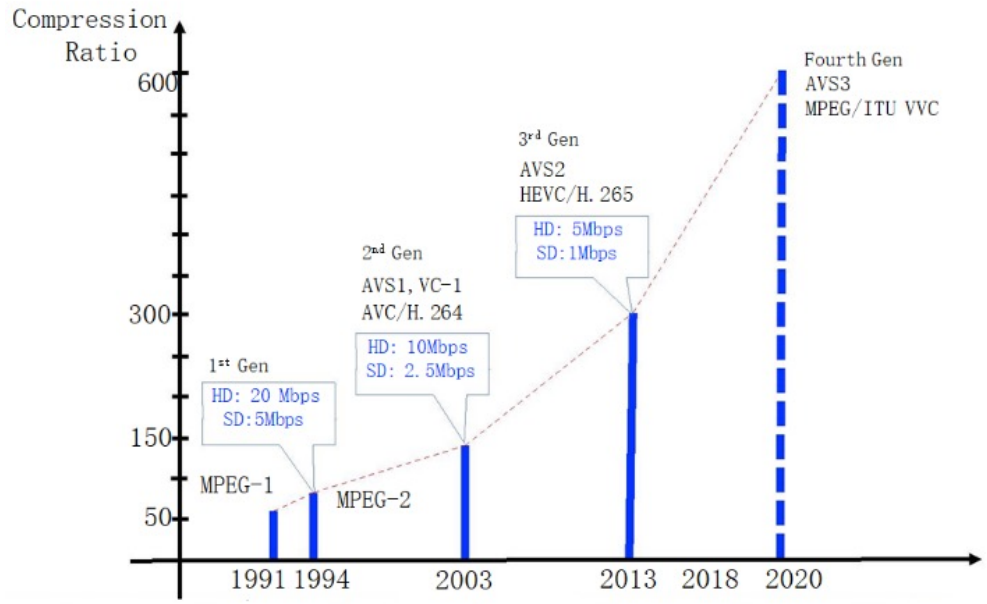


Traditional Codecs

Problem

- Image Compression
  - Trade-off between rate and distortion



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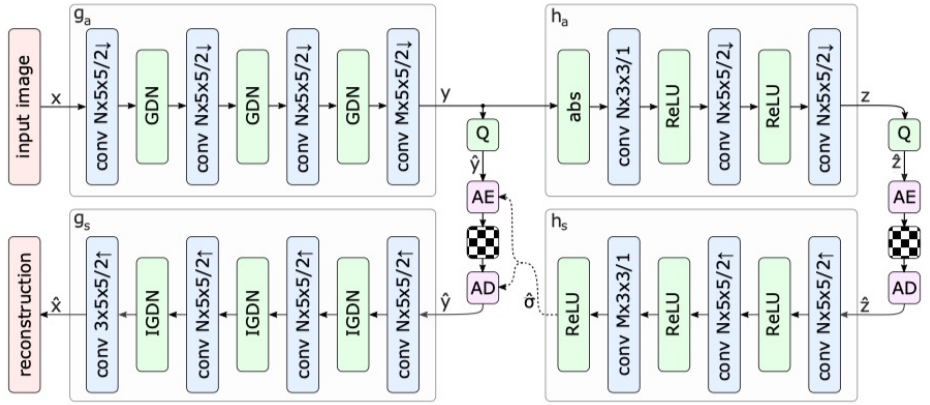
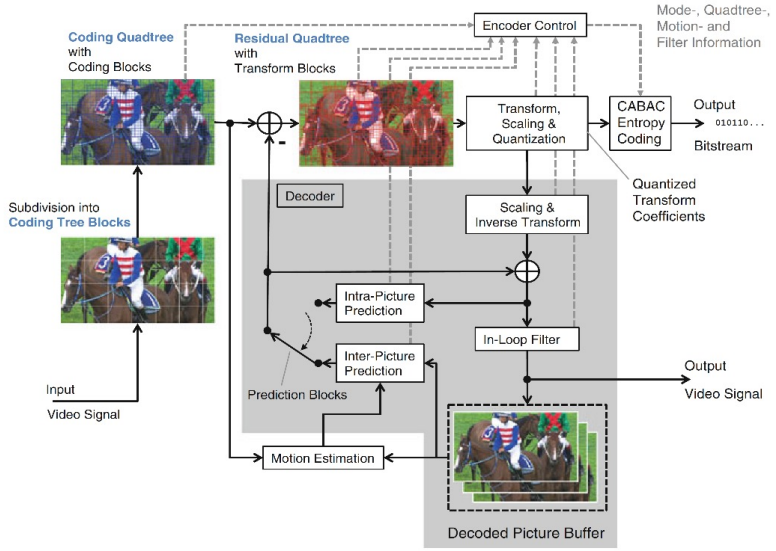


Start to surpass traditional ones!

Learning-based Codecs

Related Work

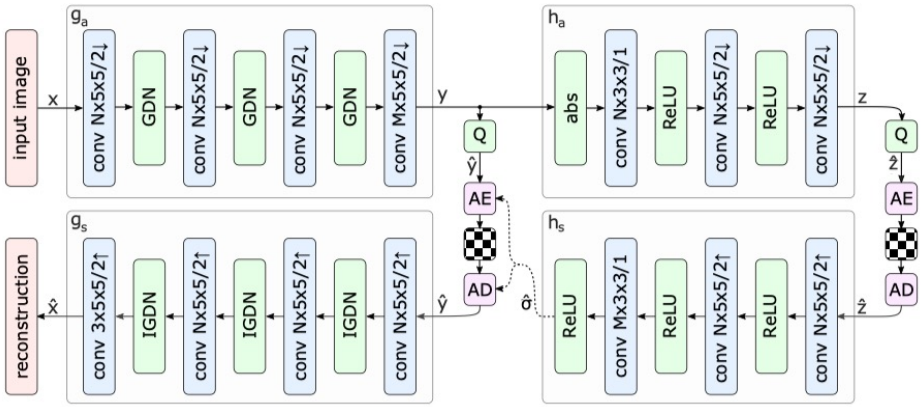


Traditional codec

JPEG, H.264, H.265/HEVC, H.266/VVC,...

Frequency Transform & reduce redundancy

DCT ,wavelet transform



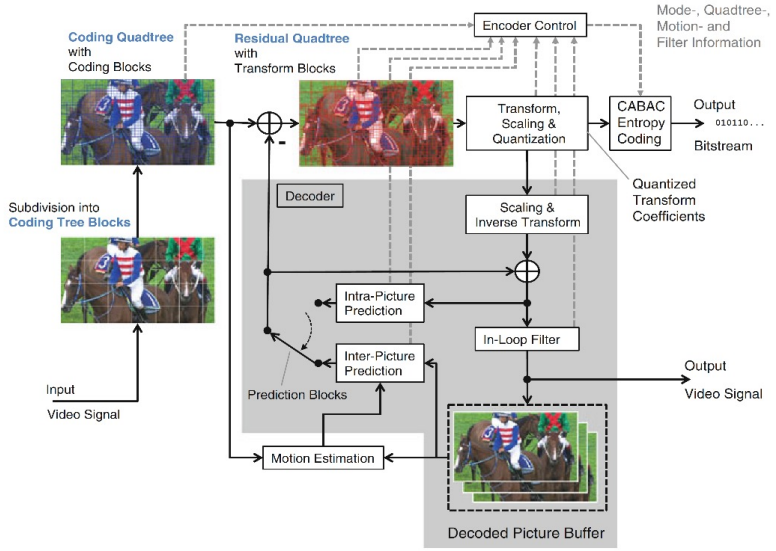
End-to-end image compression

Balle et al. 2018

Rippel et al. 2018

Agustsson et al. 2019

Related Work



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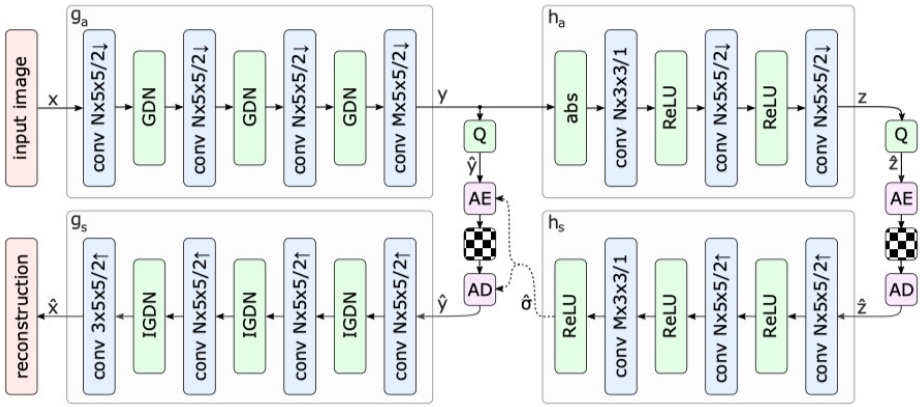

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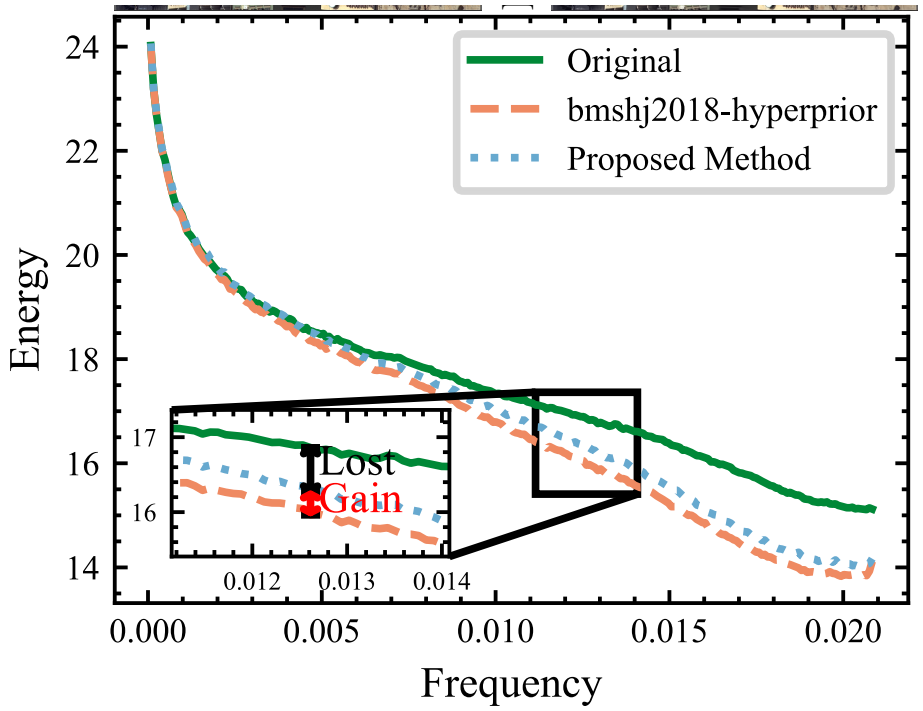
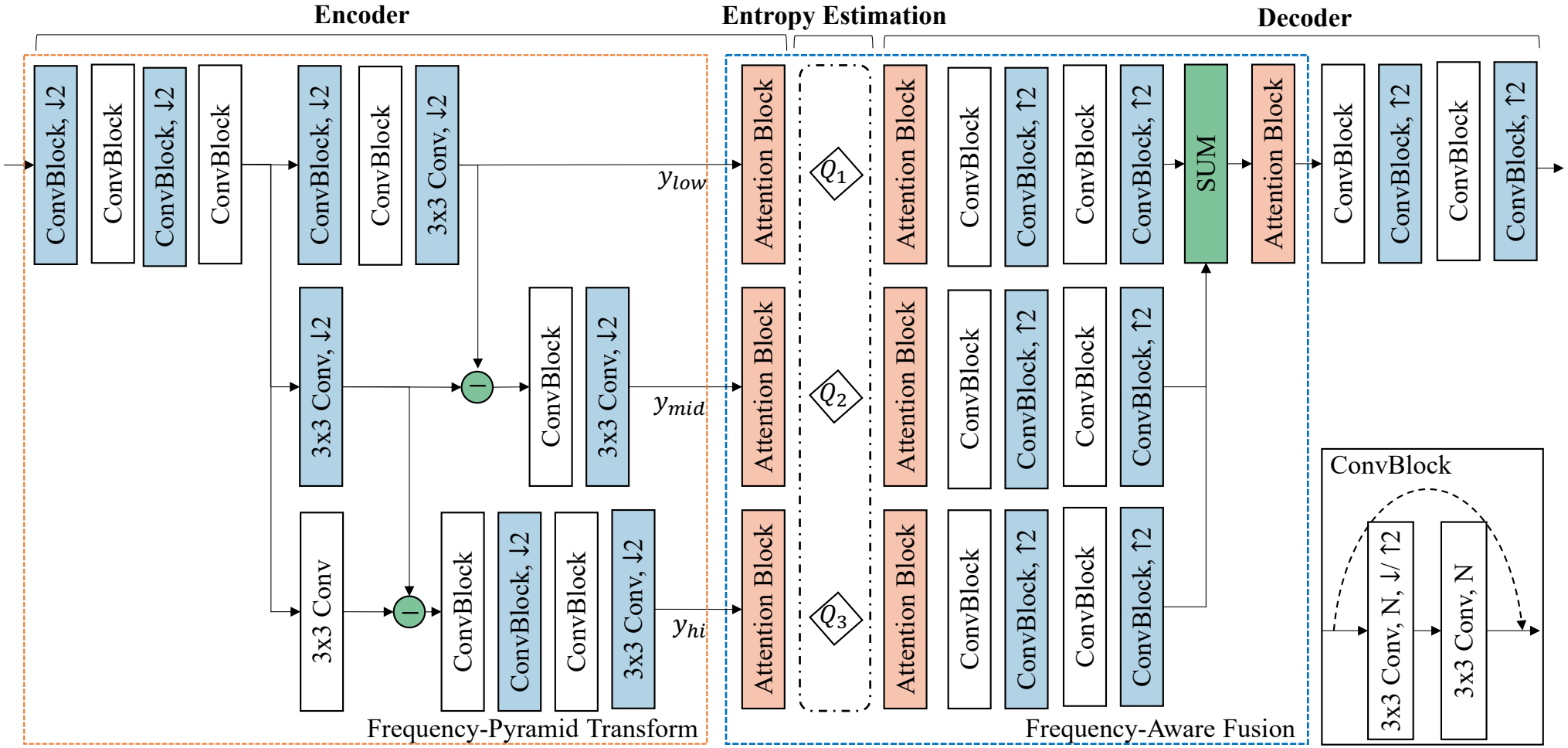
Performance & interpretability?

Frequency Domain Analysis



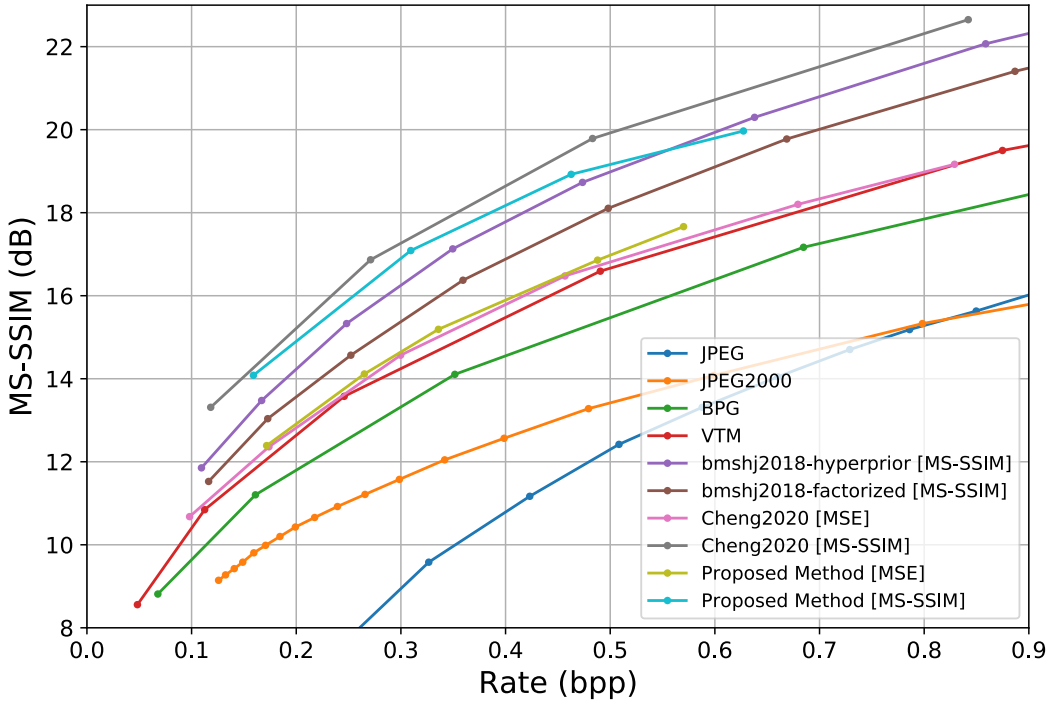
- Energy Analysis with Fourier Transform
- **Different degradation** on different frequency band
- Split Frequency band
  - Low -> lower degradation
  - Middle
  - High -> higher degradation
- Low frequency component: global shape
- High frequency component: sharp edges and fine details

Proposed Model

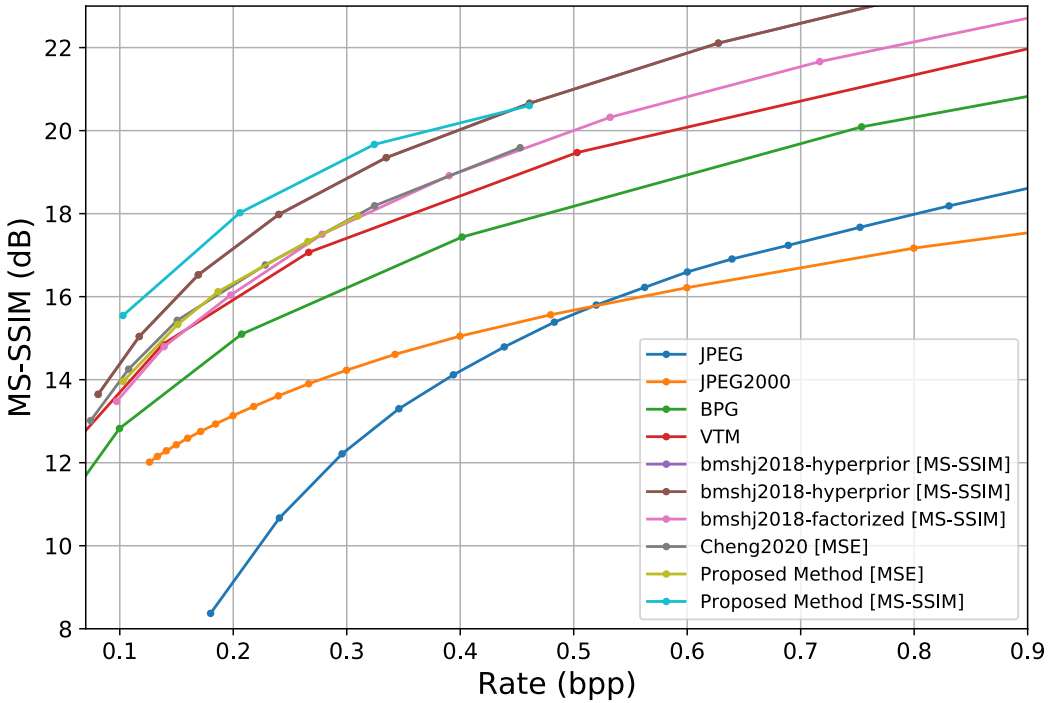


- Pyramid Structure
- Separate data distribution estimation
- Frequency transform
- Non-overlapping band split

Experimental Results



Kodak



CLIC2020 professional

Experimental Results

Original Image

High Frequency
0.125 bpp | 11.64 dB | 0.442

Middle Frequency
0.011 bpp | 11.73 dB | 0.408

Low Frequency
0.154 bpp | 19.20 dB | 0.905

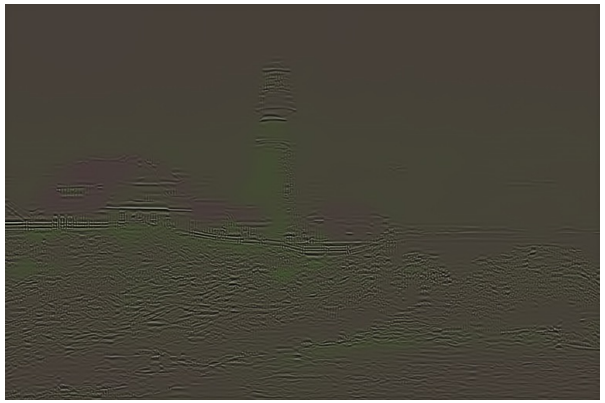
Low + Middle Frequency
0.165 bpp | 23.889 dB | 0.929

Low + High Frequency
0.279 bpp | 23.05 dB | 0.948

Low + Middle + High Frequency
0.290 bpp | 32.05 dB | 0.966

Experimental Results

Original Image



High Frequency
0.182 bpp | 11.62 dB | 0.448

Middle Frequency
0.019 bpp | 11.90 dB | 0.445

Low Frequency
0.171 bpp | 18.60 dB | 0.902

Low + Middle Frequency
0.188 bpp | 23.67 dB | 0.944

Low + High Frequency
0.354 bpp | 21.53 dB | 0.941

Low + Middle + High Frequency
0.372 bpp | 31.40 dB | 0.

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