Image Compression Formats

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JPEG

Year: 1990s

Algorithm: Discrete Cosine Transform (DCT)

Still widely used in daily life.

Most images are stored in this type of formats

JPEG2000

Year: 2000

Algorithm: Discrete Wavelet Transform (DWT)

Widely used in specialized areas, less common in daily life

HEIF

Year: 2017

Algorithm: Derived from HEVC (High-Efficiency Video Coding) / H.265

New format, increasingly used in high-quality visuals

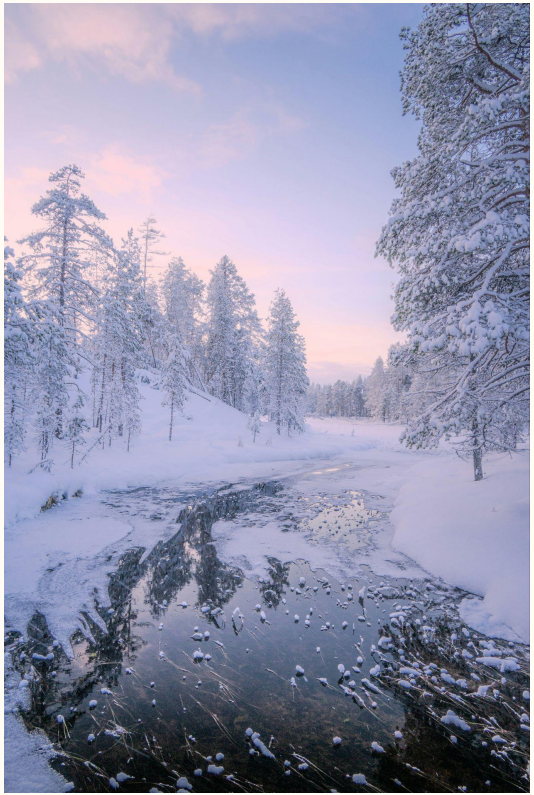
Some older systems do not support this format

Experiment 1

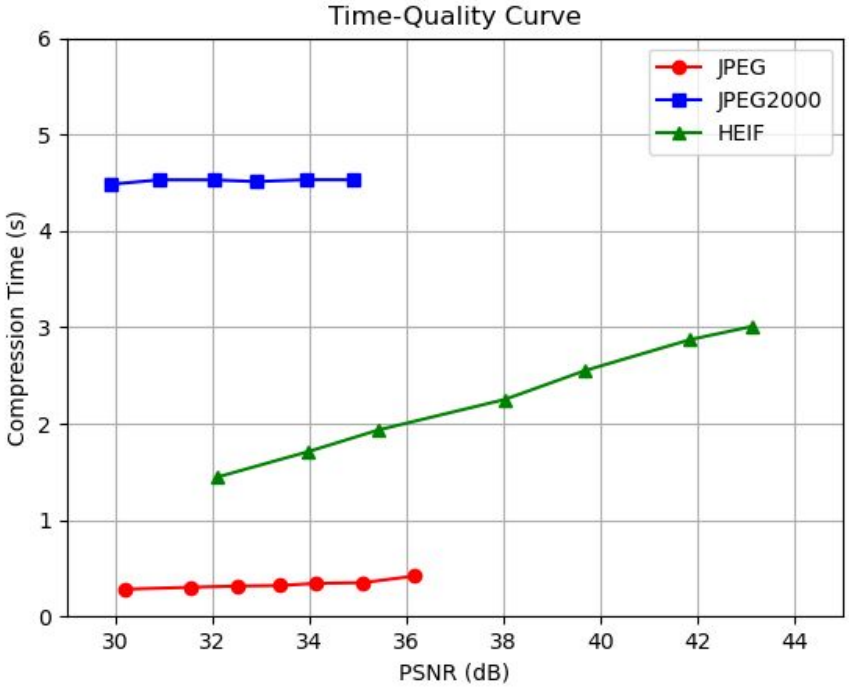
Use a photography work

Test the Ability to compress cinematic images and align with human perception.

1. Compression Time
2. Peak SNR
3. SSIM
4. Plot Quality-Ratio Curve



Time

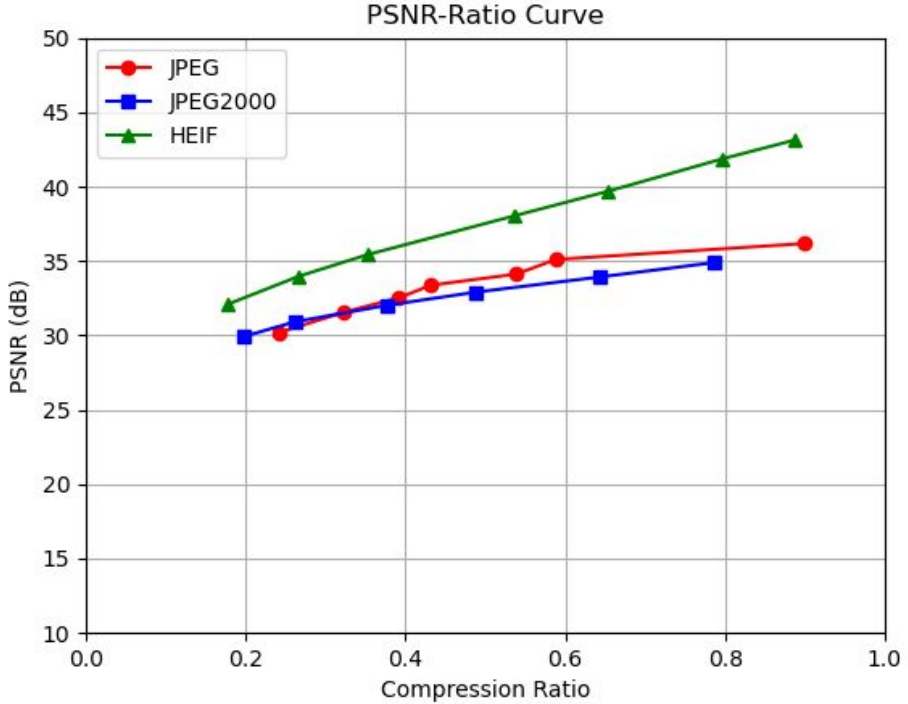


JPEG is the fastest

JPEG2000:
Compression Time is independent of the output quality

Both JPEG/HEIF take longer time for higher output quality

PSNR-Ratio Curve

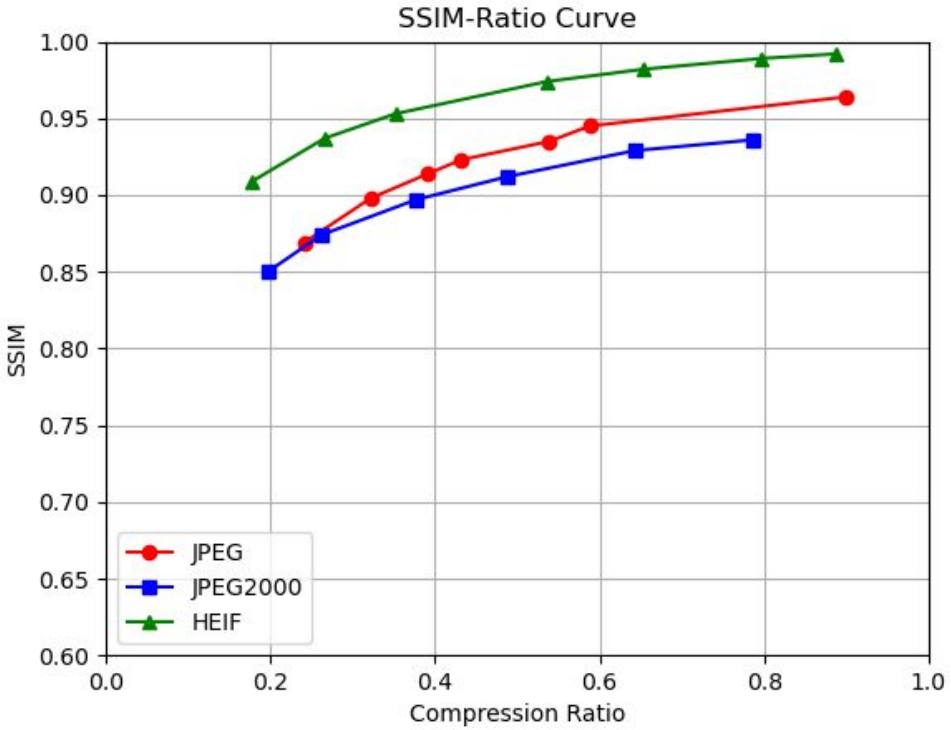


PSNR (dB):

Peak Signal-to-Noise Ratio

A mathematical metric to measure distortion.

SSIM-Ratio Curve



SSIM:

Structural Similarity Index Measure

Predicts the perceived quality of cinematic picture.

Higher SSIM indicates better quality.

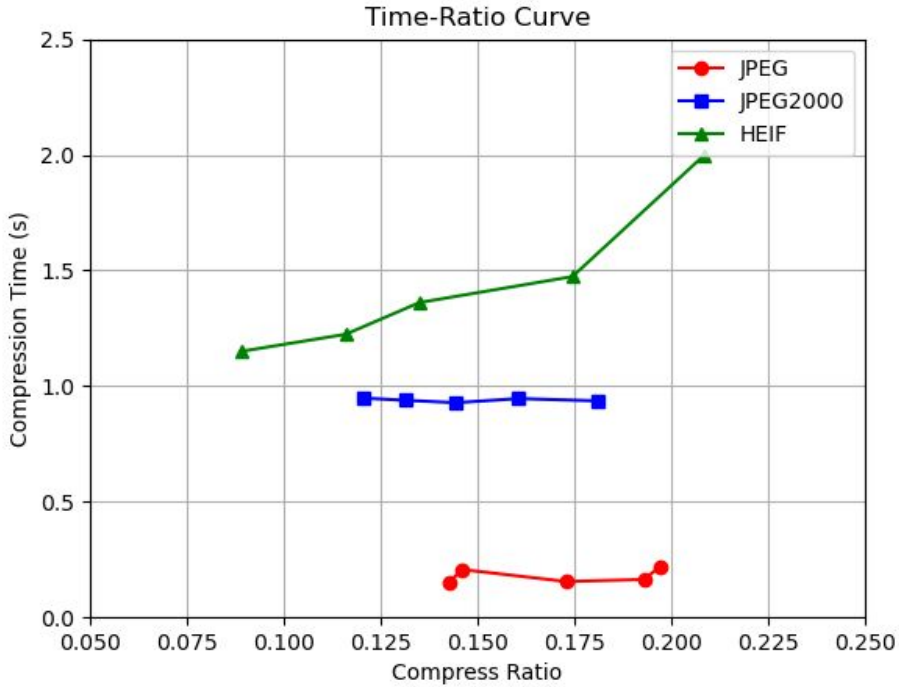
Experiment 2

Use medical imaging (X-ray / CT-scan / etc)

Test the Ability to preserve subtle grayscale gradients and critical fine details (e.g. edge clarity)

1. Compression Time
2. Gradient Difference Metric (GDM)
3. Plot Distortion-Ratio Curve

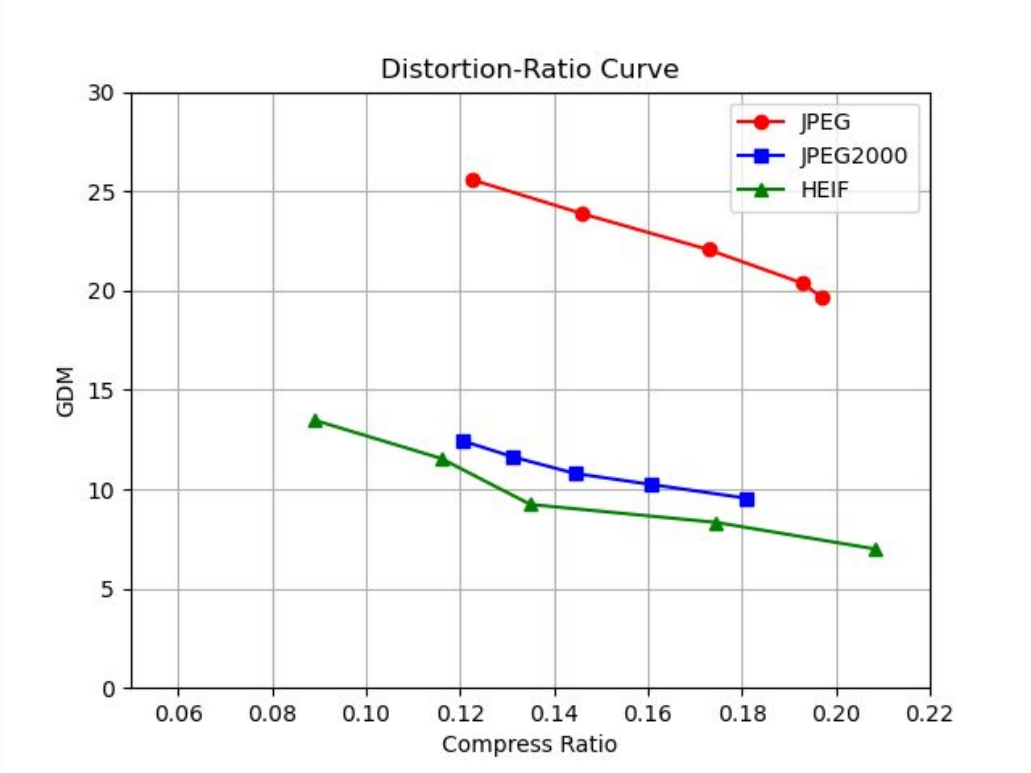
Time



JPEG is still the fastest

JPEG2000 is faster than HEIF

Distortion-Ratio Curve



Lower GDM indicates less distortion.

Other Features of JPEG2000 not explored in this project

1. Region of Interest (ROI) Encoding

   Assign more bits to ROIs

2. Resolution Scalability

   Images can be compressed and stored at multiple resolutions, allowing viewing at different zoom levels.

3. Metadata Support

   Allows embedding of comprehensive metadata directly within the image file

4. Error Resilience

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Conclusion

1. JPEG

   Quick compression. Suitable for daily use (web page, regular image display).

2. JPEG2000 (or other wavelet-based formats)

   Capable of preserving gradient details, along with other features makes it suitable for specialized applications like medical imagery, satellite imagery, etc.
   The complication makes it not widely used in daily life.

3. HEIF

   Outstanding performance

   Ideal for high quality visuals (e.g. 4k+ photography)

   Gaining hardware support like GPU acceleration (e.g. NVENC)

Questions?