Evaluation of intra-coding based image compression

Steve Göring, Alexander Raake

Audiovisual Technology Group, Technische Universität Ilmenau, Germany;
Email: [steve.goering, alexander.raake]@tu-ilmenau.de

code & demo: `https://git.io/Je0ip`

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Motivation

- increase of uploaded/shared images[1], e.g. flickr, instagram, ...
- higher resolutions, more content of different quality

$\rightarrow$ image compression review

[1] for Flickr: average 1.68 million photos per day for 2016, see
https://www.flickr.com/photos/franckmichel/6855169886/

Image Compression – status

- popular/new lossy image codecs:
  - JPEG, PNG, GIF, JPEG-2K, JPEG-XR
  - video codec based: BPG[2], HEIF [4][3], WebP[4], AVIF[5]
- most evaluation, i.e. [5, 1, 2, 4, 3]
  - small dataset (<100 images), small resolution (≤ 1MPix), mostly PSNR, SSIM
- intra-frame compression-quality vs. JPEG in case of high resolution images

  → large scale evaluation

[2] https://bellard.org/bpg/
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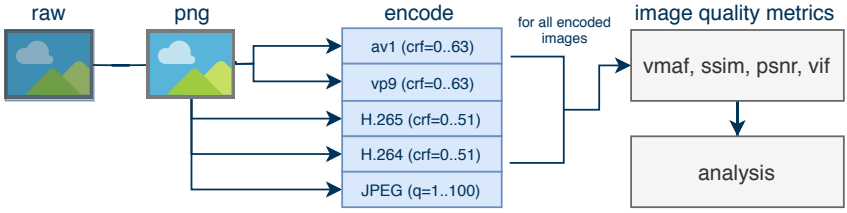
Our Approach



- raw images: wesaturate.com; all raw images of $\leqq$ year 2018
- remove duplicates, unify to PNG: 1133 images
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  - all possible settings CRF settings: $\approx 380k$ encoded imgs
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- quality metrics: **VMAF**, SSIM, PSNR, VIF

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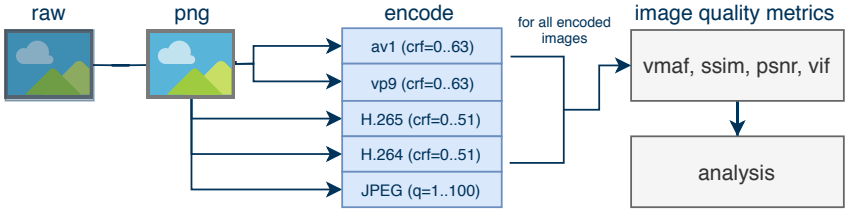

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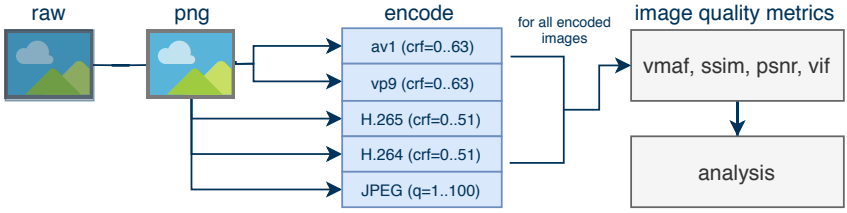

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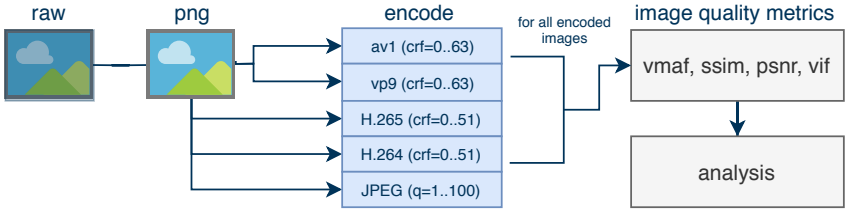

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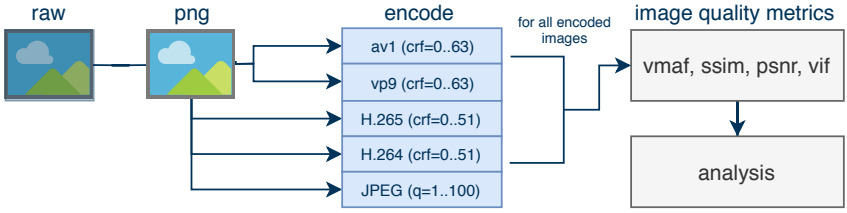

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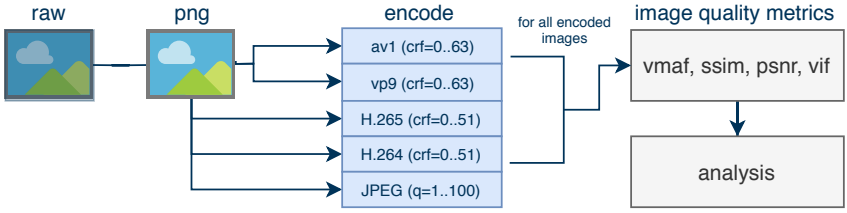

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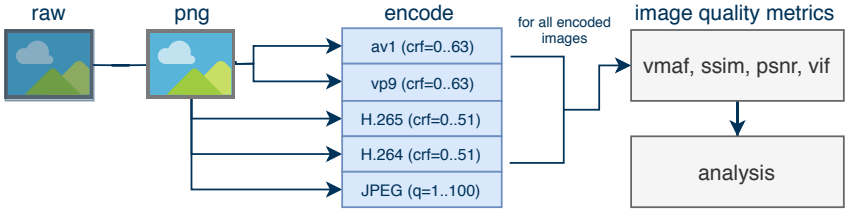

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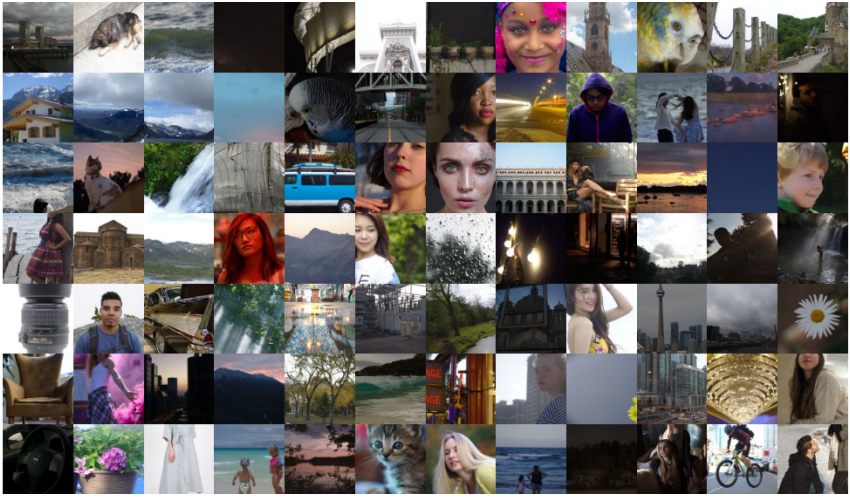
Evaluation – Dataset (sample)

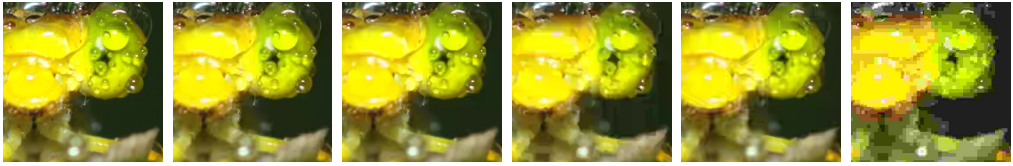


- CC0 licenced images; 36GB; **download:**
  `https://zenodo.org/record/3459357#.XbdXVd-YWvZ`
- mean height/width 3980 to 4375 pixel

Evaluation – Visual Comparison (1)

- left: av1: crf=63, right: jpeg quality=1; $ql = 0$

Evaluation – Visual Comparison (2)



(a) Source (83 MB)

(b) VP9 (15 KB) PSNR=45.36

(c) AV1 (11 KB) PSNR=45.87

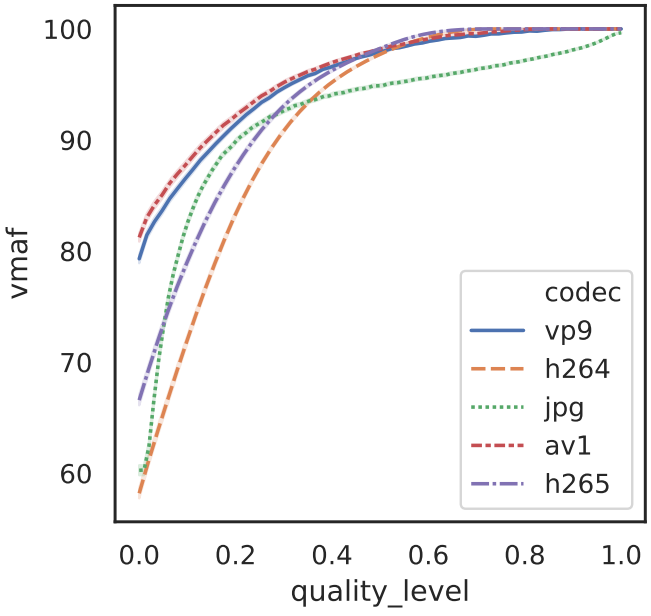
(d) H.264 (19 KB) PSNR=39.74

(e) H.265 (17 KB) PSNR=42.72

(f) JPEG (110 KB) PSNR=32.26

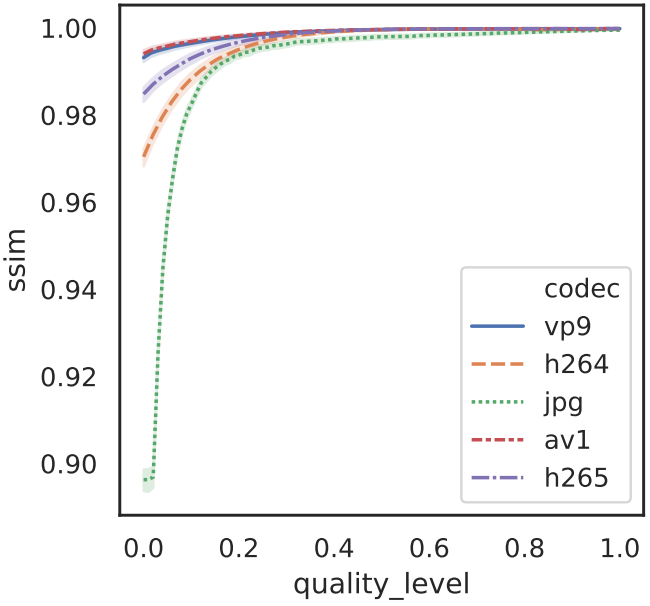
- 360p center crop with $ql = 0$

Evaluation – Quality-level vs. Quality (VMAF)



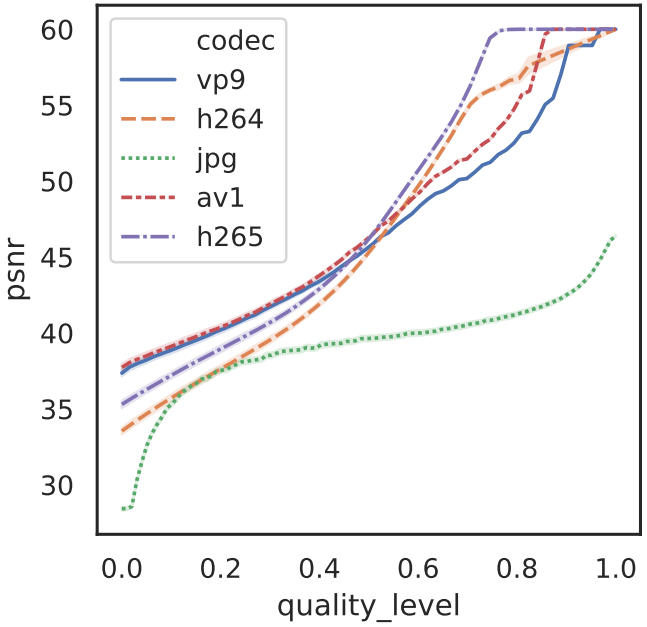
- AV1 $\approx$ VP9,
- H.265 $>$ H.264
- JPEG $<$ AV1,VP9

Evaluation – Quality-level vs. Quality (SSIM)



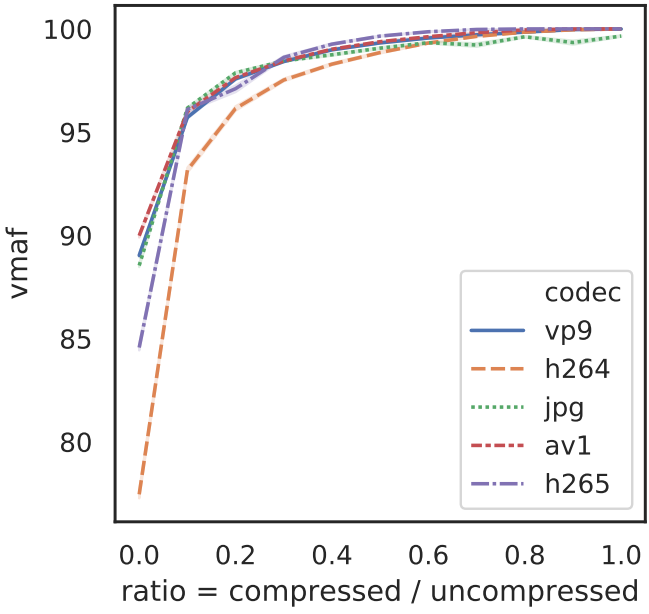
- AV1 $\approx$ VP9 $>$ H.265,
- H.265 $>$ H.264 $>$ JPEG

Evaluation – Quality-level vs. Quality (PSNR)



- JPEG worst

Evaluation – Quality-level vs. Compression



- $cr = FS(I)/FS(R)$,
- I lossy compressed,
- R lossless
- FS: filesize
- AV1 $\geqq$ JPEG

Conclusion, Summary and Future Work

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- evaluated different intra-coding based image compression methods
  - quality & compression: **AV1**|VP9 > H.265 > H.264 > JPEG
- large raw image dataset
  - 1133 images; high resolution; user content
- open and next steps:
  - evaluate image resolution as parameter
  - include other image codecs; subjective test

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Thank you for your attention

. . . . . are there any questions?

References I

[1] Umar Albalawi, Saraju P Mohanty, and Elias Kougianos. "A hardware architecture for better portable graphics (BPG) compression encoder". In: *2015 IEEE International Symposium on Nanoelectronic and Information Systems*. IEEE. 2015, pp. 291–296.

[2] Abhilash Antony and G Sreelekha. "HEVC-based lossless intra coding for efficient still image compression". In: *Multimedia Tools and Applications* 76.2 (2017), pp. 1639–1658.

[3] Nathan E Egge et al. "Using Daala intra frames for still picture coding". In: *Proceedings of Picture Coding Symposium*. 2015.

[4] Jani Lainema et al. "HEVC still image coding and high efficiency image file format". In: *2016 IEEE International Conference on Image Processing (ICIP)*. IEEE. 2016, pp. 71–75.

References II

[5] Maurizio Pintus et al. “Objective evaluation of webp image compression efficiency”. In: *International Conference on Mobile Multimedia Communications*. Springer. 2011, pp. 252–265.