Supplementary Materials

A. Comparison in Different Datasets

We compare the compression performance of our model on Kodak, ImageNet, and Cityspace datasets, as shown in Fig. 1. Overall, the performance on different test datasets only has subtle differences. In general, our method can achieve good results in a variety of different datasets.

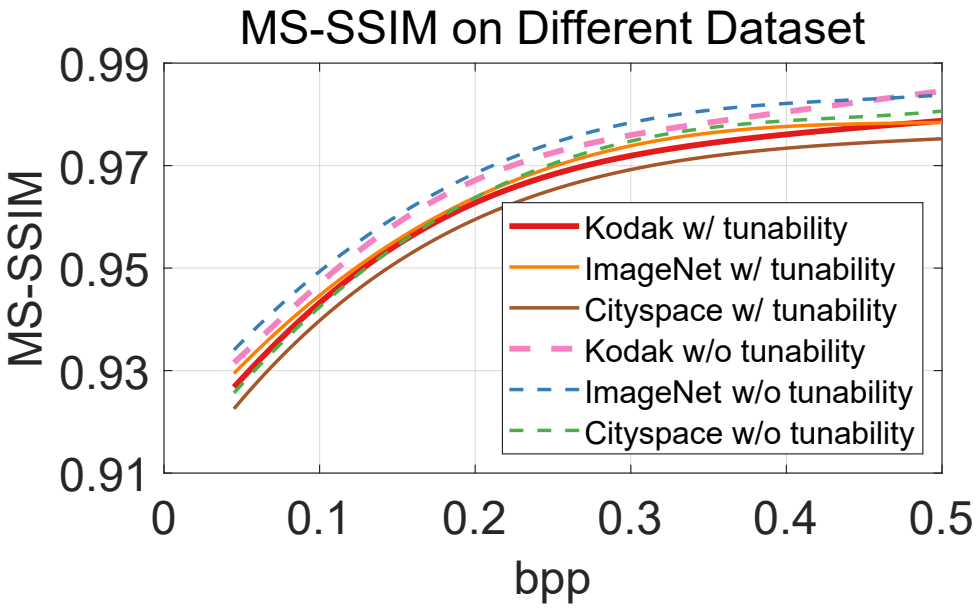


Figure 1. Comparison of the performance of our tunable and non-tunable methods tested on three datasets —— Kodak, ImageNet, and Cityspace. In the figure, the abscissa *bpp* represents the compression ratio, and the ordinate MS-SSIM characterizes the image quality.

B. Comparison of Visual Effects

Firstly, we compare our method with JPEG [4], JPEG 2000 [3], BPG as well as the content-based method of Fabian Mentzer et al. [2] visually. The GAN is applied to our model to compensate for the severe distortion caused by insufficient bit allocation in non-important regions at low *bpp*. Therefore, compared with other methods, our method preserves the details of the texture, color, and structure of images for a better visual experience. For example, in Fig. 2, our model generates the clearest purple flag on the sailboat. Moreover, the text on the sailboat in our model is preserved better than that of other methods except for BPG and JPEG2000. Nevertheless, there are many blurred blocks on the sea surface when using BPG and JPEG2000, which dramatically affects the visual experience. In Fig. 3, our model keeps the details of the cracks on the door better and more realistic than the others. In Fig. 4, the details of the fences in the method of Fabian Mentzer et al. are almost lost, and the image compressed by BPG has a lot of ambiguity on the coast and the clouds. Our method overcomes the above flaws by reconstructing the information in the non-important regions. In Fig. 5, the details of the face region in our model are preserved better and closer to the original image, while the images compressed by other methods are blurred, and the texture information of the face and sweater is nearly missing. In Fig. 6 and Fig. 7, the cracks in the wall and the hair of the woman are more clearly visible in our method. In Fig. 8, our reconstructed lawn looks better than others, and there are a lot of blurred blocks in the lawn of BPG, which greatly affects the visual experience.

(a) Original 24 *bpp* (b) Jpeg 0.147 *bpp* (c) Jpeg2000 0.152 *bpp*

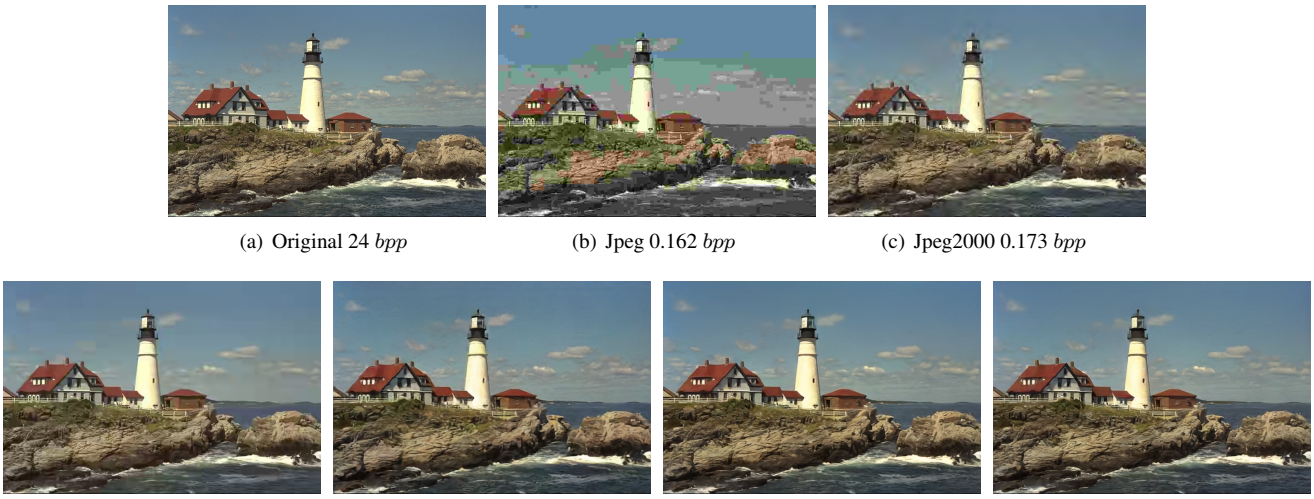
(d) Bpg 0.124 *bpp* (e) Mentzer et al. 0.156 *bpp* (f) Tunable 0.134 *bpp* (g) Not tunable 0.113 *bpp*

Figure 2. Illustration of the original image and the reconstructed images produced by different compression methods.

(a) Original 24 *bpp* (b) Jpeg 0.148 *bpp* (c) Jpeg2000 0.166 *bpp*

(d) Bpg 0.117 *bpp* (e) Mentzer et al. 0.145 *bpp* (f) Tunable 0.125 *bpp* (g) Not tunable 0.118 *bpp*

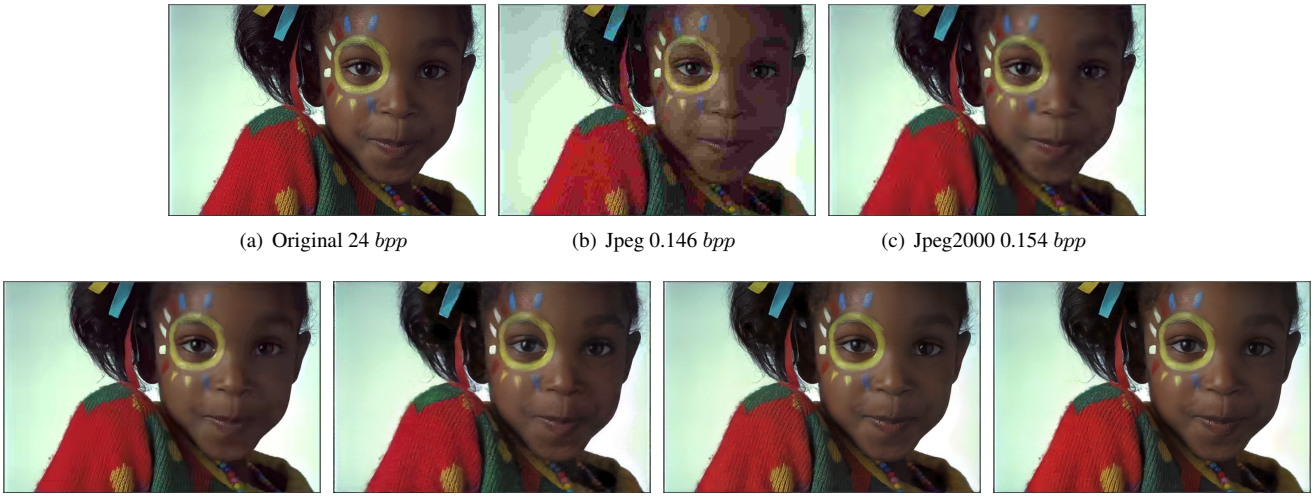
Figure 3. Illustration of the original image and the reconstructed images produced by different compression methods.



(a) Original 24 *bpp* (b) Jpeg 0.162 *bpp* (c) Jpeg2000 0.173 *bpp*

(d) Bpg 0.156 *bpp* (e) Mentzer et al. 0.155 *bpp* (f) Tunable 0.126 *bpp* (g) Not tunable 0.113 *bpp*

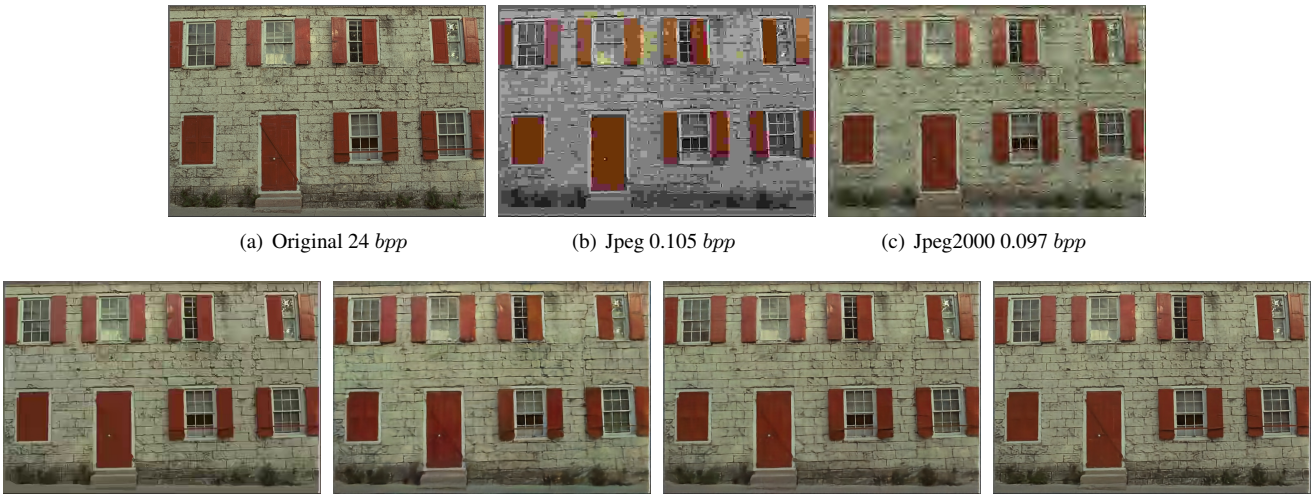
Figure 4. Illustration of the original image and the reconstructed images produced by different compression methods.



(a) Original 24 *bpp* (b) Jpeg 0.146 *bpp* (c) Jpeg2000 0.154 *bpp*

(d) Bpg 0.123 *bpp* (e) Mentzer et al. 0.145 *bpp* (f) Tunable 0.130 *bpp* (g) Not tunable 0.116 *bpp*

Figure 5. Illustration of the original image and the reconstructed images produced by different compression methods.



(a) Original 24 *bpp* (b) Jpeg 0.105 *bpp* (c) Jpeg2000 0.097 *bpp*

(d) Bpg 0.152 *bpp* (e) Mentzer et al. 0.135 *bpp* (f) Tunable 0.126 *bpp* (g) Not tunable 0.119 *bpp*

Figure 6. Illustration of the original image and the reconstructed images produced by different compression methods.

(a) Original 24 *bpp* (b) Jpeg 0.090 *bpp* (c) Jpeg2000 0.101 *bpp*

(d) Bpg 0.143 *bpp* (e) Mentzer et al. 0.141 *bpp* (f) Tunable 0.132 *bpp* (g) Not tunable 0.122 *bpp*

Figure 7. Illustration of the original image and the reconstructed images produced by different compression methods.

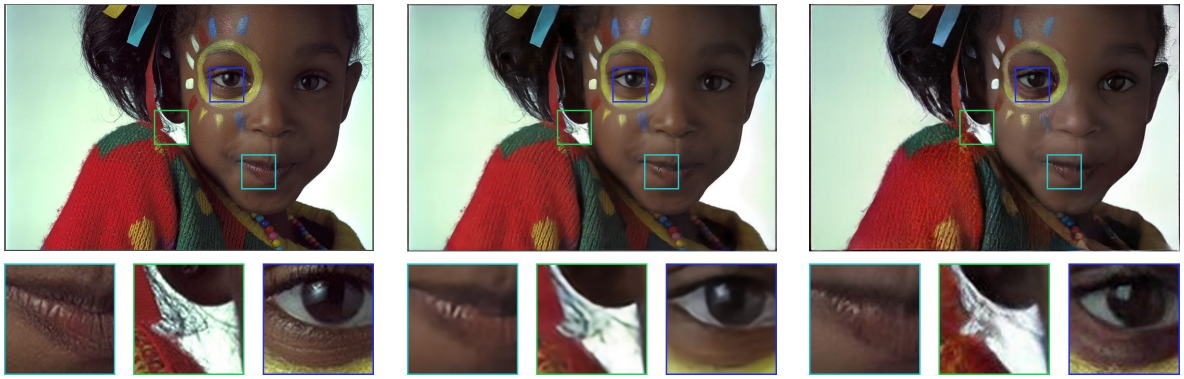
(a) Original 24 *bpp* (b) Jpeg 0.096 *bpp* (c) Jpeg2000 0.093 *bpp*

(d) Bpg 0.146 *bpp* (e) Mentzer et al. 0.144 *bpp* (f) Tunable 0.131 *bpp* (g) Not tunable 0.116 *bpp*

Figure 8. Illustration of the original image and the reconstructed images produced by different compression methods.

The following is the comparison with the start of the art GAN-based image compression method at extremely low *bpp*. At low *bpp*, [1] mainly relies on GAN to reconstruct images, but the generating characteristic of GAN is often uncontrollable. Therefore, as shown in Fig. 9(a), the text on the hat looks like a mass of black, and the shape of the yellow hat is distorted in method [1]. However, our method overcomes the above drawbacks, more bits are allocated to those important regions, ensuring the consistency of the object structure, shape, and color with the original image. In Fig. 9(b), measured by MS-SSIM, the performance of our method is better than [1]. They rely heavily on the generation of GAN, so their reconstructed images are harmonious but far from the original images.

(a) *bpp* / MS-SSIM: Ours 0.038 / 0.926, Agustsson et al. 0.035 / 0.852



(b) *bpp* / MS-SSIM: Ours 0.071 / 0.932, Agustsson et al. 0.067 / 0.874

Figure 9. Illustration of comparison with the state of the art GAN-based method. From left to right: Original, Ours, Agustsson et al.

References

[1] E. Agustsson, M. Tschannen, F. Mentzer, R. Timofte, and L. Van Gool. Generative adversarial networks for extreme learned image compression. *arXiv preprint arXiv:1804.02958*, 2018.

[2] F. Mentzer, E. Agustsson, M. Tschannen, R. Timofte, and L. Van Gool. Conditional probability models for deep image compression. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, pages 4394–4402, 2018.

[3] A. Skodras, C. Christopoulos, and T. Ebrahimi. The jpeg 2000 still image compression standard. *IEEE Signal processing magazine*, 18(5):36–58, 2001.

[4] G. K. Wallace. The jpeg still picture compression standard. *IEEE Transactions on consumer electronics*, 38(1):xviii–xxxiv, 1992.