2022 International Symposium on Nonlinear Theory and Its Applications,
NOLTA2022, Virtual, December 12-15, 2022

Hierarchical Lossless Compression Method for Color Images using CNN predictors

Hideharu TODA†, Hisashi AOMORI†, Tsuyoshi OTAKE‡, Ichiro MATSUDA∗ and Susumu ITOH∗

†Department of Electrical and Electronic Engineering, Chukyo University
101–2, Yagoto Honmachi, Syouwa-ku, Nagoya, Aichi, 466–8666 Japan
‡Faculty of Engineering, Tamagawa University
6–1–1 Tamagawagakuen, Machida, Tokyo, 194–8610 Japan
∗ Department of Electrical Engineering, Tokyo University of Science
2641 Yamazaki, Noda, Chiba, 278–8510 Japan
Email: h-toda@sist.chukyo-u.ac.jp

Abstract—We have been studying a hierarchical lossless compression method using cellular neural network (CNN) predictors. In our previous work [1], we confirmed that our method has better compression performance for grayscale images than the conventional methods. However, the framework of [1] is not able to compress color images efficiently. Color images are now commonly used in general, similarly in fields where hierarchical lossless encoding is required (e.g., motion picture editing and medical images). Therefore, modification of [1] for color images is indispensable. In this paper, we propose the hierarchical lossless compression method for color images using CNN predictors. In general, the selection of color space in encoding is important in terms of compression ratio. The RGB color space has the advantage of being able to use correlation between channels. However, the CNN prediction used in our method has difficulty utilizing correlation between color channels. By contrast, the YCoCg-R (integer-reversible) color space [2] is known to have good coding efficiency, although it has the disadvantage of expanding the dynamic range of the color difference signals. Therefore, proposed method adopts the YCoCg-R color space. In addition, the histogram packing technique is employed to deal with the expanded dynamic range of color difference signals (Co and Cg). Fig. 1 shows a schematic diagram of the proposed method. Firstly, the color space of the input image is converted from RGB to YCoCg-R. Secondly, in order to reduce the dynamic range of each channel, our proposed method employs the histogram packing technique. Then, the histogram-packed channels are encoded separately by modified [1]. Lastly, the encoded data of each channel is merged to obtain the final compressed data. Table 1 shows the results of coding experiments on the test images shown in Fig. 2. From experimental results, we confirmed that proposed method has better coding performance than conventional methods.

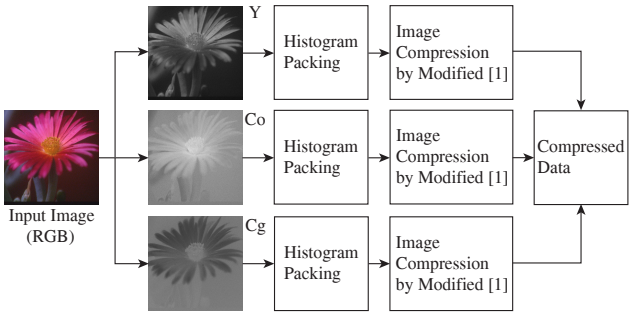

Figure 1: Schematic diagram of the proposed method

(a) Fiore (b) Portofino (c) Raiz1

(d) Safari04 (e) Toucan

Figure 2: Test images

Table 1: Coding performance of each method [bit/pel]

Image	Proposed	FLIF	WebP	JPEG 2000
Fiore	16.510	16.712	**16.053**	16.887
Portofino	**16.212**	16.288	16.289	16.571
Raiz1	10.271	**10.233**	10.896	11.234
Safari04	5.792	**5.627**	6.222	6.363
Toucan	**6.430**	6.454	6.900	7.092
Average	**11.043**	11.063	11.272	11.629

ORCID iDs Hideharu TODA: 0000-0001-8727-4714, Hisashi AOMORI: 0000-0002-4934-2824, Tsuyoshi OTAKE: 0000-0002-0721-5034

References

[1] Y. Kawai, H. Toda, H. Aomori, T. Otake, I. Matsuda, and S. Itoh, "Hierarchical Lossless Image Compression using CNN Predictors Optimized by Adaptive Differential Evolution and Context-Adaptive Coding," *The 2020 International Symposium on Nonlinear Theory and its Applications (NOLTA 2020)*, pp. 65–67, Nov. 2020.

[2] H. S. Malvar and G. J. Sullivan, "YCoCg-R: A Color Space with RGB Reversibility and Low Dynamic Range," ITU-T/ISO/IEC JVT Document JVT-I014, Jul. 2003.