Study on image encoding considered focus area of still image

Kaiya Shimura (Faculty of Production Systems Engineering and Sciences, Komatsu University, kaiya.s0420@gmail.com, Japan)
Shinichi Funase (Faculty of Production Systems Engineering and Sciences, Komatsu University, shinichi.funase@komatsu-u.ac.jp, Japan)
Haruhiko Kimura (Faculty of Production Systems Engineering and Sciences, Komatsu University, haruhiko.kimura@komatsu-u.ac.jp, Japan)
Takashi Oyabu (Nihonkai International Exchange Center, oyabu24@gmail.com, Japan)

Abstract

The fundamental objective of image encoding is to transfer the image at high speed and transmit the image contents clearly. It is essential to reduce the use of memory capacity in the study on high speed transmission of images. However, the transfer time is determined by the total time of the following items: namely, encoding time, transfer time, and time to return to original image. Therefore, the investigation of high speed processing for encoding is also important. A consideration on image encoding is examined in this study, in which notable parts in a still image can be easily identified. The encoding process of an image, in which the notable parts are considered, is proposed specifically in this study, and a smoothing process is also proposed to decrease the image size and processing time so as not to degrade the image quality with the naked eye as much as possible. Moreover, this study proposes to increase the quality for high complexity images and degrade the quality for low image quality. Objects are extracted from the original image in the image encoding considering the notable parts and the original image is processed to understand easily using 'outputting still image.' And, the effectiveness of the proposed method is made clear by conducting comparative experiments with related other image encoding methods.

Key words

image encoding, notable part, detecting object, compression of JPEG image, smoothing process

1. Introduction

Image encoding has been considered in the order of binary, multiple value and video (Shinjo, 2011; Ishikawa, 2013; Yizawa, 2022). Videotex (VTX) was invented in the 1970s, which used a telephone line as an information service. Although various types of VTX systems were invented in England, Canada and Japan etc., those systems did not spread because the image display was limited only at receiving data. After the Consulting Committee of International Telegraph & Telephone (CCITT) standardized VTX in 1984, JPEG (Joint Photographic Experts Group) was set up as an image coding standardization team in 1986 and promoted the standardization. Then, the standardized JPEG became popular with the spread of digital cameras and the Internet, and it became the mainstream of the standardized still image since 1992, and it is still used today. There are two types of compression in image encoding, i.e., reversible and irreversible compressions. JPEG adopts the irreversible type, namely the compressed image using JPEG standard cannot revert to the original image (Sungrove, 2022). In image compression using discrete cosine transform (DCT) such as JPEG, the appearance probability of code bits associated with DCT coefficients is constant, and its compression is an issue. JPEG adopts the transform and the compression is a subject (Suzuki, 2021).

An image encoding considered focus area is proposed in this study and a smoothing process is also proposed to decrease the image size and processing time so as not to degrade the image quality with the naked eye as much as possible. Moreover, this study proposes to increase the quality for high complexity images and degrade the quality for low image quality.

2. Proposal

2.1 Proposal 1

An object is extracted from the original image, and the compression accuracy of the object is maximized to 95 and the accuracy of the image background is minimized to 0. The object stands out from the outputted still image and it can be determined at a glance. In the process, (1) prepare the original image, (2) the object is extracted by extracting contours, (3) prepare the original image in which the compression accuracy of background is 0, and (4) the targeting compression image generates by combining the processes (2) and (3).

2.2 Proposal 2

This proposal is an upgrade type of Proposal 1. The background processing is speeded up by changing item (3) in Proposal 1 to the smoothing process for the original image.

2.3 Proposal 3

The quality for a high complexity image is increased and it is reduced for a low complexity one. Specifically, the complicity C is expressed in the following equation when the number of pixels per one screen is 64 × 64 and the value of the number is maximum (255) .

$C = 10\sqrt{w}$

At this time, the smoothing filter size is adjusted according to the value of C. In other words, the filter size is reduced as the value of C increases and the size is increased when the value of C decreases conversely. The filter size takes (3, 3) for the targeting image having the maximum value of C and the size takes (9, 9) for the one having a minimum value of C.

3. Experiment

3.1 Experiment 1

Experiment 1 is for Proposal 1. For the image of (256, 256) size, holding the object image compression accuracy at 95 of the maximum, then each JPEG compression image was created when the compression accuracy of the background changed to 0, 25, 50, and 75. And, the processing time, image size, and reduction ratio in that time were derived.

Figure 1: Image with background compression accuracy of 0 in Experiment 1

Figure 2: Image with background compression accuracy of 25 in Experiment 1

Figure 3: Image with background compression accuracy of 50 in Experiment 1

Figure 4: Image with background compression accuracy of 75 in Experiment 1

Table 1: Processing time, image size, and reduction rate in Experiment 1

The background compression accuracy	0	25	50	75
Processing time				
Background processing* (s)	0.003469	0.003827	0.00399	0.006487
Detecting object (s)	0.000358	0.000358	0.000357	0.000358
Combining (s)	0.108879	0.106876	0.105618	0.107178
Total (s)	0.11266	0.111061	0.109965	0.11403
Image size				
Original image (B)	29433	29433	29433	29433
Background** (B)	8784	15637	18493	21985
Image after compression (B)	21910	23709	24815	26085
Reduction rate				
Reduction bytes (B)	7523	5724	4618	3348
Compression rate (%)	74.4403	80.5524	84.3101	88.625
Reduction rate (%)	25.5597	19.4476	15.6899	11.375

Notes: * Required time for compressing the full original image with a background compression accuracy. ** Image size when the full original image is compressed with a background compression accuracy.

3.1.1 Result

The created images are shown in Figure 1 to 4. Also, the processing time, image size, and reduction ratio are shown in Table 1.

3.2 Experiment 2

Experiment 2 is for Proposal 2. For the image of (256, 256) size, holding the object image compression accuracy at 95 of the maximum, then each JPEG compression image was created when the background processing of the smoothing filter size changed to (3, 3), (5, 5), (7, 7), and (9, 9). And, the processing time, image size, and reduction ratio in that time were derived.

3.2.1 Result

The created images are shown in Figure 5 to 8. Also, the

Figure 5: Image with the smoothing filter of (3, 3) in Experiment 2

Figure 6: Image with the smoothing filter of (5, 5) in Experiment 2

Figure 7: Image with the smoothing filter of (7, 7) in Experiment 2

Figure 8: Image with the smoothing filter of (9, 9) in Experiment 2

Table 2: Processing time, image size, and reduction rate in Experiment 2

Smoothing filter size	(3,3)	(5,5)	(7,7)	(9,9)
Processing time				
Background processing* (s)	0.001699	0.001666	0.001755	0.001687
Detecting object (s)	0.003277	0.000928	0.000974	0.000902
Combining (s)	0.109784	0.147832	0.136168	0.113602
Total (s)	0.114761	0.150426	0.138897	0.11619
Image size				
Original image (B)	29433	29433	29433	29433
Background** (B)	21625	18499	16840	15661
Image after compression (B)	26442	25570	25221	25011
Reduction rate				
Reduction bytes (B)	2991	3863	4212	4422
Compression rate (%)	89.8379	86.8753	85.6895	84.976
Reduction rate (%)	10.1621	13.1247	14.3105	15.024

Notes: * Required time for compressing the full original image with a smoothing filter size. ** Image size when the full original image is compressed with a smoothing filter size.

processing time, image size, and reduction rate are shown in Table 2.

3.3 Experiment 3

Experiment 3 is for Proposal 3. This is an experiment of smoothing by complexity of the image. The detecting object is not derived. For the image of (256, 256) size, the image compression accuracy is set to 95 of the maximum. Figure 9 (a) to 12 (a) were used as original images, and the complexity of the image was derived and the target image was created with a corresponding smoothing filter size. In this case, the binary original image was obtained. A binary original image is obtained by binarizing the original image by converting pixel values of less than 255 to 0 (white when 255, black when 0). And, the processing time, image size, and reduction rate were derived.

3.3.1 Result

The created images are shown in Figure 9 to 12. Also, the processing time, image size, and reduction rate are shown in Table 3.

4. Conclusion

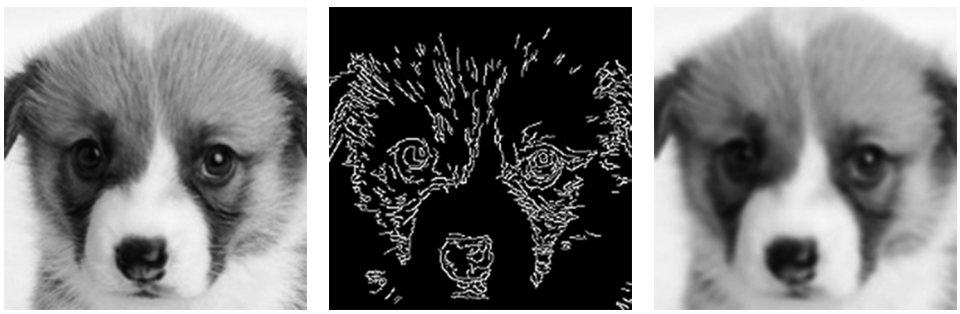
It was confirmed to understand an object easily in Experiment 1 by the method of Proposal 1 (refer to Figure 1). Small changes were also observed after compressing the image in which the accuracies of the compressed background are 25, 50, and 75 (Figure 2 to 4). The time required to synthesize the image is a little longer, although it takes a short time to process the image background and detect the object. In regarding image size, the rate of reduction is 25.56 % in the method of Proposal 1. The reduction rates are 19.45, 15.69 and 11.38 % and the accuracies of the compressed background are 25, 50, and 75 respectively.

In Experiment 2, it was confirmed that the image process of the background is accelerated by the smoothing process in the method of Proposal 2. In particular, the following cases are compared: namely, the case that the accuracies of the compressed background is 50 in Experiment 1, and the case that the filter size of smoothing is (9, 9) in Experiment 2. The reduction rates are approximately the same value in the experiments. The reduction rate is 15.69 % and the processing time of background image is 0.0044 sec in the former. In the latter case, the reduction rate is 15.02 % and the processing time of background image is 0.0017 sec. The reduction rates of the image size due to the smoothing process are 10.16 %, 13.12 %, 14.31 %, and 15.02 % for the smoothing filter sizes (3, 3), (5, 5), (7, 7), and (9, 9) respectively. It becomes obvious that the reducing rate of the image size can be reduced by decreasing the accuracies of the compressed background more than the smoothing process.

In Experiment 3, the method of Proposal 3 was tried. The quality of the target image is determined automatically due to the complexity of the original image in this method. There is still room for consideration in the equation of complexity. Although the smoothing process is used in the disappearing

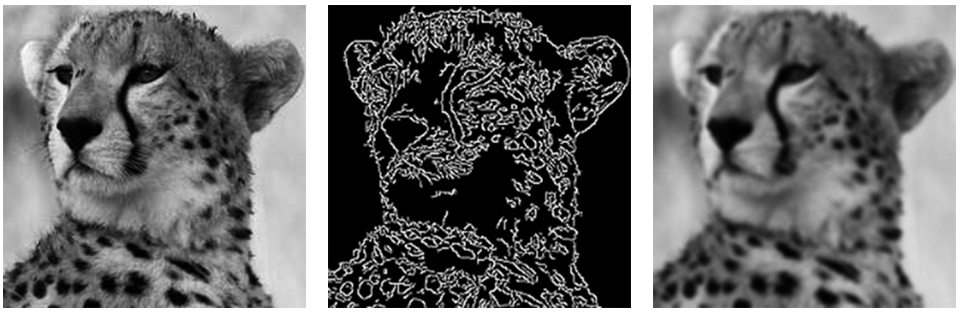
(a) Original image (b) Binary original image (c) Target image

Figure 9: Case 1 of Experiment 3



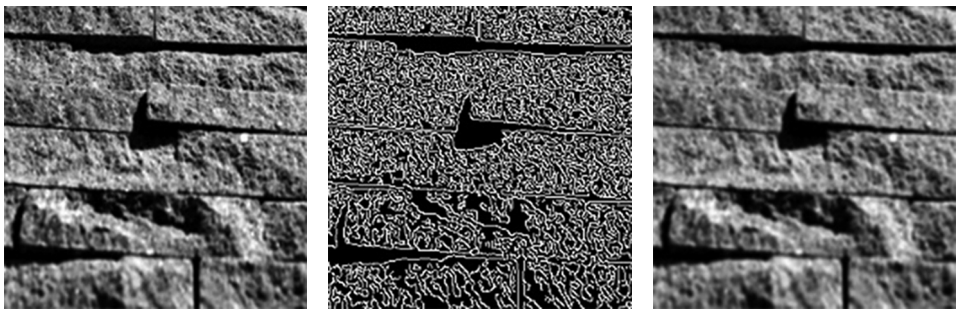
(a) Original image (b) Binary original image (c) Target image

Figure 10: Case 2 of Experiment 3



(a) Original image (b) Binary original image (c) Target image

Figure 11: Case 3 of Experiment 3



(a) Original image (b) Binary original image (c) Target image

Figure 12: Case 4 of Experiment 3

Table 3: Processing time, image size, and reduction rate in Experiment 3

Sample	Case 1	Case 2	Case 3	Case 4
Complexity				
Complexity	51.76	77.73	99.52	142.53
Smoothing filter size	8 x 8	6 x 6	5 x 5	3 x 3
Processing time				
Presume time of complexity (s)	0.080577	0.081035	0.081761	0.083916
Processing time of smoothing (s)	0.001601	0.001621	0.001805	0.001854
Total (s)	0.082179	0.082656	0.083566	0.085771
Image size				
Original image (B)	20243	26669	33442	40259
Image after compression* (B)	12849	14274	19552	29851
Reduction rate				
Reduction bytes (B)	7394	12395	13890	10408
Compression rate (%)	63.5262	53.5228	58.4654	74.1474
Reduction rate (%)	36.5262	46.4772	41.5346	25.8526

Note: * Target image.

of image size, image quality range can be widened and the range of the reduction rate can be also widened by using the compression accuracy. The process time becomes shorter than the cases of Proposal 1 and 2 because it is not synthesized.

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