

Embedding Method of Restoration Parameter in Reduction Image for High Quality Image Enlargement

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Abstract

In recent years, video portal sites represented by Youtube have become increasingly popular. The demand for such video portal sites more increases, and it will be thought that the quantity of data becomes enormous in future. There is fear that the limit of the contributed video could be set because of data server burden. The decimation of image is considered as a method of the reduction of the data of quantity. However, because a part of image data is lost through the decimation of image, the enlarged image from the decimated one becomes deteriorated. We propose a novel framework for the problem that we stated above. In our framework, this enables the restoration to a former image by embedding the reconstruction parameter to a former image in a decimated image. This enables to reduce deterioration of the image by the resolution conversion. By an experiment, we verified the efficacy of proposed method from appearance of image and error of original image and image of proposed method. Appearance is improved and error is lower.

Keywords: data embedding, image reduction, image enlargement.

1. Introduction

In recent years, video portal site such as Youtube is widely popular. The number of contributed videos increases more, and it will be thought that the quantity of the data becomes enormous in future. Load of the datacenter of the video portal site increase, and it is thereby thought that a problem such as a contribution video being limited happens.

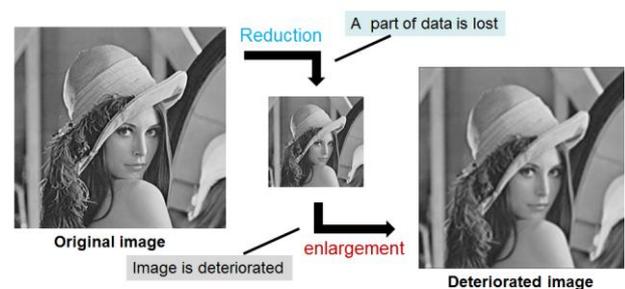


Fig.1 An issue on conversion of image resolution

It is necessary to reduce quantity of data of the contribution video to cope with the demand of increasing contribution video. We work on this problem using the reduction of the image. However, an image deteriorates because data of the image are lost by reducing an image when it went back up to original size as shown in Fig.1. The study of various image reconstruction methods [1][2][3][4] conducted until now.

In this paper, we propose a novel framework for the problem that we stated above. In the case of resolution conversion, this enables the restoration to a former image by embedding the reconstruction parameter to a former image in a reduction image. This enables to reduce deterioration of the image by the resolution conversion.

2. Proposed Method

In proposed method, we use coefficient of unsharp masking as restorable parameter which is embedded in a reduction image as shown in Fig.2. A most appropriate coefficient is calculated from image which is deteriorated

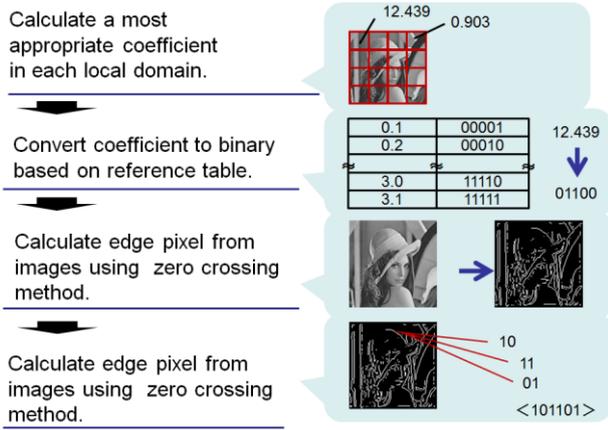


Fig.2 Overview of data embedding

by resolution image and former image. We obtain a most appropriate coefficient for restoring deteriorated image when image is enlarged as shown in Fig.3. Then, we restore deteriorated image using unsharp masking with the coefficient.

2.1 Unsharp Masking

Unsharp masking is one of method of image sharpening. First, we extract high-frequency component by subtract smoothed image from former image. Next sharps image by accentuating high-frequency component by adding extracted high-frequency component to former image. The conduct of unsharp masking is showed in eq.(1). Here, crisp image is I_S , former image is I , smoothed former image is I_L , coefficient is α .

$$I_S = I + \alpha(I - I_L) \quad (1)$$

2.2 Calculating Embedded Parameter

A most appropriate coefficient of unsharp masking is calculated by eq.(2). Here former image is I_S , deteriorated image is I , smoothed deteriorated image is I_L .

$$\alpha = \frac{(I_S - I)^T(I - I_L)}{\|I - I_L\|^2} \quad (2)$$

A most appropriate coefficient for design every local site is different each. We compared following two in a preliminary experiment.

- 1) The image which was sharpened by one coefficient
- 2) The image which was sharpened by the coefficient every local domain divided in the shape of a lattice

As a result, the error with the original image decreased the latter. Therefore, we divide an image in the shape of

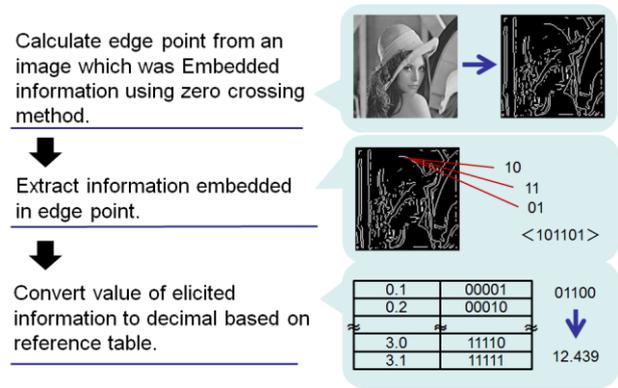


Fig.3 Overview of image restoration

8x8 lattice and calculate the value of a most appropriate coefficient every local site in this study.

2.3 Embedding Parameter and Eliciting Parameter

Flow of embedding is showed below.

- 1) Making the reference table of the embedded parameter
- 2) Calculating edge point of an image
- 3) Scanning raster and embedding information in an edge point

As a result of having applied 13 pieces of images, the value of the coefficient of the unsharp masking which was a reconstruction parameter range 0.8 to 2.6. Therefore, we can express the restoration parameter using five bits. The values of the coefficient are quantized by 0.1, and make a reference table. Restoration parameter is embedded in edge point of reduction image. Edge point is calculation using zero crossing method. We embed one parameter using three pixels. We use lower 2 bits of each pixel and use 6 bits in total for one parameter and embed the information of the sign of the coefficient in a top bit and bury the value of the coefficient in remaining five bits.

Next, flow of eliciting is showed below.

- 1) Calculating edge point of an image embedded information
- 2) Scanning raster and eliciting information
- 3) Calculating a value of coefficient using reference table

By the eliciting, we perform reverse operation of the embedding basically.

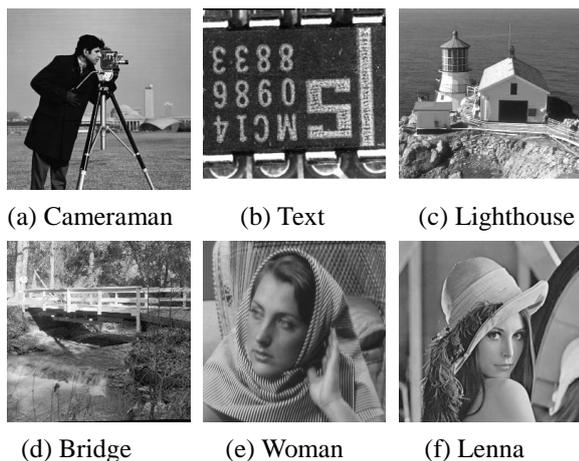


Fig.4 Test images.

3. Experimental Results

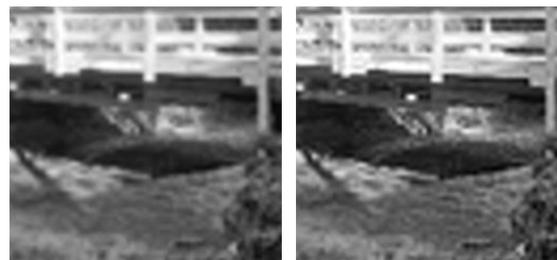
The suggestion technique buries the restoration parameter to a former image in a reduction image when an image is performed resolution conversion. Therefore, enlarged image is restored to former image when image is enlarged. In other words, we can reduce the deterioration of the image by the resolution conversion by the suggestion technique. In experiment, we used 6 images as shown in Fig.4. Image size is 256×256 and scale factor is 2. We survey how possible it is for the restoration to an original image when we use suggestion technique from appearance of image and error and estimate the effectiveness of proposed method.

3.1 Comparison about Appearance

We compare the image using the suggestion technique with the image which deteriorated by resolution conversion. Therefore, we estimate the effectiveness of proposed method from appearance of image. Image which deteriorated by resolution conversion and Image of proposed method is showed in Fig.5 and Fig.6. There is less deterioration than a deterioration image, and the image of the suggestion technique becomes the sharpness image. From this, the suggestion technique is effective for the improvement of the appearance of the image. In addition, we show the images which used for an experiment in Fig.7, Fig.8, Fig.9, and Fig.10. A deterioration image is improved by suggestion technique.

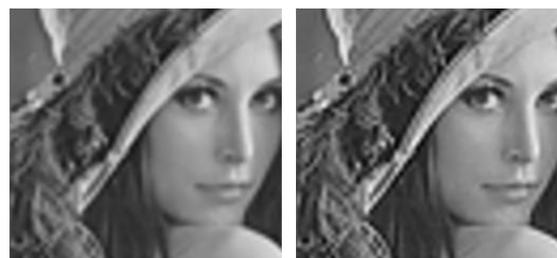
3.2 Comparison of Error

We estimate effectiveness of proposed method by



(a) naive enlargement (b) proposed method

Fig.5 Comparison of appearance.



(a) naive enlargement (b) proposed method

Fig.6 Comparison of appearance (this image is a part of Fig.10).

Table 1. Comparison of MSE. lower is better.

	naive enlargement	proposed method
Cameraman	172.28	144.76
Text	172.43	141.96
Lighthouse	279.09	247.11
Bridge	287.77	260.50
Woman	273.12	242.88
Lenna	74.15	58.52

comparing the error of former image and an image which is deteriorated by resolution conversion with the error of former image and image of proposed method. We used error of mean square (MSE) for estimating error. Result of the experiment is showed in table 1. An error became small in all the images which we used for an experiment. It can be said that suggestion technique was effective to restore a deterioration image to an original image by this experiment.

4. Conclusions

We proposed new framework for the problem which is the reduction of quantity of data using method which reduce the deterioration of the image in case of the enlargement by embedding the restoration parameter to an original image in a reduction image when an image is performed resolution conversion.

By the experiment, we estimated effective of proposed

method from appearance of image and the error with former image. We confirmed that an image of the suggestion technique was sharper than a deterioration image. In addition, the error with the former image and all images which I used for an experiment is smaller than the error with the former image and a deterioration image. We were able to show the effectiveness of the suggestion technique from these two points.

Acknowledgment

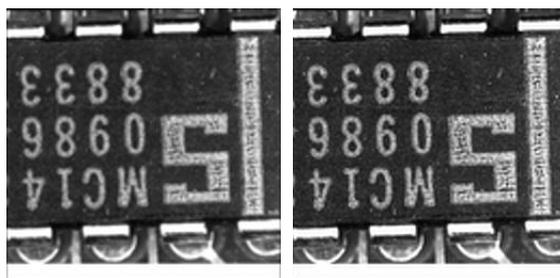
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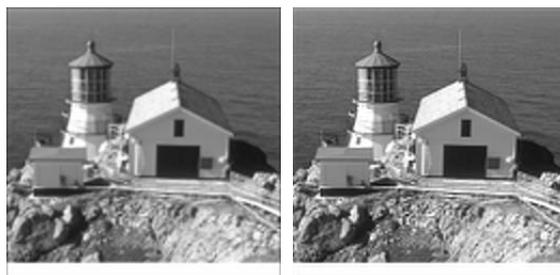
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(a) naive enlargement (b) proposed method
Fig.7 result 1.



(a) naive enlargement (b) proposed method
Fig.8 result 2.



(a) naive enlargement (b) proposed method
Fig.9 result 3.



(a) naive enlargement (b) proposed method
Fig.10 result 4.