

Method for Character Domain Extraction from Image Using Wavelet Transform

Taiki Taniguchi

ZENSHO HOLDINGS Co., Ltd., 2-18-1 Konan Minato-ku Tokyo 108-0075, JAPAN

Yasunari Yoshitomi

Graduate School of Life and Environmental Sciences, Kyoto Prefectural University,

1-5 Nakaragi-cho, Shimogamo, Sakyo-ku, Kyoto 606-8522, Japan

E-mail: yoshitomi@kpu.ac.jp

http://www2.kpu.ac.jp/ningen/infsys/English_index.html

Abstract

The number of images having private information and/or URL of illegal Web site has been increasing in the cyber space on the Internet. These images might cause infringement of human right and/or crime. In the present study, a method for extracting the region(s) having characters on an image has been developed using the discrete wavelet transform and the empirical knowledge that a character has strong vertical and/or horizontal element(s). The experimental results show the usefulness of the proposed method.

Keywords: Internet, Private information, URL of illegal Web, Character domain extraction, Wavelet Transform, and Image processing.

1. Introduction

The number of images having private information and/or URL of illegal Web site has been increasing in the cyber space on the Internet. These images might cause infringement of human right and/or crime. It is very time-consuming and inefficient to detect them through watching each Web page one by one by naked eyes. The method for checking images to judge whether they have private information and/or URL of illegal Web site has been missing. For achieving the task, firstly, we must extract the region(s) having characters on the image. The algorithm for extracting the region(s) having characters on an image has received considerable attention in computer vision research.¹⁻³ However, it falls far short of practical capability.

In the present study, a method for extracting the region(s) having characters on an image has been developed using the discrete wavelet transform (DWT). For the course of developing the method, we use the empirical knowledge that a character has strong vertical and/or horizontal element(s).

2. Wavelet Transform of Image Signals

Hierarchical decomposition of DWT has been widely used in image compression and other image processing techniques. The image is first decomposed into four subbands, 1LL, 1LH, 1HL, and 1HH. The subbands labeled 1LH, 1HL, and 1HH represent the finest scale wavelet coefficients. Fig.1 describes level 1 decomposition, in which the image is decomposed into four subbands for one scale.

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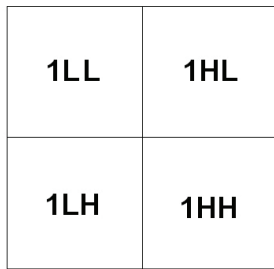


Fig. 1. Mallat division.

In general, the wavelet coefficients on the three domains described as HH, HL and LH are called elements of multi-resolution representation, whereas the wavelet coefficients of LL are called elements of multi-resolution analysis. For further information on the DWT, see Ref.4.

3. Proposed Method

Fig.2 illustrates the flowchart of the proposed method. The algorithm of the proposed method is as follows:

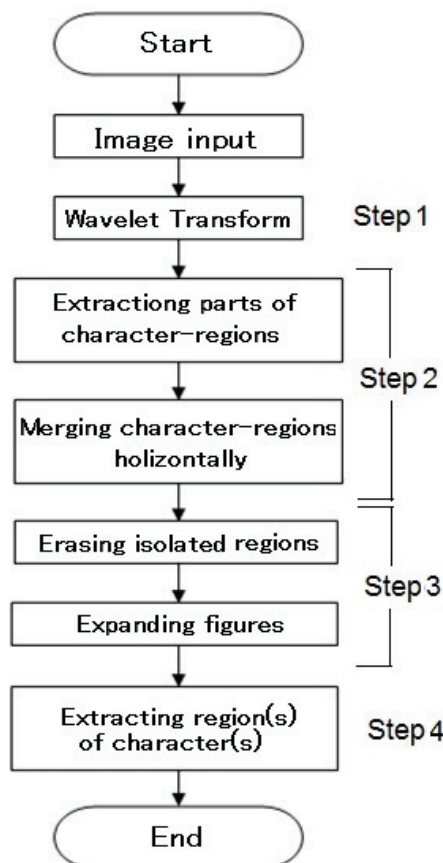


Fig. 2. Flow chart of the proposed method.

Step 1 : RGB elements of image (Fig.3) are transformed into YCrCb elements (Fig.4) , followed by DWT for each element to obtain 1HL and 1LH elements corresponding to vertical and horizontal elements respectively (Fig.4).

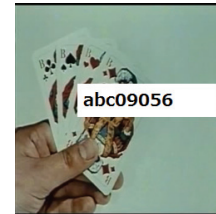


Fig. 3. Sample of input image.



Fig. 4. 1HL (upper & center) and 1LH (upper & right) elements for Y element (upper & left), 1HL (middle & center) and 1LH (middle & right) elements for Cr element (middle & left), and 1HL (lower & center) and 1LH (lower & right) elements for Cb element (lower & left) obtained from input image (Fig. 3).

Step 2 : A segmentation for both the 1HL and 1LH elements using each threshold for the elements is performed (Fig.5). Then, the scattered regions having '255' in the binary image for each of YCrCb elements are merged with changing the values of pixels existing among pixels of '255' from '0' to '255' when the pixels of '0' have the same value of horizontal coordinate as that of '255' (Fig.6).

Step 3 : The operations of erasing isolated regions and expanding the regions of the value of '255' are performed (Fig. 7).

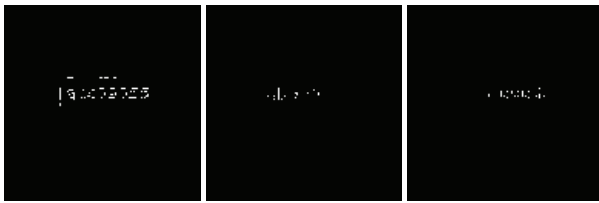


Fig. 5. Binary images obtained for both 1HL and 1LH elements for Y, Cr, and Cb elements, obtained using related images in Fig.4; left: Y, center: Cr, right: Cb.

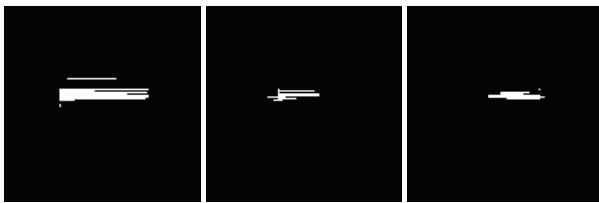


Fig. 6. Binary images after horizontally merging for binary images for Y, Cr, and Cb elements, obtained using related images in Fig.5; left: Y, center: Cr, right: Cb.

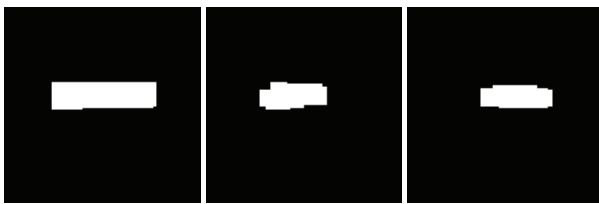


Fig. 7. Binary images just after finishing processing of Step 3 for Y, Cr, and Cb elements, obtained using related images in Fig.6; left: Y, center: Cr, right: Cb.

Step 4 : Then a mask image for extracting the region(s) having characters on the input RGB image is generated by merging the regions of '255' with logical sum operation for all of three binary images obtained for Y, Cr, Cb elements. Finally, the output RGB image is generated by the operation that the color of the pixel on the input RGB image is changed into white when the value of corresponding pixel on the mask image is '0', resulting in extracting the region(s) having character(s) on the input RGB image (Fig.8).



Fig. 8. Input image (left) and output image (right).

4. Experiments

4.1. Conditions

Three standard images (Earth, Couple, and Mandrill) in 24-bit BMP form having 256×256 pixels were prepared for evaluation of the proposed method. The images used in this experiment were selected from Standard Image Data-Base (SIDBA). We used the Daubechies wavelet for DWT. Several black characters of abc09056 were written on the original images with one of white, non-white color, and transparent backgrounds (Fig.9). The experiment was performed in the following environment for computation: personal computer; DELL OPTIPLEX780(CPU : Intel(R) Core(TM)2 Duo CPU E8400 3.00GHz, main memory : 4.00GB), OS; Microsoft Windows 7 Professional, Development language; Microsoft Visual C++6.0.

In the process of segmentation in Step 2 described in the section 3, the binary image was obtained by the way that the value of pixel in binary image was set to 255 when the value of 1HL or 1LH element was not higher than each threshold for the elements, and otherwise it was set to be 0. The threshold was set to be half of minimum value for each element except that it was higher than -40. In this exceptional case, the threshold was set to be -40. In the process of segmentation in Step 3 described in the section 3, the regions having 50 pixels or less were erased and the expansion was performed five times.

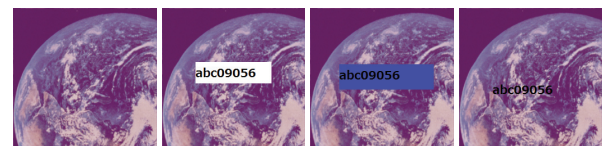


Fig. 9. Examples of original image (left end) and input images with characters (others).

4.2. Results and discussion

Figs. 10, 11 show the input images and the output images obtained using the proposed method. When the background of characters was not transparent, all regions with characters were successfully extracted by the proposed method (Fig.10). However, when the background of characters was transparent, some regions with characters were not extracted and other regions having no characters were extracted by the proposed method (Fig.11).

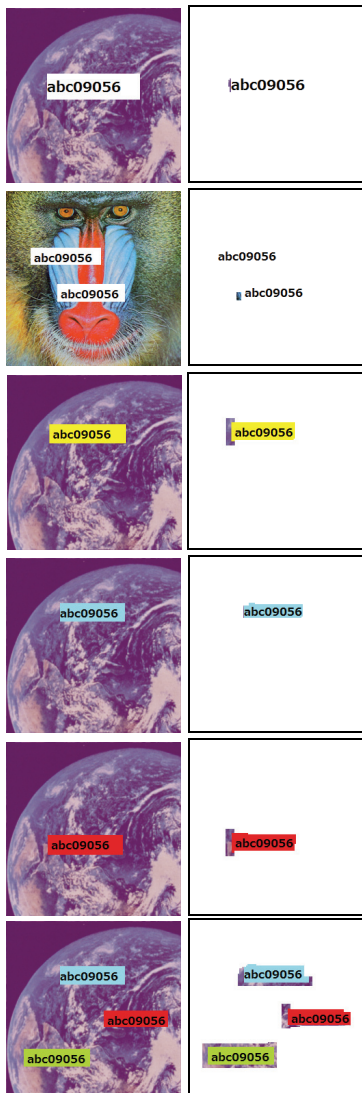


Fig. 10. Input images (left) with characters on color backgrounds, and output images (right).

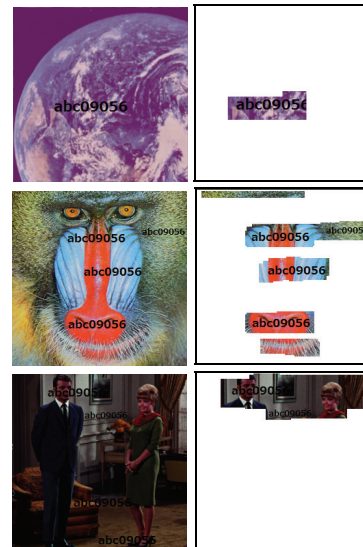


Fig. 11. Input images (left) with characters on transparent backgrounds, and output images (right).

5. Conclusion

A method for extracting the region(s) having characters on an image has been developed using the discrete wavelet transform and the empirical knowledge that a character has strong vertical and/or horizontal element(s). The experimental results show the usefulness of the proposed method.

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