International Journal of Signal Processing, Image Processing and Pattern Recognition
Vol.8, No.3 (2015), pp.11-22
http://dx.doi.org/10.14257/ijsip.2015.8.3.02

Study on Elemental Techniques of Image Search Method using Pixel Value Histograms for Ornament Attacked Images

Makoto Fujimura1, Kousuke Imamura2 and Hideo Kuroda3

1 Nagasaki University, 1-14 Bunkyou-machi, Nagasaki 852-8521 Japan
{fujimura@nagasaki-u.ac.jp}
2 Kanazawa University, Kakuma-machi, Kanazawa, Ishikawa 920-1192 Japan
{imamura@ec.t.kanazawa-u.ac.jp}
3 FPT University, Hoa Lack Hi-Teck Park, Hanoi, Vietnam
{kuroda@fsoft.com.vn}

Abstract

There is a similar image retrieval method which uses a normalized histogram of the pixel values of the original image and that of the pixel values of the illegally copied search target image. In this method, when the correlation coefficient between the two histograms is greater than a predetermined threshold value, the target image is to determine to be similar to the original image. However, the contents of the image that has received ornament attack is different from the contents of the original image, this means that it is searching for images similar to the original image is very difficult. In general, ornament processing of the image is applied to the peripheral region of the image. Therefore, if only the pixels to limit in the ROI (region of interest) which are not affected by the ornament attack are used to create the normalized histogram, it may be effective. We, in order to extract only the pixels included in the ROI, have proposed a method of using a mask image. In this paper, it describes some detailed study about the element techniques including using the mask image and normalization histogram. Moreover, the computer simulations show the effectiveness of these element techniques.

Keywords: *digital watermark, image search, correlation coefficient, pixel value histogram, ROI*

1. Introduction

Recently generating or copy of image has become easy by performance of personal computers speed and the high performance of human interface. Also, by the high speed of the Internet, digital contents upload and download have become to be performed frequently individually. Convenient, but it leads to copyright infringement by unauthorized copying of content by a third party, the above situation has become a social problem. There is a digital watermark technology to one of the measures of this copyright infringement. The copyright owner should be registered to the certificate authority both generated content and own copyright information, also should embed in the content created by the copyright information of their own. The certificate authority proves that the content is belonged to the copyright owner, but it does not teach way to search illegal copies being on the Internet. Therefore, the copyright holder must be searched own illegal copy on the Internet by himself.

In general, the object is searched by image search method in a database. In a general database, multiple feature vectors that show the characteristics of particular images are registered [1-2]. In an instance of an image search, the key word describing a characteristic of

ISSN: 2005-4254 IJSIP

the content desired is input, and images in which this key word is included in the feature vector of the database are output as an extraction result. There are some prior studies using this principle [3-4]. Extracting the keywords from the search target image, these methods extract images similar to the search target from the database that is registered in the certificate authority. That is, one searches for the image of the copyright holder from illegal copy image is a search method opposite to the intended purpose. Furthermore, since many images have similar keywords the search accuracy is poor. Also, since it is necessary to register the original keyword along with the copyright information into the certificate authority, these search systems have a problem that the system configuration is complicated. Actually, though much research [5-8] on digital watermarks have already been done, only methods for the embedding and extraction of copyright information into/from content are discussed, but it has not been sufficiently considered about methods which can search effectively illegal copies from the large amount of content on the Internet.

In order to solve the above problems, we have proposed an image retrieval method of two-step efficient for extracting an illegal copy [9-10]. However, detailed discussion of element techniques that are used in these papers has not been performed.

This paper is intended to explain in detail about these elemental techniques.

The remainder of this paper is organized as follows. Section 2 presents the pre-search in Two-stage image search model. Section 3 describes element techniques and proposal of evaluation method of any amount of attack for rotation and scaling are shown in Section 4. Section 5 denotes simulation and results for a case of any rotation and scaling attack, and concluding remarks are given in Section 6.

2. Pre-search in Two-Stage Image Search Model

2.1. Two-Stage Image Search Model

Figure 1 shows the proposed two-stage image search method before. In the pre-search stage, image content from the Internet is input, and it is investigated whether this content is similar to owned content using a simple method. If the content is not similar, the search process is terminated, and the next image content is investigated. If the content is similar, the image content is output to the main search stage as a candidate of illegal copying. In the main search stage, the embedded copyright information in the image is extracted by a predefined method. When the extracted copyright information is same as the original information, a complaint is sent to the user by a predefined procedure. It is possible to search for illegal copies efficiently because the pre-search stage is simple.

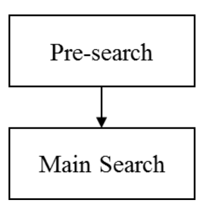


Figure 1. Two-stage Image Search Model for Illegal Copy Images with Digital Watermarking

2.2. Basic Algorithm for the Pre-search

Figure 2 shows the essential flow diagram of the previous search. Firstly input original image, be measured the pixel value histogram, and calculate normalized histogram using a number of pixels of the entire image. The process mentioned above is done by off-line as a preparatory. As online processing, first, reset the counter, an image is captured from the Internet on the search for the first image. For the first image, in a process similar to the case of the original image, the normalized histogram is calculated using the number of pixels of the entire image. Next, the correlation coefficient r of both normalized histograms of the search image and the original image is calculated. The correlation coefficient is shown in Equation 1. When r is larger than equal to the threshold value T, is determined as the candidate for the illegal copy image, and send to the main search of the subsequent stage.

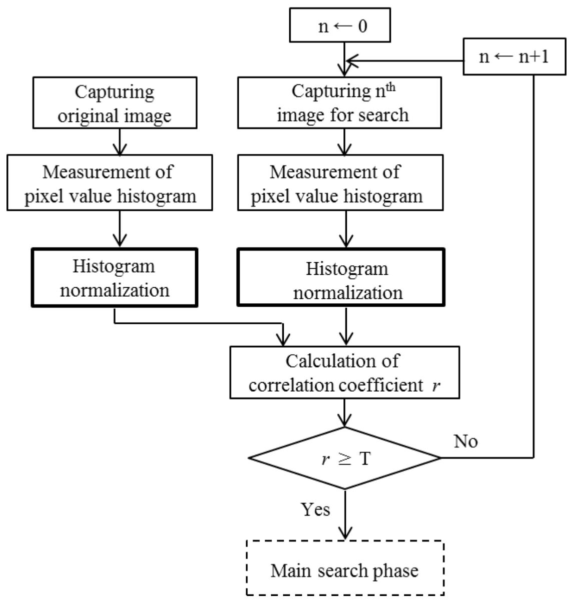


Figure 2. The Previous Proposal Flow Diagram

$$r = \frac{\sum_{i=0}^{255}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=0}^{255}(x_i - \bar{x})^2 \sum_{i=0}^{255}(y_i - \bar{y})^2}} \qquad (1)$$

If r is less than T, it is determined that the image is not similar to the original image. The counter is increment by 1 to capture the next input image.

3. Elemental Techniques

3.1. Histogram Normalization

We consider about histogram normalization indicated by a thick line in Fig. 2. In general, image enlargement or reduction such as geometric attacks, the number of samples per image is changed. However, when normalizing the histogram by the number of samples per image, if the same image, the probability of occurrence of each density level is expected to be the same even though image sizes are different each other. Under this idea, we consider about what the image size is even different extent, obtained almost the same histogram.

As test images, 10 types of the Kodim [11]; 03, 05, 07, 08, 13, 15, 21, 22, 23 and 24, are used. 10 different test images are created by reducing in 0.1 increments each side of the image, from 0.1 to 0.9, including the original image. Obtains a normalized histogram of these test images, and calculates the correlation coefficient between the normalized histograms of the two test images.

In Figure 3, (a) shows a relatively flat image Kodim21, and (b) shows the most complex image Kodim08, from the ten kinds of "Kodim" images. Hereafter, the experiments are carried out using the two types of test images.

(a) Kodim21 (b) Kodim08

Figure 3. Examples of Test Images [11]

Table 1 shows the correlation coefficient between the normalized histogram of two sets of images from the 10 types of reduced image of Kodim21.

In Table 1, image reduction ratio shown at rows and columns show the reduction ratio of the image. As shown in the table, correlation coefficient between normalized histograms of the original image and the reduced image to 1/10 is 0.962. Therefore in the case of such flat image as Kodim21, it can be determined that even the reduced image to 1/10 is similar with original image.

Table 1. The Correlation Coefficient between Reduced Images for Kodim21

		Image reduction ratio									
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Image reduction ratio	0.1	1.000	0.975	0.972	0.968	0.966	0.966	0.964	0.964	0.962	0.962
	0.2	0.975	1.000	0.994	0.993	0.993	0.994	0.993	0.992	0.992	0.992
	0.3	0.972	0.994	1.000	0.998	0.997	0.997	0.997	0.997	0.997	0.997
	0.4	0.968	0.993	0.998	1.000	0.998	0.998	0.998	0.999	0.999	0.998
	0.5	0.966	0.993	0.997	0.998	1.000	0.999	0.999	0.999	0.999	0.999
	0.6	0.966	0.994	0.997	0.998	0.999	1.000	1.000	1.000	0.999	1.000
	0.7	0.964	0.993	0.997	0.998	0.999	1.000	1.000	1.000	1.000	1.000
	0.8	0.964	0.992	0.997	0.999	0.999	1.000	1.000	1.000	1.000	1.000
	0.9	0.962	0.992	0.997	0.999	0.999	0.999	1.000	1.000	1.000	1.000
	1	0.962	0.992	0.997	0.998	0.999	1.000	1.000	1.000	1.000	1.000

On the other hand, Table 2 shows the case Kodim08 of the most complex image in the 10 types of images. For this complex image, the correlation coefficient of the image that has been reduced to one-tenth with any reduced sizes, is less than equal to the evaluation threshold value T, 0.95, shown in Figure 2 ([9] reference). So it is not possible to use for similarity determination image. If the reduction ratio is 0.2 or more, be an image of any reduction ratio, the correlation coefficient has a 0.97 or more, it can be seen that can be used for similarity determination image.

3.2. Filtering for Normalized Histogram

Even complex image Kodim08 shown in Table 2, same as in the case of a flat image shown in Table 1, a normalized histogram of the compression ratio 0.1 may try to consider whether there is no way to be used for image similarity search. That the correlation coefficient of normalized histogram is reduced, it means that the distribution of the histogram changes by reducing the image to 0.1-fold. So, we did a comparison of the distribution of the histogram.

Figure 4 shows the normalized histogram of 0.1-fold the reduced image and the original image size. Whereas the peak value of the histogram of the original size is large, the peak value of the histogram of 0.1-fold the reduced image becomes much smaller. This difference causes the correlation coefficient is reduced.

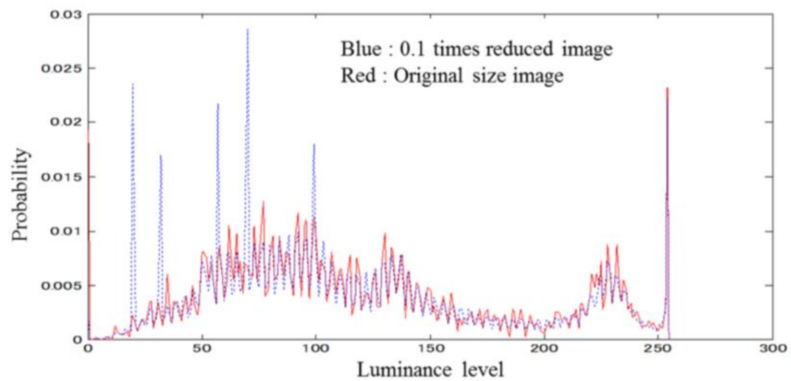


Figure 4. The Normalized Histogram of 0.1-fold Reduced Image and the Original Image Size of Kodim08

On the other hand, Figure 5 shows the normalized histogram after applying the filtering of the 5-dimensional.

By smoothing, the peak value of the original size becomes significantly smaller, and the difference of peak values between 0.1-fold image and the original size image is reduced. This causes the correlation coefficient shown in Table 3 become larger than the values in Table 2.

Table 3 shows the effect of smoothing to the normalized histogram of the complex image Kodim08. In Table 3, 3dFlt shows the correlation coefficient in the case of applying a simple smoothing of the three-dimensional for each density value, 5dFlt shows the correlation coefficient in the case of the simple smoothing of the five-dimensional. Even though 3dFlt is subjected to a normalized histogram, still the correlation coefficient of the reduced image to one-tenth is 0.95 or less, it is 0.96 or more in the case of 5dFlt.

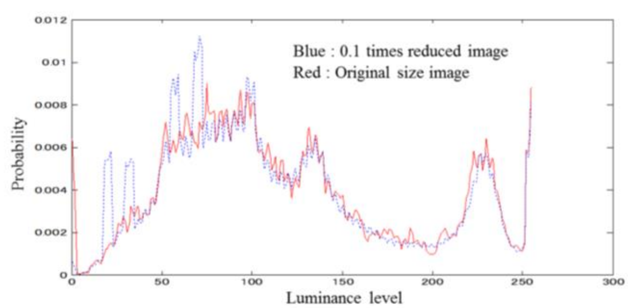


Figure 5. The Normalized Histogram with Five Dimensional Smoothing Filter of 0.1-fold Reduced Image and the Original Image Size of Kodim08

Table 3. The Correlation Coefficient between Reduced Images and the Filter Effect for Kodim08

		Filter	Image reduction ratio									
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Image reduction ratio	0.1	3dFlt	1.000	0.949	0.946	0.939	0.946	0.943	0.940	0.938	0.934	0.937
		5dFlt	1.000	0.969	0.969	0.965	0.969	0.966	0.964	0.963	0.961	0.963
	0.2	3dFlt	0.949	1.000	0.989	0.988	0.987	0.988	0.987	0.985	0.987	0.985
		5dFlt	0.969	1.000	0.992	0.992	0.991	0.992	0.992	0.990	0.991	0.990
	0.3	3dFlt	0.946	0.989	1.000	0.997	0.993	0.993	0.993	0.995	0.995	0.993
		5dFlt	0.969	0.992	1.000	0.998	0.996	0.996	0.996	0.997	0.997	0.996
	0.4	3dFlt	0.939	0.988	0.997	1.000	0.995	0.995	0.996	0.997	0.998	0.996
		5dFlt	0.965	0.992	0.998	1.000	0.997	0.997	0.998	0.998	0.999	0.998
	0.5	3dFlt	0.946	0.987	0.993	0.995	1.000	0.999	0.999	0.998	0.997	0.999
		5dFlt	0.969	0.991	0.996	0.997	1.000	0.999	0.999	0.999	0.998	0.999
	0.6	3dFlt	0.943	0.988	0.993	0.995	0.999	1.000	0.999	0.999	0.998	0.999
		5dFlt	0.966	0.992	0.996	0.997	0.999	1.000	1.000	0.999	0.999	1.000
	0.7	3dFlt	0.940	0.987	0.993	0.996	0.999	0.999	1.000	0.999	0.999	1.000
		5dFlt	0.964	0.992	0.996	0.998	0.999	1.000	1.000	1.000	1.000	1.000
	0.8	3dFlt	0.938	0.985	0.995	0.997	0.998	0.999	0.999	1.000	0.999	1.000
		5dFlt	0.963	0.990	0.997	0.998	0.999	0.999	1.000	1.000	1.000	1.000
	0.9	3dFlt	0.934	0.987	0.998	0.998	0.997	0.998	0.999	0.999	1.000	0.999
		5dFlt	0.961	0.991	0.999	0.999	0.998	0.999	1.000	1.000	1.000	0.999
	1	3dFlt	0.937	0.985	0.993	0.996	0.999	0.999	1.000	1.000	0.999	1.000
		5dFlt	0.963	0.990	0.996	0.998	0.999	1.000	1.000	1.000	0.999	1.000

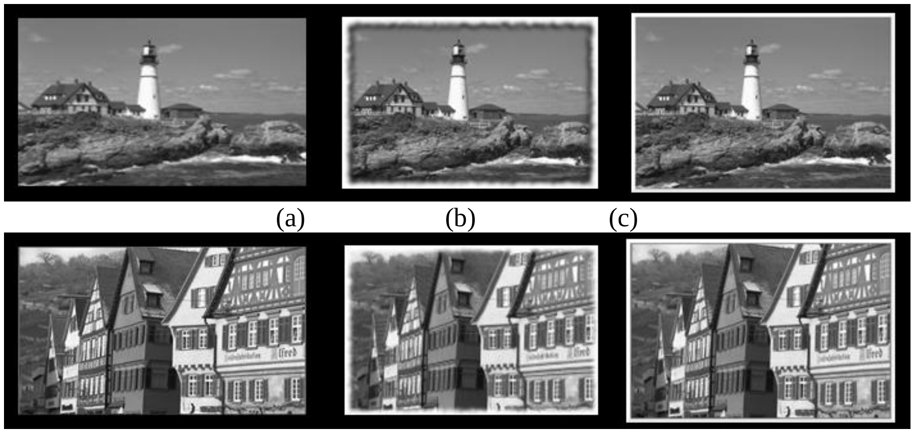
3.3. Proposal of Mask Image Use for the Ornaments Attack Image

By the recent advances in image processing techniques, ornament image process has become relatively easy. Fig. 6 shows proposal of use of mask image for ornament attacks. In Fig. 6, (a) is a sample of ornament. In general, as shown in Fig. 6(a), the trim process is often done at not only near the edges of the upper and lower left and right, but particularly corners parts. To address the piracy image which attacks on the peripheral region of the original image, it is required how to ignore the area attacked.

So we propose mask image use as shown in Fig. 6(b). The mask image is used for the original image and the search target image, and determines the pixels to be used for voting in the calculation of the histogram. Namely, only the pixel values of the addresses corresponding to pixels which are included in the white area of the mask image are used to vote for calculating the pixel histogram. By using the mask image can be made to eliminate the influence of change in pixel values on the peripheral region of the ornament attacked images.

(a) Sample of ornament [12] (b) Proposed mask image

Figure 6. Proposal of Use of Mask Image for Ornament Attacks



(a) (b) (c)

(d) (e) (f)

(a) Just illegal copy (Kodim21), (b) Decorated (Kodim21), (c) Framed (Kodim21)
(d) Just illegal copy (Kodim08), (e) Decorated (Kodim08), (f) Framed (Kodim08)

Figure 7. Test Images for Ornament Attack

Figure 7 shows the test image to be used to test the ornament attack. (a) and (d) are the just illegal copied images. (b) and (e) are decoration attack images to the original image (a) and (d) by using GIMP[13], with a decoration of the 16 pixels width from top and bottom edges and left and right edges of the image inside, with the width of the shadow of 100%, with 4 granularity, then the image size is 768×512 as same as that of the image (a) and (d). (c) and (f) are framed attack images, with (size 792 × 536), that is, plus the frame with 12 pixel width to the outside of the image (a) and (d) by using GIMP[13].

These correlation coefficients have calculated by Equation 1. In the experiments, in order to reduce the processing time be reduced to one-sixteenth each test images.

Table 4 shows a comparison of the correlation coefficient between the original image and the decoration image. While the correlation coefficient when it is not used a mask image becomes 0.95 or less, when using the mask image, the correlation coefficients of both decorated image and framed image is 1. Therefore, use of the mask image is found to be effective against o ornament attack.

Table 3. Comparison of Correlation Coefficient between without and with Mask Image

Test images	Kodim21			Kodim08		
	(a)Original	(b)Decorated	(c)Framed	(d)Original	(e)Decorated	(f)Framed
Without mask	1.0000	0.8478	0.8996	1.0000	0.7907	0.7327
With mask	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

4. Proposal of Evaluation Method of Arbitrary Amount of Attack for Rotation and Scaling

Figure 8 shows the proposed pre-search algorithm which is improved by using the mask image. In the filtering block shown by a thick frame in Figure 8, only the pixels can pass through to be voted in the calculation of the histogram. Subsequent portions of it are same to the conventional method.

Generally illegally image copied on the Internet is not clear what attack was added. Thus, the copyright owner must evaluate by himself the amount of attack and the type of attack.

Figure 9 shows the relationship between the rotation angle and image size. This relationship is shown in the formula (2). Changing θ in equation (2) to one degree increments from 0 to 360 degrees, the copyright holder calculates the aspect ratio ko = x/y for his original image, from x and y, which are obtained using θ as parameter.

$$\begin{cases} x = a \cdot \cos\theta + b \cdot \sin\theta \\ y = a \cdot \sin\theta + b \cdot \cos\theta \end{cases} \quad (2)$$

In the block shown which is "Evaluate amount of rotation/scaling", by a thick frame in Figure 8, enter the search target image, then determine the aspect ratio kt of the image. For this kt, from the table above, search the value of ko close to the value kt most, the θ corresponding to the ko value is the true rotation angle. That is, the amount of any rotation and scaling can be determined.

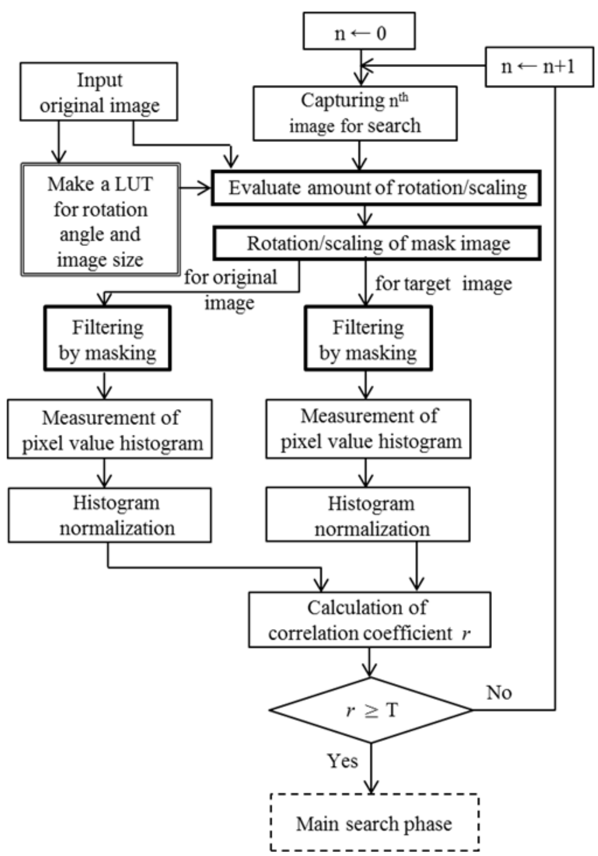


Figure 8. Proposed Flow Diagram for Ornamental, Rotation and Scaling Attack Image

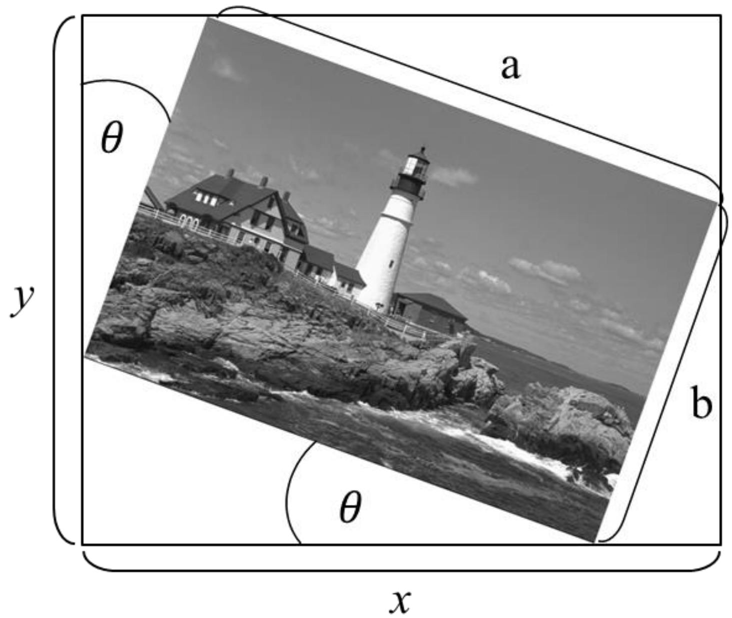


Figure 9. Relationship between Rotation Angle and Image Size

After this, as with the conventional method, whether or not similar to the original image can be decided, by calculating the correlation coefficient of the normalized histogram of the two images.

5. Simulation and Results for a Case of any Rotation and Scaling Attack

The experiments were conducted in the case of rotation and scaling attack at the same time.

Table 5 shows the experimental results for Kodim21. In Table 5, (a) is the original image. (c), (d) and (e) are attack images enlarged to twice its sides of the original image (a), and rotated 30 degrees clockwise. The image (d) has been decorated, and (e) framed in particular. (b) is the produced mask image from the original mask image of the same size as the original image which is got by scaling 1.999 times using detected scale rate 1.999, by rotation with 30 degrees using detected rotation angle based on the algorithm shown in Fig. 8. Scaling factor and rotation rate in Table 5 are the values used to create the image attack, values in parentheses indicate the value detected by the above algorithm.

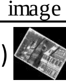
Each image sizes are as shown in Table 5. In rows of the correlation coefficient shown in Table 5, the values show the calculation results of the correlation coefficient by normalized histograms obtained for each attack images to the original image even without any filter.

Table 6 shows the experimental results for Kodim08 as complex image. By performing three-dimensional or 5-dimensional filter, the correlation coefficient of 0.95 is obtained even for complex images such as Kodim08.

Table 5. Experimental Results Rotation and Scaling Attack for Kodim21

Image name	Original image	Mask image	Unornamented image	Decorated image	Framed image
Images	(a) 	(b) 	(c) 	(d) 	(e) 
Scaling factor	1	(1.999)	2(1.999)	2(1.999)	2(2.0675)
Rotation angle	0	(30)	30(30)	30(30)	30(30)
Image size	192x128	(466x418):for Decorated (482x433):for Framed	466x416 (466x418)	466x416 (466x418)	478x430 (482x433)
Correlation coefficient	No filter		0.9984	0.9916	0.9916
	3-dimension filter (3dFlt)		0.9996	0.9977	0.9977
	5-dimension filter (5dFlt)		0.9998	0.9986	0.9986

Table 6. Experimental Results Rotation and Scaling Attack for Kodim08

Image name	Original image	Mask image	Unornamented image	Decorated image	Framed image
Images	(a) 	(b) 	(c) 	(d) 	(e) 
Scaling factor	1	(1.999)	2(1.999)	2(1.999)	2(2.0675)
Rotation angle	0	(30)	30(30)	30(30)	30(30)
Image size	192x128	(466x418):for Decorated (482x433):for Framed	466x416 (466x418)	466x416 (466x418)	478x430 (482x433)
Correlation coefficient	No filter		0.9924	0.9463	0.9326
	3-dimension filter (3dFlt)		0.9976	0.9747	0.9679
	5-dimension filter (5dFlt)		0.9987	0.9812	0.9759

6. Conclusions

As the elemental techniques for the method to search similar image attacked by ornament, three techniques; normalizing of histogram, smoothing to normalized histogram, and way to use of mask image, are described in detail.

With the normalization of the histogram, by checking the value of the correlation coefficient normalized histogram of the two images even if the image size is different, it is possible to find similar images. Simulation results, if the flat image, it was found that even with a 0.1-fold compression of images is possible to search for similar images.

In addition, by use of the normalized histogram to 5-dimensional simple smoothing filter, even in complex images, becomes possible to search for similar images using a 0.1-fold compression of images.

Focusing on that the ornament attack is applied to the peripheral image; we propose the use of a mask image. Only the pixel values in the mask image are used for the histogram calculation because these pixels are not affected by ornament. With the use of this mask image it was able to search a similar image from even the image affected by ornament attack.

By simulation results for the automatic detection algorithm, the rotation angle and scaling rate can be automatically detected, and even for complex images that affected ornament attack, it was shown that can search for similar images.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number 24560466. This paper is a revised and expanded version of a paper entitled Search Method using the Pixel Value Histogram of ROI for Illegal Copy Image with Geometric Attacks, presented at Proceedings International Conference UNESST2014, 20-23 Dec. 2014, Hainan, Chaina.

References

[1] T. Nocke and H. Schmann, “Meta Data for Visual Data Mining”, Proceeding Computer Graphics and Imaging, CGIM 2002, (**2002**) August, Kaua'i, Hawaii, USA.
[2] M. B. H. Hmida and Y. Slimani, “Meta-learning in Grid-based Data Mining Systems”, International Journal of Computer Network and Communications (IJCNC), vol. 2, no. 5, (**2010**), pp. 215-230.
[3] H. S. Ju, “An Anonymous Buyer-Sellar Watermarking Protocol, Springer, Information Security and Cryptology, ICISC2002, (**2002**), pp. 421-431.
[4] D. Birk and S. Gaines, “Using Digital Watermarking for Securing Next Generation Media Broadcasts, Springer, Advances in Machine Learning and Data Analysis, (**2010**), pp. 27-41.
[5] C.-W. Tang and H.-M. Hang, “A Feature-Based Robust Digital Image Watermarking Scheme”, IEEE Transactions on Signal Processing, Vol.51, No.4, (2003), pp.950-959.
[6] C.-Y. Lin, M.. Wu, J. A. Bloom, I. J. Cox, M. L. Miller and Y. M. Lui, “Rotation, Scale, and Translation Resilient Watermarking for Images”, IEEE Transactions on Image Processing, vol.10, no. 5, (**2001**), pp. 767-792.
[7] I. J. Cox, M. L. Miller, J. A. Bloom, J. Fridrich and T. Kalker, “Digital Watermarking and Steganography”, Morgan Kaufmann, (**2008**).
[8] M. Kim, D. Li, and S. Hong, “A Robust Digital Watermarking Technique for Image Contents based on DWT-DFRNT Multiple Transform Method”, International Journal of Multimedia and Ubiquitous Engineering (IJMUE), vol. 9, no. 1, (**2014**), pp. 369-378.
[9] K. Imamura, H. Kuroda and M. Fujimura, “Image Content Detection Method Using Correlation Coefficient between Pixel Value Histograms”, INFORMATION, vol. 16, no. 1 (B), (**2013**), pp. 675-680.
[10] H. Kuroda, K. Imamura, and M. Fujimura, “Search Method using the Pixel Value Histogram of ROI for Illegal Copy Image with Geometric Attacks”, Proceedings International Conference UNESST2014, pp. 3-6, 20-23 (**2014**) December, Hainan, Chaina.
[11] Kodak Test Images, http://r0k.us/graphics/kodak
[12] RICOH Clip Art Factory, http://www.printout.jp/clipart/
[13] GIMP: The GNU Image Manipulation Program, http://www.gimp.org/

Authors

Makoto Fujimura, he received his Eng. D. degree from Kyushu University in 2007. He is currently an associate professor in Faculty of Engineering at Nagasaki University. He is interested in an image processing.

Kousuke Imamura, he received the B.S., M.S. and Dr. Eng. degrees in Electrical Engineering and Computer Science in 1995, 1997 and 2000, respectively, all from Nagasaki University. He is currently an Associate Professor in the Institute of Science and Engineering at Kanazawa University. His research interests are high efficiency image coding and image processing.

Hideo Kuroda, he received his Eng. D. degree from Tokyo University in 1986. He is currently an emeritus professor in Nagasaki University, Japan and a professor of FPT University, Vietnam. He is interested in a high efficiency image coding and image processing.