DIGITAL WATERMARK REPRODUCTION IMAGE ATTESTATION THAT USES PHASE ONLY CORRELATION METHOD

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ABSTRACT

The infringement of the copyright is a problem by the distribution of digital contents copied illegally. The digital watermark is expected as a thing preventing unjust copying by burying information in digital data such as image, animation, the sound, TV, radio and movies. [1] [2]But a noise is included in a digital watermark reproduction image. So there is the case that the certification of the reproduction image has difficulty with. If a computer cannot recognize the information reproduced from digital watermarking, the information does not have a meaning. This paper aimed at improvement of the proof of a digital-watermarking reproduction image. And it is verified whether the difference of the form of a character affects the degree of correlation.

1. INTRODUCTION

The digital watermark is technology to bury specific information without changing most of picture and the sound quality into the data such as an image and an animation, the sound. The infringement of the copyright is a problem by the distribution of digital contents copied illegally. The data of the digital watermark can extract information by using special software and can prevent unjust copying by it.

This paper describes attestation of the reproduction image of frequency domain embedding type digital watermarking which used the correlation function. Computational complexity a lot of calculation costs are high when they compare the correlative operation that they used frequency information for with normal correlative operation. However, some problems about the calculation cost were canceled by development of the recent electronics technology. Important information is included in the phase information of the image. [3] Therefore the correlation that used phase information in a correlative function with frequency information can put up precision of the image collation.

In this experiment, the input picture of the alphabetic character of three characters is used. Next, the input image is buried in digital watermark and reproduction image is taken out. In this paper take the correlation of an input image and the reproduction image and examine the difference of the correlation degree.

2. A PRINCIPLE OF THE PHASE ONLY COREELATION METHOD

2.1 A CORRELATIVE FUNCTION

There is a correlative function as means to measure the resemblance degree when there are a certain two functions.

$$h(\tau) = \int_{-\infty}^{\infty} f(t)g(t+\tau)d\tau \qquad \cdots (2.1)$$

The expression (2.1) expresses correlative h(τ) of f(t) and g(t). The thing which integrated the thing which only τ moved f(t) and g(t) as for h(τ), and multiplied it by. The correlation between the same functions is called autocorrelation. h (τ) will become a delta function if the value of an autocorrelation function is calculated. In addition, the correlative function between different functions is called a mutual function. The value of a cross correlation function is set to 0 with the functions which go direct mutually at the time of τ= 0. Thus, it is thought that it is same with taking the inner product of two functions to calculate a correlation function. Image data is a two-dimensional signal, and when calculating a correlation function, it calculates about a transverse direction and a lengthwise direction. When setting two pictures of a size M×N pixel to f (x, y) and g (x, y), the cross correlation function h (m, n) of f (x, y) and g (x, y) is defined as follows.

$$h(m,n) = \frac{\sum_{x=0}^{N-1}\sum_{y=0}^{M-1}(f(x,y)-f(m,n))}{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}(f(x,y)-f(m,n))^2} \cdot \frac{g(x,y)-g(m,n))}{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}(g(x,y)-g(m,n))^2} \qquad \cdots (2.2)$$

Two pictures need to be the same sizes to calculate a correlation function. When picture sizes differ, it is necessary to make picture size the same.

2.2 THE DISCRETE FOURIER TRANSFORM

The following formula defines the two-dimensional Fourier transform of f (x, y) and g (x, y) as F (u, v) and G (u, v), respectively.

$$F(u,v) = \sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)e^{-2\pi j\left(\frac{ux}{M}+\frac{vy}{N}\right)}$$

$$u = 0,\ldots,M-1; \quad v = 0,\ldots,N-1 \qquad \cdots (2.3)$$

$$G(u,v)=\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} g(x,y)e^{-2\pi j\left(\frac{ux}{M}+\frac{uv}{N}\right)}$$

$$u=0,\ldots,M-1;\quad v=0,\ldots,N-1$$

$\cdots$ (2.4)

2.3 PHASE ONLY CORRELATION

Two formulas can be expressed with the following formula, when the amplitude ingredient of a formula (2.3) and the two-dimensional Fourier transform of (2.4) is expressed with *A(u,v)* and a phase ingredient is expressed with $e^{j\theta(u,v)}$

$$F(u,v)=A_F(u,v)e^{j\theta_F(u,v)} \qquad \cdots (2.5)$$

$$G(u,v)=A_G(u,v)e^{j\theta_G(u,v)} \qquad \cdots (2.6)$$

Phase limited composition of *f (x, y)* and *g (x, y)* is set to $PF^*G(u,v)$, and it defines by the following formula.

$$PFG(u,v)=\frac{F^*(u,v)G(u,v)}{|F^*(u,v)G(u,v)|} \qquad \cdots (2.7)$$

The following formula defines the phase limited correlation function *PH (u, v)* of *f (x, y)* and *g (x, y)*.

$$PH(u,v)=IDFT[PF^*G(u,v)]$$

$$=IDFT\left[\frac{F^*(u,v)G(u,v)}{|F^*(u,v)G(u,v)|}\right]$$

$\cdots$ (2.8)

When Pictures f (x, y) and g (x, y) are the same pictures (i.e., when it is f(x, y) =g (x, y)), a phase limited correlation function becomes the following formula.[4]

$$PH(u,v)=\delta(x,y)=\begin{cases}1\ (x=y=0)\\0\ (x\neq 0, y\neq 0)\end{cases} \qquad \cdots (2.9)$$

2.4 WATERMARK EMBEDDING TO A SHADE IMAGE

The value of the luminous intensity of a M×N pixel picture is set to *f(m,n)*. The Discrete Fourier Transform of *f(m,n)* is set to *F(u,v)*. *F(u,v)* is (2.10) and has a real part and imaginary part.

$$F(u,v)=C(u,v)+jS(u,v) \qquad \cdots (2.10)$$

Frequency of the image which has a watermark embedded is set to *(u',v')*. The watermark intensity is (2.11).

$$\delta=\delta 1+j\delta 2 \qquad \cdots (2.11)$$

δ1 and δ2 is the real numbers. The discrete frequency *(u,v)* considers it as (2.12) , when equal to *(u',v')*. *(u,v)* set to (2.12) , also when equal to *(N-u',N-v')*.

$$F'(u,v)=F(u,v)+\delta \qquad \cdots (2.12)$$

It is referred to as *F'(u,v)=F(u,v)* except it.
A shade difference becomes large , so that the value of δ becomes large. It is possible to embed two or more images in the same frequency using this.[5][6]

3. THE METHOD OF AN EXPERIMENT

3.1 COLLECTION OF THE DEGREE DATA OF SIMILAR

In this paper, a picture is compared using a phase only correlation function. A picture is explained first. What are used for a template picture is 50 pictures on which the English character of three characters is drawn. The English character of three characters used for the sample is a word of three characters along which a meaning passes, and every character of A to Z is used twice at least.
The example of a template picture is shown in Fig. 3.1(a)and Fig.3.1(b).

Fig3.1 (a)AND

Fig3.1 (b)GAP

3.2 REPRODUCTION IMAGE

The reproduction image of digital watermarking for taking a template picture and correlation is explained. All the reproduction images of digital watermarking use what embedded and took out the template picture in the picture of Fig. 3.2 (a). The example of a reproduction image is shown in Fig. 3.2 (b)and Fig.3.2(c).

Fig3.2(a)

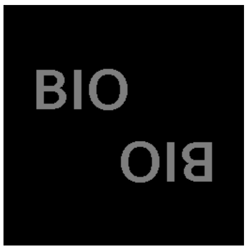

Fig3.2(b)BIO

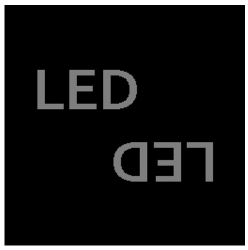

Fig3.2(c) LED

3.3 THE MEASURING METHOD OF THE DEGREE OF CORRELATION

Measurement of the degree of correlation takes correlation with all 50 reproduction images to one template picture. That is, the data of 50×50 will be taken.

4. EXPERIMENTAL RESULT

Table4.1 The degree of correlation of the reproduction image of the same alphabetic character as a template picture and a template picture

aid	and	bet	bio	can
0.635202	0.635319	0.635901	0.637137	0.636528
cow	dew	due	ear	eat
0.638308	0.635472	0.637829	0.636653	0.636477
faq	fit	fun	gap	gun
0.637898	0.639886	0.635838	0.636808	0.635572
gut	her	hut	int	its
0.636148	0.636733	0.636535	0.637006	0.635084
jam	jet	jis	kid	kph
0.6387	0.637238	0.636437	0.637575	0.637621
led	let	max	new	off
0.636984	0.636467	0.636793	0.635856	0.635741
per	pic	qua	rib	run
0.636736	0.636261	0.637711	0.636337	0.636806
sit	sub	the	ufo	uno
0.636321	0.635356	0.637557	0.636543	0.636769
vag	vid	wat	win	xml
0.637399	0.636931	0.63559	0.635148	0.635968
yen	yet	ymo	zip	zoo
0.636474	0.636036	0.636772	0.637089	0.636397

Table4.2 The degree of correlation high to the 2nd

	aid		and		bet		bio
zoo	0.03141	zoo	0.0316	max	0.02665	max	0.02987
	can		cow		dew		due
the	0.03485	the	0.0248	int	0.03147	max	0.03117
	ear		eat		faq		fit
zoo	0.02901	cow	0.02882	win	0.02834	vag	0.03256
	fun		gap		gun		gut
wat	0.03454	new	0.0303	wat	0.02681	max	0.02556
	her		hut		int		its
zoo	0.03317	max	0.03205	cow	0.02887	max	0.0311
	jam		jet		jis		kid
cow	0.02745	max	0.03336	wat	0.03106	max	0.03234
	kph		led		let		max
zoo	0.03283	max	0.03146	cow	0.02855	gut	0.02528
	new		off		per		pic
zoo	0.02878	max	0.03145	wat	0.03089	jet	0.0346
	qua		rib		run		sit
new	0.02912	wat	0.03045	wat	0.03206	xml	0.02992
	sub		the		ufo		uno
wat	0.03017	cow	0.02525	xml	0.02871	wat	0.02478
	vag		vid		wat		win
new	0.03059	zoo	0.03629	uno	0.02615	zoo	0.02528
	xml		yen		yet		ymo
cow	0.02659	cow	0.02844	cow	0.02901	wat	0.03018
	zip		zoo				
max	0.03834	jam	0.02455				

Table4.3 The minimum value of the degree of correlation

	aid		and		bet		bio
zoo	0.03141	zoo	0.0316	max	0.02665	max	0.02987
	can		cow		dew		due
the	0.03485	the	0.0248	int	0.03147	max	0.03117
	ear		eat		faq		fit
zoo	0.02901	cow	0.02882	win	0.02834	vag	0.03256
	fun		gap		gun		gut
wat	0.03454	new	0.0303	wat	0.02681	max	0.02556
	her		hut		int		its
zoo	0.03317	max	0.03205	cow	0.02887	max	0.0311
	jam		jet		jis		kid
cow	0.02745	max	0.03336	wat	0.03106	max	0.03234
	kph		led		let		max
zoo	0.03283	max	0.03146	cow	0.02855	gut	0.02528
	new		off		per		pic
zoo	0.02878	max	0.03145	wat	0.03089	jet	0.0346
	qua		rib		run		sit
new	0.02912	wat	0.03045	wat	0.03206	xml	0.02992
	sub		the		ufo		uno
wat	0.03017	cow	0.02525	xml	0.02871	wat	0.02478
	vag		vid		wat		win
new	0.03059	zoo	0.03629	uno	0.02615	zoo	0.02528
	xml		yen		yet		ymo
cow	0.02659	cow	0.02844	cow	0.02901	wat	0.03018
	zip		zoo				
max	0.03834	jam	0.02455				

Table 4.1 is a value of the degree of correlation of each template picture from "AID" to "ZOO", and the digital-watermarking reproduction image of itself. It saw, and no value of the degree of correlation was less than 0.63 so that it might understand. Table 4.2 is a value with the degree of correlation of each template picture from "AID" to "ZOO", and a digital-watermarking reproduction image high to the 2nd. The alphabetic character of three characters at that time was simultaneously written in the left sequence. Table 4.3 is the minimum value of each template picture from "AID" to "ZOO", a digital-watermarking reproduction image, and the degree of correlation.

5. EXAMINATION OF AN EXPERIMENTAL RESULT

No values of Table 4.1 are less than 0.63. When the degree of correlation becomes 0.63 or 0.62 or more from this, it can be said that the two pictures have a relation of the reproduction image of a template picture and its picture. It seems that the degree of correlation will be what becomes high in order of the similar picture if it thinks ordinarily. That is, if it is this experiment, those to which "GUN" and the degree of correlation become high are "GUT", "FUN", "RUN", etc. However, if data is looked at, that is not generally right. "AID", "DEW", "EAR", and "LET" have "AND", "NEW", "EAT", "JET", and the high degree of correlation respectively. Among three characters, since two characters are the same also as for a position and a form, these are considered that the degree of correlation becomes high. However, the reproduction image and the degree of correlation of "PIC", "ZIP", "GUT", and "OFF" of "CAN", "ZOO", "VAG", and "ZIP" are high, respectively. Among three characters, since one character similarly was not the same as for one character, either, these were considered that the degree of correlation does not become high, but in this experiment, the degree of correlation became high. When Table 4.2 is looked at, the image with the high degree of correlation of "OFF" is "UFO." The image with high "UFO" and degree of correlation serves as "OFF."

The same relation is applied to "KPH", "ZIP", "ITS", and "SIT." These characters are not alike by appearance. However, when it is made phase information, it is possible that it is the similar phase. When Table 4.3 is looked at, 8 pieces have "ZOO" and 11 pieces and 9 "WAT" have "MAX." That is, it is thought that correlation with other character strings cannot take these three character strings easily. It is thought that others, a character string, and distinction are easy for these character strings when a phase only correlation method is used. When Table 4.2 is seen again, the peak price of the degree of correlation in this table is 0.4689. The above-mentioned described "When the degree of correlation becomes 0.62 or more, it can be said that there are two pictures in the relation between an original picture image and a reproduction image." From the result of Table 4.2, even if it makes the standard of this 0.62 into a lower standard to a slight degree, it is thought that matching of an original picture image and a reproduction image can be taken. However, it is necessary to increase and examine the quantity of data about this from now on.

6. A FUTURE SUBJECT

In this paper, correlation with a template picture and the reproduction image of digital watermarking embedded with the frequency domain type was taken, and it succeeded in drawing the standard of the degree of correlation required for matching of two pictures. As a future subject, it is use to correlation with other digital-watermarking reproduction images. And improvement in the degree of correlation of the pictures which have a position gap as a future subject etc. Moreover, in this experiment, the size of an original picture image and a reproduction image was the same. The technique of raising the degree of correlation of those picture size is different from is also required. It turned out that there are a character which is easy to take correlation by comparing the minimum value of the degree of correlation, and a character which is not so. About this, it seems that it is possible to draw the result of having excelled in increasing an amount of data from now on.

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