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Stego-tool

ECI-2019

Introduction

Steganography is the study and application of techniques that allow to hide messages within other objects, establishing a cover channel that prevents the very act of communication from being noticed by external observers.

Images are commonly used as cover objects due to the relatively high amount of data they contain and some other properties that will be detailed later, making them ideal candidates for hiding information without notice. In the present article, the development of an algorithm for injecting text within this type of files and the results obtained from its execution on many examples will be discussed.

The image format chosen corresponds to the BMP file format, which stores digital images as a bitmap. Each pixel is represented by a fixed number of bits (may it be 1, 2, 4, 8, 16, 24, 32 or more). This array of bits is most commonly arranged in RGB format, establishing the beginning bits as the red value of the image, the middle ones as its green value and the last ones as its blue value.

The human eye is not as responsive to blue as to the other two colours, making the blue component of a BMP file a good candidate for hiding information within it. That lead to the decision to implement an algorithm that given a picture in BMP and a text encoded using ASCII, it replaces the least significant bits of the image (which correspond to its blue component) with the bits that represent the text.

Development

A requisite for the programme developed was for it to be able to receive a maximum number of least significant bits (k for here on) which could be used to hide the message.

The algorithm implemented takes the value of k and checks if it will be enough to hide the message within the pixels of the given message; if not, then k is changed to the minimum value needed. k can have a value from 1 to 8 (a greater number could potentially take more bits that what are given to the blue component). If the text can be properly inserted in the image, then the number k is hidden within its first three pixels, using one bit from each one.

After that, the length in characters of the message is stored as a character in itself, using the same algorithm as for the rest of the message. This allows text sizes of up to 256 characters (as only 8 bits are used to represent them).

The algorithm for hiding a character is pretty simple: the bits of the character are taken in chunks of k bits, which are then stored in the k least significant bits of some consecutive pixels. If the last chunk is of a size less than k, due to an uneven size difference within the size of a character and the k chosen, then only the needed less significant bits of the next pixel will be used.

Before inserting the next character, there is the possibility of a pseudo-random padding being introduced. First, for adding a padding at all the binary exclusive or (xor) operation between the amount of pixels left available for padding (its total is calculated at the beginning of the hiding algorithm) and the last pixel used for steganography must result in a 1 in the least significant bit. If this condition is fulfilled, then the jump is calculated as follows:

$$jump\ =\ ((padding\_left\ xor\ prev\_pixel)\ \%\ (char\ size\ *\ k)\ +\ 1)\ \%\ (padding\ left\ +\ 1)$$

% representing the calculation of the remainder of a division between integer numbers and the char size equalling 8, as ASCII is used as the encoding.

The procedure for recovering the hidden message is straightforward: after extracting k and the text size from within the first pixels of the image the reverse algorithm for inserting a character must be applied. Also, the calculation of the padding jumps is executed in the very same manner. This results in that the recipient of the message only needs to know this algorithm for recovering it, as the original image has no more porpurse after the text has been hidden.

Ultimately, for the development of the so-called “stego-tool” the programming language C was chosen because of the low level facilities that it provides. Additional modules were created to provide functionality for extracting and storing the pixels of images in BMP format and for calculating certain measures between an original image and its resulting copy after applying steganography on it, which will be explained in more detail in the next section.

Procediment

In order to test the tool and get results about the performance, several images were selected and classified into four groups, depending on the theoretical difficulty in hiding messages without notice. These groups are: open nature (landscapes), portraits, still lifes and text.

Figure 1: *Open nature (landscape) image examples*

Figure 2: *Portrait image examples*

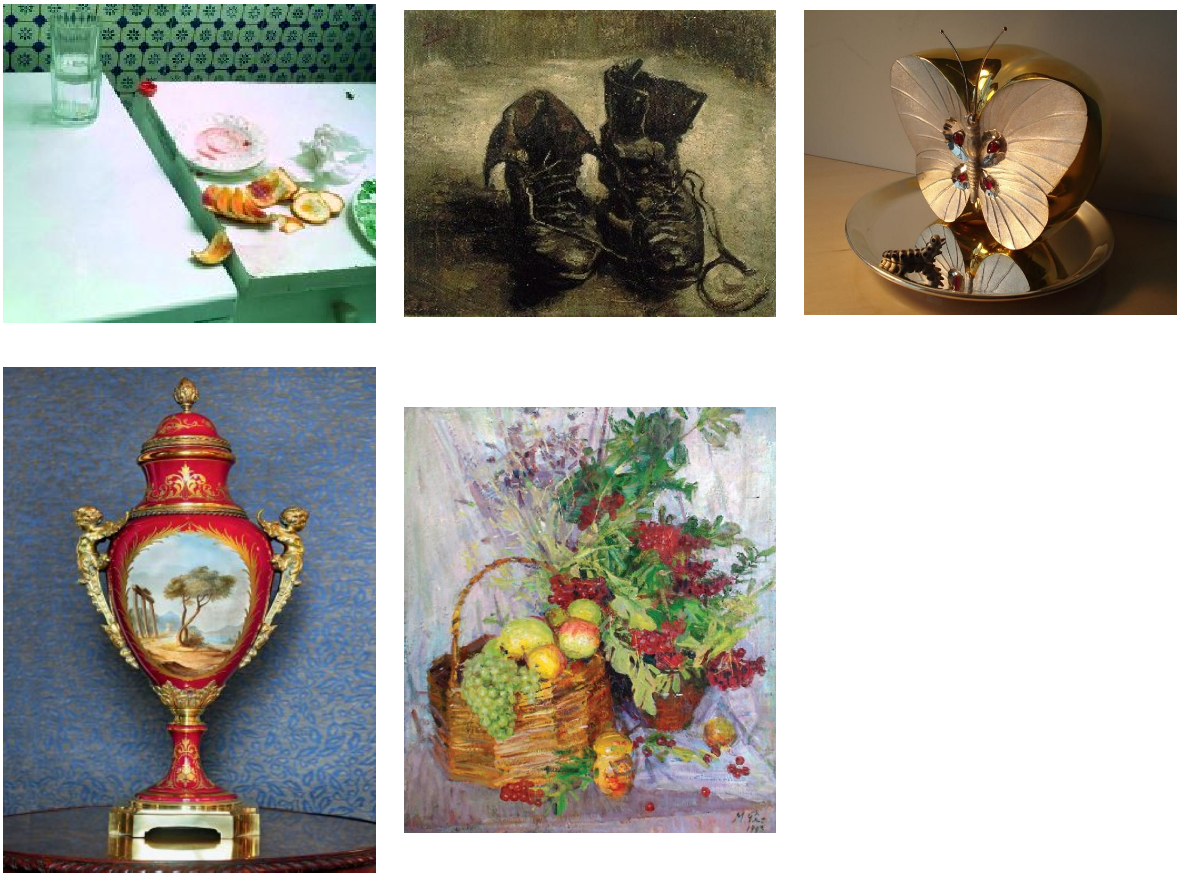

Figure 3: *Still life image examples*

A varied career

Chloe Kelling, a successful model and singer-songwriter, now has a new venture

I arrive for my interview with Chloe Kelling and I'm asked to wait in the garden. I hardly have time to start looking round at the carefully tended flowerbeds when Chloe appears. Every bit as tall and striking as I'd expected, Chloe emerges from the house wearing an oversized man's jacket, a delicately patterned top and jeans. Chloe is known for her slightly quirky sense of fashion and, of course, she looks great as she makes her way towards me through the flowerbeds.

'Let's talk in my office,' she says, leading the way not back to the house, but instead to an ancient caravan parked up next to it. As we climb inside the compact little van, the smell of fresh baking greets us. A tiny table is piled high with cupcakes, each iced in a different colour. Chloe's been busy, and there's a real sense of playing tea parties in a secret den! But what else should I have expected from a woman with such a varied and interesting career?

Chloe originally trained as a make-up artist, having left her home in the country at nineteen to try and make her name as a model in London, and soon got work in adverts and the fashion business. 'I went to Japan to work for a short period, but felt very homesick at first,' she recalls. 'It was very demanding work and, though I met loads of nice people, it was too much to take in at nineteen. If I'd stayed longer, I might have settled in better.'

Alongside the modelling, Chloe was also beginning to make contacts in the music business. 'I'd been the typical kid, singing with a hairbrush in front of the mirror, dreaming of being a star one day,' she laughs. She joined a girl band which 'broke up before we got anywhere', before becoming the lead singer with the band Whoosh, which features on a best-selling clubbing album. Unusually though, Chloe also sings with two other bands, one based in Sweden and another in London, and each of these has a distinct style.

It was her work with Whoosh that originally led to Chloe's link with Sweden. She was offered a song-writing job there with a team that was responsible for songs for some major stars, but gradually became more involved in writing music for her own band.

Although she now divides her time between London and Sweden, her first stay there turned out to be much longer than she'd bargained for. 'The rooms are very tall over there and so people have these rather high beds that you climb up to,' she explains. 'I fell as I climbed up the ladder and cracked three ribs. Although the people at the hospital were very kind, I was stuck there for a while, which was very frustrating. Sneezing and laughing were so painful at first, let alone singing!' It was while recovering from her injuries that Chloe hit upon the idea of staging what she calls vintage fairs.

'It was snowing in Sweden and I wanted something nice to look forward to.' Chloe had always loved vintage clothes, particularly from the 1950s, and decided to stage an event for others who shared her passion for these. Finally back in England, she began turning her plans into reality.

The first fair was held in her home village and featured stalls selling all sorts of clothes and crafts dating back to the 1950s. It was a huge hit, with 300 people turning up. 'When I had the idea of the first fair, it was only meant to be a one-off, but we had so many compliments, I decided to go ahead with more,' says Chloe. 'There's something for all ages and people find old things have more character than stuff you buy in modern shops. It also fits perfectly with the idea of recycling.' Looking round Chloe's caravan, I can see what she means.

XXI CONGRESO Sademi
Sociedad andaluza de

15.- LOS NIVELES DE INTERLEUKINA 6 AUMENTAN EN EL POSTPRANDIO DE FORMA INDEPENDIENTE AL TIPO DE GRASA CONSUMIDA EN VOLUNTARIOS SANOS.

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Objetivos:
Estudiar el efecto de la ingesta de tres dietas con distinto contenido en grasa sobre las concentraciones basales de Interleuquina-6 (IL-6) y su incremento en el postprandio.

Material y métodos:
Se seleccionaron 20 hombres sanos normolipémicos con el genotipo de apoE E3/E3, que fueron sometidos a tres periodos de intervención dietética de forma aleatorizada y cruzada de cuatro semanas de duración cada uno. La composición de las dietas fue: una dieta rica en grasa saturada (SAT) con 38% de grasa (22% SAT, 12% monoinsaturada, 4% poliinsaturada y 0.4 ácido linolénico), una dieta rica en grasa monoinsaturada (MONO) a expensas de aceite de oliva virgen con 38% de grasa (<10% SAT, 24% MONO, 4% poliinsaturada y 0.4 ácido linolénico); y una dieta rica en hidratos de carbono (CHO) y en n-3 de origen vegetal compuesta por <30% de grasa (<10% SAT, 12% MONO, 8% poliinsaturada y 2% ácido linolénico). Al final de cada periodo, todos los voluntarios fueron sometidos a un estudio de lipemia postprandial. Tras 12 horas de ayuno, se les administró una comida grasa de composición igual a la que venían consumiendo en cada periodo de intervención dietética, compuesta por 1 gramo de grasa/kg peso, 7 mg de colesterol/kg peso y 40 equivalentes de retinol/kg de peso, con la siguiente distribución calórica: 60% grasa, 15% proteínas y 25% de carbohidratos. Se realizaron extracciones en los tiempos 0 y 3, y se separó el plasma mediante centrifugación. Se cuantificaron los niveles de IL-6 con un kit comercial (R&Dsystems) de ELISA, y los lípidos plasmáticos por métodos enzimáticos.

Resultados:
No se observaron diferencias en el estado basal al analizar los niveles plasmáticos de IL-6 tras el consumo de las tres dietas. Por el contrario, en la hora 3 de la ingesta, se observó un aumento significativo en los niveles de IL-6 respecto al basal: 2.32 veces tras la dieta rica en aceite de oliva (p=0.03); 2.97 veces tras la dieta rica en grasa saturada (p=0.02) y 3.40 veces tras la dieta rica en CHO y en n-3 de origen vegetal (p=0.001). Este incremento se correlacionó con los niveles de triglicéridos totales vehiculizados en las lipoproteínas ricas en triglicéridos grandes y pequeñas de origen intestinal, e inversamente con los niveles de HDL.

Conclusiones:
Los niveles postprandiales elevados de IL-6 sugieren que tras la ingesta de grasa se produce un estado proinflamatorio que se correlaciona con el incremento de las partículas ricas en triglicéridos de origen intestinal.

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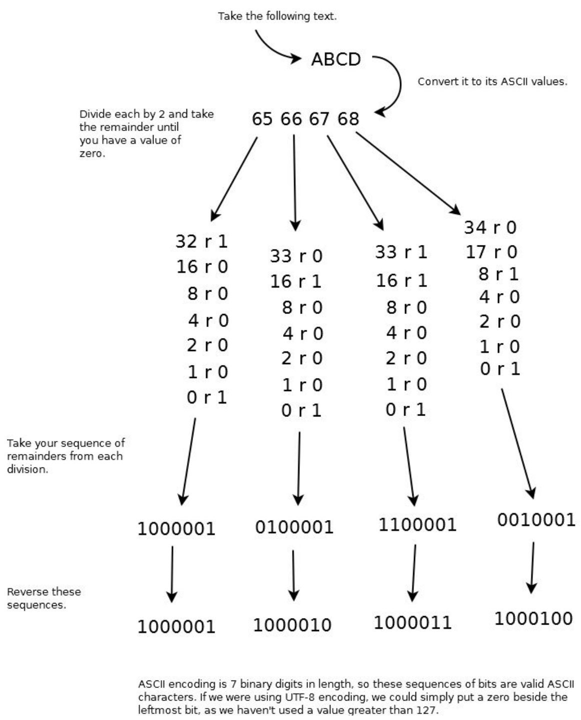

Table 5: Regression Results

	Dependent variable:	
	Overall Rating	
	(1)	(2)
Handling of Complaints	0.692*** (0.447, 0.937)	0.682*** (0.470, 0.894)
No Special Privileges	−0.104 (−0.325, 0.118)	−0.103 (−0.316, 0.109)
Opportunity to Learn	0.249 (−0.013, 0.512)	0.238* (0.009, 0.467)
Performance-Based Raises	−0.033 (−0.366, 0.299)	
Too Critical	0.015 (−0.227, 0.258)	
Advancement	11.011 (−8.240, 30.262)	11.258 (−0.779, 23.296)
Observations	30	30
R^2	0.715	0.715
Adjusted R^2	0.656	0.682
Note:		*p<0.1; **p<0.05; ***p<0.01

Figure 4: *Text image examples*

Each picture was used to hide messages, varying the k parameter and the length of the text to hide. For each time, it was calculated three values that represent the effectiveness of the algorithm hiding the given text. These are: the mean squared error (MSE), the peak signal-to-noise ratio (PSNR) and the structural similarity (SSIM).

Results

The tables below show the worst values obtained for each image of the four groups taken.

Table 1: *Open nature images worst values*

#	MSE	PSNR	SSIM
1	13329	103.25	0.999994
2	3147	109.51	0.999999
3	3640	157.05	0.999998
4	9629	104.66	0.999996
5	8949	56.81	0.999996

Table 2: *Portrait images worst values*

#	MSE	PSNR	SSIM
1	92615	94.79	0.999957
2	9794	104.58	0.999995
3	5541	107.06	0.999997
4	4604	107.26	0.999998
5	6529	106.34	0.999997

Table 3: *Still life images worst values*

#	MSE	PSNR	SSIM
1	6180	106.59	0.999997
2	5353	107.21	0.999998
3	23310	100.14	0.999989
4	15476	102.43	0.999993
5	40332	98.43	0.999981

Table 3: *Text images worst values*

#	MSE	PSNR	SSIM
1	3541	109.00	0.999998
2	3	139.72	0.999999
3	14638	102.84	0.999993
4	4	138.47	0.999999

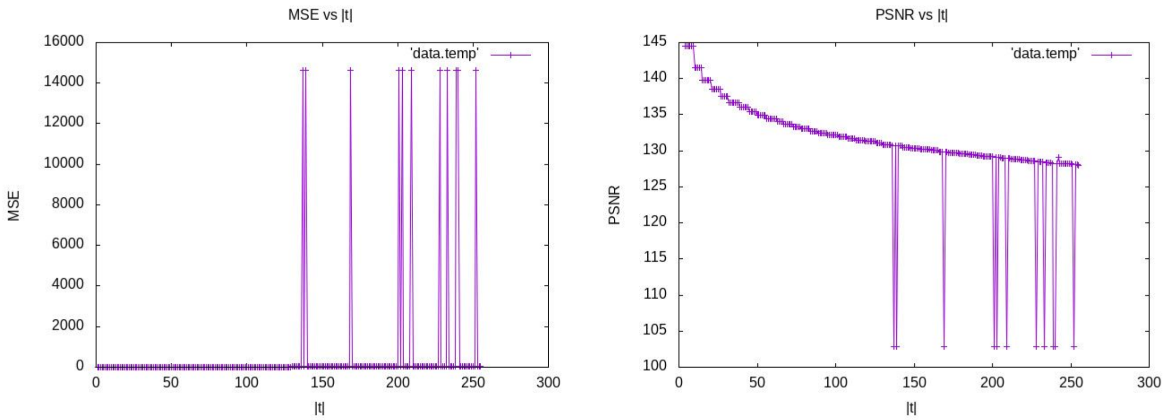

Figure 5: *Graphics of MSE and PSNR vs length of hidden text in the text image #3*

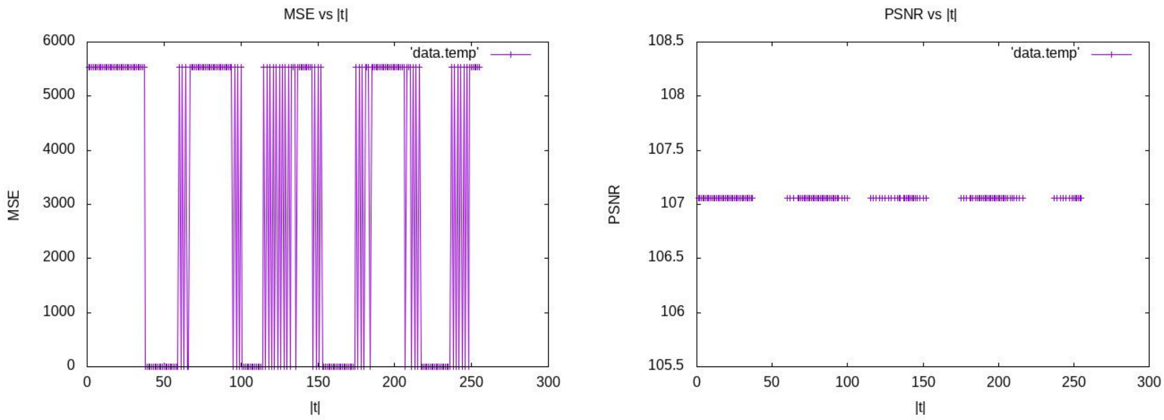

Figure 6: *Graphics of MSE and PSNR vs length of hidden text in the portrait image #3*

Conclusions

After testing the programme with many different images, variable messages and various values of k, the following conclusions were reached:

- Every message correctly hidden in an image was properly recovered.
- The pseudo-random padding generates localized jumps; in other words, the spaces between adulterated pixels are relatively small. This results in the text been inserted in the lower border of the screen, as the pixels are actually counted starting from the bottom left corner of the picture.
- The best results were unexpectedly obtained from text images. These are usually the worst performing in steganography due to having very little difference in its content. In these cases, it was clearly observed how the MSE increased as k or the length of the text did so. Also, the PSNR decreased when those values raised.
- The MSE of the images of the other categories tends to concentrate around a certain value or be close to zero. This last behaviour could be caused due to the combination of least significant bits of the images being similar to the bits representing the text to hide.
- The values of SSIM obtained all across the board were extremely good. This could be caused due to the small length of the text hidden in comparison to the size of the images used. Also, the previously discussed location of the adulterated pixels could be a factor in this.

A possible modifications to be made in the future is to increment the amount of bits used to store the length of the text from 8 to 16 (2 bytes or characters), which would allow messages of up to 65536 characters.