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Approach to Find Optimal Graphic Container Using Segmental Steganographic Algorithm

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Abstract

The article proposes an approach to selecting a suitable graphic container from multiple images for a specific message. Searching for an optimal container requires an analysis that takes into account both the human perception of the image and the mathematical relationships that can be analyzed in detail about the contents of the container. Experimental results have shown that if one image is split into separate zones, and in each one a steganographic embedding of information is applied, in one of them the changes are the least.

Keywords: Steganography; Image processing; Steganalysis; Information security

1 Introduction

Most of the research is aimed at creating improved stereotypes in order to increase the processing speed of embedding and retrieving the secret message, increasing the capacity, increasing the stability of the hidden message after various attacks, using different types of containers, and messages, the use of complex mathematical dependencies, etc.

When improving steganographic methods in image files, the right approach to container selection is also very important. In practice, this choice has to be transformed into a well-thought-out and conducted analysis, where the right indicators must be selected and used to make the best choice.

Incorrect container selection could compromise the hidden transmission of information, regardless of the well selected steganographic algorithm.

2 Methods and Algorithms

Vision is a heuristic process. The three-dimensional vision can be explained as a synthesis. This requires a clear view of vision as a phenomenon and a visual process as a function of the viewer. "We" do not reflect the world outside, and "our brain" transforms the impulses from the eye.

The brain adjusts to see what it sees and does not receive it passively. The brain blends memory, expectation and sensation to generate visual integrity [1,2,3].

One looks upwards when he makes a decision. This is what the prefrontal cortex is responsible for. When it is concentrated from the bottom up - the sensory crust. One can only see one thing at a time [4]. Man performs sensory sorting, fills the holes in reality. The images are formed in the visual cortex, for positioning using the shadows of the

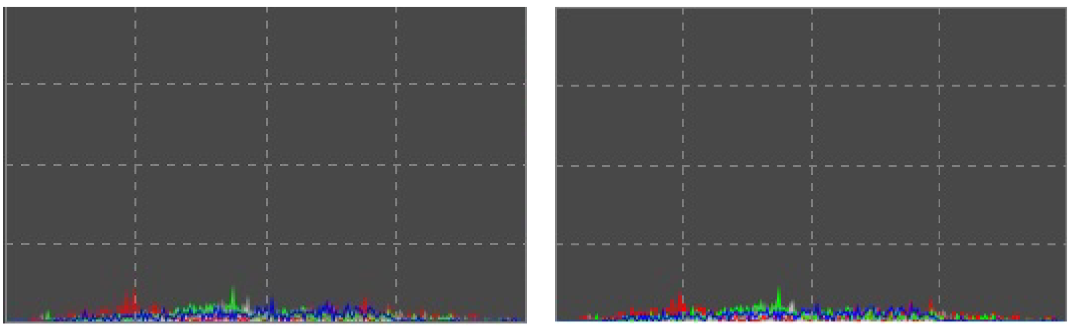
objects, trusting them to determine the place of the object in the space.
This gave rise to the idea of the algorithm - to find a suitable area for embedding the hidden message in order to reduce the changes in the container. To make the right choice, not only one but multiple images are used.
The algorithm divides each of the files into zones (sectors) and embeds the hidden message into them. On the basis of certain criteria, all the results obtained are analyzed both in all areas of the file and in all files. The file on the base where the smallest modification was made in a particular area is selected as a container.
From the point of view of obscurity, it is advisable that the size of the carrier file is not too large, because its larger size raises the suspicion that it may be the carrier of other, invisible information at first glance.
There is no precompression block in the algorithm that would allow the volume of the inserted message to be increased. For this reason, the maximum amount of information to be deployed in the image is determined by the size of the sector minus the header information divided by eight. The size of the carrier file does not change when a message is embedded.

3 Results and Discussion

Experiment 1:
In this experiment, all images from the 100 image database were used, and a 14 000 byte text message was generated by Lorem Ipsum.
It aims to fill almost the capacity of the picture container and examine the new file for visual defects and changes in image color, Fig. 1.

(a) Original (b) Stego file
Fig. 1 Visual analysis

After the visual evaluation, the histograms of the original images and stefofiles were also analyzed, Fig. 2.



(a) Original (b) Stego file
Fig. 2 Histogram analysis

Experiment 2:
Embedding efficiency E_e is the ratio of the size of the largest message that can be embedded in the container to the container size.

$$E_e = \frac{V_{mes.}}{V_c} \tag{1}$$

where:
V_{mes} – size of hidden message in KB or MB
V_c – size of the container in KB or MB.
All baseline images were used to examine the Embedding efficiency of the container, with the built-in message of different sizes. The experimental data of randomly selected images is presented in the following Table 1.

Table 1 Coefficient values Embedding efficiency

Image number	Message size in KB	Embedding efficiency
1	4	0.048911356
2	5	0.054345951
3	6	0.059840094
4	7	0.066666667
5	8	0.070649737
6	9	0.075851852
7	10	0.091657716
8	11	0.086636261
9	12	0.092388117
10	13	0.109338435
52	14	0.102616034
64	15	0.108691903
66	16	0.114126592
68	17	0.119561093
96	18	0.124347298
98	19	---

The results clearly show the gradual increase in the value of the built-in coefficient. Image 98 shows that the size of the message is larger than the LSB allowable embedding and therefore can not be calculated correctly. This proves that the algorithm fully meets the requirements of the LSB method.

Experiment 3:
In the PSNR study, all images from the base were used, with the embedded message of varying sizes. The following table, Table 2, presents the experiment data of randomly selected images using sector embedding.
The results clearly show the difference of two units of PSNR values in the same image, depending on the particular sector in which the image is inserted. This means that there is a container from the base that will be most suitable for creating a stegofile.

Experiment 4:
In order to find an optimal container selection in one database of many images, it is necessary to select criteria to be selected. One of the important indicators is to minimize the changes of the zeros and units in the stego file relative to the container.

Table 2 Values of PSNR for different sectors

Image number	PSNR			
	Sector 1	Sector 2	Sector 3	Sector 4
1	102.8529925	103.3467767	102.9493283	104.8151443
2	101.5558889	102.0496730	101.6522247	103.5180407
3	100.2587853	100.7525694	100.3551211	102.2209371
4	98.96168170	99.45546582	99.05801750	100.9238335
5	97.66457809	98.15836221	97.76091388	99.62672990
6	96.36747448	96.86125860	96.46381028	98.32962630
7	95.07037087	95.56415499	95.16670666	97.03252268
8	93.77326726	94.26705138	93.86960306	95.73541908
9	92.47616365	92.96994777	92.57249944	94.43831546
10	91.17906004	91.67284416	91.27539584	93.14121186
52	89.88195643	90.37574055	89.97829222	91.84410824
64	88.58485282	89.07863694	88.68118862	90.54700464
66	87.28774921	87.78153333	87.38408500	89.24990102
68	85.99064560	86.48442972	86.08698140	87.95279742
96	84.69354199	85.18732611	84.78987778	86.65569380
98	83.39643838	83.89022250	83.49277418	85.35859020

The search for the appropriate container for the respective message can be done by looking at the minimum value between the difference in the number of zeros in the container and the stereo file to the difference between the zeros and the units in the container.

$$TargetCover = \min\left[\left(\frac{S_0 - C_0}{C_1 - C_0}\right) * 100\right] \quad (2)$$

where:
S_0 - Count of zeros in the stego file
C_0 - Count of zeros in the container
C_1 - Count of units in the container
Following the experiment, the following data are obtained, Table 3.

Table 3 TargetCover coefficient values

Image number	Container		Stegofile		TargetCover
	Count of zeros	Count of units	Count of zeros	Count of units	
1	622729	583175	626681	579223	9.991404
2	643600	562304	647266	558638	4.509447
3	633218	571486	635749	568955	4.099981
4	624673	554975	628273	551375	5.165141
5	647594	558310	651318	554586	4.170960
6	530851	678749	537953	671647	4.801958
7	654026	418486	657266	415246	1.375563
8	625098	585222	630523	579797	13.60467
9	696528	509376	697594	508310	0.569590
10	526601	567415	530636	563380	9.886314

The resulting values are in quite a large range, but in the results of image # 9 it is noted that the changes made in the stego file are minimal. Therefore, this file will be selected as a container and will further seek to select the sector with the smallest changes.

4 Conclusion

Searching for an optimal container requires an analysis that takes into account both the human perception of the image and the mathematical relationships that can be analyzed in detail about the contents of the container.

From the point of view of human perception, it turned out that the eye of a person does not look at all the details of an image, and on the basis of his experience and sensation, the brain complements the areas "not seen" by the eyes. Based on this analysis, the idea of searching for zones in the file, in which changes even if made, will be the least reported.

The analysis of mathematical dependencies has proved the hypothesis that areas can be selected in the file where the changes are minimal.

The experiments have shown a very close connection between the container and the secret message - the same secret message inserted into different files brings different changes to the containers.

Acknowledgements

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