PERFORMANCE OF STEGANOGRAPHY USING MULTIRESOLUTION ANALYSIS APPLIED TO DIGITAL IMAGES

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ABSTRACT

This paper will allow us to know and understand what is the art of steganography with the support of a digital image. The main objective of the steganography is to transmit a message without anyone knowing the existence of the latter and also to keep a high transparency against the statistical and visual attacks. Our work consists of transforming the image into four sub-bands using the discrete wavelet transform, and then inserting the message into the 3 sub-detail spaces with insignificant coefficients. The algorithm will allow us to design a steganographic diagram respecting a good transparency and imperceptibility compared to other existing algorithms.

Keywords: *Steganography, wavelet, transparency, imperceptibility*

1. INTRODUCTION

There are several safety techniques such as tattooing and fingerprinting, but the latter is different from the desired goal. The insertion can take place on several domains but each domain must respect several properties such as the capacity, the transparency and the robustness. The insertion in the spatial domain using the LSB (Last Significant Bit) of directly modifying the pixels of the image has been used previously but the insertion in the domain of the transforms allow us to respect the different properties by not modifying the image only after transformation. [1] [2] Wavelet decomposition is widely used in compression, denoising and tattooing of images because it allows us to distinguish the low and high frequency coefficients after a multi-resolution analysis [3] [4]].By inserting the message in the 3 subspaces of detail; extracting the message consists of applying the wavelet transformation to the stenciled image and retrieving the message in the detail spaces.

2. WAVELET TRANSFORM

The discrete wavelet transform is derived from a continuous wavelet transform, unlike the latter, the TOD uses a scale factor and a discretized translation [5].

$$T^{ond}f(m,n) = {a_0}^{\frac{-m}{2}} \int_{-\infty}^{+\infty} f(t)\Psi({a_0}^{\frac{-m}{2}}t - nb_0)dt \quad (1)$$

- m: is the scale factor
- n: is the translation parameter
- If we choose $a_0 = 2$ and $b_0 = 1$, we then speak of a dyadic transform.

2.1 Multiresolution analysis

The direct construction of discrete orthonormal 2-D wavelet bases is based on the theory of multiresolution analysis (AMR). This analysis allows the successive study of the smoothed approximations of a 2-D signal in which the details are progressively suppressed. The idea is to project a signal $f(t) \in L^2(R)$ belonging to a space V_j on a subspace V_{j+1} and a subspace W_{j+1} for the purpose of reduce the resolution to half [6] [7].

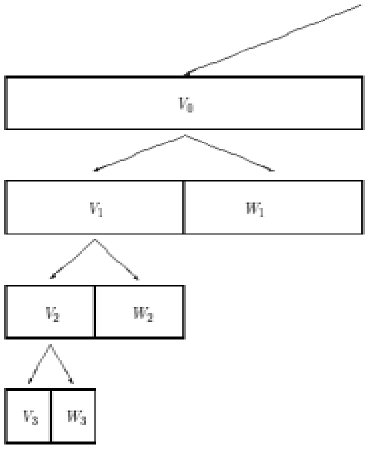

Fig - 1: Principle of multi-resolution analysis

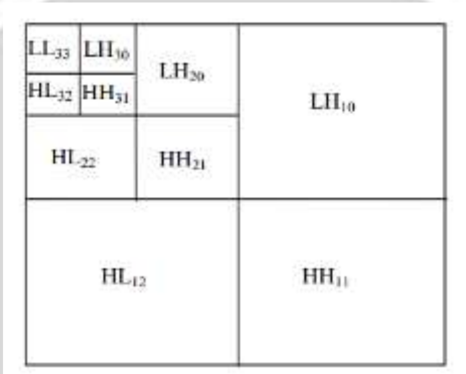

Fig - 2: Decomposition of a wavelet image with 3 levels.

3. PROCESS OF INSERTION

The Haar transformation uses many coefficients that are 0 or close to 0. After applying the transform to the original image, we get 4 subspaces. The message will be inserted in the 3 detail spaces whose coefficients are insignificant. [3] [7]

3.1 Insertion into the horizontal detail

In this space, we only insert information about the message to be transmitted which is the length of the message and the character of the message with the highest value. This information will be used as a reference for extracting the message so that the receiver can first know the length of the message we have inserted.

3.2 Insertion Insertion into vertical and diagonal detail

For insertion into these two spaces, the information will be divided: in the first part will be inserted in the vertical detail and the second in the diagonal. Note that the message we are going to insert will be encoded in ASCII. In theory, since we hide data in insignificant coefficients, it must not change the appearance of the image significantly.

4. DESCRIPTION OF THE ALGORITHM

Here is how the insertion algorithm works:

- Take a picture

- Perform a wavelet transformation stopped at the first level using the Haar wavelet.
- Generate a key to encrypt the message.
- Insert the message in the horizontal, vertical and diagonal detail space
- If the whole message could be inserted, then "successful process".

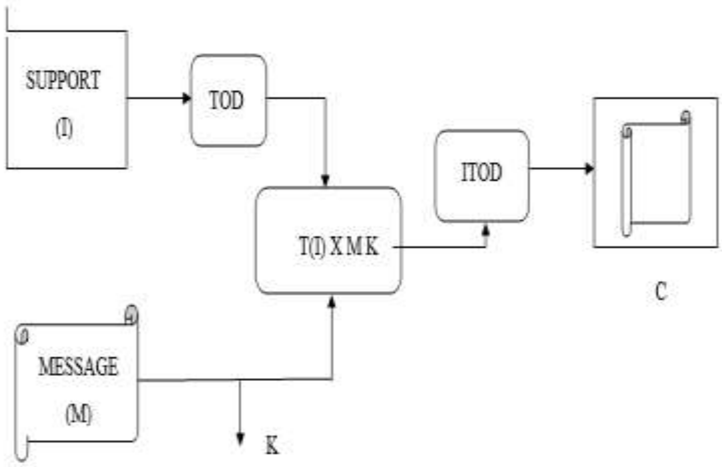

Fig - 3: Insertion process.

During the extraction, the receiver will then only have to generate the random walk, and find the parameters of the algorithm used. The message is encrypted using private key encryption, that is, the sender and the receiver share the same key.

5. RESULTS

All the tests were carried out on the "lena, butterfly" images of dimension 512 * 512 and a very high definition image of dimension 1600 * 1000. We then compared two insertion methods, one using theLSB and the other the DWT. The following figures respectively show the original image and the steganographed image using the two algorithms. The message inserted on the two algorithms is the same "Hello". There is a resemblance between the original image and the steganographed image but the information given by the metrics such as the MSE (Mean Square Error) and the PSNR (Peak Signal Noise Ratio) show that the image steganographed by the LSB method has been distorted.The algorithm using the LSB method has an MSE equal to 0.00875473 and a PSNR equal to 68.708 while that using the DWT has an MSE that is equal to 0 and a PSNR that tends to infinity [8] [9].

Fig - 4: Original image and steganographed LSB

Fig – 5: Original image and steganographed DWT

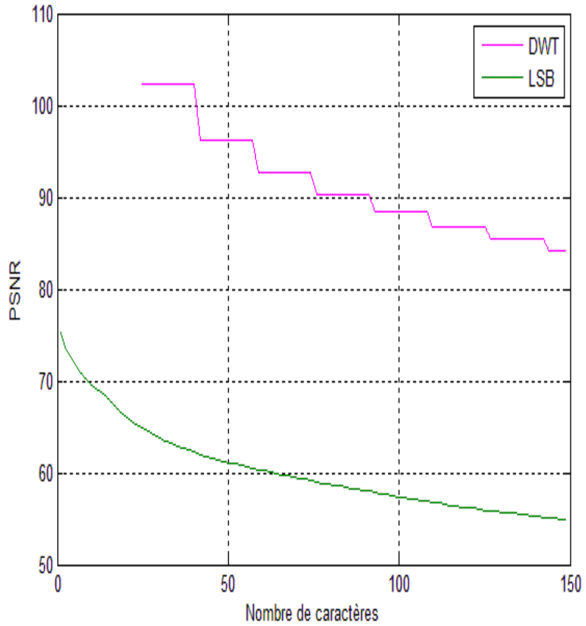

Fig – 5: PSNR according to the number of characters of the two algorithms

The PSNR versus character number curve shows us that the algorithm using the DWT is highly efficient compared to the one using the LSB in terms of imperceptibility and transparency. The more the number of characters increases, the more the support deteriorates.

6. CONCLUSION

One of the constraints for a good steganographic scheme is a transparency. We were then able to find a message insertion algorithm to respect this important property.

We have proposed a method of steganography operating in the frequency domain, that is to say by inserting the message in the high frequency coefficients. The use of another algorithm such as the LSB allowed us to see the effectiveness of our algorithm.

We can freely manipulate these coefficients because they present the useless information of the image in which the decomposition had been applied.

An algorithm combining imperceptibility and robustness can be envisaged by using at the same time multiresolution analysis and a method using spread spectrum for a high robustness against the attacks present on the transmission channel.

7. REFERENCES

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