ADAPTIVE WATERMARKING – TWO WAYS TO DEFINE IT

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Abstract: Digital watermarking has been proposed as a solution to the problem of copyright protection of multimedia data in a networked environment. It makes possible to tightly associate to a digital document a code allowing the identification of the data creator, owner, authorized consumer, and so on. Content-based image watermarking techniques bring improvements to the robustness of the watermark and to the reconstruct image quality. In this paper, two different ways of defining the adaptability of the watermark to the host image will be presented. The first one is based on human visual system (HVS) properties and in the second one the areas that will be marked are chosen depending on the image. The obtained results for both schemes show that the techniques are resilient to most common attacks including filtering, lossy JPEG compression, geometric transformations etc.

Key words: adaptive watermarking, image content, geometrical transforms.

INTRODUCTION

The appearance and the development of the watermarking techniques wanted to guarantee the authenticity and the identity of an object like video or audio sequences, text and still images. For still images, a watermarking algorithm contains two parts: watermark embedding – adding a pseudo-random sequence to the host image parameters, and watermark detection – extracting the added sequence or deciding if a image was marked or not, based on statistical criteria.

There are several types of watermarking techniques like visible or invisible watermark, embedding in the spatial or in the frequency domain, blind or non-blind detection and for all these the general criteria for a functional scheme are a good quality for the reconstruct image and robustness to common attacks like noise addition, contrast, brightness or color adjustments, low pass filtering, geometric transformations, JPEG compression and any image processing that doesn't affect image quality too much.

To achieve these goals, adaptive watermarking schemes were developed because they become robust by using both spatial and frequency domain [1]. Adaptability can be defined like a measure of the reconstruct image quality by using HVS properties, like a measure of robustness by choosing different watermarking areas for each image or like a measure of authenticity by using the proper watermark for each image.

In this paper, two adaptive watermarking schemes are presented. The first algorithm is based on the invisibility of the watermarks using the frequency domain and several masking methods. During the watermark detection, the introduced mark is extracted using a correlation function. The second one proposes feature points extraction and a watermark embedding in the spatial domain, using the surrounding areas of the extracted points, for achieving robustness to geometric transformations. For this algorithm the presence of the mark is detected based on a statistic decision, using a circular correlation function and a threshold.

INVISIBLE WATERMARKING USING PROPERTIES OF THE HUMAN VISUAL SYSTEM (HVS)

HVS properties are used to ensure an invisible watermark, in order to protect the quality of the image. The masking methods define parameters that make a difference between a pixel from an uniform region and one from a region with strong texture because it is known that uniform regions are less resistant to noise and the mark can be treated as noise [2]. There are four masking methods described in this work:

JSEG - J-Segmentation - a vector quantization is used to reduce the number of the colors from an image to a given value and a J parameter is defined that measures the distance between different classes over the distance between the members of each class

EM - Entropy masking - this model is using a JPEG quantization.

JND - Just Noticeable Distortion - the texture information of an image is extracted using the DCT (Discret Cosinus Transform) coefficients.

VM - Variance masking - this masking method is using the variance of a pixel relative to a RxR window, over the maximum of all the variances computed for the image pixels.

For all masking methods, the DCT is first computed, for 8x8 blocks, to find the frequency domain coefficients. The mark is added to the coefficients from each block corresponding to a marking image. Because high frequencies are sensitive to compression, we choose to insert the watermark into the low and medium frequencies of each block.

The mark consists in a pseudo-random sequence uniformly distributed or with normal, standard distribution. The pseudo-random sequence is introduced additionally by scaling with the gain factor obtained using one of the masking methods proposed in the previous section.

Watermark detection has the following steps: DCT for 8x8 blocks, generate the pseudo-random sequence used for watermark embedding with the same secret key, compute the correlation function for each block and compare the obtained value with a threshold. If the obtained value is higher than this threshold, the block is considered marked and the corresponding pixel in the extracted image is set to black, if not the pixel is set to white.

IMAGE DEPENDENT WATERMARKS

This method uses the spatial domain for watermark embedding [3]. It is based on feature points extraction technique Harris-Laplace. At each scale space level, feature points are extracted using Harris operator and only the ones for which this measure exceeds a threshold and are local maximums are kept. For these points the laplacian is computed at different scales and the points for which this value is high enough and the associate scales are considered feature points.

We consider as marking areas the disks surrounding feature points with radius 8s, where s is the scale chosen for each point. It is necessary to choose disks with maximum Harris value and who doesn't intersect between them.

At watermark detection, feature points are extracted and associate scales computed. For each extracted point a circular correlation function is computed and its maximum value is compared with a threshold to decide if the point was marked or not.

RESULTS AND DISCUSSION

The advantages and disadvantages of the presented algorithms are revealed by testing their robustness to attacks like JPEG compression, geometric transformations (rotations, scaling, translations), gif compression, noise adding ("salt and pepper", uniform noise, gaussian noise), linear filtering (blur, gaussian blur, sharpening) and non-linear filtering(median filter).

In the test image the watermark was embedding using the algorithms above. The reconstruct images are given in figure 1.

a) b) c) d) e)

Figure 1

Algorithm1 a) using JSEG b) using variance masking c) using entropy masking d) using JND. The test image was marked using this marking image ✱.

e) Algorithm 2 – Four disks were coded

The color space used for all four variants of the first algorithm was YIQ for embedding and a linear combination of $I_1I_2I_3$ and XYZ for detection. For the second one we use YUV for embedding and for detection and α was computed using the variance masking method.

CONCLUSIONS

In this paper, two content-based watermarking techniques were presented. The experimental results show the problems of the first one to geometric transformations. The reason for this situation is the synchronization introduced in the algorithm by using 8x8 blocks. For other kind of attacks the results show functional schemes.

Robustness to geometric transformations can be achieve by finding the transformation performed and resynchronize the image.[16] The results are better for grayscale images or if we choose a higher gain factor, but in this case the image quality is affected.

The attacks used in this paper were performed with Adobe Photoshop 7.0

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