A New Multiple Watermarking Schema for Medical Image in Frequency Field

Mohamed KALLEL*, Mohamed Salim BOUHLEL* and Jean-Christophe LAPAYRE**

* Research Unit: Sciences and Technologies of Image and Telecommunications
    Higher Institute of Biotechnology, Sfax TUNISIA
    kallel_mohamed2004@yahoo.fr
    medsalim.bouhlel@enis.rnu.tn

**Informatics Laboratory of Franche Comte LIFC (FRE CNRS 2661) Besançon - FRANCE
    jean-christophe.lapayre@univ-fcomte.fr

Abstract: A multiple watermarking technique can be used to ensure record of the commentaries realised by practitioners in the collaborative work. Multimedia applications need high requirements on their security, for this reason the use of digital watermarking is a field that has received an increasing degree of interest to protect media against piracy. The fundamental challenge of this paper is to hide information into a digital image file so that the information is not perceived. In fact, an overview of the multiple watermarking schema in the frequency domain is presented to ensure a record and a traceability on the collaborative work between practitioners.

Keywords: multiple watermarking, frequency field, TeNeCi platform, medical image.

INTRODUCTION

The past few years have seen an explosion and a revolution in the use of digital media. Digital media offers several distinct advantages for manipulation and transmission. Digital media must be protected against piracy [NOR 03]. In fact, it is possible to hide information in the sense that it is perceptually and statistically undetectable. The hidden information can still be recovered if the host signal is modified. Digital watermarking has been proposed as a means to identify the authenticity and the traceability of the signature inserted on the image. The objective on this paper is to apply the technique of digital watermarking on the medical field.

In the next section, we review requirements for data embedding algorithms. Insertion of the data into medical image is then described, followed by previous work in the field. Our latest research describes the solution which is used to surmount the errors caused by the DCT (discrete cosines transform). Finally, results are presented to confirm and prove the improvement and perfection in DCT function.

1. Context

This research is in reality implemented in a European project TeNeCi [KAL 08] (Télé-neurologie Coopérative) between France and Switzerland. This project was conducted by the Besançon University Hospital and the informatics laboratory of Franche Comte on the one hand and Vaudois University Hospital of Lausanne and the federal polytechnic school in Lausanne on the other hand. It was performed to establish coordination among practitioners in these hospitals to treat emergency illnesses. Our research is to ensure the traceability of each practitioner in the collaborative work.

2. Overview of the multiple watermarking techniques in the frequency domain

The message embedded in the image is a character type because the doctor inserted a comment. This message is converted on the ASCII code and then embedded on the image. In spite of the loss created by the discrete coefficient transform [CHA 05], in this case we can not find the inserted message on the extracted phase. In fact, the application of the DCT and The inverse DCT generates a loss which produce defect on the inserted message [CHE 00].
Figure 1 showed that after the application of DCT on the medical image, we embedded the message on the high frequency [FIS 04].

We observe that the extract message is different from the inserted message. Indeed, if we apply to a number the cosine function we can not find it using the inverse cosine function due to the irreversibility criteria.

3. A suggestion of a practical solution to the current problem

The aim of this paragraph is to search a technique that allows recuperating the same inserted message.

The major problem is the application of the function used. In fact, it causes errors and produces a false message even if the medical image is authentic.

After statistic study on the medical image (base), we observe that the error ε is box between -1 and 1.

For this reason, it is necessary to allocate an interval for each character that contains many values which are not limited to the ASCII code conversion [KAL 07]. Indeed, we take “pathology” as an example. After conversion in the ASCII code we obtain « 97 110 111 109 97 108 105 101 ». The embedded of this number on the high frequencies causes a default and we get in the extraction phase an error message. Therefore, we have not limited the conversion on one value but also on an interval i.e. the letter “p” takes three numbers and in this way even the presence of the error does not change the letter “p” and consequently the totality of the message.

Figure 2 shows the insertion of the converted message as the novel attributed code to surmount the eventual error that has been introduced on the medical image.

3.1. The embedded technique phase

The developed approach in the embedded phase on the frequency domain is composed of six phases:

- The image is decomposed of block 8x8 pixels to minimise the assessment time
- The DCT function is applied to this divided block (if the size of the medical image is 256x256 pixels we obtain 1024 blocks).
- The image is divided into the number of the practitioners (in our approach we used 4 doctors).
- The diagnosis inserted by each doctor is converted to surmount of the problem caused by the DCT function and especially by loss produced by the cosines function.
- The coded message is inserted on the high frequency DCT-coefficients.
- Finally, the inversed function of the DCT function is applied to rebuild the watermarked image.
3.2. The extracted technique phase
This phase is composed of 4 stages:

- The watermarked image is decomposed on block having a size of 8x8 pixels.
- The DCT function is applied on these blocks.
- The coded message is extracted.
- This message is decoded to find the real message inserted.

3.3. Interpretations
In the insertion phase we observe that the coded diagnosis was inserted on the right inferior coin of each block that is illustrated in figure 3.

![Figure 3: Division of the image on blocks 8x8 pixels](image)

The emplacement used for the insertion of the message is selected to ensure the imperceptibility of the medium and especially to eliminate the defects caused by the DCT function [FRI 04]. Any different position can create modifications on the medical image and also increase the error established by this function.

4. Experimental study and results

Figure 4 depicts the quality of the original image and the watermarked image after the message insertion.

![Figure 4: Watermarked Image](image)

We notice that the watermark is imperceptible and does not appear on the image thus the addition of the signature on the medical image does not cause alteration.

Following the multiple insertion by a group of practitioners, we can show in figure 5 the image quality variation using a PSNR (Peak Signal Noise Ratio) metric.

![Figure 5: PSNR Variation](image)

Referring to Figure 5, we observe the watermark degradation of the medical image. This change is due to the amount of information quantity embedded on the image i.e. the more the information inserted on the image increase the more the degradation on the watermarking image is accentuated.

The diagnoses realised by each doctor are illustrated in table 1.

**Table 1: Diagnoses for the practitioners**

<table>
<thead>
<tr>
<th>Practitioners</th>
<th>Diagnoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practitioner 1</td>
<td>Pathology</td>
</tr>
<tr>
<td>Practitioner 2</td>
<td>Pathology in the superior zone</td>
</tr>
<tr>
<td>practitioner 3</td>
<td>Pathology in the superior coin</td>
</tr>
<tr>
<td>practitioner 4</td>
<td>Pathology on the right</td>
</tr>
</tbody>
</table>

The image is always affronted by the pirates. This major problem annoys practitioners who defend any type of attack on the medical image while the
diagnosis became certainly modified. Therefore, the comment of the doctor will be modified which affects his compliance conformity principally on the patient. For this reason, the elaborated technique must limit this event. Table 2 shows the sensitivity of the watermarking technique against attacks.

Table 2: sensitivity against attacks

<table>
<thead>
<tr>
<th>Attacks</th>
<th>Without attacks</th>
<th>Inserted message: pathology</th>
<th>Extracted message</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>pathology</td>
</tr>
<tr>
<td>Contrast enhancement</td>
<td></td>
<td>X</td>
<td>pbvip phkg</td>
</tr>
<tr>
<td>Adding Noise</td>
<td></td>
<td>X</td>
<td>auhjlocie</td>
</tr>
<tr>
<td>Filtering</td>
<td></td>
<td>X</td>
<td>nce bec</td>
</tr>
<tr>
<td>Rotation</td>
<td></td>
<td>X</td>
<td>aa</td>
</tr>
<tr>
<td>JPEG compression</td>
<td></td>
<td>X</td>
<td>tg m ggg</td>
</tr>
<tr>
<td>Histogram equalization</td>
<td></td>
<td>X</td>
<td>yg w s kh</td>
</tr>
</tbody>
</table>

This table illustrates that the developed approach is sensible to any eventual attack. In fact, the practitioner can make his diagnosis and it is certain that if the comment is attacked it will be signalled on the extraction stage.

5. Conclusion

The discrete cosines transformation function is not reversible, thus the application of the multiple watermarked technique in the frequency field cause an error on the message during the extraction phase even if the image is not falsified. Therefore, the debate between the practitioners will be interrupted with out any real causes that increase the judgment time to make a diagnosis. For this reason, we judge it primitive to apply a multiple watermarking technique that codes a message before its insertion on the medical image ensuring, in this way the elimination a potential error which can affect the authenticity of the medical image commentary.

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