Implementation of watermarking algorithms for medical imaging

Oueslati sameh- Cherif Adnen- Laboratoire de traitement du Signal, Faculté des sciences de Tunis, 1060- Tunis

Abstrct-In this paper, we are going to present a convivial interface which makes it possible the medical profession in our hospitals to treat, consult and divide a numerical library of medical images of various methods:
(echography the IRM: (imagery by magnetic resonance), x-ray, Scannographie, the Scintiscanning.....) whole while ensuring the confidentiality of information relating to the patient and his diagnosis. In this interface developed under Matlab we achieves out four algorithms of watermarking pertaining to two great families; three operative on the space field and one on the frequent field.

I. INTRODUCTION

Numerical watermarking is a good means definitively to bind date, name of the patient and stereotype "it can also be useful to prevent any modification the picture, a significant problem for questions of insurances" one can go there further and this by conveying useful information on the media in question. [1]The advantage is in the fact that it not only invisible but of more indelible and robust screw to screw with the traditional treatment would be applied to the pictures. The operation of watermarking must answer three principal constraints; invisibility, the robustness and capacity of insertion .[10] Le second principal quality standard of an algorithm relates to its robustness screw to screw with handling of the picture, the estimate of the robustness is done by calculation of correlation between the mark attacked after its extraction of the picture and the original mark .The third and last criterion are the capacity of insertion characterized by the ratio carried out the watermarking of several images by using the following methods:

- substitute method in the space field
- Method of direct addition of the mark in the space field.
- Method of addition of a sequence ±K in the space field.
- additive method in the frequent field

The operation of phase of insertion and extraction must take account of several parameters in order to ensure the imperceptibility of the mark and the robustness of the algorithm

.

II. WATERMARKING IN THE SPACE FIELD

In the space field, watermarking applies directly to the pixels of the original picture, according to two techniques:
The first consists in modifying one of the bits of the weakest weights of these pixels according to those of the mark, called watermarking by substitution The second consists in adding a mark, called watermarking by addition, these two techniques answer the constraints of visibility and robustness by modifying the order of the bit of insertion (for watermarking by substitution) or by optimizing the value of the profit (for watermarking by addition) [2].

II.1.THE WATERMARKING OF PICTURES BY SUBSTITUTION

To insert a text in a medical picture by the substitute method takes into account
Size of the text as well as the size of the medical picture which one wishes to watertmark.
Size of the text as well as the size of the medical picture which one wishes to watermark [2, 3]

II.1.1. Algorithme d'insertion

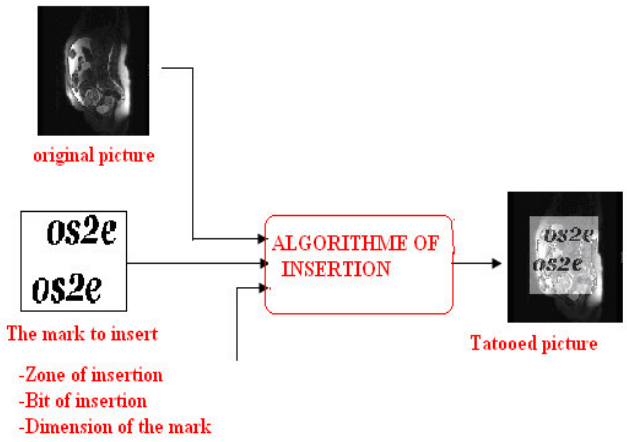


Fig .1. Substitutive watermark diagram in the spatial domain

Here a substitute example of insertion of a text in the space field.

bits = (1,..,3) Invisible mark | bits =6 a little visible mark | bits=8 visible mark

Fig.2. Results of substitutive insertion of a mark in the spatial domain

According to these medical pictures , the visibility of the armadillo increases as the weight of the bit in which one will insert the armadillo increases, we can notice that from the fourth bit, the mark begins to be visible

II.1.2. *operation of extraction of the text inserted text by substitution*

The algorithm of extraction can be regarded as dual algorithm of insertion i.e.[5] the operations carried out in phase of extraction derive directly from those defined in phase of insertion of watermarking The extraction of the text is made only if one knows the key defined by the following parameters:

- The position of the text.
- The bit in which the text is inserted.
- The dimension of the text.

II. 1. 3. algorithm of extraction

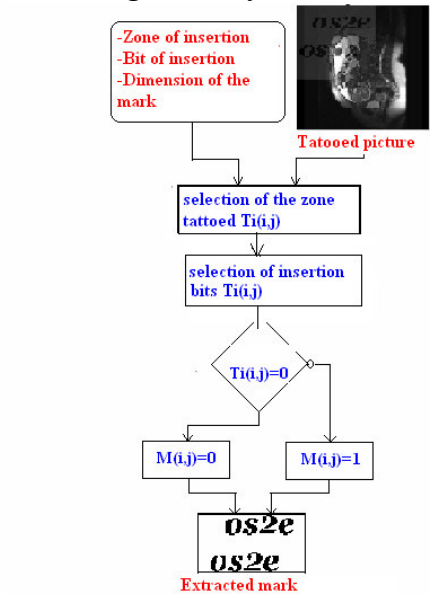


Fig. 3. Organization chart of extraction of a mark inserted by substitution of bits in the spatial domain

II.2. THE WATERMARKING OF PICTURES BY THE DIRECT ADDITION OF THE MARK

This method of watermarking consists in adding the mark with the original picture by using a coefficient for the visibility of the mark called profit of insertion.[4] This operation applies only in one quite localised zone of the original image according to the following equation:

Ot (I, J) = O (I, J) +G * M (I, J) (1)

(Ot (I, J): the tattooed image, O (I, J): the picture to be tattooed (original picture), G: profit of insertion, M (I, J): the mark.)

II. 2. 1. algorithm of insertion

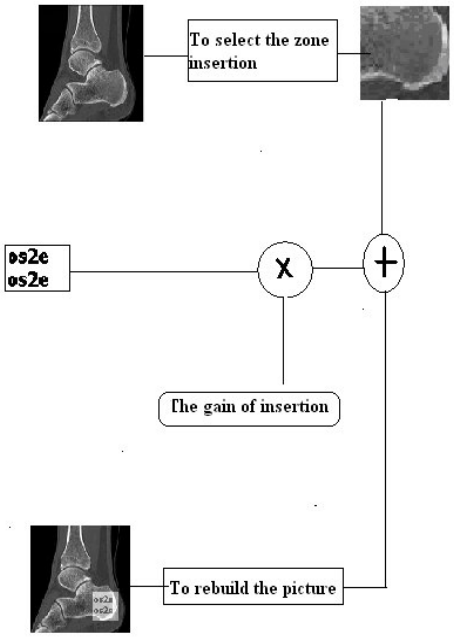


Fig. 4. Organization chart of the insertion by the direct addition of the mark

Here an example of insertion by the direct addition of the mark in the space field.

G= (1 to 9) G = (10 to 25) G = 50

Fig. 5. Results of insertion of a mark by the direct addition of the mark

According to the preceding figures one notices that the choice of the profit is according to two constraints. On the one hand we want to have a maximum profit of insertion to ensure a good robustness against the attacks. In addition a profit of insertion is wanted minimum so that the armadillo is invisible.

II.2.2. Operation of extraction of the mark inserted by the direct addition of the mark

For this technique of watermarking, the extraction of the armadillo is nonblind i.e. that it requires the knowledge of the original picture in more of the zone of insertion and the value of the profit, this operation is done as follows:

- To locate the tattooed zone (Ot (I, J)).
- To locate the zone in which the armadillo is inserted in the original image (O (I, J)).
- To release the mark (M (I, J)) by making the following operation:
  (Ot (I, j)-O (I, j))/G=M (I, J) (2)

II.2.3. algorithm of extraction

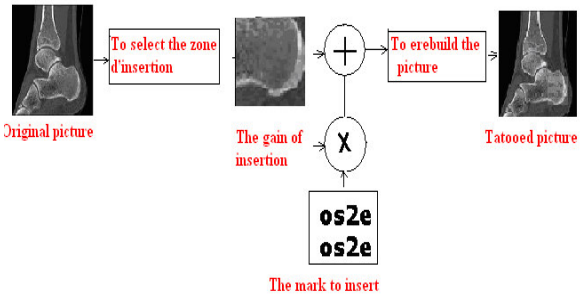


Fig. 6. Organization chart of extraction of a mark by the direct addition of the mark the watermarking of images per addition of a sequence ±k

II.3. Operation of insertion of the mark by addition of a sequence ±k

This second technique of insertion of watermarking by addition consists in adding or to withdraw a coefficient of each value of the various pixels of the original picture existing in the zone of insertion of the mark, to add or withdraw depend on the value of the pixel of the mark (0 or 1) according to the following procedure: [6]
(M being the mark, Io being the original picture, It being the tattooed image)
if M(i, j) = 1, It(i, j)=Io(i, j)+k (3)
if M(i, j) = 0 ; It (I, J) = Io (I, j)-k
((I, J) being the position of the mark in the original picture)

II.3.1. Algorithm of insertion

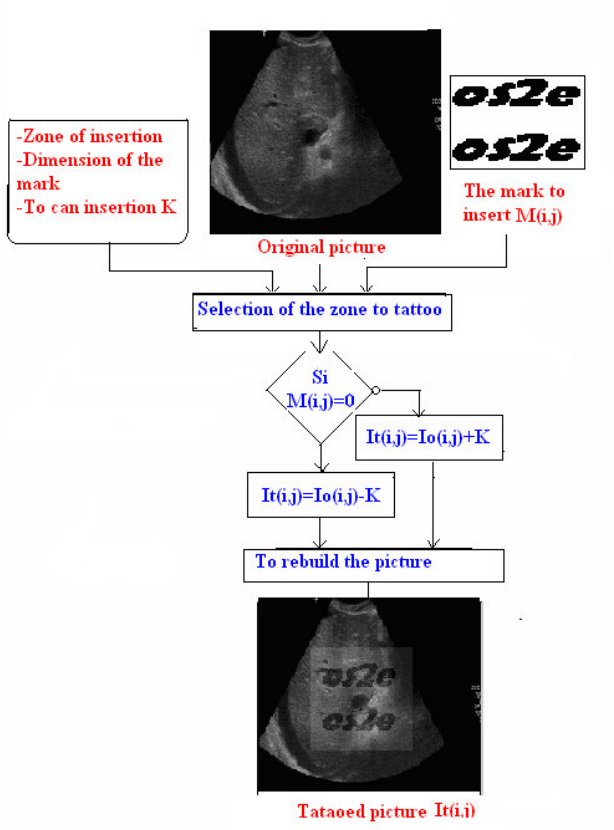
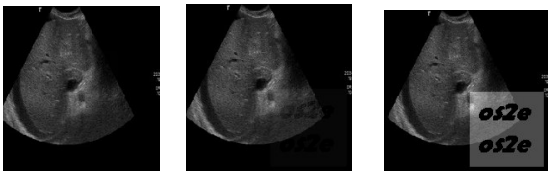


Fig .7. Organization chart of insertion of the mark by addition of a ±K sequence

Here an example of insertion by the direct addition of the mark in the space field.



k= 1 k=7 k=75
Invisible mark a little visible mark visible mark

Fig. 8. Results of insertion of a mark by addition of a ±K sequence

According to the medical images located above, one notices that the visibility increases as the capacity of insertion increases moreover the visibility of the mark depends on the zone on insertion Indeed, the original

picture which one wishes to watermark presents several zones which oscillates between clearness and the darkness, so the visibility of the mark will be more important in a clear zone and will be it less in one dark zone. [8].

II.3.2. Operation of extraction of the mark inserted by addition of a sequence ±k

The operation of extraction of a mark inserted by addition of a sequence ±K requires the knowledge of the original picture and the zone of insertion of the mark in the picture. The comparison between the values of the existing pixels in the tattooed zone and their counterparts in the same zone of the original picture carries out us to extract the mark.

II.3.3. Algorithm of extraction

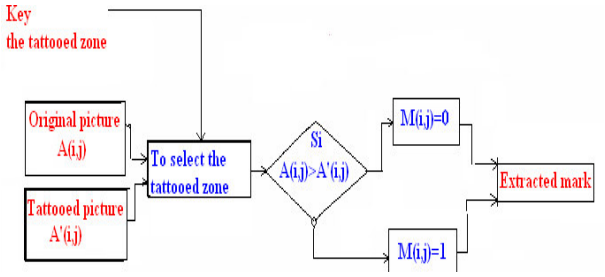


Fig .9. Organization chart of extraction of the mark by addition of a ±K sequence

III. WATERMARKING IN THE FREQUENT FIELD

The utility of watermarking in the frequent field comes owing to the fact that in this field one can tattoo components whose modification will be less on the visual impact than if the pixels of the picture directly were modified (in the space field). Indeed, these components in which the mark will be dissimulated and which is perceptuellement significant in the frequent field, are low the, average ones, and high frequencies; however, the modification of the low frequencies will involve an important visual impact whereas if this modification aims at the high frequencies, watermaking will be less robust and vulnerable to least handling. From where need for choosing an average frequency band which ensure the compromise between a deterioration of the quality of the not very visible image and a maximum resistance to the attacks. [7, 2]

III.1. watermarking of pictures by additive method in the frequent field

III.1.1. Operation of insertion of the mark by the additive method in the frequent field

The operation of insertion of the mark in the frequent field is carried out while following the following stages:
To divide the original picture into blocks of (8×8) pixels: i.e. if an picture consists of (256×256) pixels, it will be divided into 1024 blocks.
To apply the discrete transform as a cosine for all the blocks
To select the block: each picture area in the space field is equivalent to a table (8×8) of frequencies in the frequent field, called: table of quantification. [7]
To try to have a compromise between the visibility and the robustness, one must choose two coefficients: C1 and C2 among the range of the average frequencies provided that they have the same value of quantification
By choosing a mark A (I, J) of dimension the number of original picture areas, each value of a pixel of this mark determines the addition or the subtraction of a value K (coefficient of invisibility or force of insertion) of each coefficient:
if A (I, j)=0 then It 1=C1+k and It 2=C2.
if A (I, j)=1 then It 1=C1 and It 2=C2-k.
Once the block is an affected new coefficient, one them reinsure Apply the transform as an opposite cosine discrete.

Here an example of insertion of the mark by the additive method in the frequent field

G= 10 **G= 30** **G= 100**

Fig.10. Results of insertion of the mark in domain frequented

According to the Results of insertion of the mark in the frequent field, one notes that the profit limits insertion for which no modification is visible with the naked? It is about 20. More the profit increases more the picture is distorted.

III.1.2. Operation of extraction of the mark inserted by the additive method in the frequent field

The extraction of the mark inserted in the frequent field requires the provision of the mark, the position

of insertion as well as the coefficients affected in the table of quantification. The operation of extraction enables us to obtain the original mark without any distortion. Indeed, the value of the correlation calculated between the extracted mark and the original mark are always equal to 1.

IV. CONCLUSION

In this article and according to the application of the algorithms (insertion and extraction), we could determine the limits of the first criterion to knowing the imperceptibility of the inserted mark; i.e. values of the parameters (weight of the bit of insertion, profit of insertion...) With the top of which the mark will be visible, such as the third bit for the method of substitution in the space field.
A profit of insertion of 10 for the additive method in the space field. However, these results remain relative:
To the pictures (original picture, mark) to which these algorithms are applied.
At the zone of insertion (for the methods of the space field) to the selected coefficients (for the additive method in the frequent field).

REFERENCES

[1] Hatem Besbes : « Contribution au contrôle qualité et au traitement numérique des images en médecine nucléaire » Thèse de doctorat en physique Faculté des sciences de Tunis 2004.
[2] Watermarking digital and video data; IEEE: signal processing magazine (September 2000).
[3] Jean-Philippe Thiran : « Reconnaissance des formes » Cours 3: segmentation d'images Swiss Federal Institute of Technology, Lausanne.
[4] Christine PODILCHUK et Edward DELP; «digital watermarking: algorithms and applications »; IEEE: signal processing magazine, July 2001.
[5] Fabien PETICOLAS, « watermarking schemas evaluation », IEEE signal processing, vol. 17, no 5, pp. 58-64, S [9] Jean Marc CHASSERY. «Tatouage de documents audiovisuels» ; IEEE: signal processing magazine (mai 2000).
september 2000.
[6] Jean Marc CHASSERY. «Tatouage de documents audiovisuels» ; IEEE: signal processing magazine (mai 2000).
[7] Fabien PETICOLAS ; «tatouage numérique : une nouvelle utopie »; Microsoft research.
[8]Cédric PIOVANO et Julien PUGLIESI ; « Tatouage d'image ou 'watermarking' »; juin 2004 ; université de NICE.
[9] Joie P.Jones, Z. H.Cho, Manbir Singh: « Foundation of medical imaging »
[10] Yann Bodo : «Elaboration d'une technique d'accès conditionnel par tatouage et embrouillage vidéo basée sur la perturbation des vecteurs de mouvement », thèse de doctorat spécialité : Signal et Images Ecole National Supérieur des Télécommunication, Septembre 2004.