Application of Robust Digital Watermarking Technology in Image Copyright Disputes

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Abstract. In recent years, with the increasing application of computer technology in daily life, the phenomenon of data transmission or transaction on the network is becoming more and more common. On the one hand, it brings great convenience to our life, on the other hand, there are also great hidden dangers, such as information replication, forwarding, and even tampering. Based on the research of DWT dual color image digital watermarking algorithm based on HVS, this paper introduces Arnold transform to improve the robustness of the algorithm, and studies the application of the improved algorithm in e-commerce image disputes.

1. Introduction
In recent years, the practical application of digital watermarking technology has become a hot research direction, mainly including: watermark embedding, watermark attack, watermark system application, watermark evaluation system and so on. For different application requirements, there are different requirements for these algorithms. For example, to study the copyright protection problem, the algorithm is required to have strong robustness.

The digital watermarking algorithm to be studied in this paper is based on dual color image, that is, the watermark image and the original image are both color images. The reasons for studying dual color image include: (1) In practical application, because color image is more beautiful and intuitive, and easier to attract the attention of users, so its application is more extensive. But most of the mature watermarking algorithms are for single color image, even the original image and watermark image are gray image or binary image; (2) Color image can be divided into R, G, B three gray images, each gray image can be embedded with information. So the color image, whether as the original image or watermark image, can embed more information.

This paper summarizes the existing problems in the research of color image digital watermarking, including the following aspects:

(1) At present, the research of color image is generally based on R, G and B layers. Although many algorithms can embed watermarks, most of them use fixed embedding coefficients, which limits the invisibility of watermarks.

(2) Many algorithms can not flexibly choose the appropriate color space according to different situations;

(3) At present, some popular color digital watermarking algorithms have some limitations in the balance of robustness and invisibility, which need further research.
2. Research on HAD dual color image digital watermarking algorithm

The algorithm studied in this paper is a better one in the current research of dual color image: DWT dual color image digital watermarking algorithm based on HVS, after embedding the watermark image, the existence of the watermark can hardly be seen from the vision, which indicates that its invisibility is very good; when it is not attacked, it can extract the watermark image from the original image, and ensure little distortion. At the same time, the algorithm has good resistance to cutting, compression, filtering and other attacks, strong ability to balance robustness and invisibility, and large capacity of embedded information. However, the algorithm is not robust enough for rotation.

Arnold transformation can make an image meaningless. It is a kind of periodic transformation. After Arnold transformation, the image will become irregular. However, the original image can always be restored when the image is transformed several times by Arnold transformation, and the number of Arnold transformations is the period T. When the number of Arnold transform is recorded as K, the original image can be recovered by T-K Arnold transform, where k can be used as the key.

2.1. HAD dual color image digital watermarking algorithm

The improved algorithm proposed in this paper is as follows:

Firstly, decompose the original color image with R, G and B, and decompose the R layer, G layer and B layer with two-level wavelet transform;

Secondly, transform the color watermark image with K times Arnold transform, and the value of K represents the number of scrambling, which can be used as password; Then decompose the color watermark image with R, G and B after Arnold transform, and the R layer, G layer and B layer of the watermark are transformed by wavelet transform;

Thirdly, the R layer, G layer and B layer of the watermark are embedded into the R layer, G layer and B layer of the original color image by using an embedding algorithm to obtain the R layer, G layer and B layer of the embedded watermark. The embedding strength of the algorithm can be obtained according to experimental data of human visual characteristics.

Forthly, The R, G and B layers embedded in the watermark are transformed by one-level wavelet transform, and then the three layers are combined to get the image containing the watermark.

Since Human visual characteristics HVS, Arnold scrambling transform and DWT discrete wavelet transform are used in this algorithm, it is named HAD dual color image digital watermarking algorithm.

2.2. The embedding process of HAD dual color image digital watermarking algorithm

The embedding process of HAD dual color image digital watermarking algorithm is shown in Figure 2-1.

The specific steps are as follows:

(1) Firstly, the original image C and the color image W are read respectively, and the original color image C is decomposed by R, G and B layers. Then the R layer, G layer and B layer are transformed by two-level DWT, using Haar wavelet;

(2) The watermark image W is transformed by Arnold transform for K times. The period of Arnold transform is T and the value of K represents the times of transformation, which can be used as a password. The watermark image is decomposed by R, G and B layers, and each layer is transformed by one-level DWT, using Haar wavelet;

(3) The R layer, G layer and B layer of the watermark are embedded into the R layer, G layer and B layer of the original color image respectively by using the embedding algorithm. The embedding strength is obtained according to HVS and experiment of human visual characteristics. The embedding position of the algorithm is in the middle and low frequency region of the watermark;

(4) The R, G and B components of the watermarked image are obtained by two-level inverse DWT transform on the three layers, and the image $C^W$ is obtained by combining the three layers.
2.3. The extraction process of HAD dual color image digital watermarking algorithm

The extraction process of HAD dual color image digital watermarking algorithm is shown in Figure 2.

1. Firstly, the image \( C^w \) with watermark is read and decomposed into R, G and B layers. Then, the R, G and B layers are transformed by two-level DWT, using Haar wavelet; The same operation is performed on the original image \( C \);

2. According to the coefficient value obtained by DWT transform, the watermark is extracted by algorithm D;

3. The R layer, G layer and B layer extracted by algorithm D are transformed by inverse DWT, and the three layers are combined;

4. The watermark image \( W' \) is obtained by inverse Arnold transform, and the transformation times is \( T-K \);
2.4. The experimental results of HAD dual color image digital watermarking algorithm
Finally, a lot of attack experiments are done on the improved had algorithm, including filtering, clipping, noise, JPEG compression and so on. The experimental results show that the robustness of had algorithm is enhanced compared with the original algorithm.

3. Case study of had dual color image digital watermarking algorithm
With the research of digital watermarking algorithm, its application fields are more and more extensive, such as printing anti-counterfeiting, e-commerce and so on. In the past ten years, e-commerce has been developing rapidly in all fields of social and economic life. More and more people quickly see and seize the business opportunities. As a result, the number of sellers on the network is increasing. Due to the lack of effective image copyright management scheme, more and more businesses embezzle pictures, which seriously infringes on the interests of some businesses, but also blinds the eyes of consumers on the Internet. Accordingly, the cases of reporting embezzlement of pictures are also increasing.

After receiving reports from businesses, how to determine the ownership of the image and is there a platform that can handle this problem has become an extremely important issue. At present, the well-known Taobao platform's solution to this problem is: ask both sides to provide their own original pictures, and determine the final ownership of the pictures by judging whether the pictures have not been processed by software, but are directly completed by the photography equipment. There are obvious problems in this method.

Based on the improved had watermarking algorithm, this paper studies the application of the algorithm in e-commerce image copyright disputes, and designs an image copyright management system with the following functions.

The goal of the system is to register and add the copyright mark image to the image. When the copyright of the image is infringed, the copyright ownership can be determined by obtaining evidence. The designed system includes the following functions:

1) Image registration: businesses need to add their own watermark images to upload, including watermark images;

2) Watermark verification: there is a special user in the system who is responsible for verifying the original image, watermark image and merchant's identity uploaded by the merchant. If the verification is passed, the system adds watermark to the merchant's image, and then the merchant can view the image after adding watermark. If the verification is not passed, the user needs to be informed of the reason for the failure;

3) User management: system users are divided into tourists, businesses, users responsible for verification and system administrators. It is necessary to manage users effectively, verify various applications of users, and grant corresponding authorization only for legitimate users;

4) Product display: businesses can view their products and download them;

5) Image attribution Arbitration: when there is a dispute about image attribution, the user in charge of verification extracts the watermark from the original image provided by both parties, determines the attribution, and finally cancels the authority of the embezzled user.

The system will also combine encryption, digital fingerprint, security database and other technologies to form a complete copyright management system.

4. Conclusion
This paper studies the color image digital watermarking algorithm based on HVS. On the basis of HVS and wavelet transform theory of human visual system, combined with Arnold scrambling transform, an improved had dual color image digital watermarking algorithm is formed.

This paper also makes a case study of had dual color image digital watermarking algorithm, that is, a case study of image copyright disputes between businesses in e-commerce, and designs an image copyright management system based on this situation.
It is not enough to study the theory of digital watermarking. Only by combining it with practical application, can it play a powerful role. The application of robust digital watermarking technology in image copyright management of e-commerce is a good example. Digital watermarking can also be used in e-commerce, printing anti-counterfeiting, e-government, e-publishing and other fields. Most of the existing digital watermarking algorithms are based on gray image or single color image, and in practical application, dual color image is more widely used. So the research on dual color image digital watermarking technology has very practical significance.

The development of digital watermarking technology in the field of image is very rapid. However, there is a lack of a platform for image attribution confirmation, which depends on a watermarking algorithm that can resist various attacks. The research on this kind of problem is very meaningful.

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