Open access Journal International Journal of Emerging Trends in Science and Technology

Impact Factor: 2.838 DOI: http://dx.doi.org/10.18535/ijetst/v3i06.02

A Survey of Techniques in Digital Watermarking

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Abstract
Due to advancement in the technology mostly in the digital multimedia, the storage and distribution of materials has become very easy. This has led to security threats where copying of images, video, and audios files can be done from one website to the other without the owner's consent. Digital watermarking technology was therefore developed to provide security, authenticity, and identity of digital media. This research paper reviews various categories and algorithms involved in digital watermarking. The paper discusses the watermark embedding algorithms as well as watermark extraction and detection algorithms. The research focuses more on application of watermarking technology on image protection which is referred to as Image digital watermarking as well as the various watermarking techniques used.
Index Terms—*Algorithm, Digital watermarking, image embedding.*

Introduction

Digital watermarking refers to a process of embedding or hiding a message which is related to a digital signal within a specified signal by making small modifications on the material being protected. Its main aim is to verify the identity of certain information with the copyrighted owner hence being a mark of identity or authenticity. Its invention was to address the emerging issues as a result of technology integration which included illegal copying of digital materials as well as the lack of copyright protection and identification [1]. The processing of watermark involves the use of invisible or visible signature encapsulated inside an image, video or audio with the aim of proving/showing ownership of the material in line with copyrights. In the watermark, certain information is stored which include the details of the individual who created the watermark usually in initials, the organization or individual who have the copyright of the material, it also includes the date of creation and other special unique identifiers.

Watermarking is often preferred due to its characteristics. Digital watermarks in the first place are very difficult to remove or destroy hence materials with watermarks cannot be easily tampered with due to its robustness [2]. It also ensures that the quality of the material is not interfered with even after embedding the watermark. Other characteristic includes its provision of the capacity to encapsulate majority of information and its ability to allow the removal of the watermark from the watermark image. Digital watermarking has also other crucial applications other than providing security and copyright protection. It is also used to serve as a content link which includes aninvisible label [3]. This application is often used in the photo development libraries where a watermark is embedded into a picture in order to link the print into its negative. To extract the information in the negative one need just to scan the print. Digital watermarking is also used to differentiate different copies where different watermarks are embedded on the different copies. This enables easy identification of unique copies.

We can group digital watermarking into different categories based on characteristics, media attached, and detection process and lastly based on purpose. According to characteristics, digital watermarking can be grouped as either robust or fragile watermarking. It can also be grouped as video watermarking, image watermarking, graphic watermarking, and audio watermarking depending on the media attached. The third category is based on detection process where digital watermarking can be grouped as either visual watermarking or blind watermarking. Copyright protection is the last grouping based on purpose. The process of digital watermarking involves a three-stage process. The stages are watermark insertion, watermark extraction, and watermark detection processes.

Digital image watermarking techniques

The field of digital watermarking has elicited considerable interest in the research community due to its flexibility in that it conveys necessary information that can be used to embed the watermarks. Digital image watermarking techniques may be divided into two domains which include the spatial domain and transform domain [4]. The spatial watermarking technique applies the use of image pixels to embed an image. In transform domain technique the process of embedding an image involves the modification of the transform domain coefficients [5]

Spatial Domain Watermarking

In the spatial domain watermarking technique, the image is represented in the form of pixels. The process of embedding a watermark in the image therefore involves the modification of the color value and intensity of the image of the pixels selected. This technique can easily be applied to many images although it is less robust against interference than transform domain. The most common and applied method of spatial domain is the Least Significant Bit (LSB) [6]. This is mostly applied to embed watermark on randomly selected pixels of the cover image. The main disadvantage of LSB is that the watermark can easily be attacked.

Transform Domain Watermarking

In this digital watermarking technique, the image is represented in form of frequencies. The image is then first transformed in preparation for the watermark process of embedding. In order to obtain the watermark image, the inverse of the process used to embed is performed. The most used transform domain technique include Discrete Wavelet Transform (DWT), Discrete Cosine Transform (DCT), and Discrete Fourier Transform (DFT).

The Discrete Cosine Transform is used to process the image signals which involve transforming a signal into frequency domain from spatial domain. This technique is applied in the field of image processing which involves processes such as pattern recognition and data compression. The process of embedding in DCT involves dividing the image into unique or different frequency bands. The image is divided into the lowest frequency component, middle frequency and higher frequency component. DCT is robust against attack as compared to spatial domain technique [7].

The Discrete Wavelet Transform is an improvement of DCT in that this technique analyses the signal at multiple resolutions [8]. DWT therefore represents the image in multi resolutions form. The image is divided into two types of quadrant which includes high frequency and low frequency quadrants. The process of decomposition goes on where the low frequency quadrant is divided into low and high frequency quadrants until the quadrants are entirely decomposed. In single DWT, a two dimensional image is divided into four parts which include original image low frequency, horizontal details of the image, vertical details and finally high frequency of the original image. This technique is mostly applied in digital image watermarking due to the techniques applied.

Discrete Fourier Transform is used to offer image protection against geometric editions and attacks such as cropping, rotation and translation. The DFT decomposes the image through application of trigonometric knowledge where the image is decomposed into sine and cosine form [9]. The DFT watermark embedding techniques is divided into direct embedding and template based embedding. Direct embedding involves the modification of phase coefficients and magnitude whereas template based embedding involves the use of templates to estimate the factor of transformation. The application of DFT is limited due to its poor computational efficiency.

Experimental results

The experiment included a research on three different image watermarking techniques which are LSB, DCT and DWT. Three images of 256 by 256 pixel value were used for watermarking while the watermark embedded is of 20 by 50 pixels. The tests are done using Matlab 7.8 software [10].

Table 1: Embedding time used for LSB, DCT and DWT.

# of Images	LSB in ms	DCT in ms	DTW in ms
1	0.6643	0.7057	2.9043
2	0.3001	0.6082	2.8221
3	0.2537	0.5829	3.94355

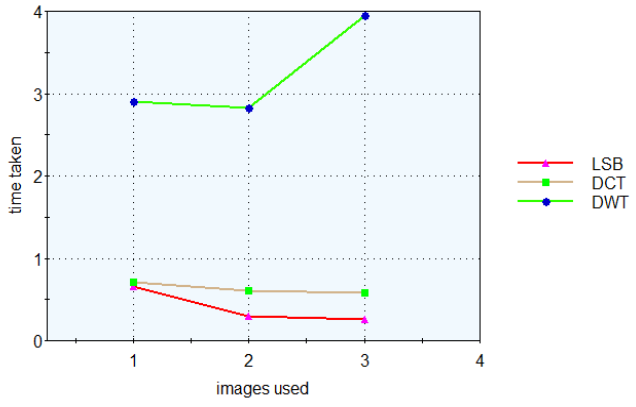

Fig 1. Time required to embed images using different algorithmic techniques

This graph represents the time used in different techniques (LSB, DCT,DTW) while embedding watermark in the three images. From the graph, DTW takes more time followed by DCT and finally LSB. This shows that DTW takes most time to embed the watermark compared to the other techniques. Image 1 takes the least time in all the techniques.

From the experiment, we are able to determine the memory space used by each technique. Space complexity describes the memory an algorithm takes while being executed. Spatial domain takes less space as compared to the transform domain techniques during image embedding. This is due to the complex algorithms that are used in the case of transform domain.

Conclusion

With technological integration being experienced today, safety of the digital media has become an important research topic. This research paper discusses digital embedding in image protection. The paper also discusses the characteristics that makes the watermark used in digital watermarking preferred as well as the applications of digital watermarking in different fields such as image processing. Different image watermarking technique which include LSB, DCT and DWT are discussed and the process used by each to embed a watermark on the image. DWT is the most used technique in the market due to its properties. From the experiment conducted, LSB takes the least time to embed the watermark in the three images while DWT takes the most time than both DCT and LSB.

Reference

1. Bianchi, Tiziano, and Alessandro Piva. "Secure watermarking for multimedia content protection: A review of its benefits and open issues." *Signal Processing Magazine, IEEE* 30.2 (2013): 87-96.
2. Rhoads, Geoffrey B., and J. Scott Carr. "Digital watermarks." U.S. Patent No. 8,483,426. 9 Jul. 2013.

3. Singh, Prabhishek, and R. S. Chadha. "A survey of digital watermarking techniques, applications and attacks." *International Journal of Engineering and Innovative Technology (IJEIT)* 2.9 (2013): 165-175.
4. Nin, Jordi, and Sergio Ricciardi. "Digital watermarking techniques and security issues in the information and communication society." *Advanced Information Networking and Applications Workshops (WAINA), 2013 27th International Conference on*. IEEE, 2013:1553-1558
5. Emami, Mir Shahriar, et al. "A study on the resiliency of spatial domain watermarking techniques to geometric attacks using approximation perspective versus direct correlation view." *Advanced Science Letters* 20.2 (2014): 510-513.
6. Dabas, Pooja, and KavitaKhanna. "A study on spatial and transform domain watermarking techniques." *International Journal of Computer Applications* 71.14 (2013).
7. Rao, K. Ramamohan, and Ping Yip. *Discrete cosine transform: algorithms, advantages, applications*. Academic press, 2014.
8. Lai, Chih-Chin, and Cheng-Chih Tsai. "Digital image watermarking using discrete wavelet transform and singular value decomposition." *Instrumentation and Measurement, IEEE Transactions on* 59.11 (2010): 3060-3063.
9. Britanak, Vladimir, Patrick C. Yip, and KamisettyRamamohanRao. *Discrete cosine and sine transforms: general properties, fast algorithms and integer approximations*. Academic Press, 2010.
10. Pooja, Dabas and Kavita, Khanna. "Efficient Performance of Transform Domain Digital Image Watermarking Techinique over Spatial Domain." *International Journal of Advanced Research in Computer Science and Software Engineering* 3 (2013): 642