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Analysis of Watermarking Techniques in Multimedia Communications

Balakrishnan Sridhar[1], Vadlamudi Syambabu[1]

Abstract: Multimedia information is critical of examining, information perceived and which are illustrated by the human cerebrum. In our brain, 33% of the cortical area concentrates only on visual information processing. Digital watermarking technology is being received to guarantee and encourage such kinds of digital data authentication, security, and copyright. These algorithms permit the expandable values of different techniques to prevent the problems of copyright issues during the transmission. This paper discusses the detailed about the point by point investigation of watermarking definition and different watermarking applications and strategies used to improve information security.

Keywords: Digital watermarking, Confidentiality, Authenticity, Integrity, DWT, SVD.

1 Introduction

Nowadays, applications have referenced an ever-extending work for interactive media and surveillance content. A huge proportion of information is stored and it is possible to distribute digitally to the internet, while in transmission, an unapproved individual may easily capture the information; at present, the security and the managing activity of multimedia information is a significant task [1]. The characteristics of the electronic multimedia data have no contention between a novel and its copy [2]. Different scientists have been bored down the responses for copyright security. The most ideal way, where the interactive media data is guaranteed against unlawful transmission and control is to put a sign on the spread mechanism for the affirmation of the owner of the data. Multimedia is the text, images, sound, graphics, animation, and other media together to shape an organic whole, to achieve a certain function.

An advanced image [3] is a portrayal of a two-dimensional function that has a limited arrangement of coordinates of x and y elements is said to be pixels. This arrangement of pixels will form the meaning information. In the present time, a video is considered an important tool that can combine all segments of text, audio,

[1]Department of Electronics and Communication Engineering, MLR Institute of Technology, Hyderabad, India; E-mails: sridharbece@gmail.com; syam.vadlamudi@gmail.com

static images and moving images, hence video illustrates transferring the huge volume of video frame information in the time-limited environment. Likewise, as a result of modern developments in Information Technology innovation, the greater capacity of the high quality of digital content is created from High Definition Television (HDTV) and Digital Video Disk (DVD). However, this progress is difficult due to the intellectual protection of video content [4]. The necessary prerequisite for the methodology that controls access of video content by compelling the survey rights and copyrights.

A methodology that is liable to fetch the marking data into the propelled media is known as Digital Watermarking or Copyright marking. A Human can't envision the concealed data with an eye and believes it to be a typical spread medium [5 – 6]. Computerized watermarking has broadened more ideas demonstrating the integrity and authenticity of the proprietor [7 – 8]. Subsequently, the business and research people are working truly on cutting edge copyright marking. Fig. 1 displays the essential parts of the watermarking system.

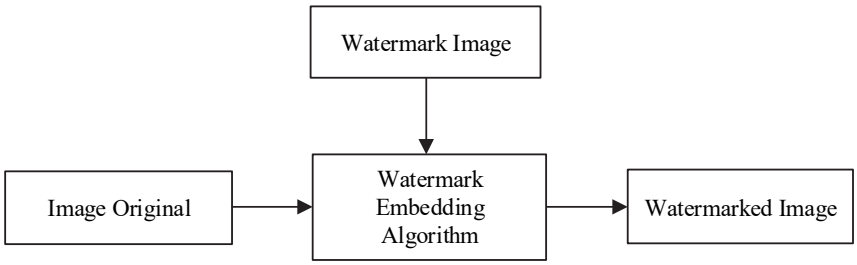

Fig. 1 – *Basic elements of watermarking technique.*

Right now the copyright watermark image is brought into the essential image by utilizing a mystery key and receiving the watermarked image. Computerized Watermarking can help copyright assurance, communication checking, and information validation. Any watermarking method must be assessed dependent on the accompanying features [9]. The main properties of the watermarking systems are Capacity, Robust, and Invisibility.

Capacity: The quantity of data that can be concealed in the host medium. Mainly it depends on the method used for the watermarking.

Robust: A marking approach is said to be robust it can withstand the secret message under various attacks like filtering, compression or cropping.

Invisibility: A marking technique has a good invisibility property if we are unable to notice the changes in the cover medium after concealing the watermark.

The above three requirements carry a trade-off triangle as shown in Fig. 2. If we are achieve the two out of three properties, then the third one should be traded off.

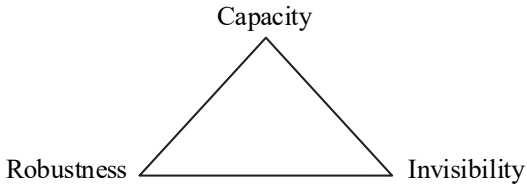

Fig. 2 – *Features of watermarking system.*

2 Types of Watermarks and Watermarking Techniques

Watermarking systems can be separated into different classes in different manners as portrayed in Fig. 3.

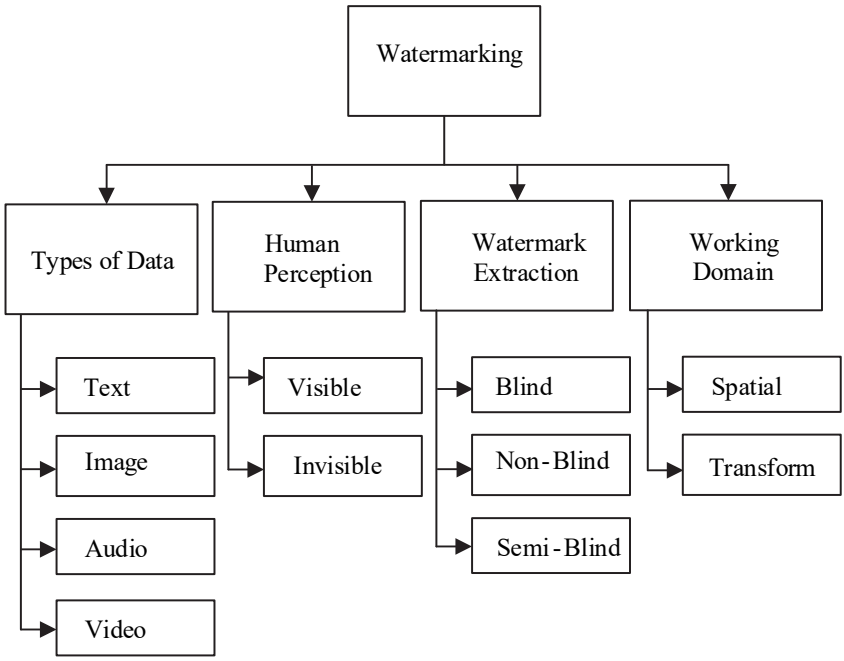

Fig. 3 – *Types of watermarking techniques.*

As per the type of document to be watermarked, it is arranged into Text, Image, Audio, and Video watermarking [10]. Content watermarking targets inserting additional data in the content itself [11]. The fundamental highlights are to transfer the hidden information of authorship authentication. Image watermarking is hiding secret data into a computerized image with the accomplishment of robustness for copyright insurance [12 – 14].

Audio watermarks are special signs inserted in computerized sound [15 – 16]. Audio watermarking plans depend on the imperfection of the human sound-related framework. Be that as it may, individuals are more delicate than sensory motors and in this way, audio watermarking plans are hard to construct.

Based on the visibility nature the copyright mark can be shared into Visible and Invisible watermarks. Convey the copyright information appears visibly on the image which can be identified by a human is called visible watermarking. Invisible watermarking technique copyright information is hidden from the host media and extraction technique is required to retrieve the watermarks. The imperceptible copyright mark is installing results any alternation of the authenticated image would damage the watermark. Concealing the inserting data in advanced video outlines [17 – 19] is video watermarking. Preferably, a client seeing the video can't see a contrast between the first, watermarked and un-watermarked video.

In the aspect of the discovery of the watermark, the systems can be grouped into Blind, Semi-blind and Non-blind detection procedures. In Non-blind watermarking plan is otherwise called a private watermarking plan [20 – 21]. This framework requires the first spread data for the location. The Semi-blind watermarking plan is otherwise called the semi-private watermarking plan [22]. This framework doesn't require the spread data for discovery, however, it needs the watermark data since it can look through the watermark present in the spreading medium or not. The blind watermarking plan is otherwise called a public watermarking plan [23 – 24]. This kind of watermarking framework doesn’t require the cover and embedded watermark.

The two distinct methodologies that are utilized to implant the copyright data concerning the embedding domain are the Spatial and Transform [25]. In the spatial domain, the watermark is effectively installed to have an image by changing the pixel esteems straightforwardly utilizing bit substitution. Thus, the implanting undertaking should be possible effectively and requires an insignificant computational force; however, the embedded data can be effortlessly distinguished utilizing related systems. Generally, various scientists are anticipated only on the frequency domain, in this, the marking data is fetched only on the wavelet coefficients also removal of identity mark is very hard in wavelet-based techniques. Hence this domain felicitates more robust and stable [26]. Most common transforms are Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT).

2.1 Discrete Fourier transform based watermarking

Discrete Fourier Transform (DFT) of an image is a complicated esteemed, and it prompts to represent the magnitude and phase for the image [27]. Covering the watermark utilizing DFT is arranged into two sorts: direct inserting and format based installing procedure. The copyright is installed by altering the

magnitude and phase of the DFT coefficients; this methodology is called a direct implanting approach. In the template-based technique, the transformation factor can obtain by installing the pattern of a template that is installed in the DFT. A pattern of the template is detected to resynchronize the image if the image transforms. The main demerits of the DFT are complex value and it consumes more frequency rate also the poor computational efficiency.

2.2 Discrete cosine transform based watermarking

In Discrete Cosine Transform (DCT), an image is a quarantined into various recurrence bands as lower-level band (FL), medium level band (FM) and high-level band (FH) [28 – 29]. Where low- frequency band FL shows up in an upper left corner and the high-recurrence band FH lies at the lower right corner. A Human can undoubtedly get the mystery information if a watermark is embedded in the low band or if its high-frequency band means local distortion occurs with boundaries. Henceforth, medium level frequency band FM felicitates the optimum zone region for modification; it cannot degrade the quality of an image. Fig. 4 shows the different bands on the image by DCT. In this way, a medium level frequency layer is the optimum band to install the watermark. This DCT based approach can withstand regular image processing attacks.

FL	FL	FL	FM	FM	FM	FM	FH
FL	FL	FM	FM	FM	FM	FH	FH
FL	FM	FM	FM	FM	FH	FH	FH
FM	FM	FM	FM	FH	FH	FH	FH
FM	FM	FM	FH	FH	FH	FH	FH
FM	FM	FH	FH	FH	FH	FH	FH
FM	FH	FH	FH	FH	FH	FH	FH
FH	FH	FH	FH	FH	FH	FH	FH

Fig. 4 – *Frequency discrimination by DCT.*

2.3 SVD based watermarking

The Singular Value Decomposition (SVD) is a notable system for factorizing a rectangular matrix, genuine or complex, which has been broadly utilized in image processing application like image compression, face recognition, watermarking and texture classification. Equation (1) shows the factorization of the matrix components

$$A = UDV^{\mathrm{T}}, \tag{1}$$

where U and V are the orthonormal matrices and D is a diagonal matrix comprised of singular values of A. In SVD based watermarking, a host image is factorized into three matrices; U, D, and V^T. Mostly SVD-based watermarking algorithms the secret information is added only to the singular values of the diagonal matrix because robustness can be achieved in that diagonal matrix [30].

2.4 Discrete wavelet transform based watermarking

The wavelet transform deserves an important role in image processing applications [31], like removing redundancy in an image, signal processing, edge, and boundary detection, copyright marking, and so on. A numerical capacity that is identified to obtain the different scale components from the continuous-time signal is said to be wavelet. The DWT is received by shifting the non-stationary signal through a digital filter at various scales [32 – 33]. The fundamental idea of the DWT for 2D images is decayed into four different levels of bands like high, medium, and low-recurrence sub-parts like LL1, LH1, HL1, and HH1 [34]. The high recurrence zone holds the boundary segments, wherein the LL_1 recurrence band deserves the scaled image information. For the next level decomposition, the sub-part LL1 is additionally disintegrated and fundamentally sub-inspected to LL2, LH2, HL2, and HH2. Fig. 5 shows the Second level decomposition, of an image under DWT. In DWT just the aggregate or contrast of the pixel is determined, the outcomes it procures e more speed than DCT and DFT. With the help of DWT Coefficients, the decomposed image can be retrieved to form the original image. This procedure is said to Inverse DWT.

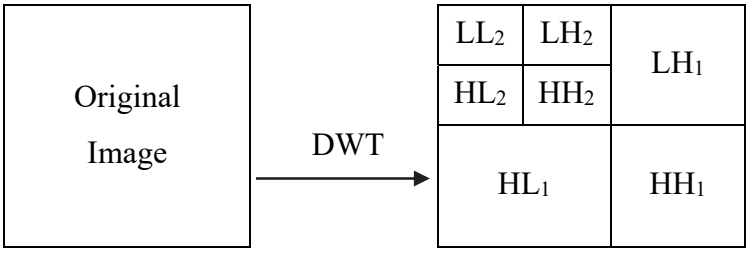

Fig. 5 – *Two level DWT decomposition.*

3 Related Works

This section shows the State-of-art watermarking methods. An adaptive image copyright marking approach based on DCT-SVD for e-government reports is outlined in [34]. The identity data is implanted into the singular values of the DCT transformed cover image utilizing the Genetic Algorithm (GA). The strategy is robust and imperceptible for different attacks.

Amini et al. [35] proposed a blind watermark decoder utilizing a vector-based Hidden Markov model (HMM) in the DWT. The results demonstrated that the strategy is profoundly robust for different assaults including checkmark and offered a lower bit error rate than other methods [36]. Further, the technique is likewise appropriate for the color images. Nonetheless, poor directional data and need shift affectability are significant limits of the DWT-based watermarking strategies. Results showed that the strategy offered better PSNR and NC values than other high-quality methods [37]. Singh et al. [38] introduced a semi-blind watermarking strategy utilizing a combination of Non-Sub-sampled Contourlet Transform (NSCT), Redundant Discrete Wavelet Transform (RDWT), and SVD. In this method, better recreation of the watermarked image is accomplished through NSCT and RDWT. Further, the robustness and security of the watermark are accomplished through SVD and Arnold Transform, respectively. Experimentally, the technique offered better execution as resolved as far as PSNR, Correlation Coefficient (CC), and Bit Error Rate (BER) than other existing strategies [39].

Pan-Pan et al. [40] develop a local invariant significant bit-plane histogram-based robust watermarking procedure utilizing a color images. Initially, the element points of the color image are separated utilizing the color invariance model and the probability density-based feature point detector.

After, the produced mark is implanting into the three unique parts (Red, Blue, and Green) of the cover. The outcomes demonstrated that the proposed technique is strong against signals preparing assaults including de-synchronization attacks. Further, the proposed strategy offered better identification rates for the majority of the considered attacks than other strategies [41]. Nonetheless, the strategy has less concealing limit and is computationally costly.

Abbas et al. [42] presented a watermarking procedure utilizing a combination of lifting wavelet change (LWT) and, Arnold Transform. The LWT decayed the chosen cover image into the four subbands and the logo watermark image is implanting to the low recurrence part of the cover. The considered watermark image is likewise decayed by DWT prior to inserting it into the cover image. The method is tried against various types of assaults and the outcomes showed that the robust watermark can be recovered progressively under thought about the attacks. Further, the author detailed that the strategy can distinguish any tampering attempts. Ansari et al. [43] acquainted a fragile marking strategy with resolves the issue of restriction and self- recovery tamper. In this method, alter restriction bits and Self recovery bits are considering about as two distinct watermarks data is installed into the cover utilizing SVD. Execution is evaluated as far as localization rate and precision and tracked down that the strategy is robust for different sorts of attacks at the adequate nature of the image.

Sridhar et.al [44] proposed the non-blind watermarking technique on video; initially, a watermark is reshaped and grouped into odd and even row images. Next, the luminance band of the frame is shared into alternative pixel shares and it is concatenated. Further, gatefold operation is enabled on a concatenated luminance band. Now, single-level decomposition is imposed on the gatefold image and, the copyright marking process is enabled only on the medium level of frequency sub-bands. The main objective is to design and develop a gatefold based video authentication approaches with ownership information that can be used for copyright protection. Also increase the robustness, payload, and minimize the bit error rate.

4 Applications of Digital Image Watermarking Systems

Watermarking advances have been proposed for usage in numerous applications. This underneath segment clarifies some significant arrangements of digital image watermarking applications.

4.1 Digital rights management

Digital rights management (DRM) can be characterized as the depiction, distinguishing proof, exchanging, securing, checking and following of all types of uses over perceptible and imperceptible multimedia contents. DRM frameworks have three significant segments, to be specific empowering advances, the plan of action and the administrative structure. DRM systems are consistently used to guarantee the benefits of authorized advancement (IP) holders through copyright safety efforts. Besides, copyright identity applied in DRM systems moreover engage copyright affirmation, copy protection, device control, affirmation, and modification acknowledgment.

4.2 Protection of copyright

Copyright insurance is huge to the utilization of copyright checking, as it positions the distinctive character of the proprietor and subsequently guarantees their benefits in content apportionment. A watermark is embedded into the host image to make sure about the benefits of the owner. It should be possible to perceive the watermark despite normal image processing, geometrical distortion and various sorts of image control. Crypto-watermarking approach reserves more popularity in certain important fields like medical, military, and law enforcement. The main objectives of developing this crypto-watermarking application are that it can provide the user with the security of data. Also, these techniques aim to protect the Multimedia Contents aim to restrict the avoid unauthorized copies of digital documents. Payload and minimize the bit error rate are the parameters that are in line with these techniques [45].

4.3 Authentication

Verification in advanced image copyright marking demonstrates the genuineness affirmation of an image. An image is said to be 'authentic' if it has not been altered. An integrity check utilizing a watermark is beneficial because, as a matter of first importance, the installed watermark remains with the image and can't be evacuated easily.

4.4 Tamper identification and localization

Tamper detection is utilized to clear away the modifications made to an image, and it is firmly identified with verification. If any alterations are suspected in an image, at that moment, the image is viewed as not authentic. Alter localization empowers further examination of a demonstration of altering by distinguishing the region which has tampered with into an image. This information can assist the media crime scene investigation examination; for example, the reality of the adjusting and the manners of thinking behind it might be developed.

5 Conclusion

The tremendous growth in technology and the need for multimedia services have made it possible to circulate these videos in easy, which is a greater advantage to the modern communication medium. Digital Watermarking is one of the best solutions for copyright protection of multimedia data. In this paper, we have introduced a concise presentation of Digital Image Watermarking. Further, the paper presented a summary of various state-of-the-art watermarking techniques and various recent applications. It has become a functioning and significant zone of research, and the advancement and commercialization of copyright marking procedures are being considered basic to help address a portion of the difficulties looked at by the quick multiplication of computerized content.

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