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Security of Medical Images by Watermarking using DWT-DCT-SVD

Priyanka[1]
[1]Department of Computer Science and Engineering,
PG Scholar,
SRMCEM, Lucknow

Dr. Pankaj Kumar[2]
[2]Departmentl of Computer Science and Engineering,
Assistant Professor,
SRMCEM, Lucknow

Dr. Raj Gaurang Tewari[3]
[3]Department of Computer Science and Engineering,
Assistant Professor,
SRMCEM, Lucknow

***Abstract*: The watermarking is the technique which provides security to the sensitive image data. In the creation of watermarked image the two steps has been followed in the first step, properties of the input image is analyzed and in the second step encoding process is initialed which create final watermarked image. To analyze the properties of input image the technique of SVD-DCT and DWT is been analyzed in this paper which analyze textual and color features of the image. In this paper, various advancements which has been proposed in the recent time in SVD-DCT and DWT technique is been reviewed and discussed in terms of various parameters**

Keywords: Discrete Wavelet Transform (DWT) Discrete Cosine Transform (DCT) Singular Value Decomposition (SVD), Security, PSNR , MSE.

I .INTRODUCTION

1.Introduction(Watermarking)

1.1 Watermarking is the process of embedding data called a watermark into a multimedia object such that watermark can be detected or extracted later to make an assertion about the object. The object may be an audio, image or video. A copy of a digital image is identical to the original.

1.1Properties of watermarking:

An effective digital watermarking algorithm must have number of properties.

Imperceptibility: The basic requirement of digital watermarking is to have the watermarked image should look alike as the original image. This confirms there is not much degradation on the original image.

Robustness: The watermark must resist changes due to some unintentional attacks or legitimate and illegitimate attacks.

Capacity: Capacity of the watermarking system describes embedding of maximum amount of watermark information

Invertibility: The digital watermarking system describes the possibility of generating original data during the extraction process of watermark.

1.2Medical Image Watermarking

A fairly broad definition of medical information can be stated as follows: it is information which contributes to the realization of a diagnosis,a therapeutic action and the prevention on health of an individual or a group of individuals.The expression "medical data" refers to all the personal data relating to the health of a person and to data that has a clear and narrow link with health. Some administrative and legislative texts use almost the same definition but they tend to emphasize especially the nominal aspect of the data. The Committee of Ministers of the
European Council defines the data as medical data if it refers to any personal data concerning the health of an individual, but also when it provides information allowing identification such as for example a genetic profile. Uses of advanced electronic and digital equipments in health care services are increased, where traditional diagnosis system has been replaced by e-diagnosis system. In fact, in most of the hospitals physicians diagnose their patients by relying on the provided electronic and digital data (such as Ultrasonic, Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and X-ray images). Now-a-days exchange of medical images between hospitals located in different geographical location is very common .Moreover, as this exchange of medical reference data done via unsecured open networks leads to the condition of changes to occur in medical images and creates a threat which results in undesirable outcome. Considering this fact, demand of security is getting higher due to easy reproduction of digitally created medical images. For copyright protection and authentication of these medical images, watermarking is an emerging technique, which includes the embedding and extraction process. Embedding process hides some secrete information in to medical images. This secret information is extracted during the extraction process. If failure occurs in extraction process the physician would come to know that there has been some kind of tampering with that image, and he would take precaution of not making diagnosis based on that image. However, if the extraction process extracts the correct watermark, which generally consumes a few seconds, physician can continue with diagnosis.

II.VARIOUS IMAGE WATERMARKING TECHNIQUES

According to watermark embedding process, watermarking techniques are classified into two different domains.

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Spatial Domain: The spatial-domain watermark insertion manipulates image pixels. However, the spatial-domain watermark insertion is simple and easy to implement, it is weak against various attacks and noise.

Transform domain: The transform-domain watermark insertion is based on the transform coefficients of cover image. It is more robust against attacks. Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), and Discrete Fourier Transform (DFT) are three popular methods in transform domain.

2.1 SVD is popular for the watermarking because:

Few singular values can represent large portion of signal energy, SVD can be applied to square and rectangular images, The SV‟s (singular values) of an image have very good noise immunity, i.e., SV‟s do not change significantly when a small perturbation is added to an image intensity values, SV‟s represent intrinsic algebraic properties.

2.2 Discrete Cosine Transform (DCT):

DCT expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. Important to many applications like lossy compression of audio and images also to spectral methods for the numerical solution of partial differential equations.

2.3 Discrete Wavelet Transform (DWT):

DWT is a multi-resolution decomposition of a signal. It is a new signal analysis theory and is a “time-frequency” method i.e. it captures both frequency and location information (location in time). The basic idea in the DWT for a one dimensional signal is the following. A signal is split into two parts, usually high frequencies and low frequencies. The edge components of the signal are largely contained to the high frequency part. The low frequency part is split again into two parts of high and low frequencies. This process is continued an arbitrary number of times, which is usually determined by the application at hand. Furthermore, from these DWT coefficients, the original signal can be reconstructed. This reconstruction process is called the inverse DWT (IDWT)IDWT the image is first divided into a set of high pass (detail) & low pass (approximate) coefficients.The image is first divided into blocks of 32*32. Each block is then passed through the filters: the first level decomposition is then performed to decompose the input data into an approximation &detail coefficients. After obtaining the transformed matrix,the detail & approximate coefficients are separated as LL,LH,HL &HH coefficients.All coefficients are discarded except the LL coefficients that are transformed into second level. The coefficients are then passed through a constant scaling factor to achieve the desired compression ratio.Another technique DCT image compression is used for converting a signal into elementary frequency components.It attempts to de correlate the image data.After de correlation each transform coefficient can be encoded independently without losing compression efficiency.

I.TABLE

Types of Processing	Advantages	Disadvantages
Spatial domain	Comparatively simple and faster operation	Vulnerable to compression, geometric distortion, and Filtering
Transform domain	Compression compatible and robust against many geometric distortions (e.g., rotation, scaling, translation, cropping) and Filtering	Comparatively higher computational time and complexity

III.VARIOUS CHALLENGE OF MEDICAL IMAGE WATERMARKING

through online networks for telediagnosis, teleconsultation ,telesurgery and cooperative work. The availability of electronic data within the modern health information infrastructure presents significant benefits for medical providers and patients, including enhanced patient autonomy, improved clinical treatment, advances in health research and public health surveillance. For example, the flow of information between hospitals, physicians and others has increased by 40% during the year 2008 to 2009, and many of them using such systems are starting to see cost savings according to an e-Health Initiative study released in late July, 2009 While the recent advances in information and communication technologies provide new means to access, handle and move medical images, they also compromise their security due to their ease of manipulation and replication. Nowadays, questions of health information security and medical privacy are of utmost importance ,since the medical information plays an important role in the health system and its alteration might bring misdiagnosis. The amount of medical images has increased however over the last decades. From the beginning of the 20th century up the 50’s, standard X-ray was the only imaging modality offering access to anatomical features of the human body. The early emergence of optical and ultrasound techniques, nuclear imaging (Single Photon and Positron) followed by X-ray Computer tomography systems (CT-Scanner), Magnetic Resonance Imaging (MRI) opened new and powerful observation ways.These digital image sources, or imaging modalities, have brought new insights into patient-specific pathological features and therefore major means for diagnosis. They also play today an important role in therapy. Nowadays, the evolution of computer and communication technologies has offered new possibilities to analyze, transfer, store and access these data, but at the same time new requirements have emerged for their protection. With the advent of high-speed network transmission, the practice of medicine is also changing. Communications between hospitals, or hospitals / general practitioners and the patients at home (i.e. aging

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people for instance) have significantly evolved these last years. This new frame, known under the name of "telemedicine", has been formally accepted by French government through an official decree in October 2010 defining the activities of telemedicine and their conditions of implementation and financial reimbursement. Since the medical information plays an important role in the health system, its quality should be assured. There is an intrinsic link between the quality of the information contained in the patient record and the quality of care.L.Dusserre states that, to be considered as valid, the following minimal qualities must be fulfilled:

Mechanisms for protecting images.
The medical sector is using the same means of protection as those operating in the industrial sector. It is important that we always consider the worst situation in the health field. Even if the risks are marginal in terms of probability, an intruder, for example, can destroy the entire information system of the hospital.lossy image compression may induce inacceptable information loss. It may result in a misdiagnosis involving at the same time the responsibility of the physician who, not informed, interprets the modified image**.**

Two methods of calculating performance measure:
To ensure the reliability and quality of the watermarked image, the performance of watermarking is calculated, which measured in terms of perceptibility. There are two method of calculating the performance measure.
Mean Square Error (MSE): It is simplest function to measure the perceptual distance between watermarked and original image. MSE can be defined as:

$$\mathbf{MSE}=\frac{1}{n}\sum_{i}^{n}(\mathbf{I'-I})$$

Peak Signal to Noise Ratio (PSNR): It is used to measure the similarity between images before and after watermarking.

$$\mathbf{PSNR}=10\log_{10}.\frac{\max I_2}{\mathbf{MSE}}$$

IV.LITERATURE REVIEW

Wakatani[1] proposed a medical image watermarking, in order not to compromise with the diagnosis value, it avoids embedding watermark in the ROI. In this algorithm watermark to be embed is firstly compressed by progressive coding algorithm such as Embedded Zero Tree Wavelet (EZW). Embedding process is done by applying Discrete Wavelet Transform (DWT). Extraction of watermark is reverse of embedding process. The major drawback of this algorithm is ease of introducing copy attack on the non-watermarked area.
Yusuk Lim et al.[2] reported a web-based image authentication system for CT scan images. This technique considers the principal of verifying the integrity and authenticity of medical images. In this approach, the watermark is preprocessed by using 7 most significant bit-planes except least significant bit (LSB) plane of cover
medical image, as a input to the hash function. This hash function generates binary value of 0 or 1 using secrete key, which is then embedded in LSB bit of cover image to get watermarked image.

Hemin Golpira[3] et al. reported reversible blind watermarking. In which embedding process, firstly by applying Integer Wavelet Transform (IDWT) image is decomposed into four sub bands. By selecting two points, called thresholds, according to the capacity required for the watermark data, watermark is embedded. To get watermarked image Inverse Integer Wavelet Transform (IIDWT) is applied. In the extraction process, all of these stages are performed in reverse order to extract watermark as well as host image.

Ghazy *et al* (2007)[4] divided the image into non-overlapping blocks and then applied SVD to these blocks. Singular values of these blocks were used to embed the watermark. This scheme gave good results against compression, filtering, noise addition but failed against cropping and geometric attacks.

Bhandari *et al* (2005)[5] used spread spectrum (SS) along with SVD to increase the robustness of watermarking scheme. Used two watermarks to embed, one was embedded using SS and other by pure SVD. This complementary technique covers wide range of attacks and also non-blind in nature.

Quan & Qingsong[6] proposed hybrid method based on DCT and SVD. In this DCT is applied to cover image and separated into frequency bands. SVD of DCT transformed are needed to modify with singular values of watermark to generate watermarked image.

Ganic & Ahmet Eskicioglu[7] presented watermarking scheme using DWT frequency domain. The following section gives brief description about the techniques frequently used in the watermarking techniques. The proposed method also uses the same technique for securing medical images**.**

Huang[8] proposed a blind technique in which the original image is not required at the same time of detection.In this technique,HVS is used to insert the watermark in wavelet domain.In this method four adjacent coefficients after conversion to wavelet domain domain are grouped.Watermarked is then added to the average of these four adjacent coefficients.

Odriquez et al. [9] searches for the suitable pixels to embed information using the spiral scan starting from the centroid of the image. Then obtain a block with its center at the position of the selected pixel. If the bit to be embedded is 1, change the luminance value of the central pixel by adding the gray-scale level mean of the block with luminance of the block. If the bit to be embedded is 0, change the luminance value of the central pixel by subtracting the luminance of the block from the grayscale level mean of the block. In the extraction procedure, marked pixels are located using the spiral scan starting in the centroid of the image. If the luminance value of the central pixel is greater than the gray scale level mean of the block, then the embedded bit is identified as 1, otherwise as 0.

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AUTHOR	YEAR	DESCRIPTION	OUTCOMES
C.Thirumarai Selvi &R.Sudhakar	2016	The hiding of patient details in medical images by using one level DWT based watermarking has been proposed for medical image authentication and watermarking has been effectively done. The proposed method is examined by the performance metrics MSE and PSNR.	1.) MSE values 4 times lower than the existing methods and PSNR values are increased by 32% 2). When we use higher level DWT methods for watermarking it is expected to give the result with lesser execution time when compared to this method.
Nilesh Rathi & Ganga Holi	2014	watermarking algorithm for medical images for securing such as authentication, integrity etc has proposed. This paper uses blind watermarking techniques such as DWT-SVD and DWT-DCT-SVD both, results are evaluated for respective techniques.	It has been found that DWT-DCT-SVD based watermarking algorithm is robust when compared with DWT-SVD method.
Darshana Mistry	2013	Image is filtered by low pass (for smooth variation between gray level pixels) and high pass filter (for high variation between gray level pixels). Image is decomposed into multilevel which include approximation details (LL subband), horizontal detail (HL subband), vertical (LH subband) and diagonal details (HH subband).	Using DWT, images are decomposing into four parts: Approximate image, Horizontal details, Vertical details and diagonal details.
Jasni Zain and Malcolm Clarke	2005	The issues in watermarking medical images raised here are complete authentication Vs content authentication, reversible watermarking Vs permanent/irreversible watermarking and the practical issue of compression.	Watermarking is a potential technique to address the issue of reliability of medical images namely for verifying integrity and authentication. Since compression is included in standards such as DICOM.
Abhinav Shukla & chandan Singh	2014	Medical image is usually comprised of region of interest (ROI) and region of non interest (RONI). ROI is the region that contains the important information from diagnosis point of view so it must be stored without any distortion. watermarking technique which avoids the distortion of image in ROI by embedding the watermark information in RONI. The watermark is comprised of patient information.	various medical image watermarking algorithms which provide the confidentiality of medical data, recovering original image without any distortion, data integrity, authentication and efficient data management. Also the different segmentation algorithms are in place, which vary for the types of medical images such as MRI, CT scan, X-ray and Ultrasounds

V.CONCLUSION

In this paper, it is been concluded that the SVD-DCT and DWT algorithms to generate final watermarked image.The authencity of the work is testing by applying various attacks like salt & pepper etc.The performance of the algorithm is tested in terms of PSNR,MSE. In future the proposed technique can be compared with some other watermarking algorithms to check reliability of the algorithm. The technique of warner filter can be applied to improve performance of the proposed work. The work can be extended to replace DWT method by discrete curvelet transform to improve the robustness of the watermark.

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AUTHOR PROFILE

Priyanka received the B.tech. degree in Information Technology from Babu Banarasi Das Educational Society Group of Institution Lucknow in 2014 and pursuing M.tech in Computer Science and Engineering from Shri Ramswaroop Memorial College of Engineering and Management, Lucknow during 2015-2017 and research on topic Security of medical image by watermarking using DWT-DCT-SVD under the guidance of Dr. Pankaj Kumar and Dr. Raj Gaurang Tewari.