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Hiding Image by Using Contourlet Transform

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Abstract:

The goal of the paper is to provide a practical conceptual framework based on hiding of watermarks embedded within coefficients image disintegrated by contourlet transform, that is characterized by extra sustenance for the potential and actual security of the hiding methods, and strengthen distribution techniques of watermarking inside the cover image; thus this can be done through achieving a kind of merge between those techniques and others techniques of image processing. A case study approach was used to allow the algorithms of the recommended system (non-blind) through concealing the watermarking which is resulted in the possibility of altering the watermarking dimensions with the fixed cover measurements and reciprocally. Another important practical implication is that the quartet tried to divide the techniques into four sections before it has been embedded inside the cover-image then after they have been split up, they distribute them among the fragments of the watermark within the cover-image regarding the quartet try the method. The techniques of using the three suggested algorithms by employing the watermarks cover image of various dimensions displayed that, the correlation factor ratio preceding and succeeding the process of hiding of the cover-image has been exceeded 0.99%. The most striking outcome to emerge from the data is that the result of this research which is in the watermark measured before and after the process depending on the PSNR, SNR, MSE, NC.

Keywords: Watermarking, hiding information, hiding data, contourlet transformation

I. Introduction

Nowadays, internet communication becomes a major part of infrastructure [1]. Transmitting the data across. Internet can be done by concealing a secret message behind multimedia signals. The mention message can be decrypted either by providing the same key utilized for encryption or by verifying its reality. An example about that, image watermarking is performed by embedding a secret message into the original image, to

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guarantee authentication and verifying of ownership of the allocated multimedia data [2,3].
Data can be hided and reversed from additional data to digital images. The original image can be totally rebuilt after merging the extracted data [4, 5]. Since Internet is an open surrounding, there is need to provide effective methods of preventing data from being duplicated or exploited illegally so, among these procedures the encryption technology has been inserted and deemed among the long-established data security technologies.
There is no doubt, that technological developments made our life easier and speed up everything around us in this world. The organizations concerned with researches based on international standards mentioned that the Internet provides a large area of relaying private and confidential data from various scopes such as education, medical research, medicine and military fields. Since information leakage, illegal data creation and data copying, from one to other it's important to setup the data security system. Therefore, data security has been increased [6]. The watermark that use in digital watermarking technology are invisible for human, but computer could process. Watermark can be embedding into the printing design, and thus the location can be determined by specific key. So, this will reduce chances for counterfeiters to access it easily. At the end this will vary application technology in the digital field, like broadcast examination, identification, prove ownership, transaction monitoring, content verification, copy regulation, device regulation and digital copyright protection [7].
As for the digital image watermarking procedures the triumph of the watermarking procedures relies on how robust it is to various kinds of attacks to demolish the watermark. It is significant to discern these attacks for designing stronger and more robust watermarking methods [8].
A watermark is a data security method, among other common data security technologies used, authentication and copyright technique to suffice its intent, a watermark entails embedding digital details into multimedia data. The watermark can be further insulating into two ways depending on how views it is in the files, for instance visible and invisible watermarking. Watermarking prevents the immoral repetition of media files and claims false ownership [9,10,11].
The contourlet transform which stands for new depiction of the two-dimensional digital pictures which are needed for inspecting grey the cover-image in order to include frequency the watermark area, so this endeavor will issue the mentioned algorithm extra firmness and finally increasing the concealed potential, while still conserving cover-image quality and allow extraction of the watermark having the greatest percentage of precision.

II. Related Work

Considerable researchers have presented many works on the topic of data security, especially on the topic of information hiding. Below are some of the current work in the field of hiding information within digital images:

A. Watermark Generation Algorithm

The watermark technique for digital depends on the angle quantization. The mentioned method works on the energy ratio connecting two angles seemingly not too much risky against any alteration. Digital image watermarking method gives authentication for undisclosed channel and imperceptibility [12,13]. In spite of the huge spread of manipulation of the watermarked, image which is commonly causes breaking down of watermarked bits and change them into random bit streams. Lastly, the quantization of many angles provided a good filter for digital watermarking. For angle quantization application, every watermark bit is embedded in six pairs of actual images. Sets' dimensions of the DCT of the actual picture, like (x1, x2 x3, x4, x5 and x6) were picked to demonstrate a gap in the two-dimensional coordinate structure. Then, three coordinates of

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P(x1,x2), Q(x3,x4), and R(x5,x6) are regarded and calculated based on following Equations as in (1,2,3) [14].

$$m1 = \frac{x4-x2}{x3-x1},\ m2 = \frac{x6-x4}{x5-x3},\ m3 = \frac{x2-x6}{x3-x5} \quad (1)$$

$$\theta 1 = \arctan\left(\frac{m1-m2}{1+m1\times m2}\right) \quad (2)$$

$$\theta 2 = \arctan\left(\frac{m2-m3}{1+m2\times m3}\right) \quad (3)$$

B. Contourlet Properties

The basic idea of contourlet transform is pull directional information at multiscale resolution. The contourlet transform can be esteem is a real sensibility of two-dimensional performance of images and can achieve degeneration in any direction at any measure. The contourlet transform include many wonderful properties, for instance multiresolution, directionality, localization, and anisotropy and fix the problem of incomplete idiom of wavelet transform in directional data [15,16].

Contourlet transform deem as developed or an altered type of Discrete Wavelet Transform (DWT) . DWT dissolves an image into four sub-bands low-low (approximation coefficient), low-high (vertical details), high-low (horizontal details), and high-high (diagonal details). Furthermore, contourlet transform was capable to yield multiple sub bands as per requirements. This can be taken away by using Pyramidal Directional filter bank (PDFB) which includes of Laplacian Pyramidal filter and a double filter band [17,18].

With regard to contourlet transform theory, there are several kinds of filter banks, for instance, quincunx sampling filters and directional filters. Quincunx sampling filters is gotten on the two-dimensional spectrum segmentation. The various frequency response categories will make various sub-bands. In case of utilizing diamond filter, a low-pass and high-pass sub-band should be 45o acquired. But, when we use the fan filter, the horizontal and vertical sub-bands should be 45o direction acquired [19,20].

The contourlet transform amulets the reduction of wavelet. Contourlet transform is a multi-scale and multi directional framework of discrete picture as well. In this method, both multi scales and separated in a serial way so as, the laplacian pyramid utilized to take the point abruption, which is followed by a directional filter bank to combine both points abruption with linear structures together [21].

C. Data Hiding

The data hiding presented in this section suggests to hide data which is a technique utilized to hide data in which the find of hidden data isn't possible, data hiding (cover writing) hide the reality that a secret data is being transmitted. These methods include steganography, covert channels, copyright marking, watermarking, visible watermarking and imperceptible watermarking, the Figure.1 illustrate various section technologies utilized to conceal details and these methods and out of the way of time have taken a major awareness in the domain of availing data accuracy and privacy. Cryptography is a method that mix a data such that no one can know it. While data hiding is a method that hides the data in a way it cannot be visible. An invisible data will not appear by using methods that hide the data doubtfully from the recipient but a message in encrypted text [22].

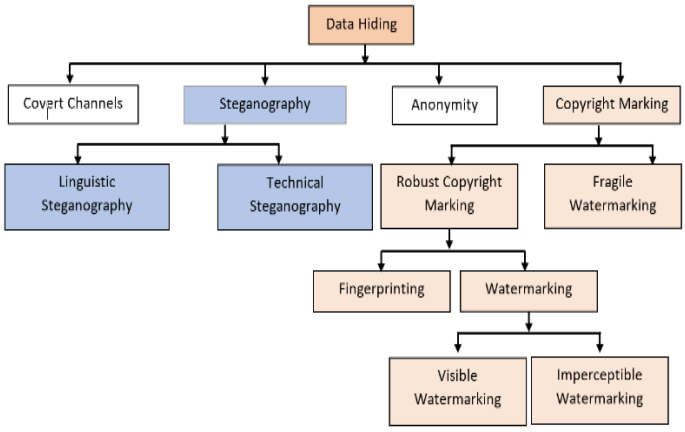

Fig 1: Classes of Data Hiding Technologies

II Proposed Method

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A watermark technique was used to merge the contribution linking those methods and the algorithms of treatment of the digital pictures. The contourlet explain a current illustration of the 2-D digital images in solving the gray cover image which is embedded in the watermark. To maintain the quality of the cover image by providing the frequency domain an effort to provide the proposed algorithm with high power and increase hiding capability. This allows us to get the watermark as accurately as possible.

A. Covert Chanel

Local authority, criminals and terrorist community have a reasonable approach to conceal their transmision secret. Nevertheless, both spy and data robbery raids are growing with advanced procedures, which request current data concealing methods to avoid such raids. Covert Channels are defined as concealing secret details within rightful data, utilizing unspecified or unlooked for ways for concealing the data, pick interest of actual network agreements to move out the data, like concealing data within TCP/IP packets, this inspire an invisible channel and permit concealed data to avoid Internet supervision without altitude the doubt [23].

B. Steganography

It is the technique and science of hide data such that that no one other than the transitter and receiver concerned can doubt the actuality of the data, a type of secrecy utilizing obscurity. Hidden data may appear differently: image, press article, shopping list. Steganography includes the hidding of data. In digital steganography, electronic links may consist of steganographic coding within the transfer layer, for instance a document record, picture record, program or agreements. Media files, due to their greater capacity, are better relayed using steganographic technique. For instance, a transmitter might begin with an unhurt picture record and set the pigment of every percent pixel to agree to a data in the alphabet. The distinction is so perfect that anyone who is not sectionicularly searching has no chance of perceiving the alteration [24].

C. Copyright

Copyright security has become an seriouse topic for executive applications. Classical methods consistes the use of encryption, watermarking, or data hiding for the security of the copyright or property of multimedia content, copyright security, also known as content security, copy protection, and copy limitation, is any effort intended to hinder reproduction of software, movies, music, and other media, specifically for copyright grounds [25].

D. Watermark

There are two broad categories of watermark: visible and invisible. These two main types must be contemplated when creating a digital watermarking algorithm.Figure 2. Emphasizes the importance of balancing strength and capacity while respecting other requirements when creating a watermark algorithm [26]. Increasing the amount of data leads to distortion in the quality of the cover and reduces the robustness in case of any attacks. [27]. Therefore, optimal solidity of data can be selected when embedding to obtain better concealment [28]. Draw attention to the size of the cover utilized to embed the watermark larger than the watermark size [29].

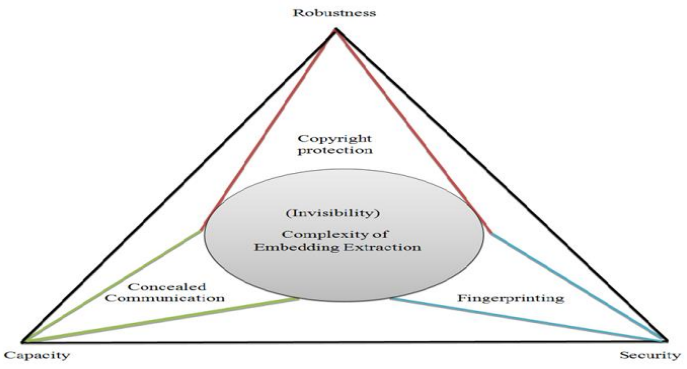

Fig. 2: The fundamental of the watermarking [26]

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III Watermark Categories

Watermark is divided into four categories [27]:

1. text: means adding watermark to the text.
2. Picture: means appending watermark to the image constituents.
3. Movies:means attaching a watermark to movie records that control these programs.

Skitching: means attaching a watermark to two or 3-dimensional illustrations

A. Visual Watermark

The observable watermark is one of the digital watermark that entails embedding the watermark of the data is embedded into the casing in a visual way that is observable by the naked eye. Thus, the watermark of the cover is completely different from the original mark after the process is fully embeded. This is the most important and generality popular method to securite your digital multimedia data, so we need to take some action to annul propagation images and videos that can be permanently utilized in unlawful acts to handle the media in question [30]. There are some qualifying properties in the visible watermark.

- The watermark is included within the wide band or significant range of the cover image to restrain it from being eliminated.
- The watermark is clearly included exclusive of blocking the significant sectioniculars of the cover picture.
- It is difficult to take off specifics as this necessitaes for huge attempts and inflated cost allocation.
- The methods of the visual watermark should be done beautifully with minimal attempt and people intrusion.

B. Unvisual Watermark

This is can be hidden in digital contents in a technique enable as to be known distinctly [31,32,33].

IV The Algorithm

Hiding of the watermark usually is performed by means of contourlet transform since this technique has the ability to hide the soft edges of the image. Human being vision is often less sensitives than edges to prevent the access to confidential information. The grey watermark has been hidden in the directional bands specifically those containing higher frequencies to the cover-image. Several research have been conducted on the algorithms for several categories of watermark grey images and the cover-image with various dimensions. To confirm the accurecy of the watermark embeding in the cover image before and beside hiding the watermark that many scarcely pedicted through the repetetive scale

A. Embedding

Analysis the cover-image and watermark.Set up the cover image coefficient of the watermark using the contourlet transform coefficient and then establish the measurements of the contourlet transform factors of the cover image. Update the pixel value according to equation (4) and then renew the structure using the inverse contourlet transform to get a section of the watermark image.

$$f(i,j) = f(i,j) + (w(i,j)X\ th) \qquad (4)$$

Encryption of the secret key used in the embedding procedure, settled on by the two sections through relaying using a contourlet transform coefficient. Regrouping the watermark image sections.

B. Extraction Watermark

The following point show how to extract the confidential data from sections of a watermark at the section of the receiver.

- Set up the cover-image by splitting it into 4 sections.
- Extract the unknown key and decrypt it in agreement to the embedding by utilizing the contourlet transform coefficients.

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- Processing the section of a cover-image and the watermark utilizing the contourlet transforms with similar number of the evaluation scale in the embedding phase.
- Take out the contourlet transform factor of the secret picture of the section watermark utilizing Equation (5), steps 2, 3 and 4 are replicated with respect to the quantity of the coefficients embedded.

$$w(i,j) = f(i,j) - f(i,j)/\,th\,) \qquad (5)$$

- Collect the contourlet transform coefficients that are take out from the watermark, and from the implementation of the inverse contourlet transform that section is recreated.
- The procedures above are replicated to take out the residual sections of the watermark picture.

Preceding move is the phase of combination the four derived sections of the watermark to get the whole watermark, on top of grouping the recover the cover-image.

C. Measurement Efficiency of Watermark Algorithm

To estimate the effective implementation of the algorithm with the aim of including the watermark, there is a need to study some metrics related to the implementation and effectiveness of the algorithm. There are many metrics, and the focus of this research has been on a set of metrics that confirm, they are active in reducing the strength of the algorithms used, based on a large issue of researches published. Below are the metrics that were based on this paper.

$$PSNR = 10\log 10\,\frac{max^2}{\frac{1}{w\,x\,h}\sum_{1=1}^{w}\sum_{j=1}^{h}(0(i,j)-c(i,j)^2} \qquad (6)$$

$$Ncc\,\frac{\sum m\sum n(mn-A)(Bmn-B)}{\sqrt{(\sum m\sum n(Amn-A^2)(\sum m\sum n(Bmn-B)^2)}} \qquad (7)$$

$$\mathrm{MSE} = \frac{1}{\mathrm{X}\times\mathrm{Y}}\sum_{\mathrm{i}=1}^{\mathrm{X}}\sum_{\mathrm{j}=1}^{\mathrm{Y}}\left(\mathrm{f(I,j)} - \check{\mathrm{f}}\mathrm{(I,j)}\right)^2 \qquad (8)$$

$$SNR = 10\log_{10}\left\{\frac{\sum_{i=1}^{X}\sum_{j=1}^{Y}f(i,j)^2}{\sum_{i=1}^{X}\sum_{j=1}^{Y}\left(f(i,j)-\check{f}(i,j)\right)^2}\right\} \qquad (9)$$

V. Results and Desscusion

All code is written in (matlab15a) to apply the contourlet transform from start to end of the project.

A. Energy

The aim of this algorithm splitting the quaternary was included to enhance the solidity of the hiding on top of what it supplies, the ability to embed a watermark with dimensions near to the size of the cover image. This was achieved by splitting the watermark. This algorithm guide to outcome that may be overtake the outcomes of the other algorithms in embedding and retrieving the watermark. As shown in figure (3) is the model of the watermark "Flower.png" using the first section of the algorithm to embed the watermark with measurements (128x128) after splitting it into four sections with a dimension of 64 x 64.

Fig. 3: Include the secrete image" flower" in the cover image's

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Table (1): Show the Outcome of Embedding Watermark Algorithm using Contourlet Transformation and Energy for the First Section of Algorithm

Cover Image	**Cover image's size**	**Watermark**	**Watermarks size**	**Coefficients**	**Different parameter outcomes of efficiency of the watermark image**			
Lena-image	1024×1024	Flower-sections	128×128		MSE	PSNR	NC	SNR
Section 1	512×512	Section1	64×64	{1,1}	0.000004	99.941003	1.000000	94.023212
				{1,2}	0.000000	121.930140	1.000000	116.012349
				{1,3}	0.000000	122.884130	1.000000	116.966339
Section 2	512×512	Section2	64×64	{1,1}	0.000016	94.451115	1.000000	86.393365
				{1,2}	0.000000	120.178846	1.000000	112.121096
				{1,3}	0.000000	121.841086	1.000000	113.783336
Section 3	512×512	Section3	64×64	{1,1}	0.000023	92.884560	1.000000	88.069917
				{1,2}	0.000000	119.699611	1.000000	114.884967
				{1,3}	0.000000	120.770526	1.000000	115.955882
Section 4	512×512	Section4	64×64	{1,1}	0.000005	99.423635	1.000000	94.881229
				{1,2}	0.000000	120.085283	1.000000	115.542877
				{1,3}	0.000000	121.336815	1.000000	116.794408

Whereas (table1) evidence the outcomes of the watermark. As shown in the (table 2) we can illustrate the outcomes of take out the watermark With its four sections "Flower.png" from the sections of the cover-image "Lena.png" and (table 3) shows the outcomes of retrieve the cover-image.

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Table (2): The Outcomes of Extracting Watermark Embedding Algorithm using Contourlet Transformation and Energy Algorithm the First Section

Image Cover	**Image size Cover**	**Watermark**	**Size of the watermark**	**Different Parameter Outcomes for Efficiency of Extracted Watermark**			
Lena	1024×1024	Earth	128×128	MSE	PSNR	NC	SNR
Section1	512×512	Section1	64×64	73.922108	27.673523	0.994689	18.355091
Section2	512×512	Section2	64×64	97.138451	27.944790	0.991037	21.655048
Section3	512×512	Section3	64×64	168.158146	24.977378	0.992986	21.079227
Section4	512×512	Section4	64×64	82.885288	27.820186	0.990559	17.900146
After of collecting the four sections				105.525998	27.585107	0.993735	20.368837

Table (3): The Outcomes of Recover Watermark Embedding Algorithm using the Contourlet Transformation and Energy Algorithm the First Section

Cover Image	**Cover Image size**	**Watermark**	**Size of the watermark**	**Conto-urlet coeffic-ients**	**Different Parameters Amount for Efficiency Performance of the Recover Cover-Image**			
Lena	1024×1024	Section from Flower	128×128		MSE	PSNR	NC	SNR
Section 1	512×512	Section1	64×64	{1,1}	0.000000	123.307609	1.000000	117.389818
				{1,2}	0.000000	134.462805	1.000000	127.934411
				{1,3}	0.000000	134.276372	1.000000	128.358581
Section 2	512×512	Section2	64×64	{1,1}	0.000000	120.553064	1.000000	112.495314
				{1,2}	0.000000	131.358427	1.000000	123.300677
				{1,3}	0.000000	132.902178	1.000000	124.844428
Section 3	512×512	Section3	64×64	{1,1}	0.000000	118.351484	1.000000	113.536840
				{1,2}	0.000000	131.034658	1.000000	126.220014
				{1,3}	0.000000	132.138745	1.000000	127.324101
Section 4	512×512	Section4	64×64	{1,1}	0.000000	123.576100	1.000000	119.033694
				{1,2}	0.000000	131.449627	1.000000	126.907221
				{1,3}	0.000000	132.375643	1.000000	127.833237

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Table (4): Illustrate the Outcomes of other Researches [32].

Measure	Method	Tested Image (Cover)						
		Peppers	**Lena**	**Elaine**	**Couple**	**Boat**	**Barbara**	**Baboon**
PSNR	**CTL.[1]**	**37**	**47**	**46**	**37**	**37**	**37**	**37**
	DWT and SVD [18]	83.0052	83.5421	……	84.2884	84.4969	…….	84.1548
	APAP-MIPOEE Applying a filling border in a set of angles - MSB6[15]	……	53	……	……	52	……	52.4855
	Non-Blind CTL [1]	48.2294	48.4094	……	48.4922	……	48.2276	48.2793
	Proposed method\3rd	96.872780	107.309568	91.560678	108.872780	101.872780	108.309934	107.735451
MSE	APAP-MIPOEE Applying a filling border in a set of angles - MSB6[17]	0.00032806	0.00028992	0.00025331	0.00024414	0.0002327	0.0002621	0.00025177
	Proposed method\3rd	0.000011	0.000001	0.000033	0.000001	0.000004	0.000001	0.000001
SNR	APAP-MIPOEE Applying a filling border in a set of	58.976	59.695	……	……	……	……	57.07

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	angles - MSB6[17]							
	Proposed method\3rd	88.074993	101.506316	80.901897	102.979408	95.526837	99.541471	101.480248
NC	CTL.[33]	0.965	0.973	0.970	0.981	0.922	0.972	0.921
	Proposed method\3rd	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

Employ the section of the cover-image and the hidden picture in constructing the concealing system to perform noise reduction in the recovered hidden picture and the extracted cover-image and then illustrated over the estimates of PSNR and SNR on top of the rise in the grade of estimation connecting the source picture and the extracted one as can be seen via the estimates of NC.

VI. Conclusion

The characteristic of information dissemination in the contourlet transform coefficients outcomes in absolute secrecy of the information requirement become concealed, where the cover-image that contains a hidden watermark very near to the actual picture and caused difficulty to the viewer to realize that when it subsists at the interior of the cover-image. This work proposed algorithm embedding utilizing the Contourlet Transformation and Energy secret data within cover image coefficients. Furthermore, contourlet transform coefficient and energy are utilized depending on the concept on quadric division tree in order to hide data. Proposed algorithms are evaluated depending on PSNR, MSE, SNR, and NC where showed that in my proposed algorithm is the best one.

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