Digital Image Watermarking Against Geometrical Attack

Sandeep Rai, Rajesh Boghey, Dipesh Shahane and Priyanka Saxena

1 Introduction

The advancement of varied networks led to the movement to packet info. On these lines, transmission parts get to be clearly accessible to very large range of users. Purchasers will get to information and, besides, management them in several ways in which. Various ways for golf shot away and replicating info will disregard the copyrights. Contingent upon the weather, any authors will decide two types of watermarks. Digital watermarking could be a system of infusion the digital mark whereas exchanging of sure parts. The most reasonable watermark is associate degree clear watermark. Noticeable watermark is plainly obvious to any shopper of the substance. The resistance of those watermarks is questionable. Manufacturing a large range of duplicates of a selected substance will undermine or maybe obliterate the character of the watermark. The second method is embedding the watermark so once its consolidation it gets to be clearly impalpable. This technique is distinctive and additionally baffled than the past one. The impalpable watermark is additionally dependable than perceptible watermark.

Watermarking infers the existence of a mark in transmission substance that contains the name, his signature or mark. Client of substance cannot see the inserted watermark [1]. Algorithmic rule for embedding associate degree impalpable

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watermark depends upon the engravings of the watermark within the frequency domain. Within the frequency domain watermarking is more durable to separate while not abusing the character of the watched image.

The application of the three basic types of transformation: Fast Fourier Transform (FFT), Discrete Cosine Transform (DCT), and Discrete wavelet Transform (DWT) square measure displayed within the literature [2–4]. It has been incontestable that DWT acquires the foremost current outcomes as well as associate degree undetectable watermark. Despite the strategy for info appropriation and also the amount of duplicates created, the chief objective of the watermark engraving is to accomplish validation.

The author has introduced various ways to watermark the photographs. This paper is focused on watermark embedding supported DT-CWT and cryptography technique. Contingent upon the connected unfold spectrum ways sure algorithmic rule can have comparable qualities as once considering a radio framework that applies the vital procedures of unfold spectrum. The final method for watermarking is given by Fig. 1 (Figs. 2 and 3).

The paper is formulated star as follows. In Sect. 1, the introduction concerning watermarking and unfold spectrum is mentioned. Digital watermarking methods

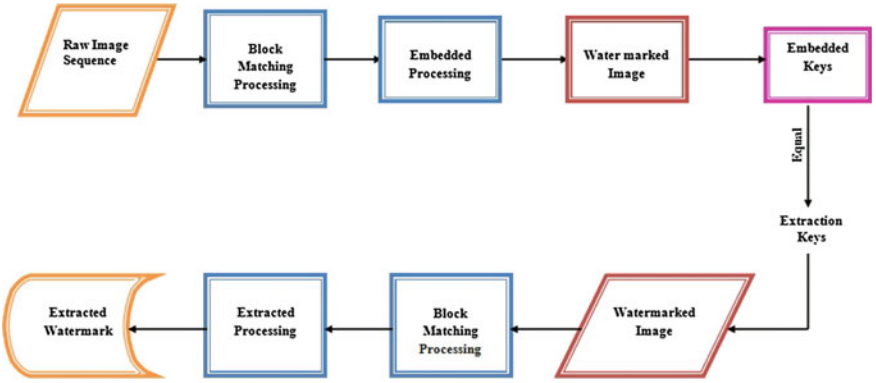

Fig. 1 Process of watermarking

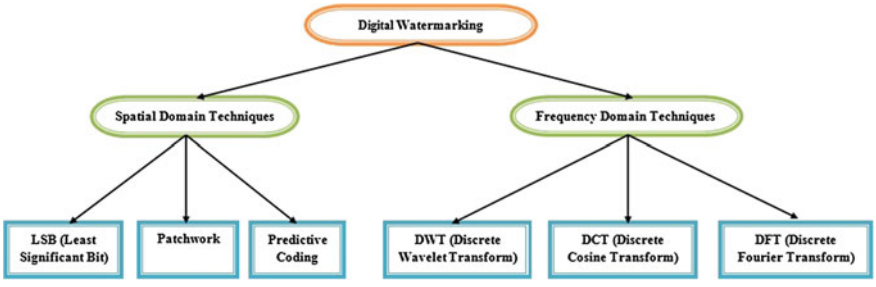

Fig. 2 Classification of digital watermarking

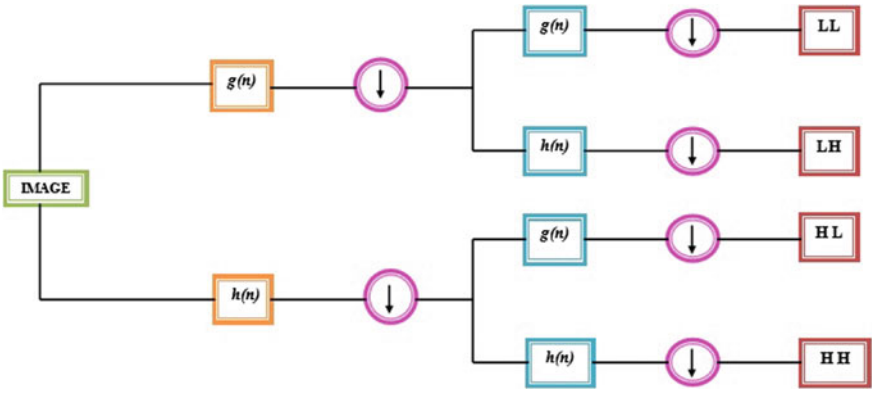

Fig. 3 2D-DWT decomposition of an input image using filtering approach

are discussed in Sect. 2. The planned methodology and its connected algorithmic rule square measure best owed in Sect. 3. In Sect. 4, experimental and its analysis is between performance metrics is discussing and last remarks square measure bestowed in Sect. 4.

2 Watermarking Techniques

There square measure several algorithms that square measure being employed to cover the key information. These algorithms are categorized into two domains, which are given as follows:

1. Spatial domain and
2. Frequency domain

Spatial domain watermarking slightly modifies the pixels of 1 or 2 indiscriminately elect subsets of a picture. On the opposite aspect, in frequency domain techniques the image is first remodeled to the frequency domain by the utilization of any demodulation ways like Fourier transform, distinct circular function remodel (DCT) or distinct rippling remodel (DWT). Currently, the knowledge is another to the values of its remodel coefficients. Once applying the inverse remodel, the marked coefficients kind the embedded image.

2.1 Spatial Domain [5]

A. Least Significant bit (LSB)

During this technique, watermark is embedded within the LSB of pixels. 2 sorts of LSB techniques square measure planned. Within the first methodology, the LSB of the picture was recouped with a pseudo-noise (PN) sequence whereas within the second a PN sequence was another to the LSB. This methodology is straightforward to use, however, not terribly sturdy against attacks.

B. Patchwork Technique

In patchwork, n pairs of image points, (a, b), were indiscriminately chosen. The image information in a very were lightened whereas that in b were darkened. High level of hardiness against many sorts of attacks square measure provided during this technique. However, here during this technique, terribly bit of data is hidden.

C. Predictive Coding Scheme

In this scheme, a pseudorandom noise (PN) pattern says W(x, y) is another to hide image. It will increase the hardiness of watermark by increasing the gain issue. However, as a result of high increment in gain issue, image quality could decrease.

2.1.1 Frequency Domain

A. Discrete Cosine Transform [6]

The high-frequency components are watermarked in frequency domain. The main steps are given as follows:

(1) Divide the image into non-overlapping blocks of 8×8
(2) Apply forward DCT to each of these blocks
(3) Apply some block selection criteria (e.g., HVS)
(4) Apply coefficient selection criteria (e.g., highest)
(5) Embed watermark by modifying the selected coefficients.
(6) Apply inverse DCT transform on each block.

B. DFT Domain Watermarking

DFT Domain Watermarking DFT domain is the favorite alternative of researches as a result of it provides hardiness against geometric attacks like translation, rotation, cropping, scaling, etc. There square measure 2 sorts of DFT based mostly watermark embedding techniques. In first technique watermark is directly inserted and the other technique is an example based mostly embedding. In direct embedding, watermark is inserted by ever-changing the section info at intervals the DFT [7].

An example could be a structure that is employed within the DFT domain to evaluate the transformation issue. First, a change is created in image then to resynchronize the image this example is searched, then use the detector to extract the embedded unfold spectrum watermark.

C. Discrete Wavelet Transform

Discrete wavelet transform is applied to decompose any non-stationary signal like a picture, audio or video signal. The remodel is based on very little waves, referred to as wavelets of varied frequency and restricted period. Frequency also as spatial info of a picture is maintained throughout rippling transformation. Temporal info is preserved throughout this conversion methodology [8]. Wavelets square measure created by transformations and dilations of constant perform referred to as mother rippling. DWT is accomplished by low-pass and high-pass filtering of a picture. High-pass filter creates elaborated image pixels and low-pass filter creates coarse approximation image pixels [9]. The outputs square measure down-sampled by two once acting the low-pass and high-pass filtering. Second DWT is finished by death penalty 1DDWT on every row that is thought as horizontal filtering then on every column that is thought as vertical filtering [10].

3 Literature Review

In previous few years, a many watermarking techniques are evolved within the history of watermarking. The researchers have examined the algorithms on distinct parameters like capability, strength physical property, etc., a number of the examinations determined by the varied researchers includes associate degree algorithmic rule that uses each digital image watermarking and digital signature to produce integrity which will be verified by user at the network and that they have instructed a changed algorithmic rule that aims that within the mixed hybrid transformation once the quilt image is altered within the singular values instead of on DWT subbands, so it makes the watermark image additionally unsafe toward various attacks, whereas PSNR of each the image are increased. [11] at that time another researches additionally propounded a way that increased verification for integrity of information over the network. [12] Next few researches mentioned concerning the combined DWT DCT transformation with low-frequency digital watermarking. The experimental outcome holds the potential to tolerate geometric attacks and customary signal process. [13] at that time researches planned a strong protection technique that was smitten by (DWT) and visual hided theme (VHI). The outcomes were tested on parameters PSNR and resistance against completely different attacks [14]. Additionally, at that time some researchers instructed a way in spatial domain watermarking as well as secret writing techniques. The results were judged on the idea of the standard of original image and square measure thought of to be satisfactory. [15] additional enhancements and changes is created in existing algorithms for higher performance in each field, however, still expecting that square measure algorithms will provide higher leads to each field appears extremely tough.

4 Proposed Methodology

This section provides temporary summary of the planned methodology DT-CWT is discussing. The Dual-Tree complicated rippling remodel (DT-CWT) has been introduced to beat the disadvantages of real DWT. The overall execution of the DT-CWT style ensures the subsequent properties:

- Approximate shift invariance,
- Good directional selectivity in 2D with Gabor-like filters also true for higher dimensionality (m-D),
- Perfect reconstruction using short linear-phase filters,
- Limited redundancy: independent of the number of scales: 2:1 for 1-D (2 m:1) for m-D,
- Efficient order-N computation - only twice the simple DWT for 1-D (2 m times for m-D);

The overall performance of the DT-CWT design ensures the shift invariance property of the transformation. Moreover, it improves the directional selectivity compared to the DWT since it produces six directional subbands at each scale oriented at $\pm 15^{\circ}$, $\pm 45^{\circ}$, $\pm 75^{\circ}$ compared to the three directional subbands of the DWT. Figure 4 shows a two-level decomposition of 1-D signal f(x) using DT-CWT (Figs. 5 and 6).

A DT-CWT transformation of 1D signal f(x) in terms of shifted and dilated wavelet function $\varphi(n)$ and scaling function $\emptyset(n)$ is given by the following equation:

$$f(x) = \sum_{l \in Z} S_{j_0,l} \phi_{j_0,l}(x) + \sum_{j \geq j_0} \sum_{l \in Z} c_{j,l} \psi_{j,l}(x) \tag{1}$$

where Z is the set of natural numbers, j and l refer to the index of shifts and dilations, respectively, is the scaling coefficient, and is the complex wavelet coefficient with

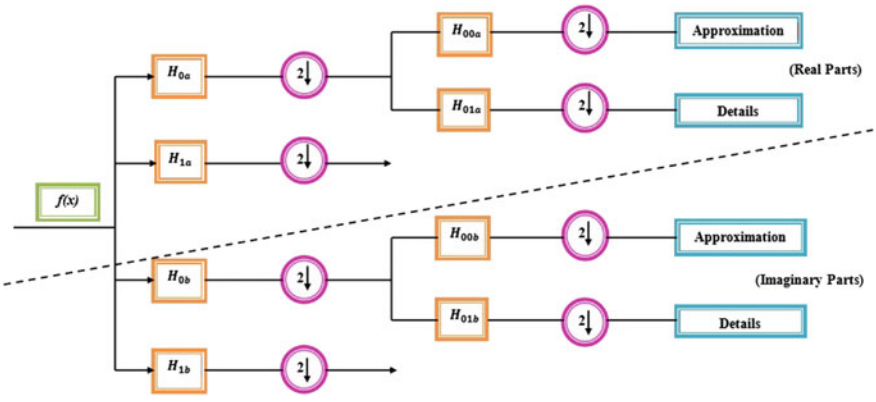

Fig. 4 DT-CWT

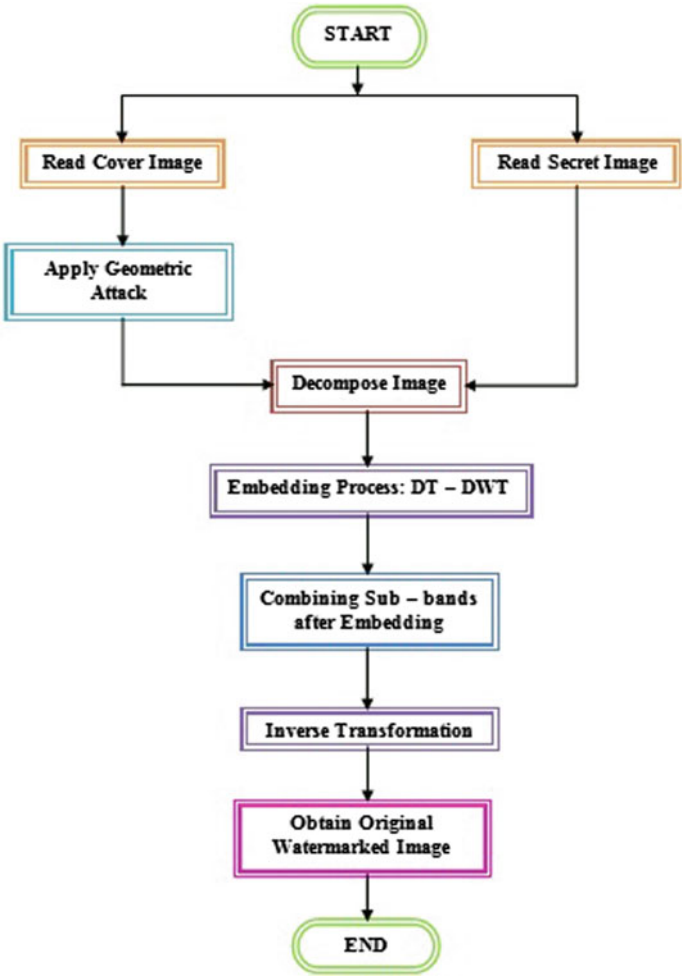

Fig. 5 Flowchart of watermark embedding

$$\phi_{j_{0,l}}(x) = \phi^{r}_{j_{0,l}}(x) + \sqrt{-1}\phi^{i}_{j_{0,l}}(x) and\ \psi_{j_{0,l}}(x) = \psi^{r}_{j_{0,l}}(x)\sqrt{-1}\psi^{i}_{j_{0,l}}(x)$$

where the superscripts r and i denote the real and imaginary parts, respectively. To compute the 2-D DT-CWT of images, the two trees are applied to the rows and then to the columns of the image as in the basic DWT. This operation results in six complex high-pass subbands at each level and two complex low-pass subbands on which subsequent stages iterate. The decomposition of 2D signal can be expressed in the same manner like the 1D decomposition in [7] as follows:

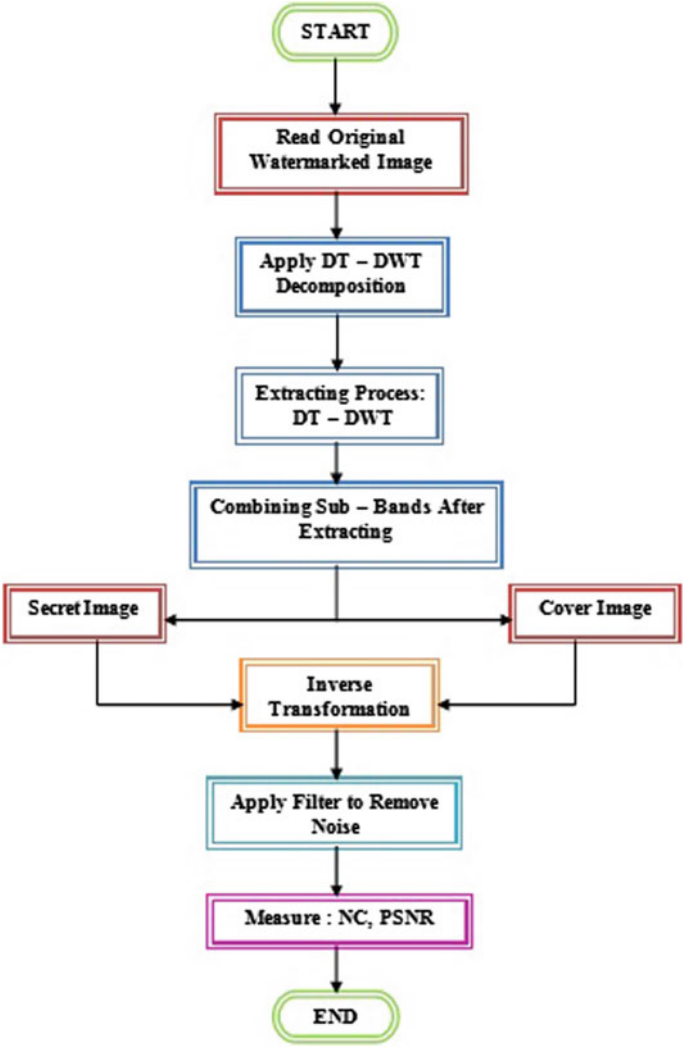

Fig. 6 Flowchart of watermark extraction

$$f(x) = \sum_{l \in Z^2} S_{j_0,l} \phi_{j_0,l}(x, y) + \sum_{\theta \in \theta} \sum_{j \geq j_0} \sum_{l \in Z^2} C^{\theta}_{j,l} \psi^{\theta}_{j,l}(x, y) \qquad (2)$$

where $\theta \in \Theta = \{\pm 15°, \pm 45°, \pm 75°\}$ which determine the complex wavelet directionality.

5 Experimental Results and Analysis

The tentative study of the planned methodology is finished employing a widely used MATLAB2012A tool cabinet and also the machine configuration is Intel I3 core two.20 Ghz processor, with 4 GB RAM, windows seven home basis. In planned methodology, we have a tendency to apply a compression and secret writing and watermarking for the surefire bar from geometric attacks.

5.1 Snapshots

The figures shown below are that of the original image that must be watermarked, and screenshot of main interface is additionally shown in Fig. 7. The planned feature image is river that is revolved, translated, and sheared concerning the angle of ten, twenty, and thirty degree. The interface of these options is additionally shown through figure (Figs. 8, 9, 10, 11, 12, 13, 14, 15 and 16).

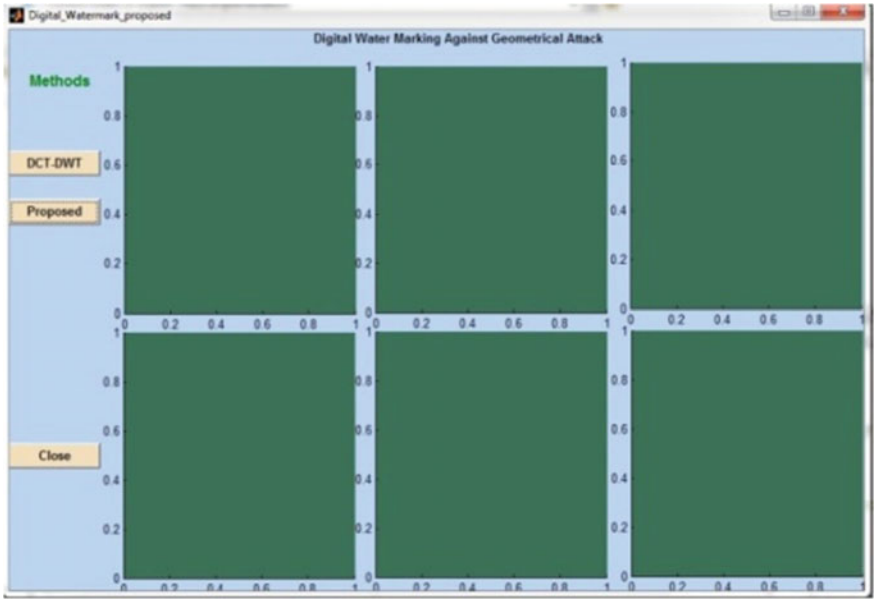

Fig. 7 Screenshot of main GUI

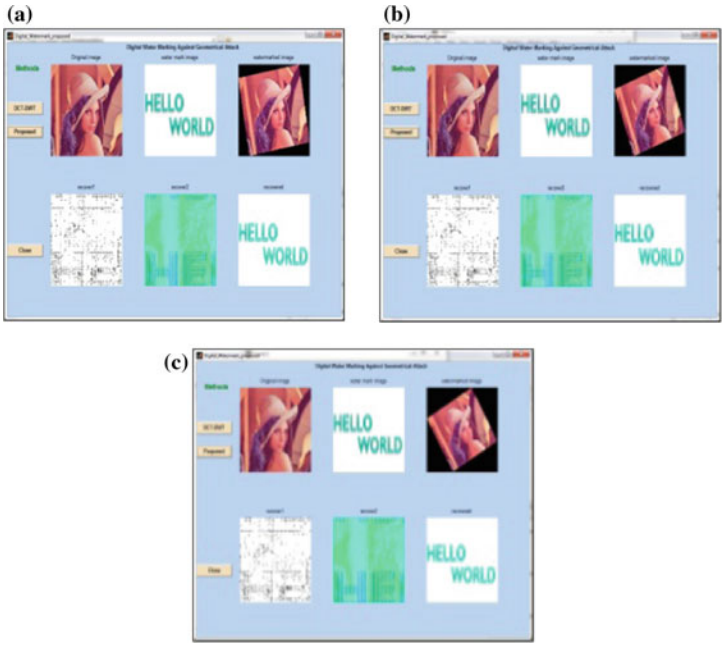

Fig. 8 Rotation of Leena about 10, 20, and 30°

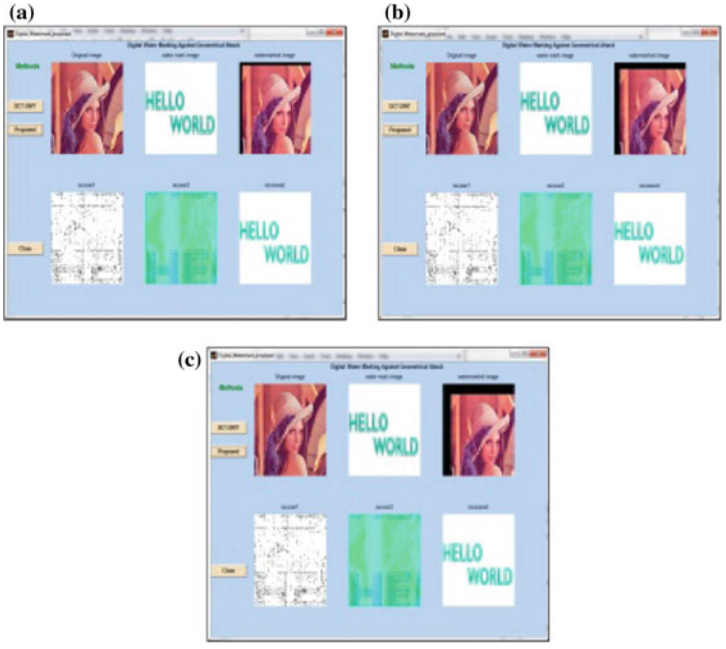

Fig. 9 Translation of Leena at value 10, 15, and 20°

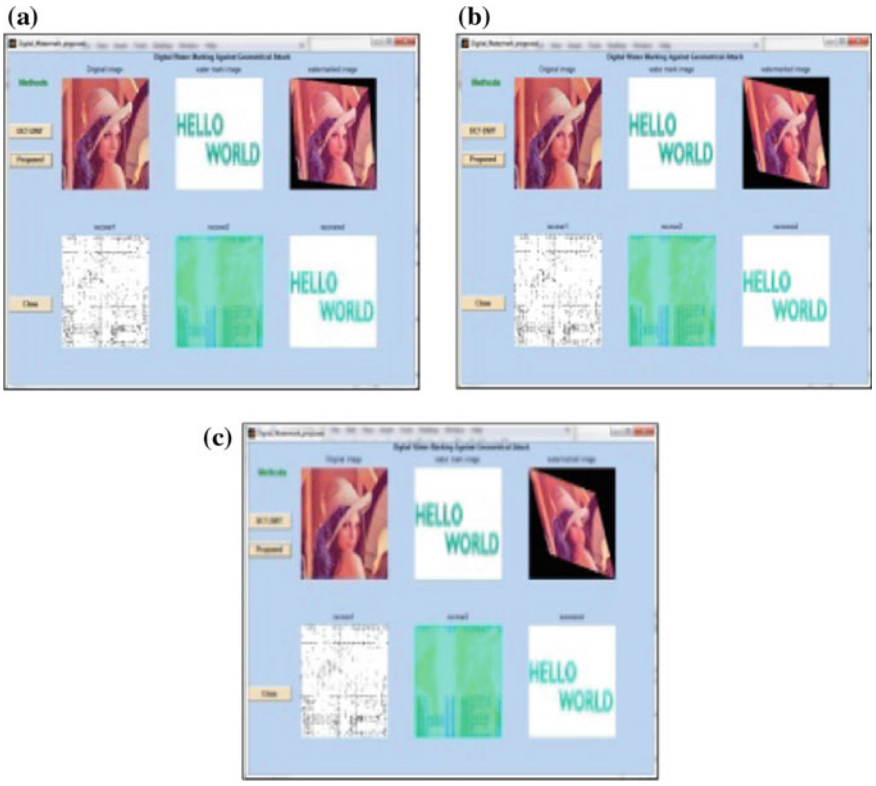

Fig. 10 Shear of Leena at value 0.15, 0.25, and 0.35

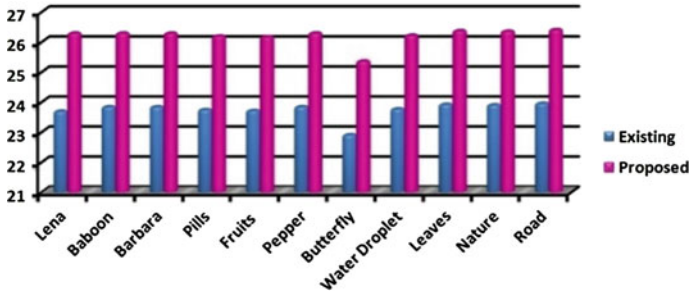

Fig. 11 Comparison of PSNR values between proposed and existing methodology (at 10^0 rotation)

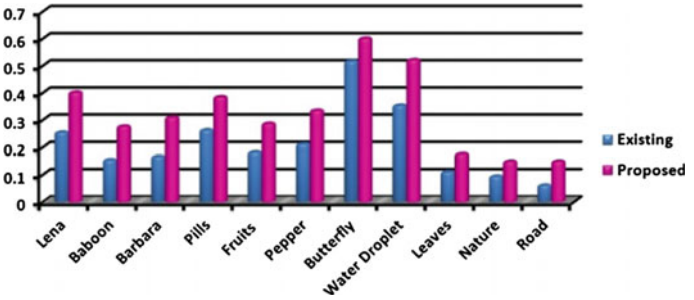

Fig. 12 Comparison of NC values between proposed and existing methodology (at 10^0 rotation)

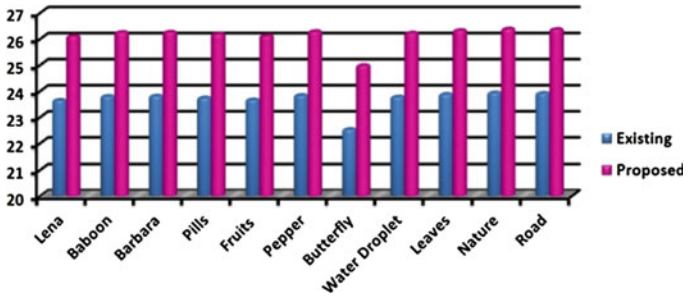

Fig. 13 Comparison of PSNR values between proposed and existing methodology (at value 10 translation)

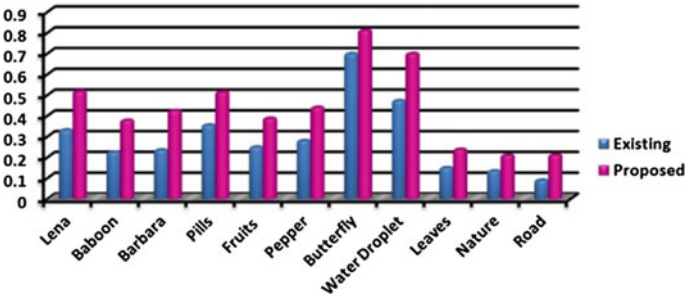

Fig. 14 Comparison of NC values between proposed and existing methodology (at value 10 translation)

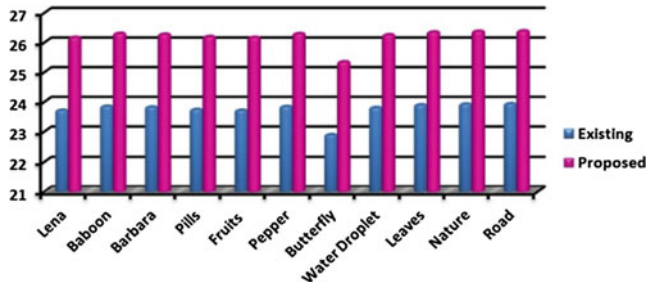

Fig. 15 Comparison of PSNR values between proposed and existing methodology (at value 10 shear)

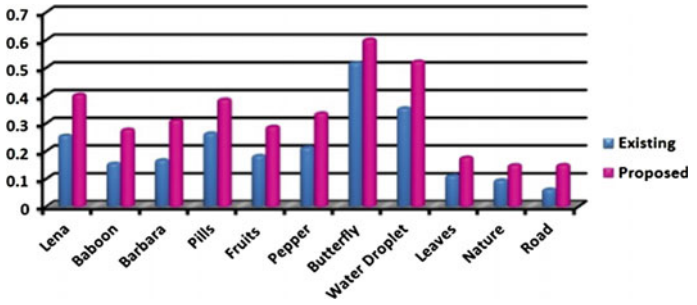

Fig. 16 Comparison of NC values between proposed and existing methodology (at value 10 Shear)

5.2 Result Analysis

The comparative study of the planned methodology is perform victimization the transformation metrics rotation, shear, and translation and also the simulation results of it shown in Tables 1, 2, 3, 4, 5, and 6.

6 Conclusion

In scientific method, during this analysis we have a tendency to gift a strong image watermarking algorithmic rule against numerous geometric attacks mathematically invariant to the cutting, translation, and rotation concerning ten, twenty, and thirty degree. A hybrid DT-CWT and cryptography technique for digital watermarking system wavelets was bestowed that incontestable sensible performance underneath numerous geometric attacks. The experimental analysis is engaged on river, Baboon, Barbara, Pills, fruits, Pepper, Butterfly, Water driblet, Leaves, Nature, and Road feature pictures. This methodology proves to be a much better technique leading to the many improvement in PSNR and Old North State activity parameter.

Table 1 Result analysis for PSNR of proposed and existing method (rotation)

S. No.	Images	Existing			Proposed		
		PSVR			PSXR		
		Angle			Angle		
		10°	20°	30°	10°	20°	30°
1	Lena	23.690442	23.723472	23.758009	26.287206	26.287386	26.294237
2	Baboon	23.834364	23.834544	23.841395	26.287206	26.287386	26.294237
3	Barbara	23.832627	23.839941	23.849818	26.285469	26.292783	26.302660
4	Pills	23.736836	23.750683	23.771723	26.189678	26.203525	26.224565
5	Fruits	23.709867	23.750487	23.783580	26.162709	26.203329	26.236422
6	Pepper	23.836499	23.839188	23.845114	26.289341	26.292030	26.297956
7	Butterfly	22.903890	23.082431	23.183102	25.356732	25.535273	25.635944
8	Water droplet	23.765383	23.772806	23.800175	26.218225	26.225648	26.253017
9	Leaves	23.916408	23.935774	23.946373	26.369250	26.388616	26.399215
10	Nature	23.897798	23.888705	23.898559	26.350640	26.341547	26.351401
11	Road	23.951449	23.963869	23.975304	26.404291	26.416711	26.428146

Table 2 Result analysis for NC of proposed and existing method (rotation)

S. No.	Images	Existing			Proposed		
		NC			NC		
		Angie			Angle		
		10°	20°	30°	10°	20°	30°
1	Lena	0.255750	0.200236	0.170715	0.282558	0.224462	0.194986
2	Baboon	0.164596	0,130370	0.113064	0.282558	0.224462	0.194986
3	Barbara	0.16”451	0.134933	0.117885	0,307476	0.247094	0.216201
4	Pills	0.259130	0.214548	0.18220”	0.379050	0.310941	0.266400
5	Fruits	0.184037	0.147744	0.124266	0.287316	0.231792	0.196530
6	Pepper	0.217269	0.169753	0.145467	0.340100	0.267992	0.230501
7	Butterfly	0.516316	0,409299	0.351918	0,602655	0,480336	0.414514
8	Water droplet	0.350765	0.277955	0.241719	0.520610	0.413987	0.359411
9	Leaves	0.108027	0.086161	0.075077	0.173377	0.139036	0.121060
10	Nature	0.094880	0,074933	0.064264	0.151297	0.119007	0.102404
11	Road	0.064249	0.052124	0.044108	0.152737	0.122227	0.104145

Table 3 Result Analysis for PSNR of Proposed and Exiting Method (Translation)

S. No.	Images	Existing			Proposed		
		PSNR			PSNR		
		Value			Value		
		10	15	20	10	15	20
1	Lena	23.643036	23.653643	23.673332	26.095878	26.106485	26.126174
2	Baboon	23.794942	23.90812	23.785124	26.247784	26.243654	26.237966
3	Barbara	23.805621	23.808931	23.813349	26.258463	26.261773	26.266191
4	Pills	23.733215	23.734345	23.735299	26.186057	26.187187	26.188141
5	Fruits	23.659369	23.669687	23.678836	26.112211	26.122529	26.131678
6	Pepper	23.831100	23.833891	23.836433	26.283942	26.286733	26.289275
7	Butterfly	22.524690	22.536192	22.5377S9	24.977532	24.989034	24.990631
8	Water droplet	23.769773	23.773554	23.775670	26.222615	26.226396	26.228512
9	Leaves	23.871067	23.871386	23.872758	26.323909	26.324228	26.325600
10	Nature	23.925209	23.930791	23.936176	26.378051	26.383633	26.389018
11	Road	23.909259	23.909065	23.909572	26.362101	26.361907	26.362414

Table 4 Result analysis for NC of proposed and existing method (translation)

S. No.	Images	Existing			Proposed		
		NC			NC		
		Value			Value		
		10	15	20	10	15	20
1	Lena	0.330870	0.316915	0.302370	0.516591	0.495148	0.473483
2	Baboon	0.223106	0.219773	0.216638	0.377121	0.369314	0.361971
3	Barbara	0.234663	0.232567	0.230225	0.423452	0.417654	0.411254
4	Pills	0.354529	0.348840	0.342604	0.513315	0.504545	0.494942
5	Fruits	0.248633	0.244956	0.240612	0.386625	0.380715	0.373929
6	Pepper	0.279385	0.269843	0.261077	0.439573	0.427250	0.415598
7	Butterfly	0.698425	0.692499	0.687426	0.810145	0.802810	0.796203
8	Water droplet	0.471893	0.464648	0.458068	0.698577	0.688885	0.679935
9	Leaves	0.149112	0.147514	0.146070	0.237602	0.235195	0.233028
10	Nature	0.133566	0.133342	0.132953	0.209118	0.207878	0.206496
11	Road	0.089387	0.089150	0.088802	0.210013	0.208578	0.207093

Table 5 Result analysis for PSNR of proposed and existing method (shear)

S. No.	Images	Existing			Proposed		
		PSNR			PSNR		
		Value			Value		
		0.15	0. 25	0.35	0.15	0.25	0.35
1	Lena	23.715015	23.752814	23.790334	26.167857	26.205656	26.243176
2	Baboon	23.850482	23.867665	23.879131	26.303324	26.320507	26.331973
3	Barbara	23.822617	23.845693	23.873258	26.275459	26.298535	26.326100
4	Pills	23.742306	23.765553	23.804496	26.195148	26.218395	26.257338
5	Fruits	23.715199	23.760868	23.796230	26.168041	26.213710	26.249072
6	Pepper	23.842548	23.856070	23.865659	26.295390	26.308912	26.318501
7	Butterfly	22.891702	23.084908	23.262813	25.344544	25.537750	25.715655
8	Water droplet	23.804681	23.832581	23.851985	26.257523	26.285423	26.304827
9	Leaves	23.897107	23.920286	23.949555	26.349949	26.373128	26.402397
10	Nature	23.921532	23.927855	23.937000	26.374374	26.380697	26.389842
11	Road	23.933676	23.939348	23.948645	26.386518	26.392190	26.401487

Table 6 Result analysis for NC of proposed and existing method (shear)

S. No.	Images	Existing			Proposed		
		NC			NC		
		Value			Value		
		0.15	0.25	0.35	0.15	0.25	0.35
1	Lena	0.254491	0.203415	0.157541	0.401799	0.312431	0.252571
2	Baboon	0.153802	0.121434	0.095522	0.276414	0.219083	0.173202
3	Barbara	0.16(5150	0.1347(56	0.106613	0.3097'3	0.250031	0.198201
4	Pills	0.262876	0.213267	0.166833	0.384710	0.311263	0.244572
5	Fruits	0.181774	0.145586	0.114336	0.286692	0.230623	0.182667
6	Pepper	0.211567	0.1(5644(5	0.119818	0.334872	0.265092	0.207252
7	Butterfly	0.515929	0.412427	0.322568	0.600815	0.482222	0.379185
8	Water droplet	0.353313	0.231437	0.219157	0.521636	0.416736	0.326777
9	Leaves	0.110082	0.087076	0.066542	0.175870	0.139792	0.107647
10	Nature	0.093815	0.074305	0.053466	0.143694	0.118264	0.003006
11	Road	0.060782	0.040130	0.038622	0.149112	0.119493	0.093769

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