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Measuring the Effects of Rational 7th and 8th Order Distortion Model in the Region of Digital Video Watermarking

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Abstract: *One of the biggest and important issues in the video watermarking is the distortion and attacks. The attacks and distortion affect the digital watermarking. Watermarking is an embedding process. With the help of watermarking, we insert the data into the digital objects. There are few methods are available for authentication of data, securing/protection of data. The watermarking technique also provides the data security, copyright protection and authentication of the data. Watermarking provides a comfortable life to authorized users. In my proposed work, we are working on distorted watermarked video. The distortion is present on the watermarked video is rational 7th and 8th order distortion model. In this paper, firstly we are embedding the watermark information into the original video and after that work on the distortion model which may be come into the watermarked video. We are also calculating the PSNR (Peak signal to noise ratio), SSIM (Structural similarity index measure), Correlation, BER (Bit Error Rate) and MSE (Mean Square Error) parameters for distorted watermarked video. We are showing the relationship between correlation and SSIM with BER, MSE and PSNR.*

Keywords: *Video watermarking, Rational 7th and 8th distortion model, Correlation, SSIM, MSE, BER*

I. Introduction

The development of the internet services and the multimedia object is increasing day by day. Today, piracy of the video is the biggest problem. The security of the multimedia objects like images, audio and video is not a small job. The news of piracy can disturb the authorized users [1]. So we have a duty to safe the hidden information. Watermarking is a process of embedding the information like image, logo, and text into the multimedia objects. With the help of watermarking process, we can hide the copyright information. This information basically represents the rights of the authorized users [2]. These rights show the ownership of the authorized users. So watermarking is so important for every authorized user. There are multiple factors which are necessary for the digital video watermarking, but some factor is so important like robustness, fidelity, imperceptibility etc. In my proposed work we are working on the robust invisible watermarking. In invisible watermarking the hidden information is not visible by anyone and in robust watermarking, we can detect the watermark information from the distorted watermarked video [2 3]. We are also working on the rational 7th and 8th distortion model. Distortion is also a very big issue for the authorized users [4]. Any type of distortion may be damaging the watermarked information. There are multiple reasons for occurrence the distortion in the watermarked video. The some reason of distortion is multiple viruses generate by the hackers, transmission medium, wide angle lenses etc. So, firstly we are embedding the watermark information and then we add the rational 7th and 8th order distortion in this watermarked video and then detect the hidden information from the distorted watermarked video [4 5]. For watermarking process we are using the spatial as well as frequency/transform domain. At starting time of the watermarking research, we are only using the spatial domain for embedding the information into multimedia objects. The spatial domain techniques are so simple techniques for embedding the watermark information. After some time we are going for transforming domain. This technique is so efficient as compared to the spatial domain but frequency/transform domain techniques are complex as comparable to the spatial domain techniques. In this paper, we have selected the both domains for the embedding the watermark information. In spatial domain we are using the LSB (Least Significant Bit), SS (Spread Spectrum) techniques and in frequency/ transform domain we are selecting the DWT (Discrete Wavelet Transform) technique [6-11]. The proposed technique is so effective because of both domains provides the contributions for embedding the watermark information. All distortion models have a mathematical formulation. The all types of the distortion have a standard lens distortion formula [12-15].

The mathematical representation of the lens distortion formula is

$$\begin{pmatrix} \hat{x} - x_c \\ \hat{y} - y_c \end{pmatrix} = f(r) \begin{pmatrix} x - x_c \\ y - y_c \end{pmatrix} \quad \dots (1)$$

$f(r)$ is decided which type of distortion can occurs. $f(r)$ is the distortion function. There are two types of distortion model are generated from the $f(r)$. One is polynomial model and the second is division model.

The standard representation of the rational 7th and 8th order distortion model is shown below:

$$f(r) = (1 + k_1 r)/(1 + k_2 r^2) \quad \dots (2)$$

$$f(r) = 1/(1 + k_1 r + k_2 r^2) \quad \dots (3)$$

$$r = \sqrt{(x - x_c)^2 + (y - y_c)^2} \quad \dots (4)$$

In rational 7th and 8th distortion model we are using the equation 2 and 3. In this equation k represents the distortion factor.

II. Related Work

In this paper, we are using the spatial as well as transform domain. If we are combining the both domains, then we should full knowledge about both domains. In the first paper, second, third and fourth paper, we have got knowledge about the distortion.

H. Tian, et al [16], 2016, in this paper, a technique was studied that was implied to identify the robust watermarking in the mobile videos in contrast to barrel distortion for Head Mounted Display i.e. HMD. In this work, to discover the watermark from the pre-wrapped image in head mounted display, an estimation method for barrel distortion was specified. After this, the related warp was forced to the implanted watermark mask with the projected parameters of barrel distortion. Hence the implementation of this shows that in case of both the images i.e. pre-warped and original respectively, the detection of watermarks is possible.

Chang, et al [17], 2010, a study is derived which emphases on the notion of lens distortion that happens in the document picture which is taken by the hand held camera. Subsequently, the new mechanism was drawn in order to sort out this problem that was composed of arithmetical morphology based lens correction algorithm. The procedure of the application was initiated with the implementation of adaptive threshold algorithms. This algorithm splits the image into multiple sections and then to use the clustered based attached modules into text lines, morphological algorithm is applied. Afterwards to repair the focus point of the text line, the second order polynomial algorithm was used and produced the object function to the lens distortion. The curved warped line was transformed into the straight site off line in order to solve the image deformation.

A. W. Fitzgibbon, et al [18], 2001, describes that how linear estimations of the base matrix with respect to double view point i.e. remedy can be enhanced to add radial lens distortion. This objective was accomplished by shifting towards the other lens model which had equivalent powers along with standardized coordinates instead of standard distortion model. In this work, a new estimated model was recommended which was compared with bundle adjusted calibration grid data. The results of this study show that the proposed estimator model was quite effective in the sense of speed.

L. Wang, et al [19], (2012), a real-time video watermarking technology had been recommended which was transparent and robust to geometric distortions, comprising rotation with cropping, scaling, aspect ratio change, frame dropping, and swapping. In the fifth and sixth paper, we have got full knowledge about the spatial as well as wavelet domain.

Rogelio Reyes, et al [20], (2010), a public video watermarking algorithm was defined in this paper, whose robustness depends on the embedding energy. It is must be inadequate due to the degradation of video sequence affected by the identical watermark signal. The projected algorithm embedded a perceptually familiar binary pattern, such as owner's logotypes. At first, the video series were segmented by each scene, and then the binary watermark pattern was inserted into Discrete Wavelet Transform (DWT) domain of the unsystematically selected scene blocks. To enhance the security of the proposed technique, the binary watermark pattern was mapped to a noise like binary pattern with the help of a chaotic mixing approach, before its embedding. Simulation results showed the watermark imperceptibility and robustness against multiple attacks, such as noise contamination, frame dropping, frame averaging and frame swapping. The results of the evaluation also represented that the extracted watermark pattern was appropriately vibrant, although the watermarked video arrangement may suffer numerous attacks.

Li Chen, et al [21], (2013), as a fresh technique of copyright protection, Digital watermarking can efficiently look after copyright of digital products. In recent times, the field of digital watermarking is mainly emphasis on the image, video and audio. This paper designs and implements a text digital watermarking algorithm. This algorithm is based on the word document after analyzing various text digital watermarking technologies. It comprehends the watermark embedding by altering the font of the letters in word document. Finally, through a test series, it analyzes and proves the feasibility of the algorithm.

So with the help of some paper we have made a new watermarking technique. We are also working on the rational 7^{th} and 8^{th} order distortion model.

III. Proposed Watermarking Techniques

In my proposed work we are combining the spatial as well as frequency/transform domain. In the spatial domain we are firstly applied the spread spectrum technique for acquiring the pixel's location of the original signal. With the help of this technique we know about the location of pixel values. If we know about the location of the pixel value, then we can easily embed the pixel of watermark image information. After applying the spread spectrum, we are applying the LSB (Least Significant Bit) to exchange the pixel values in between the original and watermark image information. In this method, we are also applying the DWT technique for providing the multi-resolution, compresses the frame and also used for embedding the watermark information. We are showing the effects of rational 7^{th} and 8^{th} distortion on the watermarked frame.

Fig.1 Original Watermarked Video's Frame

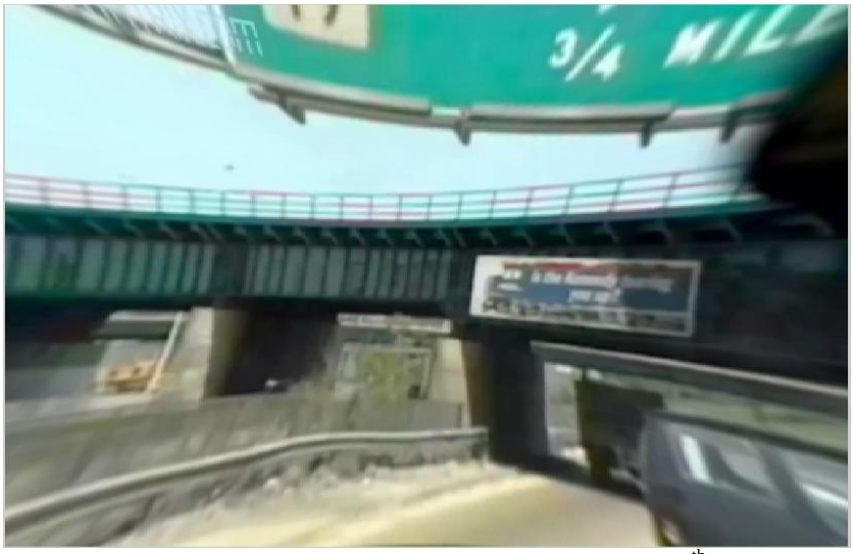

Fig.2 Original Watermarked Video's Frame Distorted by Rational 7^{th} Order Distortion

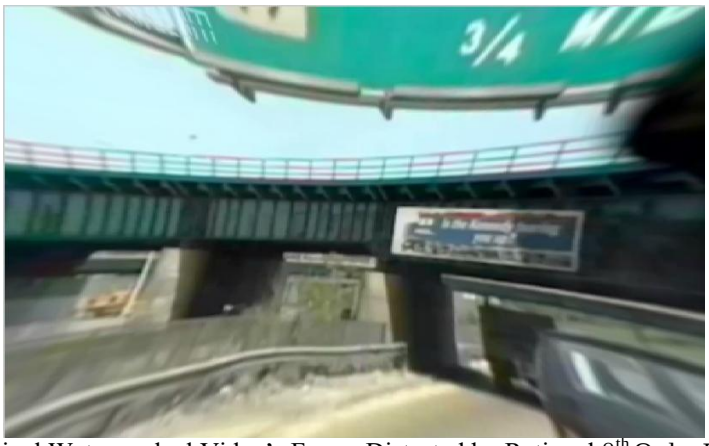

Fig.3 Original Watermarked Video's Frame Distorted by Rational 8th Order Distortion

The Fig. 1, 2, 3 represents the original and distorted watermarked video's frame. The watermark information may be destroyed from the distortion. That is a reason we have developed a new technique for distorted watermarked video.

IV. Methodology

In this paper, we are implementing the multiple techniques. The name of the implemented techniques is SS (Spread Spectrum), LSB (Least Significant Bit) and DWT (Discrete Wavelet Transform). We are also showing a block diagram of the proposed technique:

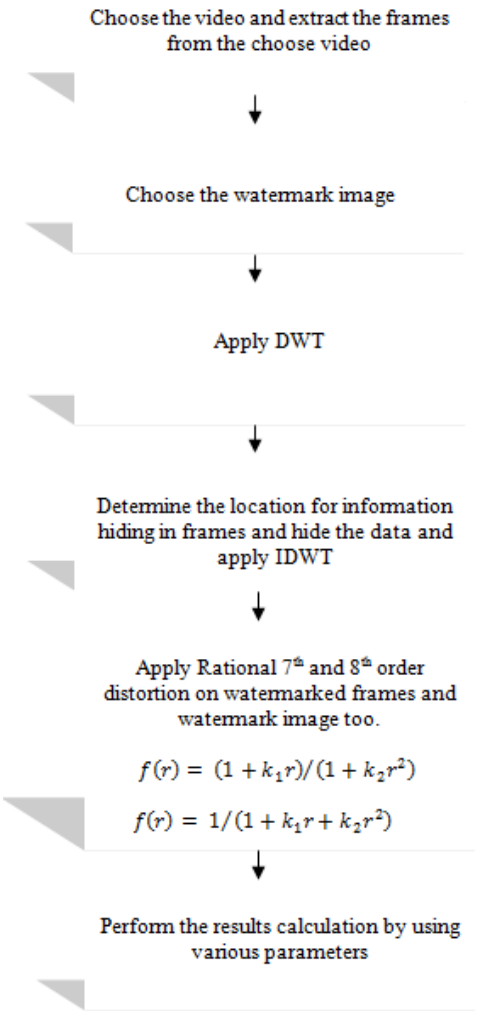

Fig.4 Block Diagram, of proposed work

1. In the first step we choose the video. After choosing the video we extract the frame from the video.
2. The second step is to select the watermark image.
3. The third step is to apply the DWT.
4. The fourth step is to determine the location of the original signal so we can easily hide the information. For this purpose, we are choosing the SS (Spread Spectrum) and LSB (Least Significant Bit) techniques and apply IDWT.
5. Apply rational 7th and 8th order distortions to the extracted frames, watermark image and watermarked embedded video. In order to apply the rational 7th and 8th distortion following formulation is used:

$$f(r) = (1 + k_1 r)/(1 + k_2 r^2) \quad \ldots (5)$$

$$f(r) = 1/(1 + k_1 r + k_2 r^2) \quad \ldots (6)$$

6. The last steps are to calculate the correlation, SSIM, BER, MSE and PSNR parameters.

These six steps are basically used in my proposed work. We are applying these steps for embedding the watermark information into the watermarked video and detect the watermark information from the distorted watermarked video.

V. Results and Experiments

In this paper, we are showing the results which one has been calculated. In my proposed work, we are working on the rational 7th and 8th order distortion model. We are also discussing five parameters. The five parameters are PSNR (Peak signal to noise ratio), SSIM (Structural similarity index measure), BER (Bit error rate), MSE (Mean square error) and correlation. Firstly, we are also finding the correlation and SSIM (Structural similarity index measure) for distorted watermarked video's frame. With the entropy factor we select the frames and embed the watermark information. If distortion is added into the watermarked frame then we are detecting the watermark information with the help of correlation and SSIM parameters.

We are working on the mobile video. The specification of the video is Number of Frames = 9290, Bits per Pixel = 24, Frame Rate = 28.9700, Height = 720, Width = 960, Video Format = RGB24.

We are choosing the 100 frames from the 9290 frames. After that we are finding the entropy of the 100 frames and selected 20 frames, which have a higher entropy value. Then we embed the hidden information into the 20 frames and add the distortion in to watermarked frame. At last we are finding out the hidden information from the distorted watermarked frame.

Table 1 Evaluation of two parameters by the addition of rational 7th order distortion model

RATIONAL 7th ORDER DISTORTION MODEL		
Frame Number	**SSIM**	**Correlation**
288	0.8553	0.9740
289	0.8537	0.9701
290	0.8505	0.9662
291	0.8352	0.9646
292	0.8334	0.9605
294	0.8303	0.9594
299	0.8185	0.9497
298	0.8154	0.9446
296	0.8054	0.9408
295	0.7962	0.9405
293	0.7893	0.9377
297	0.7784	0.9328
236	0.7756	0.9312
239	0.7736	0.9297
207	0.7685	0.9290
206	0.7654	0.9288
204	0.7633	0.9253
208	0.7623	0.9205
203	0.7501	0.9189
202	0.7393	0.9059

Note. SSIM= Structural similarity index measure

Table 2 Evaluation of three parameters by the addition of rational 7th order distortion model and show the relation between correlation and SSIM Note. PSNR= Peak signal to noise ratio, SSIM= Structural similarity index measure, BER= Bit error rate, MSE= Mean square error

RATIONAL 7th ORDER DISTORTION MODEL				
PSNR	**BER**	**MSE**	**SSIM**	**Correlation**
45.3505	0.0126	0.1926	0.8553	0.9740
47.1080	0.0125	0.1821	0.8537	0.9701
48.2880	0.0124	0.1715	0.8505	0.9662
48.4915	0.0123	0.1608	0.8352	0.9646
49.6214	0.0122	0.1502	0.8334	0.9605
49.7830	0.0121	0.1497	0.8303	0.9594
49.9847	0.0120	0.1391	0.8185	0.9497
50.4390	0.0119	0.1285	0.8154	0.9446
50.7559	0.0118	0.1178	0.8054	0.9408
51.4562	0.0117	0.0973	0.7962	0.9405
51.7780	0.0116	0.0967	0.7893	0.9377
52.4300	0.0115	0.0761	0.7784	0.9328
52.7830	0.0114	0.0655	0.7756	0.9312
53.3284	0.0109	0.0529	0.7736	0.9297
53.6019	0.0108	0.0449	0.7685	0.9290
54.4109	0.0107	0.0345	0.7654	0.9288
55.3015	0.0106	0.0258	0.7633	0.9253
56.5177	0.0103	0.0243	0.7623	0.9205
57.7247	0.0101	0.0165	0.7501	0.9189
63.8701	0.0093	0.0137	0.7393	0.9059

Table 3 Evaluation of two parameters by the addition of rational 8th order distortion model

RATIONAL 8th ORDER DISTORTION MODEL		
Frame Number	**SSIM**	**Correlation**
288	0.8641	0.9991
289	0.8559	0.9919
290	0.8542	0.9743
291	0.8431	0.9740
292	0.8348	0.9641
294	0.8300	0.9508
299	0.8267	0.9472
298	0.8211	0.9461
296	0.8122	0.9394
295	0.8041	0.9384
293	0.7959	0.9322
297	0.7816	0.9293
236	0.7763	0.9222
239	0.7709	0.9215
207	0.7703	0.919
206	0.7694	0.9157
204	0.7656	0.9140
208	0.7596	0.9090
203	0.7526	0.9039
202	0.7412	0.9008

Note. SSIM= Structural similarity index measure

Table 4 Evaluation of three parameters by the addition of rational 8th order distortion model and show the relation between correlation and SSIM

RATIONAL 8th ORDER DISTORTION MODEL				
PSNR	**BER**	**MSE**	**SSIM**	**Correlation**
45.7503	0.0129	0.1325	0.8641	0.9991
46.0082	0.0128	0.1223	0.8559	0.9919
47.2883	0.0120	0.1113	0.8542	0.9743
48.5914	0.0119	0.1108	0.8431	0.9740
48.9215	0.0118	0.1105	0.8348	0.9641
49.2836	0.0117	0.1096	0.8300	0.9508
50.6847	0.0116	0.0943	0.8267	0.9472
51.1393	0.0115	0.0863	0.8211	0.9461
52.6553	0.0114	0.0762	0.8122	0.9394
53.2565	0.0113	0.0655	0.8041	0.9384
53.9786	0.0112	0.0546	0.7959	0.9322
54.8304	0.0111	0.0478	0.7816	0.9293
54.8832	0.0108	0.0454	0.7763	0.9222
55.7281	0.0105	0.0323	0.7709	0.9215
56.1017	0.0103	0.0242	0.7703	0.919
57.0104	0.0102	0.0145	0.7694	0.9157
58.0013	0.0101	0.0126	0.7656	0.9140
59.3172	0.0099	0.0111	0.7596	0.9090
59.6246	0.0094	0.0036	0.7526	0.9039
64.3707	0.0092	0.0024	0.7412	0.9008

Note. PSNR= Peak signal to noise ratio, SSIM= Structural similarity index measure, BER= Bit error rate, MSE= Mean square error

We are calculating the correlation and SSIM. We are displaying the relationship between the BER, MSE, and PSNR with correlation and SSIM.

VI. Conclusion

From the results we have concluded that the distortion can occur due to the transmission media, hackers viruses etc. So we have a duty to protect the watermark information from the distorted watermarked video's frame. We have made a new watermarking technology and also making new methods for detection watermark information. The performance of the watermarked video can be measured in the form of SSIM, BER, MSE, PSNR and correlation. We can do further enhancement by working along the various rational order models. In this paper, we are studying only rational 7th and 8th order distortion model. With the implementation of all the rational order models we can increase efficiency the system.

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