SIGNIFICANCE OF RATIONAL 6TH ORDER DISTORTION MODEL IN THE FIELD OF MOBILE'S VIDEO DIGITAL WATERMARKING

Yogesh Verma[1] and Manjit Singh[2]
[1]Electronics and Communication Engineering
Guru Nanak Dev University Regional Campus, Jalandhar City, India
[2]Electronics and Communication Engineering
Guru Nanak Dev University Regional Campus, Jalandhar City, India

ABSTRACT

As the time passed, multiple techniques have been proposed on the invisible video watermarking. Watermarking basically means to hide the information into many multiple objects. If the object is video then the name given to this technique is video watermarking. The information which is hidden in the object and isn't seen by anyone then it is called as an invisible watermarking. In this paper, we are using the LSB, SS (Spread Spectrum) and DWT technique for embedding the information into the video and also work on the rational distortion. Today distortion is the biggest problem. This distortion can be destroyed the hide information. The reason of distortion is transmission channel, hackers, viruses etc. In my proposed work, we are working on the rational 6th order model distortion. We are finding the PSNR, SSIM (Structural similarity index measure), Correlation, BER (Bit Error Rate), MSE (Mean Square Error) parameters for the distorted watermarked video and also detects the watermark (hide) information from the distorted watermarked video.

KEYWORDS: *Video watermarking, rational distortion, Correlation, SSIM, MSE, BER*

I. INTRODUCTION

Today area of the multimedia services is totally spread out, but the security of the services is the biggest problem. Today, protecting of the multimedia services is not an easy task. At recent times multiple hackers are present in our surrounding. They can hack the authorized user's multimedia data [1]. For security from the hacker, we will increase the security level. Invisible watermark technology has been invented while increasing the safety level. This technique provides the robustness and imperceptibility. In digital watermarking, we can hide the watermark information in every multimedia objects like image, audio, video etc. With the help of digital watermarking, we can provide the protection, security to the users [1 2]. In the case of duplication, watermark information is basically used to provide the designation to the users. In the watermarking methods, researchers are using the spatial as well as frequency domain for embedding the information. The spatial domain is so simple technique for embedding the watermark information, but it provides the bounded robustness [2]. The frequency domain is so effective techniques as compare to the spatial domain. In spatial domain LSB (Least Significant Bit), SS (Spread Spectrum) are the techniques which one is used for the purpose of watermarking and in frequency domain DCT and DWT are more preferable. In this paper, we are working on the invisible watermarking. Video watermark perceptibility is split into two parts. One is a visible and another is an invisible watermark. Visible watermarking is that type of the watermarking where we can see the watermark information, but in the invisible watermarking technique the watermark information should not be seen by any third party users. So, invisible watermarking has more responsibility towards the authorized users [3]. In my proposed work, we are using the spatial as

well as frequency/wavelet domain for the embedding the watermark information and also work on the rational 6th order model. When we are using the multimedia services, then its transfer from one place to another at that time the distortion can be added. This distortion is so dangerous for the watermark information. This type of distortion can damage the watermark/hidden information. The loss of watermark information is not good for the authorized users. Firstly, we have selected the video for watermarking then we extract the frame from the video. Video are made of the number of frames. After extraction of the frame we have to need that type of the frame which has a high randomness. So acquire the randomness of the frame we find out the entropy. After finding out the entropy we select the highest entropy frame. The high entropy frame is the need for the robustness watermarking. After that we are applying spatial as well as the frequency domain technique for embedding the data. We are applying the spread spectrum technique for finding the location of pixel value of the original video then we are applying the LSB (Least Significant Bit) for an exchange the watermark as well as original pixel value. These all techniques are lies in the spatial domain [4-7]. After that we are using the frequency/wavelet domain for the decomposition of the frames into LL, LH, HL, HH components. The LL components are highly informative component. So it is used for the watermarking process. The watermark information is embedded into the LL component after location finding and exchanging the pixel value. At last we are applying the IDWT to recover the watermarked frame [8].
In this paper, we are also working on the single distortion model. The name of this distortion is rational 6th order distortion model. The standard lens distortion model equation is shown below:

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

(x,y) is the distorted point, $(\hat{x}, \hat{y})$ is the undistorted point, (x_c,y_c) is the core spot of the distortion model, f (r) is the function which basically indicates the configuration of the distortion model. k is the deformation parameter.
Granting to the function of f (r) we deliver to divide lens distortion models. One is polynomial model and the second is division model. We are molding on the polynomial model. Its function value f(r) is different for the division model [9-13].

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

This is the equation of the rational 6th order model. Where r is

$$r = \sqrt{(x - x_c)^2 + (y - y_c)^2} \quad \ldots (3)$$

II. RELATED WORK

In my paper, we are working on the spatial as well as a frequency / wavelet domain for embedding the watermark information. To know about the rational distortion we are reading Chern Sheng Lin et al [14], (2008) an automatic measuring system is proposed for lens distortion in this paper. The system contains a screen showing reticle-type target moving inward automatically and a camera to capture the image used for analysis. In this research, a new computation method of reticle positioning with linear regressions is used. In the procedure of compensation, we cancel the points of large deviation, and then convert the original sampling point coordinates from a vertical sampling point group to a horizontal one with a 90 rotation around the original point. The results of experiments, including system calibration, alignment calculation, mark locations, and statistical functions of inspection are presented and evaluated. The swiftness and accurateness of this imaging system are maintained by the available experimental observations. We are also studying the Malvar H. S et al, [5], (2003) this paper represents a new technique of watermarking modulation, which we call Improved Spread Spectrum (ISS). In comparison with traditional spread spectrum (SS), the signal does not act as a source of noise, leading to noteworthy gains. In some examples, performance enhancements over SS are 20 dB in signal-to-noise ratio (SNR) or ten or more orders of magnitude in the probability of error. The proposed approach accomplishes roughly the same noise robustness gain as Quantization Index Modulation (QIM) but without the amplitude scale sensitivity of QIM. In practice, the proposed ISS is

as robust as traditional SS. From this paper, we know about the spread spectrum technique. We are getting the information about the DWT technique from the Yang Y.et al paper. Yang Y.et al., [15], (2016) Zero-watermark technique has been applied broadly for copyright protection of images. This paper presents an audio zero-watermark scheme which is based on energy relationship between adjacent audio fragments. It gets power approximations, or energies, of audio segments by taking use of discrete wavelet transform (DWT). Then, it extracts the audio profile, i.e. the zero-water mark, according to the comparative size of the energies of consecutive sections. The results of this experiment represent that the proposed scheme is robust against common malicious attacks including noise addition, re sampling, low-pass filtering, etc., and this approach efficiently resolves the inconsistency between inaudibility and robustness. The basic information about the embedding the watermark data is given by A. Agrawal et al. [16], (2014), In the world of internet, we are using multiple applications which are used for communication, also for sharing images, audios and videos regularly in the friends group or in the social community. Therefore, our prime objective of the paper is to analyze and study various techniques in order to secure video files, so that the video will be sent securely and the data will be protected from any unauthorized or illegal access. Thus, we study and discuss in this direction and also propose some suggestions for future. In my proposed work, these are the very crucial papers for acquiring the knowledge about the watermarking techniques.

III. PROPOSED WATERMARKING TECHNIQUES

In my proposed work we are working on the spatial as well as frequency domain. Spread spectrum is basically used to find out the location of the pixel value of the original frame. With this technique we can know about the position of the pixel where we embed the information. After that we are switching over the LSB technique. This technique is very simple technique in the spatial domain. So with the help of this technique we are exchanging the pixel value in between the original and watermark information. At last we are applying the DWT technique. In DWT, we also compress the frames and also use for embedding the watermark information.

After embedding the watermark we add the rational 6^{th} order distortion model on the watermarked video and then work on it. This type of distortion may be damaging the watermark information. This distortion occurs due to many reasons. Hackers can add this type of distortion to remove the watermark information. At the transmission channel this type of distortions can add. The effects of lenses can also add this type of distortion in the watermarked video. So security of the watermark information is so necessary for the authorized users.

We are also showing the effects of this distortion model in the watermarked video's frame.

Figure 1. Original Watermarked Video's Frame

Figure 2. Original Watermarked Video's Frame Distorted by Rational 6th Order Distortion

This represents the distortion of the original watermarked video's frame. This distortion may be damaging the watermarked frame's information. So this is not good for the authorized users. That is a reason we have done work on the rational 6th order distortion model.

IV. METHODOLOGY

In my proposed work we are working on the multiple techniques. The technique is used in my proposed work is SS (Spread Spectrum), LSB (Least Significant Bit) and DWT (Discrete Wavelet Transform) for embedding the information. All the steps are shown in the block diagram.

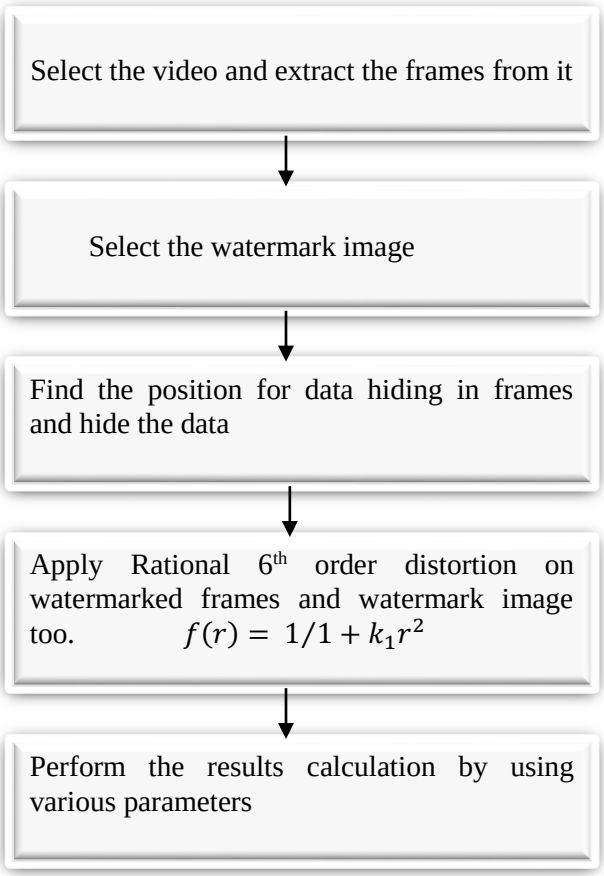

Figure 3. Block Diagram, of proposed work

i. Select the video from the database and abstract the frames from the video in order to hide the data behind them.
ii. Select the watermark in the form of digital image.

iii. Apply DWT and find the appropriate position for hiding the data by using the spread spectrum technique and correspondingly hide the data at the location by using the least significant bit technique for data hiding and last apply IDWT.

iv. Apply rational 6th order distortions to the extracted frames, watermark image and watermarked embedded video. In order to apply the rational 6th distortion following formulation is used:

$$f(r) = 1/1 + k_1 r^2 \quad \ldots (4)$$

v. Calculate proficiency of the work by performing results evaluation on the basis of performance parameters.

These five steps are used in my proposed work for detection of the watermark information from the watermarked video. The distortion is basically used is rational 6th order distortion.

V. RESULTS AND EXPERIMENTS

In this segment, we are discussing all results which have been evaluated. In this paper, we are working on the rational 6th order model. We are discussing the PSNR, BER, MSE, correlation and SSIM parameters. The results are obtained on the basis of the five parameters. Firstly, we are finding the correlation and SSIM to detect the watermarked information from the distorted watermarked video.

The correlation and SSIM parameters are basically used to find out the watermark information. Both parameter values lie in between the 0 and 1. If the value is near about 0.7 to 0.9 the we can say that the watermark is present. If the value of both parameters is low. It means we are not confirming about the presence of the watermark. So both these parameters are used to find the watermark information.

In this paper, we are using the mobile video. The video configuration is shown below:

Number of Frames = 9391, Bits per Pixel = 24, Frame Rate = 29.9700, Height = 720, Width = 960, Video Format = RGB24. In these segments we are making a table for every result. Now, we have to find Correlation, SSIM of the distorted watermarked video. After find out these results we are finding out the BER (Bit Error Rate), MSE (Mean Square Error) and PSNR (Peak Signal to Noise Ratio). These all parameters are using for the detection of the watermark information. PSNR basically used for finding the quality of the signal. If the value of the PSNR is high it means the signal quality is more. If the value of the PSNR is low then signal quality is low. The PSNR parameter is totally inverse of the BER and MSE.

If the BER and MSE is high we can say that the signal has very low similarity of the signal, but if the value of the BER and MSE is low then similarity of the signal is also less. So we are finding the all parameters to detect the watermark information and also detect the quality of the signal of the distorted watermarked video. There are different-2 mathematical formulations for all the parameters. To find out the all parameters we firstly know about the mathematical formulation. We are making a table for detection of watermark information in particular frame value and also finding out the relationship between the all parameters.

We are firstly finding the highly entropy frame. The value of the correlation and SSIM of higher entropy distorted watermarked video is shown in the table:

Table 1. Evaluation of two parameters by the addition of rational 6th order distortion model

RATIONAL 6th ORDER DISTORTION MODEL		
Frame Number	**SSIM**	**Correlation**
288	0.8557	0.9955
289	0.8532	0.9845
290	0.8501	0.9778
291	0.8350	0.9720
292	0.8336	0.9660
294	0.8302	0.9613

299	0.8184	0.9602
298	0.8150	0.9546
296	0.8058	0.9417
295	0.7967	0.9415
293	0.7894	0.9330
297	0.7786	0.9326
236	0.7751	0.9315
239	0.7738	0.9308
207	0.7686	0.9289
206	0.7652	0.9233
204	0.7632	0.9174
208	0.7629	0.9147
203	0.7509	0.9143
202	0.7396	0.9139

Note. SSIM= Structural similarity index measure

We are detecting the watermark information from the distorted watermarked video with the help of the correlation and SSIM parameters. We are also finding the PSNR, BER, MSE and show the relationship between the correlation and SSIM

Table 2. Evaluation of three parameters by the addition of rational 6th order distortion model and show the relation between correlation and SSIM

RATIONAL 6th ORDER DISTORTION MODEL				
PSNR	**BER**	**MSE**	**SSIM**	**Correlation**
47.7505	0.0124	0.1626	0.8557	0.9955
48.0080	0.0123	0.1521	0.8532	0.9845
48.2880	0.0123	0.1415	0.8501	0.9778
48.5915	0.0122	0.1308	0.8350	0.9720
48.9214	0.0121	0.1202	0.8336	0.9660
49.2830	0.0120	0.1097	0.8302	0.9613
49.6847	0.0119	0.0991	0.8184	0.9602
50.1390	0.0118	0.0885	0.8150	0.9546
50.6559	0.0117	0.0778	0.8058	0.9417
51.2562	0.0116	0.0673	0.7967	0.9415
51.9780	0.0115	0.0567	0.7894	0.9330
52.8300	0.0113	0.0461	0.7786	0.9326
52.8830	0.0111	0.0355	0.7751	0.9315
53.7284	0.0108	0.0329	0.7738	0.9308
54.1019	0.0105	0.0249	0.7686	0.9289
55.0109	0.0104	0.0245	0.7652	0.9233
56.0015	0.0104	0.0158	0.7632	0.9174
57.3177	0.0101	0.0143	0.7629	0.9147
59.6247	0.0096	0.0065	0.7509	0.9143
63.3701	0.0096	0.0037	0.7396	0.9139

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

We are holding 100 frames from the video. We have chosen only 20 frames. The entropy factor decides about selection of frames and after selection we can embed the watermark information. The 288 number has a higher entropy value frame and the 202 number has lowest entropy value frame. After addition of rational 6th order distortion into the watermarked video's frame and watermark image we are finding the correlation and SSIM. We are showing the relationship between the BER, MSE with correlation and SSIM.

VI. CONCLUSIONS

We have concluded that the multiple distortions can be occurred on the watermarked video. To overcome from this type of distortion we have been making a new watermarking technique which one is so effective at that type of distortion. With the help of this rational 6^{th} order distortion model we can solve this problem and easily detect the watermark information. The results are performed in the form of SSIM, BER, MSE, PSNR and correlation. We can do further enhancement by working on the various rational order models. In this paper, we are studying only rational 6^{th} order distortion model. With the implementation of all the rational order models we can increase efficiency the system.

VII. FUTURE SCOPE

Further enhancements can be done by applying various distortion models as this study implements Barrel distortion model, Division distortion model and Rational distortion model. Along with the distortion model any trending or most prominent technique for data hiding can also be considered in the near future in order to enhance the reliability and efficiency of the system.

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AUTHORS BIOGRAPHY

Yogesh Verma received the Bachelor in Electronics and Communication degree under Punjab Technical University, Punjab, india in 2009. He worked as Assistant Professor at Ramgarhia Polytechnic College Phagwara for two year. Currently pursuing Master's degree in the Electronics and Communication under Guru Nanak Dev University Regional Campus Jalandhar, Punjab, India. His research interests include image and video watermarking and fingerprinting, error of the concealment methods, information security, multimedia signal processing and network security.

Manjit Singh received his bachelor degree in Electronics Engineering from Baba Banda Singh College of Engineering Fatehgarh Sahib, Punjab, India in 1998, and Master's Degree in Electronics and communication Engineering from National Institute of Technical Teacher Training and Research, Chandigarh, India in 2010. Currently he is pursuing his Ph.D. Degree from Punjab Technical University Jalandhar, Punjab, India. He is working as Assistant Professor at Guru Nanak Dev University Regional Campus Jalandhar, Punjab, India. His research interest is in the area of biomedical signal processing.