Implementation the Effects of Barrel Distortion in field of Digital Video Watermarking

Yogesh Verma
M.Tech Student of Electronics and Communication Engineering
Guru Nanak Dev University Regional Campus, Jalandhar City, India
Phone no: +91-9463604258

Manjit Singh
Faculty of Electronics and Communication Engineering
Guru Nanak Dev University Regional Campus, Jalandhar City, India
Phone no: +91-9417609578

***ABSTRACT*-The field of internet is booming day by day.The elaboration of the internet facility causes theunlimited growth of the digital data(image/audio/video). This digital data (image/audio/video) are commonly used by public without any restriction. With the increasing demand for digital data, security, copyright protection of the digital data (image/audio/video) is very big concern.To remove such types of issues the concept of watermarking is created.Watermarking simply means to insert any type of information in the digital data (image/audio/video). As time passed, many issues were encountered. One of the biggest issues faces by the users at receiver end is distortion. Distortion is happening due to many reasons such as a transmission channel etc.Because of this distortion we can not detect watermark information from the digital data. In order to solve this issue the distortion model is also introduced. This study provides a mechanism to detect the watermark from the distorted video by using barrel distortion model. In this paper, weonly work on the barrel distortion model. We are finding the correlation and SSIM (Structural Similarity Index Measures) parameters and detect the watermark signal from the distorted watermarked signal. We are also showing the relationship between, the correlation and similarity index with BER and MSE.**

***Index Terms*—Video watermarking, barrel distortion, correlation, SSIM, MSE, BER**

1) INTRODUCTION

Watermarking procedure is an exacting personification of multimedia precautions [1]. A Digital Watermark is a digital signal or sample interleaved into a digital data, which can also be referred to as a digital mark. Watermarking is a key procedure in the safety of patent rights of electronic data, together with an illustration, videos, auditory, etc. [2 3]. The phrase watermarking arrives from the imperceptible ink used to mark covert messages [56]. Watermarking has the supplementary constraint of forcefulness. Still, if it is recognized that a watermark subsists, as is the case in unrestricted watermarking proposals, it should be perfectly impractical for an attacker to eradicate the embedded watermark [7]. There should be no technique of eliminating the embedded information without representation the wrap object impracticable [8]. Normally, the watermark has three dissimilar properties unnoticeable, indissoluble from the works, and endures the identical alteration as the work. A simple watermarking scheme is shown in Fig. 1.

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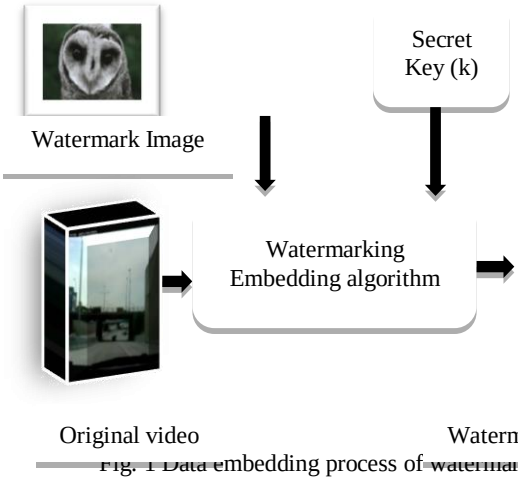

Fig. 1 Data embedding process of watermarking

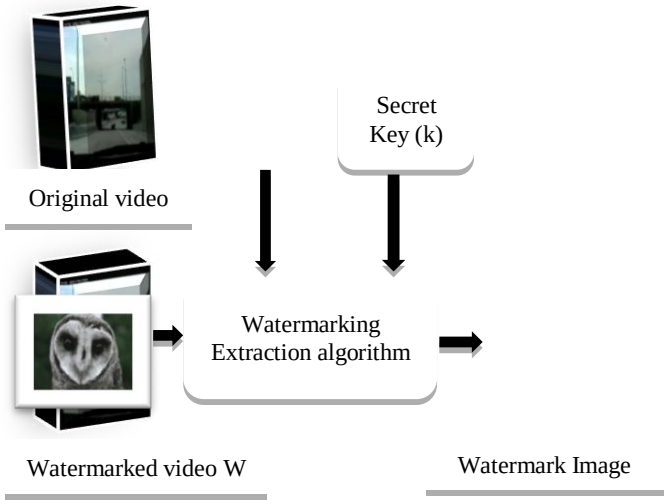

Fig. 2 Data extraction process of watermarking

In the watermarking embedding process, we have to require the secret key for embedding the watermark information. This information is in any form like logo, image, text etc. The secret key kwhich is used at the time of embedding that same secret key k is used for extracting the watermark image.This watermark image provides the security, copyright protectionand privacy control etc. Lots of information we are acquired from the internet in the form of text, image, audio and video. The every information which is present on the internet is transferred from one end to another end.

The information on the internet can be influenced by the distortion. This transmission channel/media causes for the distortion. The distortion may be occurred at the receiver end. The distortion decreases the quality of the video and

can damage the watermark information. In this paper, we are embedding the watermark information into the video and add the barrel distortion factor on the video and then find out the watermark information with the help of correlation and Structural similarity index. We are also showing the graphical representation between the all parameters.

I. Barrel distortion

Barrel distortion is a type of the radial distortion. In the barrel distortion, focus point shifts from its focal point to the center of the image [10]. Another name of the barrel distortion is negative displacement distortion. This type of the distortion present in case of wide angle lenses.

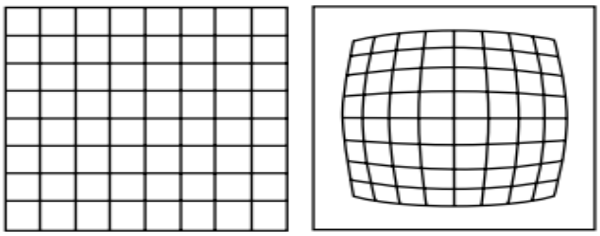

Fig. 3 Original video frame and the effect of barrel (center) [11]

Theexaggeration of the focal point reduced with the lengthwise distance which leads to the movement of the focal points radially towards the center of the frame [12]. This effect is known as barrel distortion. In the Fig. 3 depicts the frame of the video which is defected by the barrel distortion. We also show the live video frame which isaffected by the barrel distortion.

Fig. 4 Original watermarked video frame and show the effect of barrel distortion on this frame

The barrel distortion model was given by the Taylor expansion as shown in equation below:

$$\dot{r} = r(1 + k_1 r^2 + k_2 r^4 + \cdots + k_i r^{2i} + \cdots) \quad \ldots (1)$$

Here in equation (1),

$\dot{r}$; depicts the distance from center of distortion in the undistorted image.
r; depicts the distance from the center of the distortion in the distorted image.
$k_1$is a coefficient used for expressing the value of radial distortion.

$$\dot{r} = r(1 + k_1 r^2 + k_2 r^4) \quad \ldots (2)$$

The equation (2) determines the polynomial equation with two coefficients used for the barrel distortion in the case of wide angle lenses.

2) PROBLEM FORMULATION

With the largest growth of technology, we shuffle the multimedia digital devices. The newest devices replaced the oldest devices like the landline phone replace by the mobile. In recent times mobile is not only used for communication. Nowadays we can do multiple things in the mobile. We can see the videos, clicking the images, transfer the multimedia objects (image/audio/video) etc. When we acquire the video from the internet or other sources in the mobile and then we play that video. The mobile screen is small as compare to other devices like laptop, television etc. The small screen may cause the bad effects (attacks, distortion) on the video. Mobile needs to adjust the pixels or visibilities of the frame according to the size of the screen. This cause the distortion of the video and this distortion may affect the watermark signal.
If the watermark signal will damage from the video then the authorized user may lose the copyright on this video. The effect of the distortion could be given the stress to authorized users. To overcome this problem multiple provisions come and it gives the solution of this problem. But the lacking point of those methods was that the main focus was to prevent the video from attacks only whereas distortion factor were avoided. Hence there is a requirement to develop such a method which can detect the barrel distortion and also works on the basis of other parameters excepting correlation.

3) PROPOSED WORK

On the basis of the drawbacks that were defined in the previous section, the proposed work focuses to prevent the watermark in the video from getting destroyed. The focus is on removing the barrel distortion. The process of embedding the watermark is done by applying DWT technique. The objective of the proposed technique is to work upon the basis of four parameters i.e. correlation, BER, MSE and similarity Index.
In this paper, we have to detect the watermark information from the distorted video. We only work on barrel distortion.

I. TECHNIQUE USED

Techniques that are used by the proposed work to detect the watermark from the distorted video are as follows:

a) DWT (DISCRETE WAVELET TRANSFORM)

This technique is comes under transform domain. The transformations are based on small waves namely wavelet. In this paper we are using the haar mother wavelet. This transform gives the information about the signal in frequency as well as time domain [13]. With the help of this technique we are getting the four components. These components are LL, LH, HL and HH. The maximum information is lying in the LL components. LL is anapproximation, LH isa vertical, HLis a horizontal and HH is adiagonal signal [14]. In this paper, we have to choose 2-level DWT. After embedding the watermark information we apply IDWT.

Fig. 5 1, 2-level DWT Decompositions

b) SPREAD SPECTRUM TECHNIQUE AND LSB (LEAST SIGNIFICANT BIT)

This technique is comes under spatial domain. With the help of spread spectrum technique we spread the secret/hidden data/information over the wide frequency bandwidth. The spread spectrum helps to find out the location where you want to hide the information. We are using the spread spectrum technique because the SNR ratio in every frequency is very small [15]. The noise in the signal is too high due to which it is unable for anyone to detect the presence of data. If some of the data/information parts are removed from several bands, but still enough information is present on other bands in order to recover the data [16]. So this technique so helpful for finding out the randomize location of the video's frame where you cover the information [17]. Consequently, it is a robust technique mostly used in military communication.After finding the location we are using another spatial domain method. In this method least significant bit of image pixel has replaced with the bit of secret data. Thus embedding has done like this with the whole data and acquired image looks similar to the original image as LSB does not make a huge difference in the image [18].

Now with the help all techniques we are embedding the watermark information into the video's frame.

4) METHODOLOGY

The research work is related to detecting the watermark from the distorted video and the techniques used for this purpose has discussed. The step by step procedure of the proposed work is defined as below:

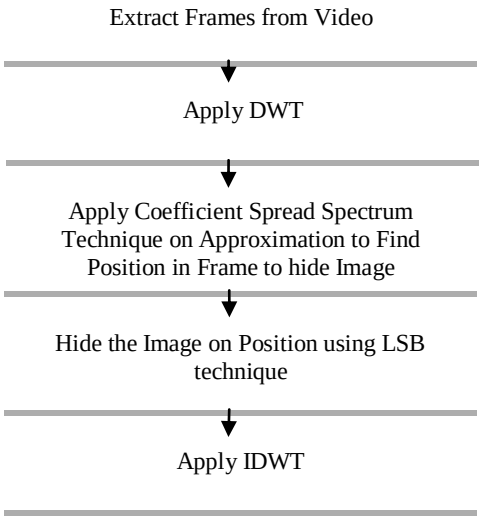

Fig. 6 Block diagram for embedding the watermark.

i. First of all, for embedding the data behind the image there is a need to extract the frames from the video.
ii. The next step is to apply the Discrete Wavelet Transform (DWT) to the frames
iii. After applying DWT next step is to employ the spread spectrum approximation coefficient to find or to locate the location in the frames in order to hide the image.
iv. Now apply LSB mechanism for hiding the data behind the cover image at the proposer positions which were located in the step before.
v. The next step to apply Inverse of DWT to the frames.

These 5 steps are only used for embedding the watermark. The procedure for embedding the distortion and detection of watermark into the distorted watermarked signal is written in steps.

i. Initially there is a need to select the video for hiding the data.
ii. In a second step the frames from the video will be extracted so that the data can be added to them.

iii. Next step is to select the image from the database which will act as the watermark image.
iv. In this step the location will be found out which will be used for hiding the data. The location will be detected by using the spread spectrum technique.
v. After locating the position for hiding the data, the next step is to hide the data by using the least significant bit technique of data hiding.
vi. Now apply barrel distortion to the embedded video. The equation for the barrel distortion is as follows:

$$\dot{r} = r(1 + k_1 r^2 + k_2 r^4) \quad \ldots (3)$$

vii. Similarly apply barrel distortion to the watermarked image also.
viii. Now evaluate the results and perform the performance evaluation by using various parameters.

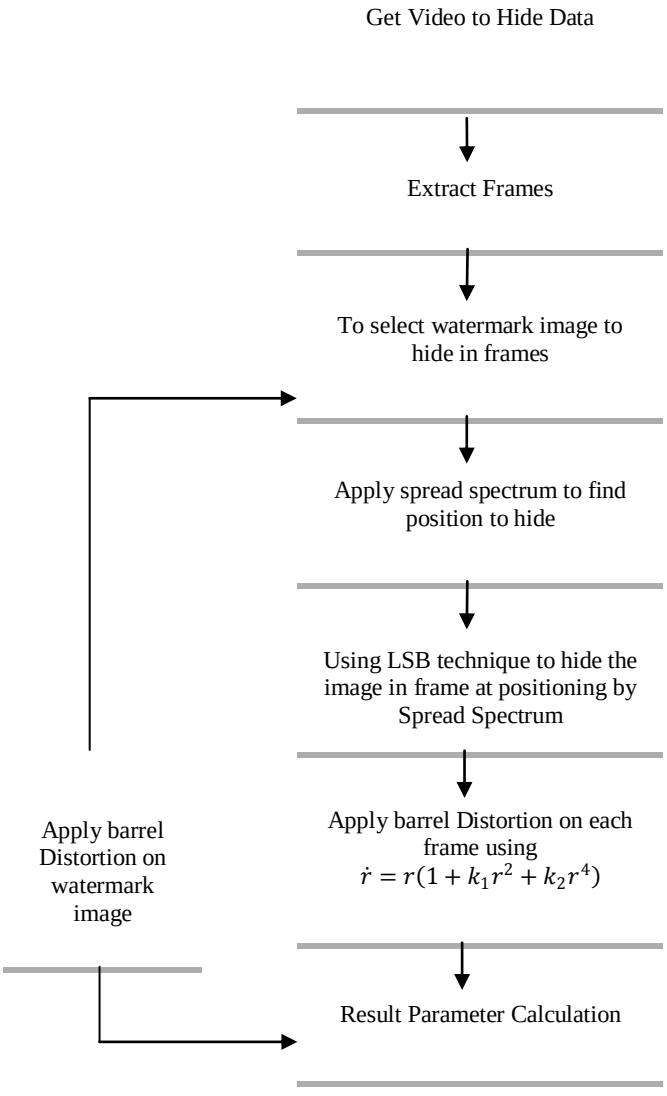

Fig. 7 Block diagram for embedding barrel distortion

5) RESULTS AND EXPERIMENTS

In this segment we are getting the results after the implementation of the proposed work. We are basically working on video watermarkingand the main aim to prevent the watermark in the video from getting destroyed. The proposed work comprises of DWT technique in order to work upon the barrel distortion model.
The results are obtained on the basis of four parameters as:

I. SSIM (Structural Similarity Index Measures)

To acquire the similarity between the two digital data (images/video), this parameter is basically used. We have to measure the value of SSIM and if its value comes high then we can say content of two digital data is same.In order to evaluate the SSIM the following equation is used.

$$SSIM(x, y) = \frac{\left(2_{\mu_x \mu_y} + c_1\right)\left(2\sigma_{xy} + c_2\right)}{\left(\mu_x^2 + \mu_y^2 + c_1\right)\left(\sigma_x^2 + \sigma_y^2 + c_2\right)} \quad \ldots (4)$$

II. Correlation

With the help of this parameter we are finding out correlation between the distorted watermarked video and distorted watermark information. The value of the correlation should be high.

III. BER (Bit Error Rate)

Bit Error Rate is a parameter which is used to evaluate the bitwise error in the output. It is measured as follows:

$$BER = \sqrt{E_b / N} \quad \ldots (5)$$

IV. MSE (Mean Square Error)

The mean square error is measured between the original and watermarked image. If the MSE value is low, then similarity between the original and watermarked image is more. It means more similarity occurs in between the original and watermarked image. If the MSE value is zero, then it shows more similarity between the images and if the MSE value is one then it shows the dissimilarity between the images.

These parameters are basically used to detect the watermark information into the distorted watermarked video. We are also presenting the graphical representation of correlation vs

BER, correlation vs MSE, SSIM vs BER and SSIM vs MSE.

Table 1 Evaluation of two parameters by the addition of barrel distortion model

BARREL DISTORTION		
Frame Number	**Correlation**	**SSIM**
288	0.9956	0.9747
289	0.9950	0.9717
290	0.9908	0.9686
291	0.9880	0.9680
292	0.9808	0.9656
294	0.9798	0.9650
299	0.9711	0.9292
298	0.9693	0.9272
296	0.9692	0.9243
295	0.9624	0.9205
293	0.9615	0.9193
297	0.9583	0.9178
236	0.9560	0.9175
239	0.9393	0.9173
207	0.9268	0.9164
206	0.9221	0.9141
204	0.9053	0.9140
208	0.9033	0.9130
203	0.9026	0.9072
202	0.9024	0.8948

Note. SSIM= Structural similarity index measure

In this paper, we are using the video. The video specification is Number of Frames = 9391, Bits per Pixel = 24, Frame Rate = 29.9700, Height = 720, Width = 960, Video Format = RGB24.

We are taking 100 frames from the video. After extraction of the frame we have selected the 20 frames. Selection of 20 frames out of 100 is totally depending upon the entropy factor and then embeds the watermark information into the selected frame. The 288 frame number has highest entropy value and the 202 frame number has lowest entropy value. After addition of barrel 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.

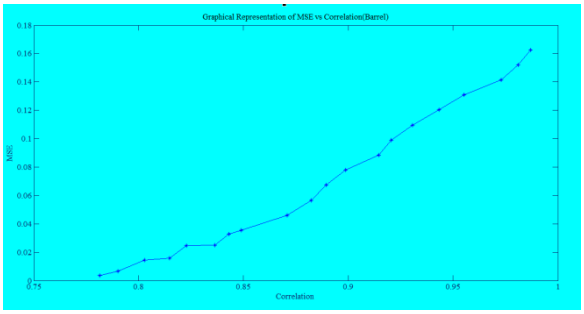

Fig. 8 Graphs for Correlation on the basis of MSE in proposed work

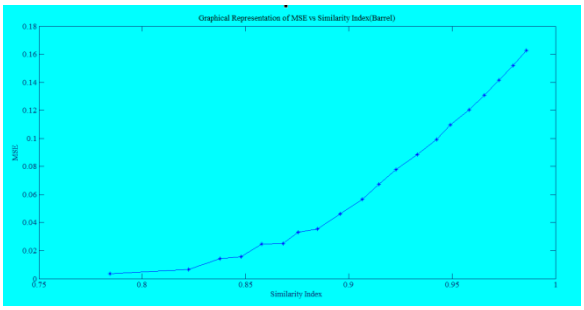

Fig. 9 Graphs for SSIM on the basis of MSE in proposed work

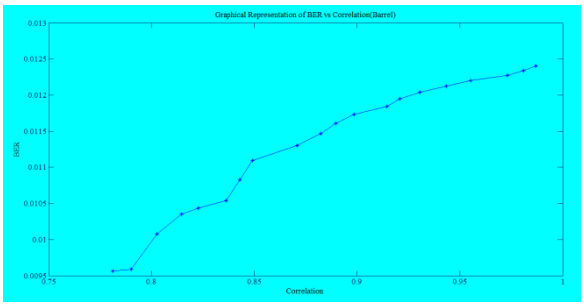

Fig. 10 Graphs for Correlation on the basis of BER in proposed work

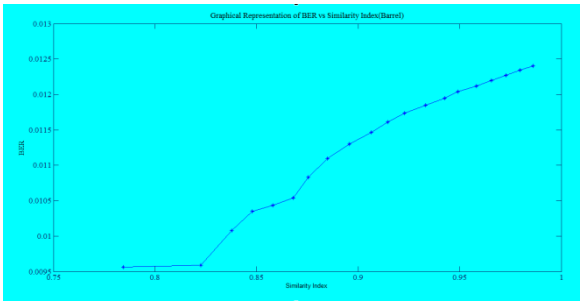

Fig. 11 Graphs for SSIM on the basis of BER in proposed work

The correlation between barrel distorted watermark image and distorted watermarked video's frame is used to finding the watermark robustness. PSNR [19 20] between original and watermarked image is used to finding the watermark imperceptibility. With the help of PSNR we can find out the BER, MSE. Watermark imperceptibility is controlled by the factor α . We are shown the relationship between watermark imperceptibility and watermark robustness.

6) CONCLUSION

We have concluded that the watermarked data (image/audio/video) are transmitted over the media. The distortion may be occurred on the watermarked video due to the unwanted effects. With the help of this study, we are detecting the watermark from the distorted video and the simulated results are performed in terms of SSIM, BER, MSE and correlation. Further enhancements can be done by applying various distortion models. In this paper, we are studying the implementation of Barrel distortion model only. 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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