

Execution of the Barrel Distortion in Mobile Video for Gaining Robust Watermarking

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ABSTRACT: In recent times camera plays a crucial part in multiple fields like image processing system, mobile technology, medical imaging system etc. Sometimes a distortion may occur while capturing the pictures/videos. The name applied to this distortion is called lens distortion. Nowadays lenses are applied in diverse fields like HMD (head mounted display), telescopes etc. HMD (head mounted display) devices are ordinarily applied for multiple purposes like gaming, engineering, video, sports and so on. The pincushion distortion can be occurred at HMD devices. To invalidate out the pincushion distortion we have to use the barrel distortion. The image which is presented along the mobile display is covered with barrel distortion. By covering the barrel distortion we can remove the pincushion distortion of the HMD devices. In this paper, we are working on robust watermarking. Watermark image implanting into the original video's frame with the scrutiny and attention of imperceptibility and robustness. We are also detecting the watermark information from the distorted watermarked video. The distortion is present at watermarked video is barrel distortion. For the detection of the watermark information from the distorted watermarked video we have found a novel technique. This technique is also helpful for removing the distortion into the HMD devices. We are also presenting the graphical representation of correlation and Structural Similarity Index parameters with PSNR for detection the watermark information from the distorted watermarked video.

KEYWORDS: Mobile video, Robust watermarking, HMD with mobile, correlation, SSIM

I. INTRODUCTION

Nowadays everyone wants to acquire a speedy internet connection. This speedy connection will provide the image/audio/video contents and services [1-5]. At present time everyone wants to get the new devices like which has a good quality display, not more expensive and easily comfortable with mobile devices. Keeping the people's interest in mind, new devices have been produced. The one name of the new device is HMD devices. The principal characteristics of these devices are to provide effective quality display [6]. In HMD devices, mobile is present very near to the optic. The lenses which are fundamentally used in HMD devices are wide angle lenses. The lenses cause for the pincushion distortion into the video for spectators. The pincushion is a sort of positive displacement [7]. To invalidate the pincushion distortion we are adding the barrel distortion into the video in advance. This addition of barrel distortion may cause the multiple issues like copyright protection, content's security, etc. In HMD devices we can remove the distortion with the help of barrel distortion, but it creates many problems for authorized users. In summation of this distortion we can lose the watermark data from the original image. In this paper, we are also canceling the pincushion distortion with the help of barrel distortion as well as also detect the watermark information from distorted watermarked video.

Watermarking is a method to which we are implanting the watermark information (logo/image/text) into the original signal (image/audio/video). In video watermarking original signal is in the form of video [8-10]. Imperceptibility and

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robustness are the primary characteristics of the digital watermarking. While watermarking these two factors are kept in mind. The watermark has also been affected by the attacks. These attacks are divided into two parts. One is signal processing and the second is a de-synchronization attacks. Because of lowpass filtering, JPEG compression etc. signal processing attacks occur and de-synchronization attacks occur due to scaling, rotation, etc. These attacks have also affected the watermark information. Recently, newer types of de-synchronization attacks have been brought out to remove the watermark information from the watermarked video. The main cause of de-synchronization attacks is the establishment of new technologies like 3D videos, free view television etc. Some new watermarking schemes are proposed for content protection against such new types of de-synchronous attacks [11-12]. The lots of 3D videos are propagated into image representation. The security of copy and copyright protection is the major concern for watermarking system. The depth image and center image are the parts of DIBR (depth image based rendering) 3D video. In DIBR 3D scheme depth image and center image are used for rendering the left and right eye images. The watermark on the 3D video should be detected from center image as well as left and right eye images [11-13].

FTV (free view television) is a new entertainment technology used in a TV system for acquiring the interactive impression for the users. In this type of system user can see the scene which is produced by IBR (image based rendering). In such types of new devices the users can record the videos according to their needs. These recorded videos may be misused by the unauthorized users. For security purpose some watermarking technologies have come into existence. These technologies are used for solving the copyright protection and security problems related to FTV [11 12]. In this type of watermarking technologies watermark information can be detected from original and virtual views.

Like DIBR based 3D images and FTV, watermarking is also providing accurate solution for copyright protection and security problems for HMD devices. Some new watermark techniques are introduced to neutralize barrel distortion in HMD devices. We have established a new technology for detection of watermark in the barrel distorted video frames. For detection the watermark information firstly we take the barrel distorted watermarked frame and barrel distorted watermark image. The same barrel parameters should be present in the watermark image. The correlation between barrel distorted watermarked frame and barrel distortion watermark image gives the results for watermark information. But in this paper, we are simply working on barrel distortion.

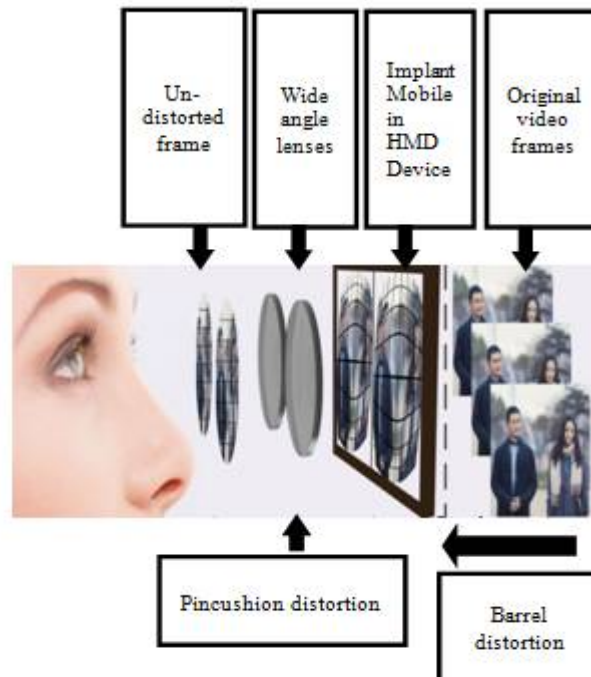


Fig. 1 Use of mobile in HMD device [14]

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In HMD devices wide angle lenses are used. So it creates the Pincushion distortion. This distortion will be affecting the video quality and giving the incorrect information about the video. To remove such type of problem we have added the barrel distortion in the covered mobile video. Barrel distortion is sort of negative displacement. The addition of both distortion gives the undistorted/ corrected video.

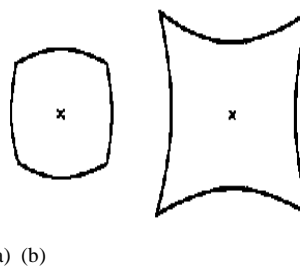


Fig. 2 Frames effected with (a) Barrel distortion and (b) Pincushion distortion [15].

This shows the effect of barrel and pincushion distortion on original video’s frame.

II. RELATED WORK

In digital data (image/audio/video) the distortion is a really big issue. A lot of work has been already done on barrel distortion, but the problem is to find the accurate and right watermark in the distorted watermarked video. The Taylor series is basically used to define the barrel distortion [14]. A barrel distortion basically needs a very few terms. In the barrel distortion the magnification of the focal point reduced to the lengthwise distance which leads to the apparent motion of the focal points radially towards the middle of the frame [14,16]. This effect is known as barrel distortion. In the Fig. 3 we also show the video frame which is regarded by the barrel distortion.



Fig. 3 Original watermarked frame and record the effect of barrel distortion on this frame

$$\dot{r} = r(1 + k_1r^2 + k_2r^4 + \dots + k_i r^{2i} + \dots) \quad \dots (1)$$

Here in equation (1),

\dot{r} :describes the distance from the midpoint of distortion in the undistorted image.
 r :describes the distance from the midpoint of the distortion in the distorted image.

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k_i is a coefficient used for expressing the value of radial distortion.

$$\dot{r} = r(1 + k_1r^2 + k_2r^4) \quad \dots (2)$$

In this paper, we are working on barrel distortion. For embedding the watermark information we are employing the concept of the spatial and transform domain. Firstly, we are using the DWT technique for compression the video's frame where we desire to embed the watermark data [17 18]. In the following step we are detecting out the location where we are embedding the watermark data. The technique is used for obtaining the location is spread spectrum technique. After getting the location, we use the LSB technique for embedding the watermark information into the original video signal [19-21]. In the next step we apply IDWT for reconstructing the frame.

III. METHODOLOGY

The research study is related to detecting the watermark from the distorted video and the techniques applied for this purpose has discussed. The step by step process of my projected or proposed work is defined as below:

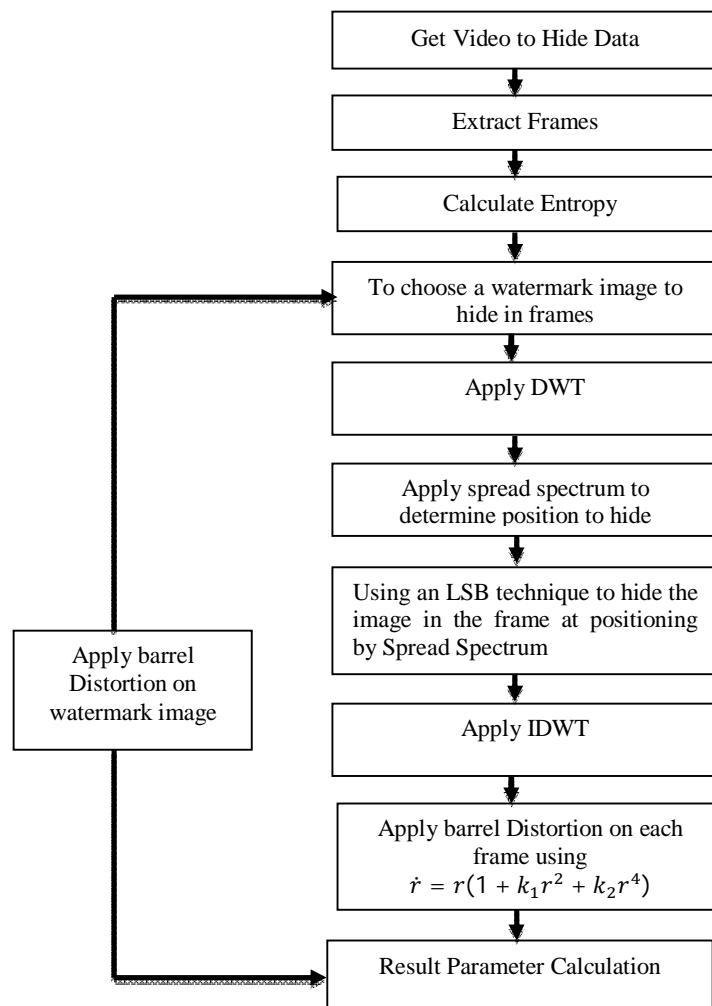


Fig. 4 Block diagram for embedding barrel distortion

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1. Initially there is a need to take the video for hiding the information.
2. In a next step the frames from the video will be pulled so that the data can be added to them.
3. The next step is immediately measuring the entropy value.
4. After measuring the entropy we take the image from the database which will behave as the watermark image.
5. Apply DWT (Discrete Wavelet Transform).
6. In this step the location will be found out which will be used for hiding or covering the information. The location will be detected by using the spread spectrum technique.
7. After placing the location for hiding the data, the next step is to hide or cover the data by employing the least significant bit technique of information hiding.
8. Apply IDWT (Inverse Discrete Wavelet Transform).
9. Now apply barrel distortion to the embedded or watermarked video. The equation for the barrel distortion is as follows:

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

10. Similarly apply barrel distortion to the watermark image also.
11. Immediately evaluate the outcomes and perform the performance evaluation by using several parameters.

IV. RESULTS AND EXPERIMENTS

In my proposed work we are employing all the steps to handling the consequences of the watermarking technique. We are essentially turning on video watermarking and the chief object to prevent the watermark in the video from getting destroyed. The proposed work comprises of DWT technique in order to play upon the barrel distortion model.

1. **PSNR (Peak Signal to Noise Ratio):** It is a parameter used to judge the noise/interference in the image or signal with respect to signal. It sets as a proportion between the maximum signal and the noise/interference. The signal in the process is taken as an original data and noise is the fault in the data. PSNR can be expressed as an equation in dB:

$$PSNR = 10 \cdot \log_{10} \left(\frac{MAX_1^2}{MSE} \right) \quad \dots (4)$$

$$PSNR = 20 \cdot \log_{10} \left(\frac{MAX_1}{\sqrt{MSE}} \right) \quad \dots (5)$$

$$PSNR = 20 \cdot \log_{10}(MAX_1) - 10 \cdot \log_{10}(MSE) \quad \dots (6)$$

In the above equation, MAX is the maximum possible value of the image and MSE is the total overall squared value differences which are separated by the size of an image.

2. **SSIM (Structural Similarity Index Measures):** It is a parameter which is utilized to measure the similarity index among two images or videos. In order to calculate the SSIM the following equation is used. SSIM should be reached, its maximum value. Its range in between the 0 to 1.

$$SSIM(x, y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)} \quad \dots (7)$$

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μ_x is the mean of frame x, μ_y is the mean of frame y, σ_x^2 is the variance of the image x, σ_y^2 is the variance of the image y, σ_{xy} is the co-variance of x and y and c_1 and c_2 are constants.

3. Correlation: It is a parameter to evaluate that how the output image is linked to the carrier/original image. The correlation is measured along the base of two different PSNR values i.e. 40dB and 49dB. The correlation should be reached, its maximum value. Its range in between the 0 to 1.

In this paper, we have worked on barrel distortion and showing the relationship between the correlation vs. PSNR and Similarity index vs. PSNR. If correlation and Similarity index is near about 0.7 to 0.99 it means we have to get similarity between the distorted watermarked video's frame and distorted watermark image. It shows that the watermark is present in the distorted watermarked video.

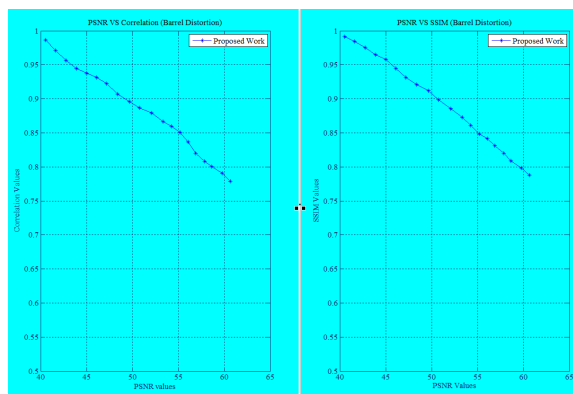


Fig. 5 The relation between PSNR with correlation and SSIM response

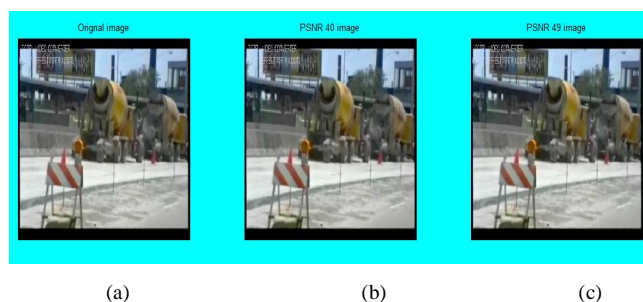


Fig. 6 Watermark imperceptibility (a) Original images. (b) Watermarked images with PSNR=40dB. (c) Watermarked images with PSNR=49dB

Watermark imperceptibility and robustness are important characteristics of video watermarking. Watermark imperceptibility basically measures by the PSNR between the carrier/original frame and watermarked frame. Watermark robustness is basically measured by the correlation between warped frame (distorted watermarked frame) and distorted watermark image. α is the factor which is controlling the watermark imperceptibility. If α value is decreasing, then watermark robustness decreases and watermark imperceptibility increases. If α value is increasing, then watermark robustness increases and watermark imperceptibility decreases [14].

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For checking the watermark robustness, we have generated 200 watermarks in which 1 correct watermark and 199 incorrect watermarks. At the correct watermark correlation and similarity index value is high. It shows that at this point watermark is present. We are set correct watermark at 100 point and distortion present on this method is barrel distortion.

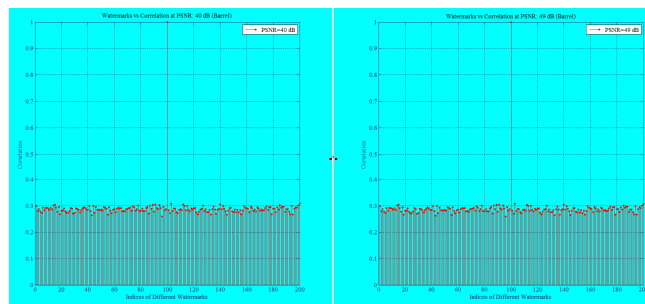


Fig. 7 Correlation responses of the watermark detector to 1 correct watermark and 199 random watermarks at 40 dB and 49 dB

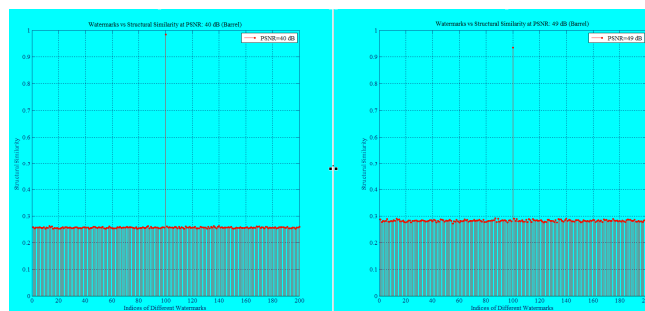


Fig. 8 Structural Similarity Index responses of the watermark detector to 1 correct watermark and 199 random watermarks at 40 dB and 49 dB

V. CONCLUSION

We have concluded that some mobile video watermarking techniques are introduced to neutralize the barrel distortion for HMD devices. In which we have worked on the robust mobile video watermarking for HMD devices. In this paper, we are detecting the watermark from distorted watermarked frames and distorted watermark image. With the availability of this study, we are detecting the watermark from the distorted video and the simulated results are done in terms of SSIM, PSNR and correlation. The results indicate that our mobile video watermarking system for HMD is so efficient. In this paper, we are only working in barrel distortion. We can further work on effects of distortion as well as an attack on the robust mobile video watermarking on HMD devices and increases the efficiency of the watermarking system.

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