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Loss Less Data Embedding In the Motion Predicted Vectors for Video Sequences

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ABSTRACT: A lossless data hiding scheme in the predicted frames during the motion estimation is proposed in this paper. The main objective of this work is to provide an efficient, low complex and faster data hiding scheme for the video sequences in compressed domain. This work utilized the concept of motion estimation from which the predicted frames are used to hide the data. This method also provides high embedding capacity while preserving the quality of the frames. Experimental results shows that the proposed approach is providing good results in terms of extracted message bits and the quality of the embedded frames.
Keywords: Data hiding, compressed video, motion estimation, preditctive values.

I.INTRODUCTION

The advancement in electronics and communications had leaded various techniques of digital signal and multimedia processing for the distribution of video much easier and faster manner [1].In this regard authentication of video is of great interest since they are very susceptible for alterations and manipulations. It is of great importance when the video is used as evidence in criminal offenses. Authentication techniques are needed in order to maintain authenticity, integrity, and security of digital video content. As a result, digital watermarking (WM), a data hiding technique has been considered as one of the key authentication methods [2] [3]. Digital watermarking is the techniques of embedded any digital content into the ownership content in order to provide authenticity. This digital content may be a random data, text, and image.

Today many video watermarking or data hiding schemes are widely used in many of the applications. Over the years researchers has investigated many visible and invisible based data hiding schemes for video authentication in both compressed and uncompressed domain.

The level of robustness of the watermark can be categorized into three main divisions: fragile, semi-fragile, and robust. A watermark is called fragile if it fails to be detectable after the slightest modification. A watermark is called robust if it resists a designated class of transformations. A semi-fragile watermark is the one that is able to withstand certain legitimate modifications, but cannot resist malicious transformations [4]. The main objective of this work is to propose lossless, robust data hiding scheme. Data hiding in video sequences is performed in two ways, data level and bit stream level. In the bit stream level the redundancies in the present compression principles are used. This kind of technique is completely reliant on the bit stream structure and it can be effortlessly exploited. Therefore this kind of data hiding is appropriate for verification. In spite of these restrictions bit stream level based data hiding schemes are pretty for strong imperceptible data hiding.

This paper is organized as follows, section I discuss briefly about the importance of the data hiding concept, the role of data hiding in secure transmission. Section II explains about the related approaches that were implemented earlier in similar domain. Section III clearly depicts the steps involved in the proposed approach with mathematical analysis. Section IV shows the results that were obtained from experiments and the quality analysis in terms of PSNR and VSNR and complexity.

II. RELATED WORK

In [5] Strycker et al. proposed a well known video watermarking scheme, called just another watermarking system (JAWS), for TV broadcast monitoring.

In [6] Liu et al. proposed a data hiding in inter- and intra-prediction modes of H.264/AVC. It uses these prediction modes to embed the watermark data. Before embedding, a pre-defined watermark area is determined. The block types in the inter- and intra-predictions are adequately partitioned to represent watermark bits and based on the correlations of block types.

In [7] and also in [8] authors tried to hide the data into a video stream using the phase angle between two successive CMV. These CMV are taken in to account based on the magnitude of the motion vectors as in [9]. So the message bit which is ought to hide is encoded as phase angle difference in regions between CMV. The block matching scheme is selected to look among the chosen sector for which the magnitude to be larger than the predefined threshold.

In [10] Jordan et. al proposed information hiding in video using inter frame. The select the inter frames in MPEG video sequences and regularize the motion vectors into a modified data sequences.

In [11] Wang et al. proposed a video watermarking technique to hide copyright information in motion vectors. In this method, the region of motion vector is restricted to hide watermark information. In order to obtain desirable video quality after watermark embedding, intra-mode is used to encode those macro blocks badly affected by restricting the region of the chosen motion vectors in inter-mode.

In [12] Choi et al. use inter-block correlation by forcing DCT coefficients of a block to be better or slighter than the average of the adjacent blocks.

In [13] Wu et al. alter chosen DCT coefficients by random shuffling and table lookup embedding. A sample-based technique is projected to embed some information bits in the JPEG compressed domain.
This method uses the predicted frames using motion estimation and the loss less data embedding is implemented on the predicted frames.

III.PROPOSED METHOD

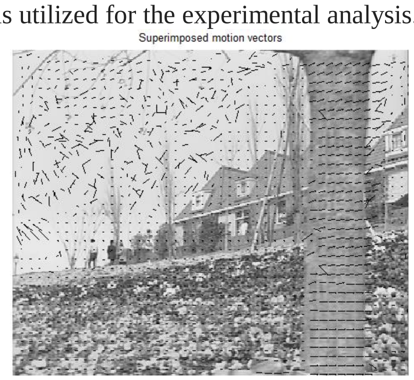
Motion estimation (ME) and compensation is an integral procedure to reduce temporal redundancy between adjacent P-frames and spatial redundancy within I-frame. Each inter-frame MB in the P-frame is represented by forward MVs and quantized DCT (Discrete Cosine Transform) coefficients of the prediction residual after motion compensation. In this research these predicted residual vectors are used for data hiding. The data hiding scheme proposed in this work is presented below.
Consider N – pixel grayscale predicted image which here considered as host image. Assume that the pixel value x_i denotes the grayscale value of the ith pixel $0 \le i \le N-1$. One important point to be noted that the predicted vectors have the values in the below form
Predicted frame= [0 13 0 -1 1; 0 14 2 1 1 ; -1 12 -6 -10 -8]
The values are in the range of [-255 to 255]. But the spatial content will fall in the region [0 - 255], so the values are normalized and corrected to fall in the region of [0 - 255].
Corrected values: =[0 16 0 1 1; 0 17 2 2 1; 1 15 9 13 11];
After the corrected vector of values are obtained. The embedding process is as follows
(i) Calculate the difference between x_{i-1} and x_i in reverse S-scan order
(ii) Seek the peak point ‘P from the vector differences
(iii) Shift the vector values by 1 unit $y_i = \begin{cases} x_i & if\ i = 1\ and\ d_i < P \\ x_i + 1 & if\ d_i > P\ and\ x_i \ge x_{i-1} \\ x_i - 1 & if\ d_i > and\ x_i < x_{i-1} \end{cases}$
(iv) Insert the message bits according to the same above equation $y_i = \begin{cases} x_i & if\ i = 1\ and\ d_i < P \\ x_i + M & if\ d_i > P\ and\ x_i \ge x_{i-1} \\ x_i - M & if\ d_i > and\ x_i < x_{i-1} \end{cases}$ here the $M \in \{0,1\}$. A high capacity of embedding can be obtained by inserting different data bits into different predicted vectors.
After embedding the data, the predicted vectors are decoded along with motion estimation vectors to form a watermarked frame.
At the receiver end the receipt first separate the motion vectors and predicted vectors using motion estimation process and later the extraction process is applied on the predicted vectors. The extraction process is as follows
(i) The predicted values are first normalized and brought into the interval of [0 255]
(ii) Scan the predicted values in the same reverse S- order
(iii) Set $x_0 = y_o$ where x_0 denotes the restored value and the message is extracted using the below equation
$M = \begin{cases} 0 & if\ |y_i - x_{i-1}| = P \\ 1 & if\ |y_i - x_{i-1}| = P + 1 \end{cases}$ Where x_{i-1} denotes the restored value of y_{i-1}
(iv) Restore the original value of predicted vector by following equation

$$x_i = y_i + (|y_i - x_{i-1}| - P) \quad if\ P < |y_i - x_{i-1}| < P + 1\ and\ y_i < x_{-1}$$
$$y_i + (|y_i - x_{i-1}| - P) \quad if\ P < |y_i - x_{i-1}| < P + 1\ and\ y_i > x_{i-1}$$

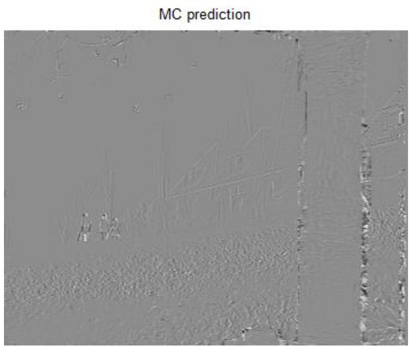
(v) Repeat the above 3 & 4 steps until the message is extracted

IV.EXPERIMENTAL RESULTS

In this work the video sequences are taken from [14].The resolution of each frame is 352x240. The videos are in YUV format in which the Y component is utilized for the experimental analysis. The results are shown below



[1]
[2] Figure 1: Motion Vectors in a frame
[3]



[4]
[5] Figure 2: Motion Compensated predicted frame
[6]

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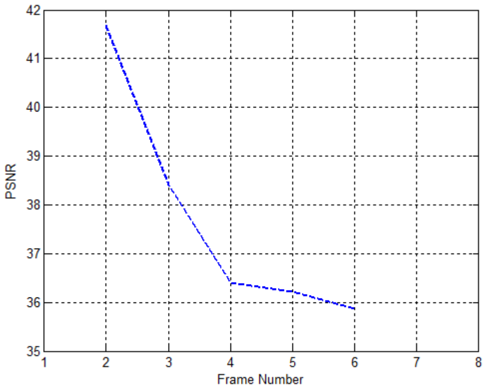
[7]
[8] Figure 3: Original Frame

[9]
[10] Figure 4: Frame after embedding data

Txt=' Hi This is sridhar';
Extracted Message is: Hi This is Sridhar
The proposed method is lossless data hiding process whose capacity is given as $\left(\frac{MxN}{8}\right) * n$ where M & N are the resolution of the frame along horizontal and vertical axis and 'n' is the number of frames.



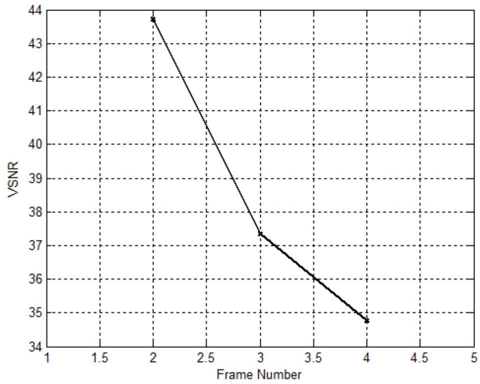


Figure 5: PSNR analysis for different frames   Figure 6: PSNR analysis for different frames

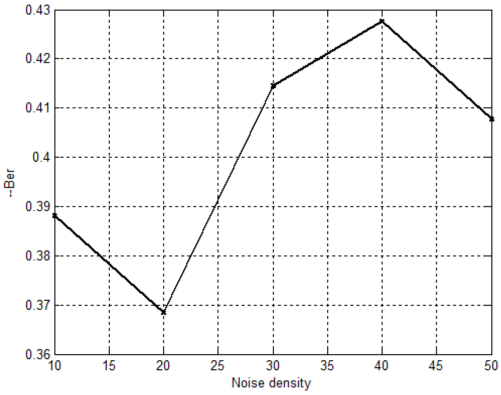


Figure 7: BER analysis under white Gaussian Noise

The proposed approach can provide high perceptual quality of the video sequence while embedding higher amount of data into it. Figure 5 shows the PSNR analysis and figure 6 shows VSNR [16] (Visual signal-to-noise ratio) analysis of the approach for different frames. As one can see that when the embedding capacity is increasing in higher frames then the PSNR & VSNR is approximately 35(dB)-36(dB) which is a good outcome of the approach The BER analysis of the proposed approach under additive white Gaussian noise is also presented in figure 7 which depicts that as the noise density increases the BER gradually increases.

V. CONCLUSION

Lossless data hiding method is proposed in this paper, the predicted values during the motion estimation were used for data hiding. However this approach attains higher embedding capacity while preserving the perceptual quality. This work has to be further extended to analyse its performance under different attacks and should be compared with traditional methods.

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