A Lossless Data Hiding Scheme in the Predicted Frames

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Abstract: ***The intrest in data hiding in compressed video frames, for digital multimedia distribution applications. Data hiding has been one of most researched issues in information security. In a video, neighboring frames have similar pattern where a secrete message can be embedded. A loss less data hiding scheme in the predicted frames during the motion estimation algorithm is proposed in this paper. This embedding technique produces the distortion videos than the classical-techniques. This data hiding algorithm supports user-defined levels of accessibility and security.***

Keywords: Data hiding, compressed video, motion vectors, predicted p-frames

1. Introduction

The traditional data-hiding schemes of compressed videos would incur a great deal of degradation enduring of signal distortion in the marked bit-stream [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 verification 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 logo content in order to provide authenticity. This digital content may be a random data, text, and image.

Recently, two methods are proposed to finding the moving area [4]. One of these methods is calculated magnitude of the motion vector. The magnitude of motion vectors in moving areas compared to stationary areas moving areas are more. So by determining both the horizontal and vertical motion vectors components and gaining their magnitude, a simple comparison can be achieved in high-motion areas. The other method is object tracking [5].

Now a day's many video watermarking or data hiding schemes are widely used in many of the applications. Over the years researchers has investigated many 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 able to detect 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 [6]. The main objective of this work is to propose lossless, robust data hiding scheme. This paper is organized as follows.

2. Related Work

In [7] Strycker et al. proposed a well known video watermarking scheme, The implementation of a real-time digital watermark embedding and detector for television broadcast monitoring is addressed it is also called another watermarking system (JAWS), for TV broadcast monitoring.

In [8] 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, Whose function has been defined previously watermark area. The block types in the inter- and intra-predictions are adequately partitioned to represent watermark bits and based on the association of block types.

In [9] and also in [10] authors explained hide the data into a video frames 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 [11]. So the message bit which is going 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 value.

In [11] Jordan et. al proposed owner 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 succession. This method uses the predicted frames using motion estimation and the loss less data embedding is applied on the predicted frames.

3. Proposed Method

Algorithm-1: Embedding
1) Read input video
2) Initialize the starting frame for embedding (STF) and the number of frames(NF) for embedding
3) Read the message or bit stream to be embedded

4) Consider the general video format IBBPBBI of frames and select only frames for embedding
5) Inter-frame MB in the P-frame is represented by forward MVs and quantized.
6) Coefficients of the prediction residual after motion compensation.
7) 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 i^{th} pixel $0 \le i \le N-1$.
8) Calculate the difference between x_{i-1} and x_i in reverse S-scan order
9) Seek the peak point 'P from the vector differences
10) Shift the vector values by 1 unit $y_i = \begin{cases} x_i & if\ i = 1\ and\ d_i < P \\ x_i + 1 & if\ d_i > P\ and\ x_i \ge x_{i-1} \\ x_i - 1 & if\ d_i > and\ x_i < x_{i-1} \end{cases}$
11) 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.

Algorithm-II: Extraction Process

1) The predicted values are first normalized and brought into the interval of [0 255]
2) Scan the predicted values in the same reverse S- order
3) 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}
4) Restore the original value of predicted vector by following equation $x_i = y_i + (|y_i - x_{i-1}| - P) \quad if\ P < |y_i - x_{i-1}| < P+1\ and\ y_i < x_{-1}$ $y_i + (|y_i - x_{i-1}| - P) \quad if\ P < |y_i - x_{i-1}| < P+1\ and\ y_i < x_{i-1}$
5) Repeat the above 3 & 4 steps until the message is extracted

Algorithm example as fallows

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 i^{th} 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

1) The predicted values are first normalized and brought into the interval of [0 255]
2) Scan the predicted values in the same reverse S- order
3) 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}
4) Restore the original value of predicted vector by following equation $x_i = y_i + (|y_i - x_{i-1}| - P) \quad if\ P < |y_i - x_{i-1}| < P+1\ and\ y_i < x_{-1}$ $y_i + (|y_i - x_{i-1}| - P) \quad if\ P < |y_i - x_{i-1}| < P+1\ and\ y_i < x_{i-1}$
5) Repeat the above 3 & 4 steps until the message is extracted

4. Experimental Results

In this work the video sequences are taken from [11]. The videos are in YUV format in which the Y component is utilized for the experimental analysis. The results are shown below

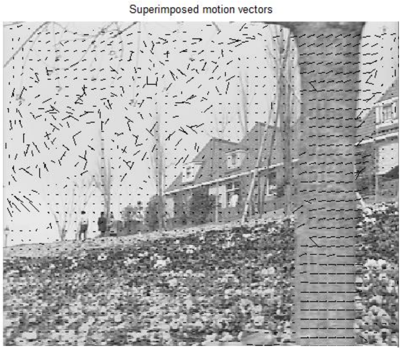

Figure 1: Motion Vectors in a frame

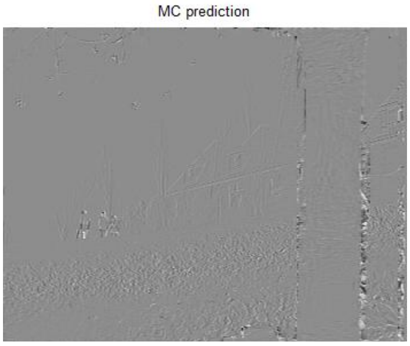

Figure 2: Motion Compensated predicted frame

Figure 3: Original Frame

Figure 4: Frame after embedding data

Txt=' Hi This is nayansrivaan';
Extracted Message is: Hi This is nayansrivaan
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.

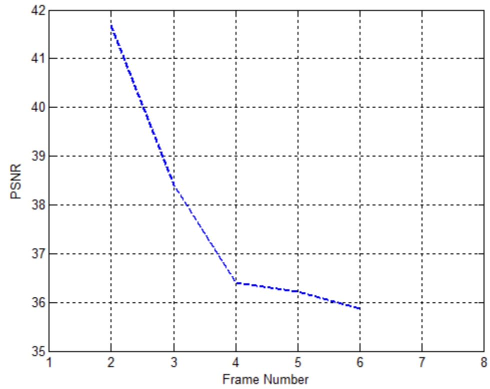

Figure 5: PSNR analysis for different frames

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 of the approach for different frames .

5. Conclusion

An improved data hiding scheme based on the modification of motion vectors is proposed in this paper, the algorithm is tested on several video streams and found that this method is leading a considerable improvement both perceptually and capacity wise. The algorithm suffers from a limitation that this approach is consuming more processing time than earlier .The deployment tool or language can be changed in order to improvise this. This algorithm can also be extended in future with changing of transformation domain and also decreasing the processing time.

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