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# "Data Hiding in Motion Vectors of Compressed Video"

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**Abstract**: Steganography is the specialty of data covering up in video, pictures and sound keeps an unapproved replicating straightforwardly. It can valuable in Military correspondences and some different applications too where instead of covering the substance of a message utilizing encryption, search for to hide its sender, its collector or even the presence of some data. The paper is executed to manage the data stowing away in compacted video in movement vectors i.e. we can say video steganography. Since pictures and crude recordings are helpless against assaults, in compacted video we concentrated on the movement vectors to shroud the data by making utilization of forward predictive (P) frames and bidirectional (B) frames.

**Keywords**: Video steganography, motion vectors, Data hiding, Compressed Video.

## I. INTRODUCTION

In this paper we will focus only on the necessary and related concepts and the idea of implementation through simplified flowcharts. The notations are mentioned which can be used for further coding.

Now day's characteristics that are generated by video compressing standards are mainly focused by data hiding in video. MPEG algorithms make use of motion vector based schemes. Encoder removes the temporal redundancies between frames by calculating the motion vectors. Such methods replace the original motion vector by another locally optimal motion vector to embed data. Different motion-compensation units available in sizes of 16×16, 16×8, 8×16, 8×8, and sub8×8 for the well-recognized H.264 video coding standard .[4]

In this paper we propose a data hiding scheme, encoder hides the desirable data by focusing on the internal dynamics of video, specially the motion estimation stage. Use of motion estimation stage results in less vulnerable to attacks and hard to detect the data by steganalysis. The reason behind this is that its contents are internally processed during the video encoding or decoding, which is not prone to quantization distortion.

As said above, it mainly targets the frame compression of the video consequences which relates to the internal dynamics [1]. Here our main attentiveness lies in the estimation of motion in the frame sequences. This is the primary step in the video processing for the processing of the data internally.

During the implementation of the pre-primary step less loss of data takes place and it is difficult to decode the hidden data and it is far away from the quantization errors. So as per the literature point of view here the data is hidden in the video or specifically in the motion in between the frames of the video which is very relevant feature. The data is hidden on the video or the motion between the frames depending on the suitable threshold condition. [1]

## II. RELATED AND NECESSARY CONCEPTS

*A. Theory of video compression:*

Basically video is 3D array of colour pixels. 2 dimensions i.e. horizontal and vertical, serve as spatial directions of the moving pictures, and remaining one dimension is the time domain. A set of all the pixels which correspond to a same or single moment of time is called as data frame. Mainly, a frame is same as still picture. Data in video has spatial and temporal redundancy. Similarities because of this can be encoded by simply calculating differences within frames i.e. spatial, and/or among frames i.e. temporal.

*B. Video Compression Picture types:*

In this field of compression a frames of video are compressed using many different algorithms with diverse advantages and disadvantages, but concentrating mainly on amount of the data compression. The various algorithms for video frames are called frame types or picture types. The major three picture types used in the different algorithms are I, P and B and they are different as the following characteristics:

**I-frames** ('Intra-coded picture') are the least compressible but do not require the other video frames to decode.

**P-frames** ('Predicted picture') more compressible than first and can use data from previous frames.

**B-frames** ('Bi-predictive picture') can use both previous as well as forward frames for reference so that to get the maximum amount of compression. [5]

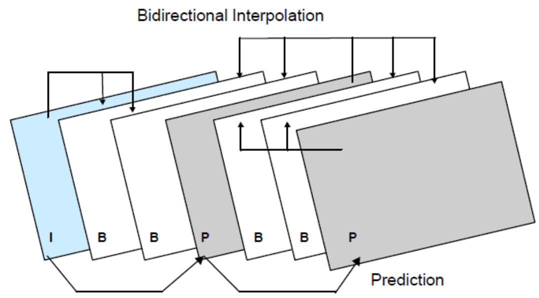


Fig. 1 Structure of Frame Types

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*C. Motion Estimation:*

Motion estimation is the process in which helps determining motion vectors which shows the conversion from one image to another image; typically from adjoining frames in a video sequence (i.e. sequence of frames). The motion vectors may relate specific parts, such as arbitrary shaped patches, rectangular blocks or even per pixel or to the whole image.

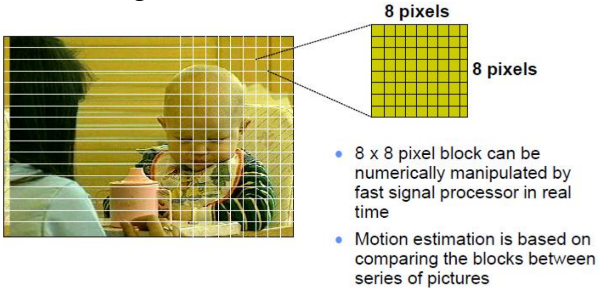


Fig. 2 MPEG Compression is based on Processing 8 x 8 Pixel Blocks [5]

*D. Motion compensation:*

An algorithmic technique employed in the video data encoding for video compression is Motion compensation. The conversion of a reference picture into the current picture is described by the motion compensation. The reference picture or frame may be previous in time or may be from the future as well. The efficiency of compression can be improved if images can be accurately synthesised from previously stored/transmitted images.

**How motion compensation works**

Motion compensation utilizes the statement that, frequently, for various frames of movie, the difference between the frames is the result of either an object in the frame moving or camera moving. Thus with reference to a video file, this means a large amount of the information that is used to represent one frame will be similar as the information used to represent the frame next to it.

By motion compensation, video stream will hold number of full frames(reference frames); because of this stored information for the frames in between will be the information needed to convert the previous frame into the next frame.

*E. Macroblock and motion vector:*

For quantization MPEG-1 operates on video in a series of 8x8 blocks. Though, because chroma (colour) is sub-sampled by a factor of 4, each one pair of (red and blue) chroma blocks corresponds to 4 different luma blocks. With a resolution of 16x16, this set of 6 blocks, is called a macroblock. A smallest independent unit of (color) video is the macroblock. Motion vectors operate exclusively at the macroblock level.

Based on the number of pixels, motion vectors (MV) record the distance between two areas on screen. MPEG-1 video uses a motion vector precision of one half of one pixel. The finer the precision of the MVs results in more accurate the match is likely to be, and thereby increasing efficient compression. Finer MVs gives larger data size, as larger numbers have to be stored in the frame for every single MV. This increased coding complexity by increasing levels of interpolation on the macroblock is essential for both the encoder and decoder.

Neighbouring macroblock is likely to have very similar motion vectors; as a result this redundant information can be compressed quite effectively. For each macroblock only the amount of difference between the MVs needs to be stored in the final bit stream.

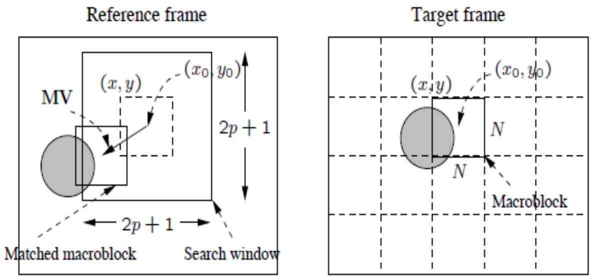


Fig. 3 Macroblocks and Motion Vector in Video Compression.[9]

The fig. 4 shows variable size of macro-blocks. A 16x16 macro-block size is encoded using single vector, but if 16x16 macro-block is divided into 16x8 or 8x16, 16x8 or 8x16 block, it is encoded using two vectors. As we process 16x16 macro-block sizes with 4x4 macro-block size, number of encoded vector is sixteen. Thus, a selection of macro-block size is trade-off between the precision in motion and the computational cost. An 8x8 macro-block size is considered for simulation in this project.

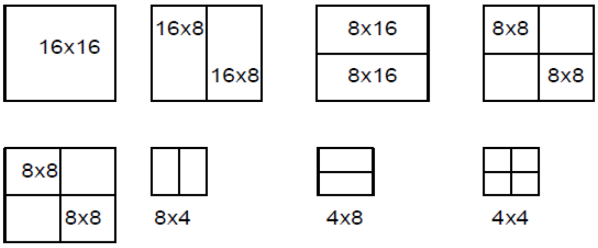


Fig. 4 H.264 macro block size 16x16 – 4x4

Fig. 5 shows macro-block of current frame (MB in light blue shade) is searched in reference frame (I in yellow shade), within predefined search area (P in gray shade).

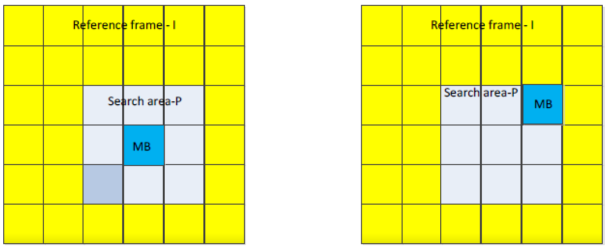


Fig. 5 Reference frame (I), search area (P), current macro-block (MB).

A video has captured multiple image frames in a second. Those consecutive frames do not have much movement with respect to one another. The regular interval frame is chosen as a reference, and the following frames of the reference frame are known as a current frame. Reference frames have high movement, and unacceptably high values of cost function. In fig. 5, the reference frame and the current frame are shown with the size of MxM, and are divided into equal number of non-overlapped mxm macro-

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blocks. Each-macro-block of current frame is compared with limited number of macro-blocks in the reference frame as shown in the above figure. That limited number of search is varies by changing restricted search area or search size. It is too costly to examine macro block of current frame with all macro-blocks of reference frame. MAD, SAD, and MSE are algorithms to get best match. The macro-block with minimum cost function would be the best candidate for motion-vector calculation. How much the macro-block of the current frame is moved with respect to the reference frame is defined as the motion-vector. This motion-vector will use by motion compensation block.

## III.DATA HIDING DURING ENCODING

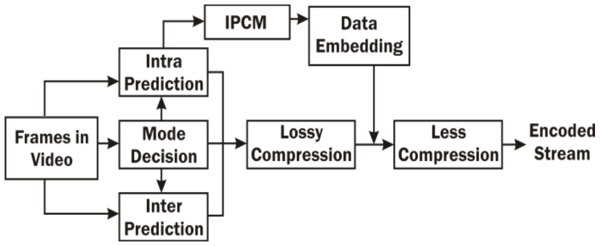


Fig.6 Data hiding during encoding

The basic methodology for frame (picture) is that it is partitioned into fixed-size macroblocks, which covers a rectangular picture area of 16X16 samples of the luma components and 8X8 samples of each of the two chroma components. All luma and chroma samples of a macroblock are either spatially or temporally predicted, and the resulting prediction residual is encoded using transform coding. For transform coding purposes, each colour component of the prediction residual signal is subdivided into smaller 4X4 blocks.

In order to hide the data using IPCM block in which data is directly processed without compression or without any loss of data. The proposed method of data embedding based on IPCM block is a secure one. Secondly we check the robustness of hidden data & thirdly we perform capacity estimation of the data hiding space available. When IPCM blocks are used to hide the data lower bits of luma and chroma samples are used. Because of change in lower bits of luma and chroma it does not affect the image or video much more. But regarding the IPCM blocks there is one practical problem i.e. rareness of IPCM blocks.

In data hiding process, number of IPCM blocks required to hide the data are less than the number of IPCM blocks required to forcefully generate the IPCM blocks. Data hiding at the encoder side raw video is taken as input to the encoder which is passed at the same time when embedded data is passed to the encoder, so that data can be hidden at the encoder side &converted to the H.264 bit stream. Output of encoder is passed to the decoder where hidden data can be extracted and raw video can be reconstructed back.

Data extraction during decoding, where input to the decoder is in the form of H.264 bit stream. Decoder will first find IPCM block. If IPCM block is present then extract hidden data from the IPCM block as well as reconstruct original input frame as it is without loss at the decoder side.

In order to hide the data in the H.264 encoder, we pass input to the mode decision. Mode decision will find out the type of prediction (inter prediction or intra prediction or IPCM) and hide the data in IPCM blocks. If the type of prediction is inter prediction, the motion estimation and compensation have become powerful techniques to eliminate the temporal redundancy due to high correlation between consecutive frames. Because two successive frames of a video sequence often have small differences, it reduces the temporal redundancy.

The process of block matching is the most time consuming one during encoding. In order to find a matching block, each block of the current frame is compared with a past frame within a search area. If the type of prediction intra prediction has been conducted in the transform domain intra prediction in H.264/AVC is always conducted in the spatial domain, by referring to neighbouring samples of previously-coded blocks which are to the left and/or above the block to be predicted.

If the encoder succeeds to find a matching block on a reference frame, it will obtain a motion pointing to the matched block and a prediction error. Using both the elements, the decoder will be able to recover the raw pixels of the block. Some data may be lost due to compression; such type of data can be seen as it is without compression. For sending such type of data IPCM blocks are used. When IPCM blocks are used there is no need of transformation and quantization.[19]

## IV.ALGORITHM AND FLOWCHART

**1. Start**

-Define data to be hidden and processing on video

**2. Encoder**

-Calculate motion vectors by using function.

Motion vector is calculated using prediction function which are,

A.Motion_prediction1-Inter construction
B. Motion_prediction2-Inter reconstruction
C. Motion_prediction3-Intra construction
D. Motion_prediction4-Intra reconstruction.

**3. Capacity estimator**

Calculate the capacity of I P B frames using YUV

**4. Data embedding**

Embed the data in estimated block by using function, Embed.

**5. Mode decision**

Decides the mode of prediction, if it is IPCM

A. Count no of IPCM blocks
B. Calculate no of pixels required to hide a data.
C. If IPCM blocks are enough, create IPCM

**6. Transmission with noise**

Noise is added with the data to check the robustness of the system, for that PSNR is calculated using function PSNR.

**7. Data retrieve**

**8. Decoder**

Retrieve the motion vectors which were calculated by encoder by suing function Retrieve_Mv.

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**Algorithm for mode decision**

1. Calculate Total number of IPCM blocks already present, ipcm_cnt
2. Calculate Total number of IPCM blocks required to hide the data, Hide_no.
3. If ipcm_cnt<hide_no
   a. Then find the extra ipcm blocks required, req_blks
   b. For every req_blks number of block, forcefully create a IPCM block
4. Repeat this for each block of the frame

Decision making algorithm will help to find out total number of IPCM blocks available & number of blocks required for hiding the data. Depending upon the number of required blocks, forceful generation of IPCM blocks is done. Using IPCM blocks, data can be send without compression as well as without loss.

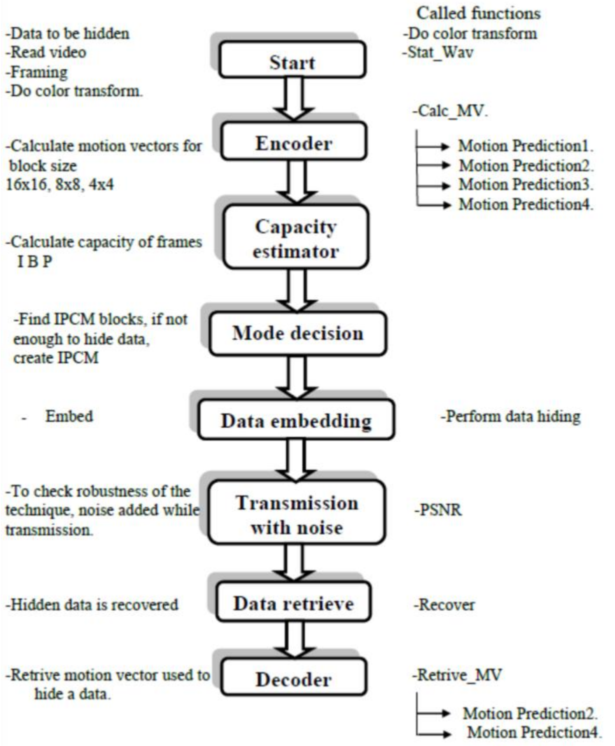

Fig. 7 Flowchart of implementation of code

## V. EXPERIMENT RESULTS AND DISCUSSION

The proposed scheme is integrated on matlab R2013a. The very first step is to select the video in which we want to hide a secret data. The video will be undergoing through compression.

*A. Data we are hiding here :* ***Dipak Mhaske***

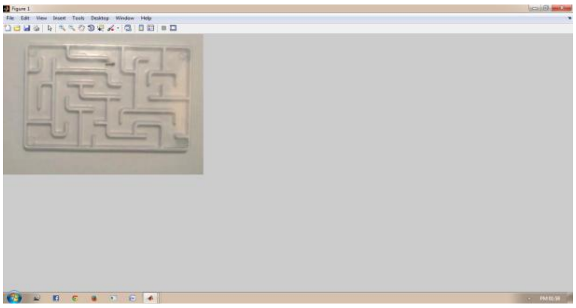
Fig. 8 Video selected

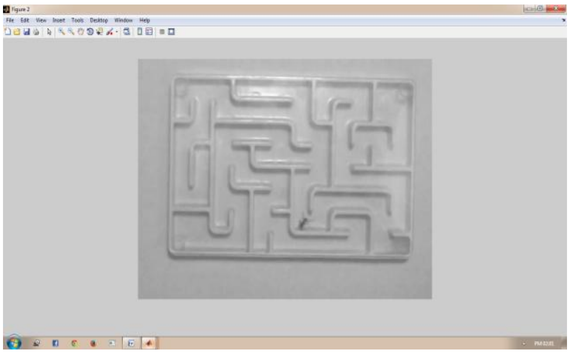
Fig. 9 Framing done and converted to gray image

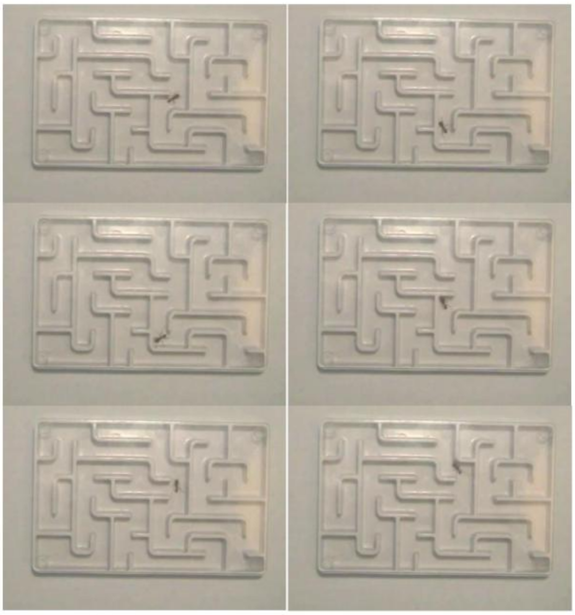
Fig. 10 Few outputs of framing

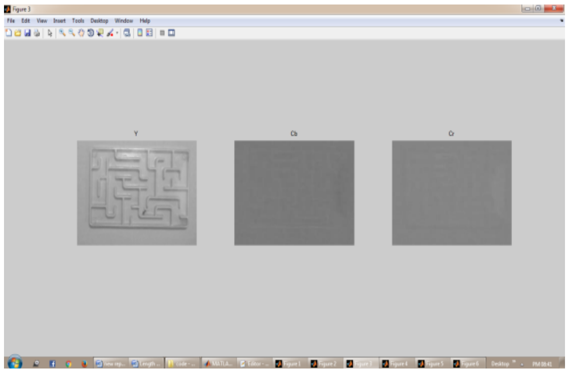
Fig. 11 Y CBCR component of video I

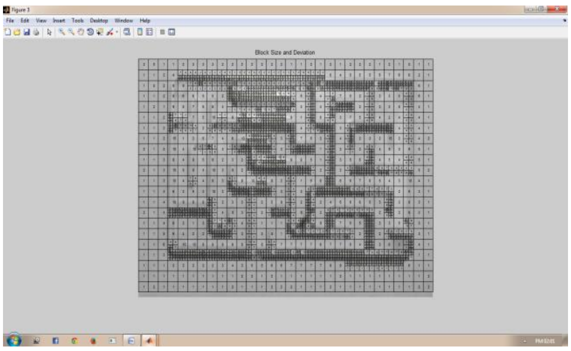
Fig. 12 Block size and deviation

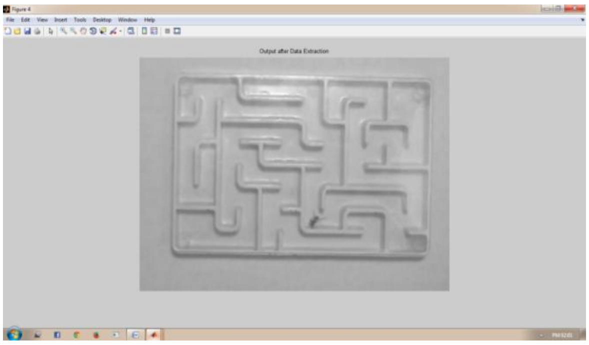
Fig. 13 Output and data extraction

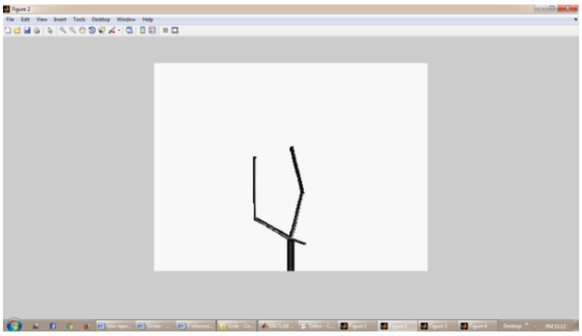
Fig. 14 Framing done (Video II)

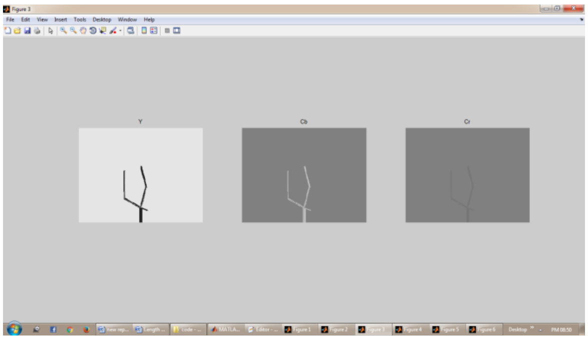
Figure 15 YCb Cr component of video II

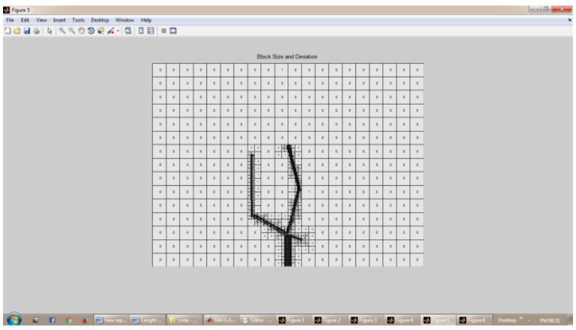
Fig. 16 Block size and deviation (Video II)

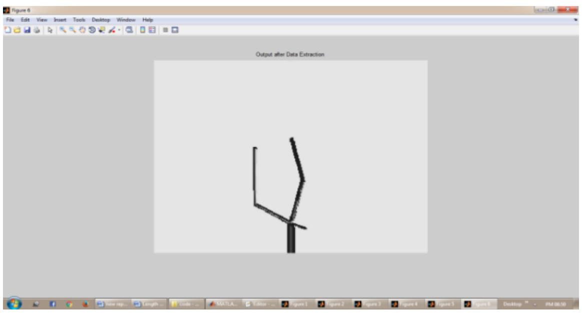
Fig. 17 Output and data extraction (video II)

Different parameters are listed in table below shows the outcomes of the study. Two test videos are taken as an input which will be further processed to hide a secret data. The payload size i.e. length of data to be hide can be varied according to our requirement.

### B. *Result*

Table 1Experimental results

| Parameter | | Video I | Video II |
|---|---|---|---|
| Length | | 00:00:03 | 00:00:07 |
| Frame Rate(fps) | | 30 | 15 |
| Total no. Of frames | | 101 | 117 |
| Frame width | | 360 | 320 |
| Frame height | | 480 | 240 |
| No. Of characters that can be hidden in one frame – | I frame | 42240 | 19200 |
| | B frame | 21120 | 9600 |
| | P frame | 10560 | 4800 |
| PSNR(dB) with specified no. of characters | 18 | 57.65 | 59.85 |
| | 25 | 56.75 | 60.17 |

As can be seen from the table videos of different lengths are chosen having different height and width. Fig. 12 (video-I) and fig. 16 (video-II) shows the block size deviation for the two videos. I B P frame capacity of the two shows that no of characters that can be hidden in I B P frames of video I are much higher than that of video II. PSNR value shows the how will quality of reconstruction of video. PSNR value will be affected by the payload size. High PSNR value represents the good reconstruction and it tends to be infinity but practically PSNR above 50 is accepted. It is also verified that for larger block size and deviation I B P frames capacity is increases, here video I has larger block size and deviation, so it results in better data hiding conditions.

Table 2 Comparison with other systems

| Sr.no | Different techniques | PSNR(dB) |
|---|---|---|
| 1. | Proposed method | 57.65 |
| 2. | Advanced Reversible Data Hiding With Encrypted Data[3] | 48.8 |
| 3. | A Novel Method for Data Hiding In Encrypted Image and Video[12] | 39.0 |
| 4. | A Data Hiding scheme in motion vector of videos by LSB Substitution[13] | 27.30 |
| 5. | A Secure Data Hiding Technique in Compressed Video Using a Secret Key[14] | 60.0 |

Different techniques that were implemented previously are compared with the proposed method. As the PSNR value shows the robustness of the system to noise, from table it is clear that the proposed method gives the better performance in terms of PSNR, if we compare the values mentioned in 2, 3 and 4.

The PSNR values for 1 and 5 are nearly same.

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*C. Application*

There are a number of other applications driving interest in the subject of information hiding.

- Military and intelligence offices require unpretentious correspondences. Regardless of the fact that the substance is encoded, the location of a sign on a current front line might lead quickly to an assault on the signaller. Thus, military interchanges use strategies, for example, spread range regulation or meteor disperses transmission to make flags hard for the foe to identify or stick.
- Criminals additionally place awesome worth on subtle interchanges. Their favoured innovations incorporate prepaid cellular telephones, cell telephones which have been altered to change their character every now and again, and hacked corporate switchboards through which calls can be rerouted.
- Law authorization and counter knowledge organizations are occupied with comprehension these innovations and their shortcomings, in order to distinguish and follow shrouded messages.
- Recent attempts by some governments to limit online free speech and the civilian use of cryptography have spurred people concerned about liberties to develop techniques for anonymous communications on the net, including anonymous re mailers and Web proxies.
- Schemes for advanced races and computerized money make utilization of mysterious correspondence strategies.

Advertisers use email falsification strategies to convey gigantic quantities of spontaneous messages while staying away from reactions from furious clients.

## VI. CONCLUSION

Data hiding for H.264 video format has been done. IPCM blocks are used for this purpose. To generate more IPCM blocks, the Mode Decision Block of H.264 has been tweaked with the generated IPCM blocks, data is hidden and transmitted. When more data is to be hidden, more IPCM blocks are generated which makes the compression to be ineffective.

An Ideal amount of data has been taken and the new algorithm has been tested on four different videos. Unlike most data-hiding methods in the motion vectors that rely their selection on at tributes of the motion vectors, we picked an alternate approach that chooses those movement vectors whose related large scale pieces forecast blunder is high to be the possibility for concealing a bit in each of their even and vertical parts. The method data hiding in motion vectors is compared to another one from the literature that relies on a motion vector attribute. Data hiding in motion vectors by exploiting the IPCM gives better performance.

The performance and the robustness of the system by adding noise while transmission. Finally, it can be easily extended, resulting in better robustness, better data security and higher embedding capacity.

The proposed system can be enhanced further for data hiding in larger size videos. Future work will be directed towards increasing the size of the embedded payload while maintaining the robustness and low distortions.

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## BIOGRAPHY

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