# DETECTING DOUBLY COMPRESSED H.264/AVC VIDEOS USING MARKOV STATISTICS SCHEME

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***ABSTRACT***

*MPEG-4 is a method of defining compression of audio and video digital data. MPEG-4 videos double compression method is used to decompress video from spatial domain to the frequency domain and then resaved with a different quantization matrix. Markov feature is a second order statistics which was adopted to detect double compression artifacts in the original video. In proposed system, double compression artifacts in H.264/AVC was detected by Markov statistics and by comparing two videos the ratios such as peak signal- to-noise ratio (PSNR), mean squared error (MSE) and structural similarity index (SSIM) are calculated.*

***KEYWORDS:*** *MPEG-4, double compression, Markov statistics, artifacts, peak signal-to-noise ratio, mean squared error, structural similarity index.*

## I. INTRODUCTION

Video compression may be lossy or lossless compression. Lossless compression may all important information after compression also but compression ratio is less compare to lossy compression. Video compression technologies are about reducing and removing redundant video data so that a digital video file can be effectively sent over a network and stored on computer disks. With efficient compression techniques, a significant reduction in file size can be achieved with little or no adverse effect on the visual quality.

Video compression algorithms such as MPEG-4 and H.264 use interframe prediction to reduce video data between a series of frames. This involves techniques such as difference coding, where one frame is compared with a reference frame and only pixels that have changed with respect to the reference frame are coded. A compression artifact is a noticeable distortion of media caused by the application of lossy data compression. Compression artifacts occur in many common media such as DVDs, common computer file formats such as JPEG, MP3 or MPEG files.

MPEG-4 Video is a video codec (compressor and decompressor) standard. A video codec is designed to compress and uncompress digital video in order to reduce the amount of bandwidth required to transmit and store the video. MPEG-4 is a lossy compression standard. This means that the compression and decompression does not reproduce exactly the same as the original video but achieves the high compression ratios required at the expense of some quality.

MPEG-4 standard defines many different coding tools and compression features. MPEG-4 provides a higher coding efficiency for storage and transmission of audio-visual data at very low bit rates. The usage of surveillance systems and video cameras is growing rapidly. For authentication of the digital contents, a variety of active techniques have been proposed, such as watermarking [10] and digital signature [6]. But passive technique is focused in [5]. With the low-cost editing software, the digital video can tampered. To avoid tampering two techniques are used to detect double MPEG compression in [8].

An efficient method is used for detection of double compressed JPEG images in [7]. The Markov transition probability matrix (TPM) can accurately identify double-compressed JPEG images which are shown in [3]. In [9], the double compression detection is done by observing the periodic artifacts in Discrete Cosine Transform (DCT) histograms. The double compression in H.264 is detected based on the probability distribution of quantized non-zero AC coefficients in [4]. Peak signal-to-noise ratio (PSNR), which is calculated as the error between the original and the compressed image. In [2], peak signal-to-noise ratio is estimated using Quantized DCT Coefficients.

## II. EXISTING SYSTEM

The existing system uses first digit distribution and discrete cosine transform (DCT) histograms for detecting double MPEG-4 compression. The disturbance in the probability distribution of the first digits of non-zero quantized AC coefficients is used as evidence of double compression. Only first digit distributions from the intra-coded frames are selected to further enhance the detection accuracy.

A method for detecting video tampering with a device, the method comprises of receiving a plurality of video frames of a Group of Pictures (GOP);determining a probability distribution for each of the plurality of video frames; comparing the probability distributions to a reference distribution; and determining whether the GOP corresponds to a tampered video bit stream in response to comparing the probability distributions to the reference distribution, wherein the plurality of video frames comprises at least one intra-coded video frame and at least one of a plurality of predictive coded video frames or a plurality of bi-directionally predictive coded video frames.

The disadvantages of using first digit distribution and discrete cosine transform histogram are high complexity, detection accuracy is less because of weak discriminative power and compression artifacts cannot be detected fully.

## III. DECODING PROCESS

MPEG-4 is the object-based representation model. Each object-based model is built using individual objects. Each object is represented by the blocks, which are encoded by using DCT, quantization, and entropy coding. The decoding process consists of three steps, entropy decoding, de-quantization and inverse discrete cosine transform. The entropy decoding consists of two steps. The first step converts the input bit stream into the intermediate symbols. The second step converts the intermediate symbols into the quantized DCT coefficients. The output of the second step is the DC difference. The DC difference is then decoded into the quantized DC coefficient.

The quantization stage is where the majority of compression is achieved. This is also the stage where the majority of information can be lost and artifacts introduced. The quantization process is inherently lossy because of the many-to-one mapping process. The quantization process basically involves division of the DCT coefficient by a corresponding quantization matrix value based on spatial frequency. In [1], the reason for quantization is to represent the DCT coefficients with no greater precision than necessary for a desired visual quality.

## IV. DOUBLE MPEG-4 COMPRESSION DETECTION

Markov statistics based features are adopted for detecting doubly compressed MPEG-4 videos. Markov statistics is a second order statistics in which the detection accuracy is increased. Markov based features are adopted to detect double compression artifact in the original video. Markov statistics is distinguishable for both single and double compression in JPEG images [5]. The various advantages of using Markov statistics are low complexity, detection accuracy is more, and compression artifacts can be detected by using Markov feature.

Markov statistics is very effective in the double MPEG-4 compression detection. Figure 1 shows the Markov feature extraction. There are various steps to extract the Markov feature in MPEG-4 videos.

- During decoding process the quantized DCT coefficients are extracted. This process consists of three steps, entropy decoding, de-quantization and inverse discrete cosine transform. For next step only the magnitudes of the coefficients are considered.
- From the quantized DCT coefficients the difference array is computed along the horizontal, vertical, major diagonal, and minor diagonal directions. The double compression artifacts are extruded during the differential operation.

- By thresholding operation the difference array is truncated. Each difference array, D, is modelled along the same direction.
- The horizontal, vertical, major diagonal and minor diagonal transition probability matrices are obtained.
- Finally, the horizontal and vertical matrices, major and minor diagonal matrices are averaged separately.

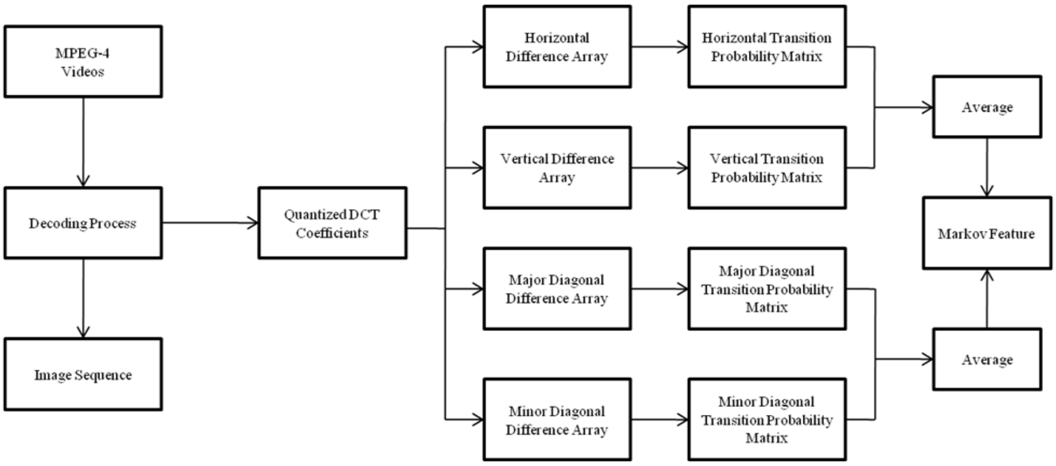


**Figure 1.** Block diagram of Markov feature extraction

## V. COMPARISON OF TWO VIDEOS

Two videos of different sizes are compressed and compared. During compression the artifacts present in the video is detected. After compression the size of the video and the detected artifacts are reduced. The ratios such as PSNR, MSE and SSIM are calculated for the compressed video.
The input video 1 is shown in Figure 2. The given input video for compression has 340 numbers of frames and size is 240*360.

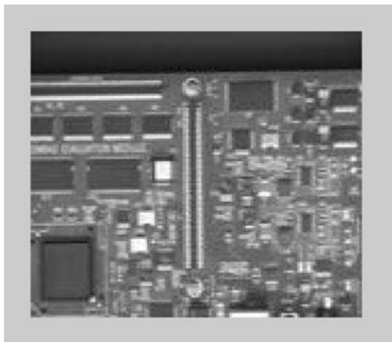

**Figure 2.** Input video 1

The input video 2 is shown in Figure 3. The given input video for compression has 440 numbers of frames and size is 340*460. The input videos comprised of several artifacts.

**Figure 3.** Input video 2

The comparison of two videos is shown in the Table 1. The table consists of the compressed video ratios such as peak signal-to- noise ratio, mean squared error and structural similarity index for each frame.

**Table 1.** Comparison of two videos

| Frame | Compressed Video 1 | | | Compressed Video 2 | | |
|---|---|---|---|---|---|---|
| | PSNR | MSE | SSIM | PSNR | MSE | SSIM |
| 10 | 17.75 | 603.57 | 0.68 | 21.17 | 62.60 | 0.57 |
| 20 | 17.67 | 680.50 | 0.66 | 17.23 | 110.32 | 0.69 |
| 30 | 18.03 | 867.79 | 0.58 | 19.06 | 74.25 | 0.39 |
| 40 | 19.06 | 922.57 | 0.57 | 14.70 | 84.49 | 0.55 |
| 50 | 17.96 | 851.38 | 0.59 | 11.33 | 94.23 | 0.62 |

## 5.1. Peak Signal-to-Noise Ratio (PSNR)

The PSNR computes the peak signal-to-noise ratio, in decibels, between two images. This ratio is often used as a quality measurement between the original and a compressed image. The higher the PSNR, the better the quality of the compressed or reconstructed image. The PSNR is most commonly used as a measure of quality of reconstruction of lossy compression codec's (e.g., for image compression). In this case, the signal is the original data, and the noise is the error introduced by compression. When comparing compression codec's it is used as an approximation to human perception of reconstruction quality, therefore in some cases one reconstruction may appear to be closer to the original than another, even though it has a lower PSNR. PSNR is measured in decibels (dB).

The PSNR is defined as:

$$PSNR = 10.\log_{10}(MAX_I^2 / MSE)$$
$$= 20.\log_{10}(MAX_I / (MSE)^{1/2})$$
$$= 20.\log_{10}(MAX_I) - 10.\log_{10}(MSE)$$

The peak signal-to-noise ratio waveform for the compressed videos is shown in Figure 4. For each frame, the ratio increases for the compressed video1 and the ratio decreases for the compressed video 2. When comparing both the compressed videos, the compressed video1 has better PSNR ratio. Based on the ratio the waveform shows the quality of the compressed videos.

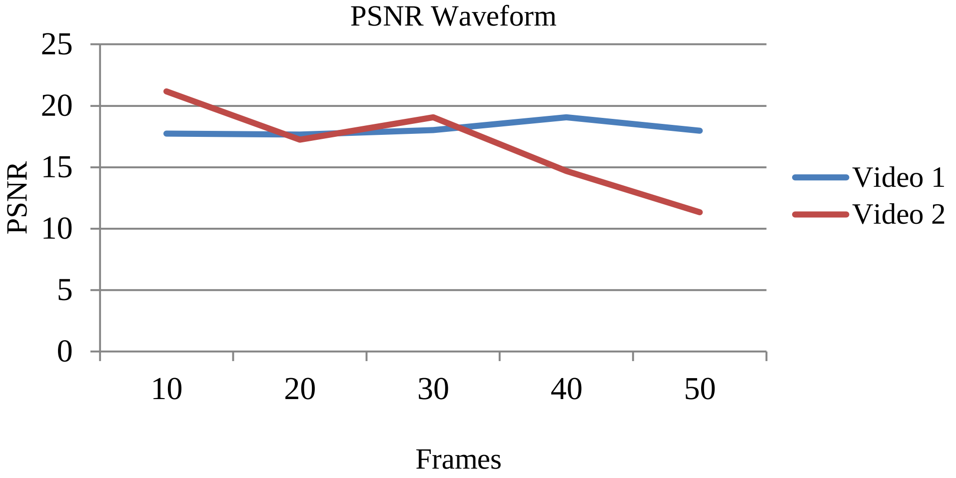


**Figure 4.** PSNR waveform for compressed videos

### 5.2. Mean Squared Error (MSE)

The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) are the two error metrics used to compare image compression quality. The MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR represents a measure of the peak error. The lower the value of MSE, the lower the error.

$$MSE = \frac{\sum_{M,N} [I1(m,n)-I2(m,n)]^2}{M*N}$$

The mean squared error w for the compressed videos is shown in Figure 5. For each frame, the ratio increases and finally decreases for the compressed video 1. The compressed video 1 have minimum quality. For each frame, the ratio increases for the compressed video 2. When comparing both the compressed video 2 has minimum mean squared error.

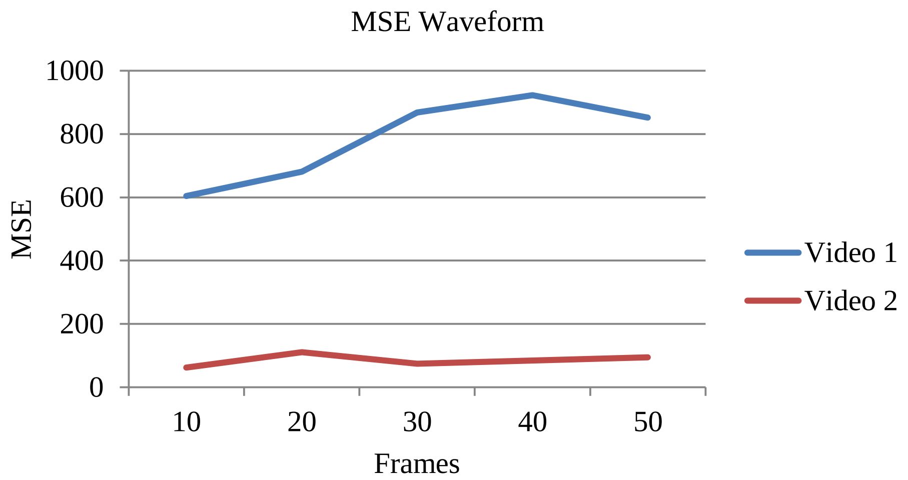


**Figure 5.** MSE waveform for compressed videos

### 5.3. Structural Similarity Index (SSIM)

The structural similarity (SSIM) index is a method for measuring the similarity between two images. The SSIM index is a measuring of image quality based on an initial uncompressed or distortion-free image as reference. SSIM is designed to improve on traditional methods like peak signal-to-noise ratio and mean squared error.

The structural similarity index waveform for the compressed videos is shown in Figure 8. For each frame, the ratio decreases for the compressed video 1 and the ratio increases for the compressed video

2. This waveform shows the quality of the video. When comparing both the compressed videos, the quality of the compressed video 2 is increased.

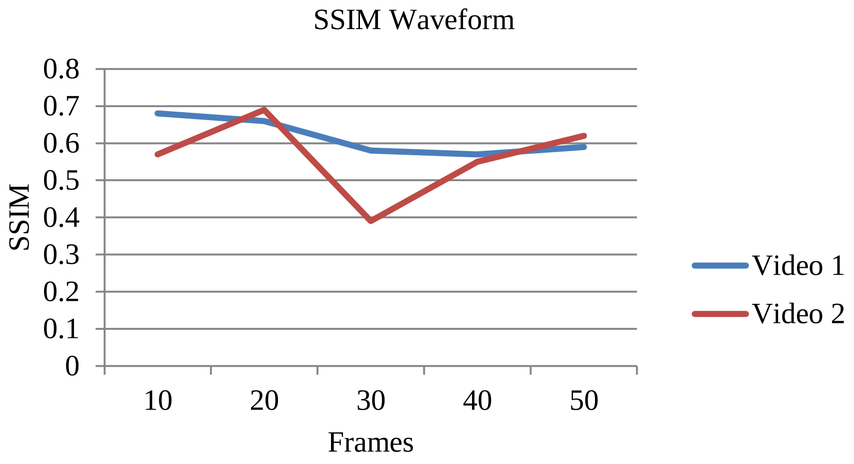


**Figure 6.** SSIM waveform for compressed videos

## 5.4. Compressed Output Videos

The compressed output video 1 is shown in Figure 7. By compressing the artifacts present in the video can be reduced using Markov statistics. Before compression the original size is 240*360 which contains 340 frames. After compression the size is reduced to 129*129 and the number of frames is also reduced to 55. The compressed video is different from the original video after removing the artifacts. Compression takes more time but produces better result.

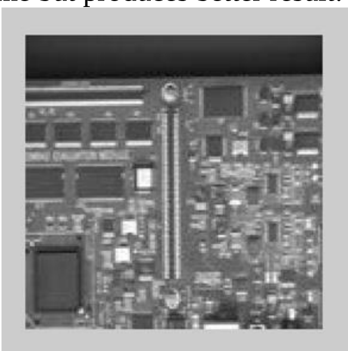

**Figure 7.** Compressed output video 1

The compressed output video 2 is shown in Figure 8. By compressing the video, size and artifacts are reduced. Before compression the original size is 340*460. After compression the size is reduced to 129*129 and the number of frames is also reduced to 55.

**Figure 8.** Compressed ouput video 2

# VI. CONCLUSIONS

In MPEG-4 videos the double compression is detected using an effective method. Double quantization with different parameters will inevitably introduce rounding errors, leaving detectable artifacts. Markov random process could capture the artifacts and detect double-compressed videos. The first digit distribution and DCT histogram fails to achieve the detection accuracy. The detection accuracies achieved by using Markov feature. Markov feature is second-order statistics and it can extrude the subtle artifacts. By using this feature the efficiency of the system increases and complexity is reduced. Finally two video are compared and the ratios such as peak signal-to-noise ratio, mean squared error and structural similarity index are calculated.

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