International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 07, July-2020

A Robust Video Compression Algorithm for Efficient Data Transfer of Surveillance Data

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Abstract - The compression models play an important role for the efficient bandwidth utilization for the streaming of the videos over the internet or TV channels. The proposed method improves the problem of low compression ratio and degradation of the image quality. The motive of present work is to build a system in order to compress the video without reducing its quality and to reduce the complexity of existing system. The present work is based upon the highly secure model for the purpose of video data compression in the lowest possible time. The methods used in this paper such as, Discrete Cosine Transform and Freeman Chain Code are used to compress the data. The Embedded Zerotree Wavelet is used to improve the quality of the image whereas Discrete Wavelet Transform is used to achieve the higher compression ratio. Finally quantitative analysis is performed on existing technique and through present technique through PSNR, CR and BER which clearly shows that present work is better that existing technique.

Keywords - Discrete Cosine Transform, Freeman Chain Code, Embedded Zerotree Wavelet and Discrete Wavelet Transform.

I. INTRODUCTION

Data compression is a reduction in the number of bits needed to represent data. The main motivation beside image compression is to reduce excess and insignificance information from the image. Thus compressed image is described by lesser number of bits in contrast with original. Therefore the required storage volume will be deceased; as a result large number of images can be stored with the same memory space and moved in quicker approach to spare the time, transmission bandwidth [1]. Compression is the mechanism or method of compacting, raw or uncompressed data into a smaller number of bits [2]. Compression can be the in form of data compression, compression of images, audio and video compression and bandwidth compression in telecommunication. Techniques of image compression have been designed to manipulate the statistical redundancy presents within images of real world. Emerging standard include MPEG for compression of motion video, JPEG of compression for still images and CCITT H.261 for compression of video telephony and teleconferencing [3]. Image compression in a brief way can be represented as a process that tend to operate on the image and hence perform modification on the elements of the image to perfectly scale down its size to a visually appealing level. By performing this process, it is possible to bring down the size required to archive the image and also the bandwidth allocated to transfer that image could be cropped [5].

Broadly compression can be classified into two types: lossless compression and lossy compression. In this paper a lossless compression technique is used to compress the video. Lossless compression compresses the image by encoding all the information from the original file, so when the image is decompressed, it is exactly identical to the original image. Lossless compression technique involves no loss of information [8].

II. LITERATURE REVIEW

The approach of two optimization procedures to improve the edge coding performance of Arithmetic edge coding (AEC) for a depth image. The first procedure operated within a code block, and allowed lossy compression of the detected block boundary to lower the cost of AEC, with an option to augment boundary depth pixel values matching the new boundary, given the augmented pixels do not adversely affect synthesized view distortion [4]. In region-of-interest (ROI)-based video coding, ROI parts of the frames are encoded with higher quality than non-ROI parts. At low bit rates, such encoding may produce attention grabbing coding artifacts, which may draw viewer's attention away from ROI, thereby degrading visual quality. In this paper, saliency-aware video compression method is presented for ROI- video based coding. The proposed method aimed at reducing silent coding artifacts in non-ROI parts of the frames in order to keep user's attention on ROI. Moreover, the method allows saliency to increase the higher quality parts of the frame, and decrease the non-ROI parts [6]. A combined DWT-DCT approach to perform the video compression with scalability vector. In this approach, DWT was performing the adaptive filtering, and DCT used these weighted values as DCT coefficient. The combined approach returned the high degree of compression ratio. It was given the compression approach to reduce the media size and improved the video compression by improving the frame based similarity and the correlation [7]. The EZW encoder was based on progressive encoding to compress an image into a bit stream with increasing accuracy and the bits in the bit stream were generated in order of importance in this coding algorithm. Another technique was discrete wavelet transform which was one of the most common method used in the signal and image compression and compared to other transform because its ability to represent any type of signals both in time and frequency domain. In future work comparison can be making between two techniques of the image compression i.e. discrete cosine transform and discrete wavelet transforms [9]. A discrete wavelet transforms (DWT) and discrete cosine transforms (DCT) which was most commonly video compression techniques and achieved a high compression ratio and preserved the video quality. DCT has high energy compaction and requires less computational resources, DWT on the other hand was a multi resolution transformation. The results gave high compression ratio and better reconstructed quality [10].

III. PRESENT WORK

The present work improves the problem of low compression ratio and degradation of the image quality by utilizing the algorithms like discrete Cosine transform (DCT), freeman chain code (FCC), embedded zero tree wavelet (EZW) algorithm, and discrete wavelet transform (DWT).

The validation of proposed work is done through quantitative analysis using metrics such as peak signal to noise ratio (PSNR), compression ratio (CR) and bit error ratio (BER). The proposed work has been implemented on 24 bit color RGB BMP frame based video files.

The existing methods for video compression had a problem of edge simplification and augmentation to clean and align the edges of the image after the compression. The edge simplification and augmentation cause the pixel distortion (low compression ratio) and the degradation of quality frames from video.

IV. METHODOLOGY

At the first stage, the video is loaded and divided into the frames. The DCT is used to improve the degradation of the image and after that the methods freeman chain code, embedded zero tree wavelet and discrete wavelet transform are applied on that frames to improve the quality of the video and compression ratio.

Following algorithm shows the working of present technique:

1. Load the video as input.
2. Extract the frames from the video. (30 frames (fps) are extracted)
3. Apply Discrete Cosine Transform (DCT) on the image for encoding and converts it into digital to binary. Firstly, image is divided into small N*N blocks where DCT is applied into these blocks and DCT coefficients are generated. Steps described below shows the generalized steps in order to implement DCT algorithm to compress an image and further mentioned as:
   i. Acquire the input image matrx.
   ii. Compute the number of blocks in the given image matrix in block size of (N, N), where N=8.
   iii Enlist the threshold values default for the DCT algorithm.

i. Iterate for all of the blocks:

a) Apply Left to Right (L-R) & Top to Bottom (T-B) approach, which jointly becomes the LRTB approach.

b) Quantize the computed image blocks using cosine transform.

c) Compute the quantized block from the given block.

i. Rearrange the small blocks to reconstruct the image matrix.

ii. Return the reconstructed image matrix.

4. Apply Freeman chain code (FCC) to return the connected sequence of straight line. Following are the steps to compress an image using freeman chain code:

i. Load the image matrix.

ii. If the image is found 3-D, then Convert the image to 2-D.

iii. Apply the active contour model over the 2-D image matrix to mark the objects or regions in the image matrix.

iv. Perform the region selection over the objects detected in the step 3, using the freeman chain code (FCC) model.

v. Compress all of the selected regions.

vi. Reconstruct the image matrix.

vii. Return the compressed image matrix.

5. Apply Embedded zero tree wavelet (EZW) to place the compressed columns or rows in the perfect sequence for handling of the compression data. The steps are as follows to compress an image using embedded zero tree wavelet algorithm:

i. Acquire the image matrix (Y) from Freeman Chain code's Output.

ii. Iterate through the image matrix by accessing each pixel (x, y)

iii. Obtain the threshold of each of the target pixel by using the equation:

iv. Compute the factor array, F ← |Y (x, y)|

a) Th ← 2 * ($\log_2$ (max(F)))

v. If image is grayscale

a) Compute the dominant pass, which gives the small orientation of the Y band

b) If threshold of the dominant pass model is lower than the Y band (Frequency band)

a. Convert the pixel to gray

a) Otherwise

a. Keep the first component pixel as grayscale pixel.

vi. Compute the final smaller orientation matrix by combining the dominant pass from step 4 or 5.

a) Iterate on all pixels in all image planes.

a. Apply the zero wavelet selection on the current component (plane)

b. Find the maximum value in the component matrix, Th1

$$\min_{value} \int_{i=0}^{m} \int_{j=0}^{n} fx(K_i\, K_j) \quad (1)$$

Where, $fx =$

$$\begin{Bmatrix} if\ K_i \geq K_j & Return\ K_i \\ if\ K_i < K_j & Return\ K_j \end{Bmatrix} \quad (2)$$

c. Compute the final threshold, Th ← Th1 / 2

d. If the pixel value is higher than Th

i. Select the pixel

e. Otherwise

i. Reject the pixel

f. Return small orientation matrix (compressed)

b. Return SOM to user

4. Apply discrete wavelet transform to compress the data by obtaining the approximation component from the data matrix. Discrete wavelet transform

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 07, July-2020

describes the steps which are required to compress an image such as:

i. Acquire the image matrix from the output of EZW.
ii. the given image matrix in block size of (8, 8).
iii. Obtain the Haar wavelet.
iv. Enlist the threshold values according to the wavelet type.
v. Iterate for all of the blocks individually

a) Apply Left to Right (L-R) & Top to Bottom (T-B) approach, which jointly becomes the LRTB approach
b) Individually inspect all of the pixels in the image data.
c) Quantize the computesd image blocks.
d) Compute the quantized block from the given block.
e) Combine the quantized blocks in the output image matrix.

vi. Compose the output matrix.
vii. Rearrange the image pixels.
viii. Return all coefficients.

5. Reassemble the frames in the video object.
6. Return the video object.

V. RESULTS AND DISCUSSIONS

Present work uses four algorithms to provide efficiency of the system. Every technique gives appropriate result with respect to reach the objectives of the present system. The following results define the present technique which has been used in order to compress the video without losing its quality.

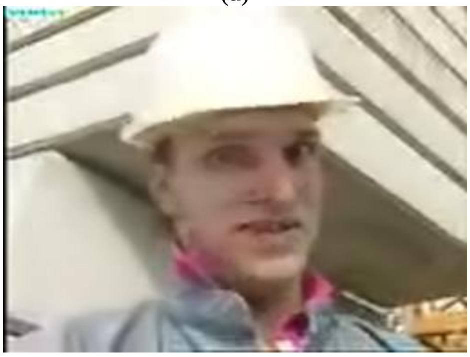
Video streaming is the first level of the proposed system. At this level, the task is to load the video for pre-processing. The video is loaded either from the system or live streaming can be done. Proposed algorithm is used to extract the frames from video and process it. The video file name is assigned to the object. Then the video file is read by VideoReader and assigned to reader object. For these video file, VideoReader can only determine the number of frames after reading the last frame.

The loading time of the video depends on the size of the video. In the proposed work, there are four testing videos and each has their own execution time in second for calculating number of frames.

Extraction of frames is done after loading the video. In the proposed system, the number of frames is calculated, while loading the already captured video. A message box is appears while extracting the frames. In the proposed work, numbers of frames are extracted according to video size.

Figure 1 shows the video frames of "Foreman" video before and after compression. The size of this video is 66.8 KB and it is of 12 seconds. The numbers of extracted frames are 144 from this video.

(a)



(b)

Figure 1: (a) Original Video and, (b) Compressed Video "Foreman"

Figure 2 shows the video frames of "Positively radiant" video before and after compression. The size of this video is 306 KB and it is of 30 seconds. The numbers of extracted frames are 363 from this video.

(a)

(b)

Figure 2: (a) Original Video and, (b) Compressed Video "Positively radiant"

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Table 1: Comparison of quality metric parameters based on compression ratio (CR)

Video names	CR(Existing)	CR(Proposed)
Foreman	72.968	73.862
Positively radiant	74.098	75.158

Table 2: Comparison of quality metric parameters based on bit error ratio (BER)

Video names	BER(Existing)	BER(Proposed)
Foreman	0.0290	0.0223
Positively radiant	0.050	0.024

Table 3: Comparison of quality metric Parameters based on peak signal to noise ratio (PSNR)

Video names	PSNR(Existing)	PSNR(Proposed)
Foreman	33.15	34.905
Positively radiant	31.65	32.532

Table 1, Table 2 and Table 3 shows that the results of present system are always better than the existing techniques. As the higher value of CR, BER, and PSNR are always considered good.

In figure 3 the comparisons of present value with existing value shows that the result of present system is better than existing.

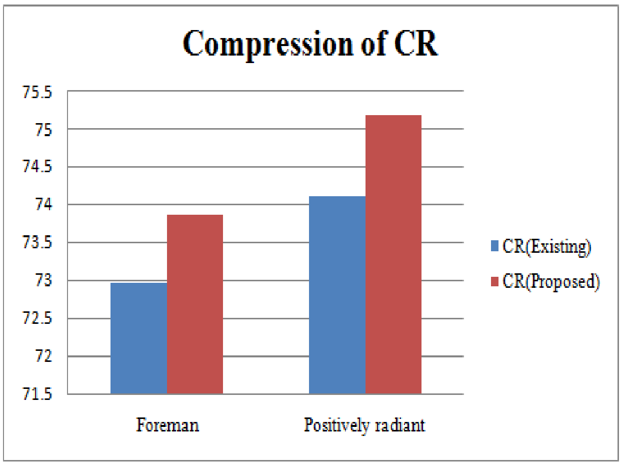

Figure 3: Comparison between existing technique and proposed compression ratioFigure 4 and Figure 5 shows the graphical representation of comparisons of existing system with proposed system based on BER and PSNR.

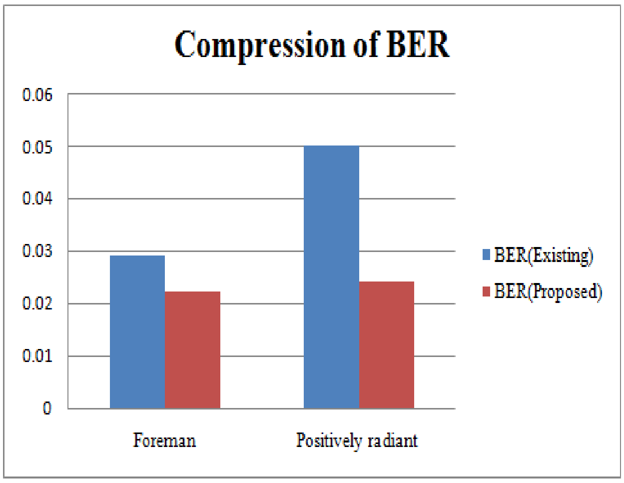

Figure 4: Comparison between existing and proposed bit error ratio (BER)

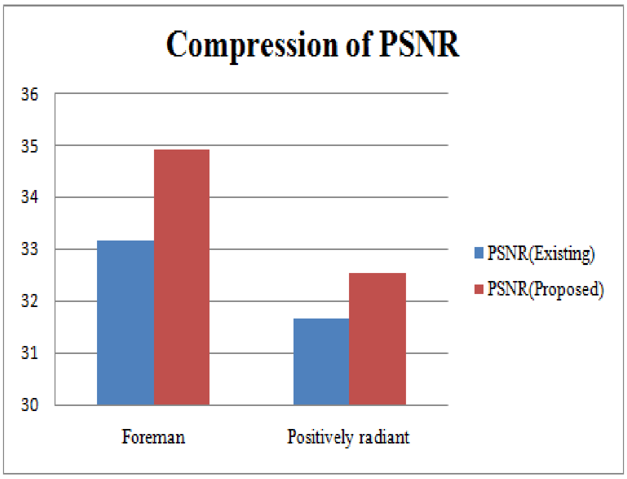

Figure 5: Comparison between existing technique and proposed peak-signal-to-noise ratio (PSNR)

VI. CONCLUSION AND FUTURE SCOPE

The compression models play an important role for the efficient bandwidth utilization for the streaming of the videos over the internet or TV channels. The proposed model is based upon the highly secure model for the purpose of video data compression in the lowest possible time. The proposed method is based upon the combination of discrete cosine transform (DCT), Freeman chain code (FCC), Embedded Zero Wavelet (EZW) and discrete wavelet transform (DWT) algorithms.

The proposed method is designed to achieve the maximum compression ratio with the minimum bandwidth utilization, while achieving the improved quality based parameters, which is measured using the parameters of peak signal to noise ratio (PSNR), compression ratio (CR) and bit error ratio (BER). The PSNR value obtained from decompressed image and original image has been recorded between 34 and 36 decibels, which are found higher than the maximum PSNR value of nearly 33 decibels in the existing model.

In the future, the proposed model can be further improved by using the combination of discrete wavelet transformation (DWT) along with the optimization models such as genetic algorithm (GA), particle swarm optimization (PSO), grey

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 07, July-2020

wolf optimization (GWO) to achieve the higher compression ratio in comparison with this model. Also, the embedded zero tree wavelet (EZW), discrete cosine transform (DCT) or freeman chain code (FCC) can be further improved or replaced with other efficient compression algorithms to realize the robust video compression model.

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