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Study, Design and Deployment of a Video Compression Technique through Crossbreeding Discrete Wavelet Transformation & Discrete Cosine Transformation

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Abstract*— Compression of video consider as a significant and most required approach in real-time applications like investigation, video conferencing, surveillance system. AVI, MPEG, and WMV are the video file format used for implementing video compression techniques. In this paper, Combination of Discrete Wavelet and Discrete Cosine Transformation technique is performed followed by Arithmetic Coding. One of the most important application of video compression, therefore we are presenting a video compression technique in this paper.

***Keywords*— Arithmetic Coding, DWT, DCT, MSE, PSNR, RGB, SNR, YCbCr**

I. INTRODUCTION

The term "video" can be defined as the visual multimedia source which is formed by the combination of sequence of images to form a moving picture which in turn transmits signals to the screen and processes the order in which the screen captures should be shown. As having a sequence of thousands of images, size of video becomes the concern when we talk about storage space.

In this paper, we have discussed and focused in the video compression techniques used to reduce and remove redundant video data so that a digital video can be effectively sent over a network and stored in disks by using our various methodologies: Discrete Wavelet Transformation and Discrete Cosine Transformation. In video compression, we have different methodologies or techniques that compresses the video on the basis of different parameters due to which results differ in bit rate, latency and quality of the video Ex: A video of 720p when compressed becomes either 480p pixel size or difference occurs in its video quality.

II. LITERATURE REVIEW

In this segment, we are presenting the research work of some prominent authors in the same field and explaining a short description of various techniques used for video compression.

Jasmeet Kaur et al [1] works on high degree of compression ratio and improve the video compression by improving the frame based similarity and the correlation. Media size is reduced by finding similar frames and discarding it. Anurag Bhatt et al [2] works on LOT (Lapped Orthogonal Transform) and Discrete Cosine Transformation are using with JPEG 2000 standard. Thazni Aziz et al [3] Full Search strategies are used to reduce computation. Their goal of wavelet based compression is to store video data in a little space. Seema Kalangi et al [4] propose an approach for video compression using DWT technique which tends to hard exploit the relevant temporal redundancy in the video to improve solidity efficiency with minimum processing complexity. Er. Naveen Dhillon et al [5] discussed about various transformation of compression like FFT, DCT, DWT and FWT. Sandeep Kaur et al [6] [7] to evaluate a set of wavelets for image compression using wavelet transforms results in an improved compression ratio on various wavelet families such as Biorthogonal, Symlets and Haar using Discrete Wavelet Transform and Fast wavelet transform. Nageswara Rao Thota et al [8] used lossy compression techniques, where data loss cannot affect the image clarity in this area. Harjeetpal Singh et al [9] presents DWT and DCT implementation because these are the lossy techniques and also introduce Huffman encoding technique which is lossless.

III. METHODOLOGY

Video is made of different frames (same as still image) passed in a sequence with 30 frames per second (fps) typically. Compression methods are acknowledged as algorithms, which are calculations so as to compress file format. There are two types of compression methods : lossy and lossless compression. Lossy compression creates smaller files by discarding some information about the original file. Whereas, lossless compression never discards any information about the original file. Lossless compression algorithms reduce file size with no loss in quality of image/video. When the encoded file is saved it is compressed file, when it is de-compressed (opened) the original data is retrieved. The main advantage of lossless compression is to maintain quality of data and the main disadvantage is it doesn't reduce the file size as much as lossy compression. Lossy and lossless techniques use different algorithms to achieve good quality

graphics with smaller file size. Video data may be represented as a series of still frames. The sequence of frames contains spatial and temporal redundancy that video compression algorithms attempt to code in a smaller size. A CODEC (Compressor/ De-compressor) is used carry out the algorithm to save a file in a compressed format and unwrap a compressed file format. CODECs can be implemented in both hardware and software. Implementation of hardware CODECs are more expensive but it uses dedicated chips instead of the computers CPU time, therefore, it is significantly more efficient. To encode the video sequence, following steps are follows :

STEP 1 : Read the input

Read the video sequence of file format. In this paper, input video file format is AVI (Audio Video Interleave) and having 320X240 dimension. This video contains 69 frames.

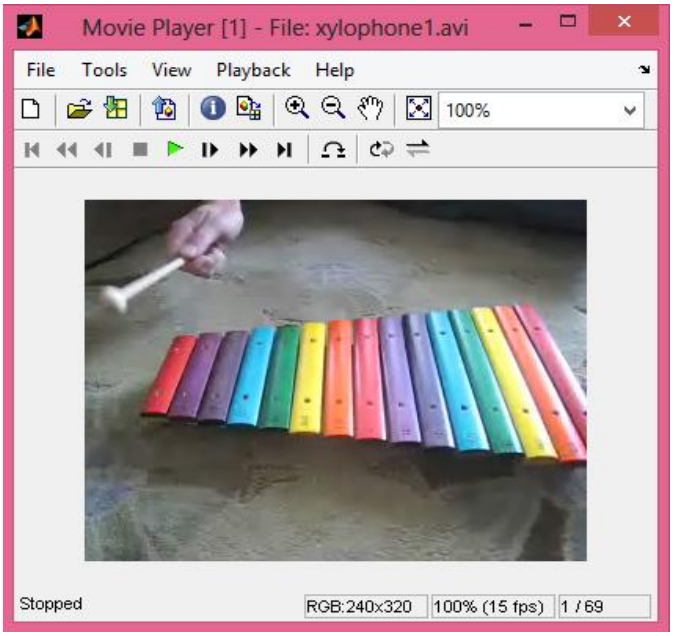


Fig 1 : Input video sequence

STEP 2 : Split the video sequence into frames

There are 69 frames so split the each frames from video for performing transformation on each frames individually. Each frame has its own significance in video. Hence, we cannot ignored any of frame.

Fig 2 : Four Consecutive Frames of input video

STEP 3 : Convert colour (RGB) frames into YCbCr components

Transformation coding is done on greyscale images. If we convert colour image into grey image then its inverse is not possible and we found output image in grey values. To overcome this problem first convert RGB into YCbCr image where Y presents luminance (brightness) of image, Cb presents blue chrominance image and Cr presents red chrominance image.

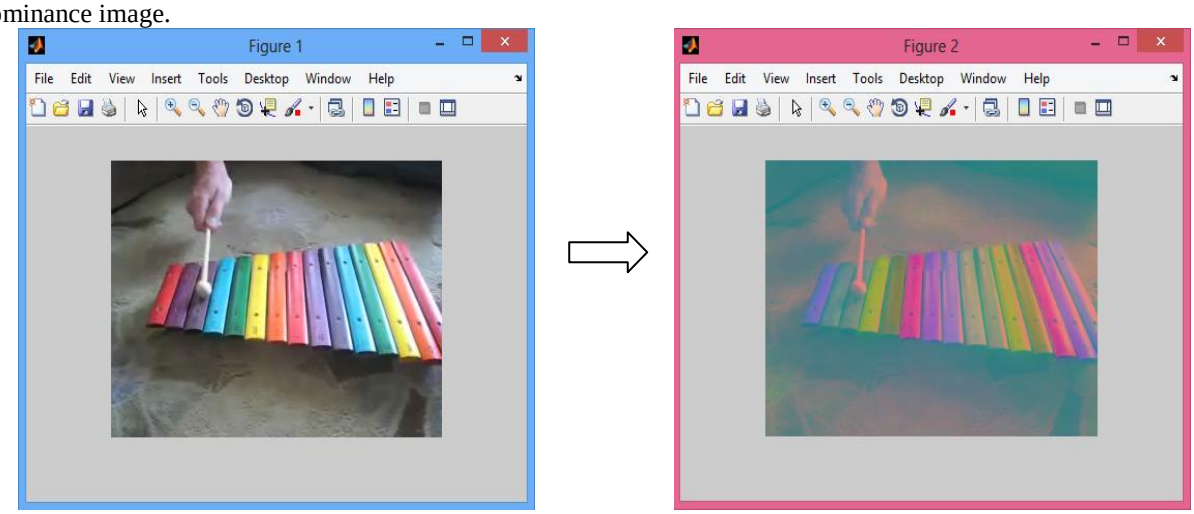


Fig 3 : RGB to YCbCr

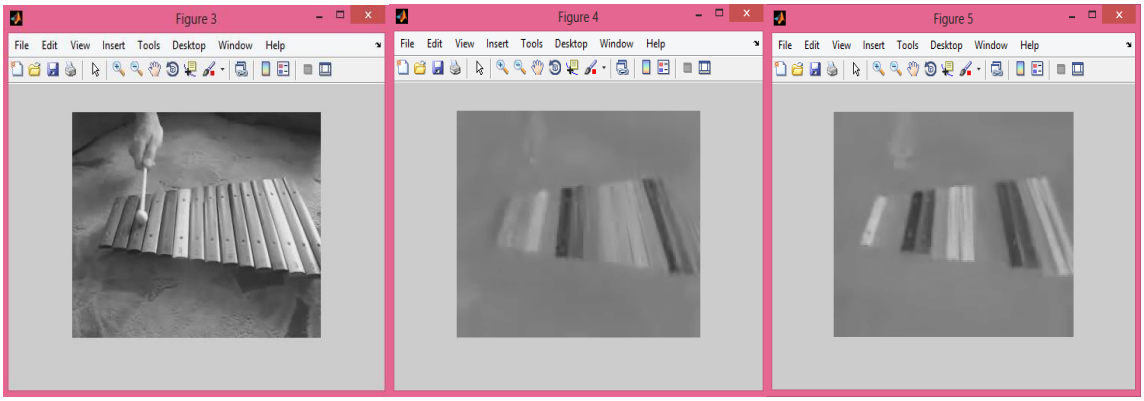


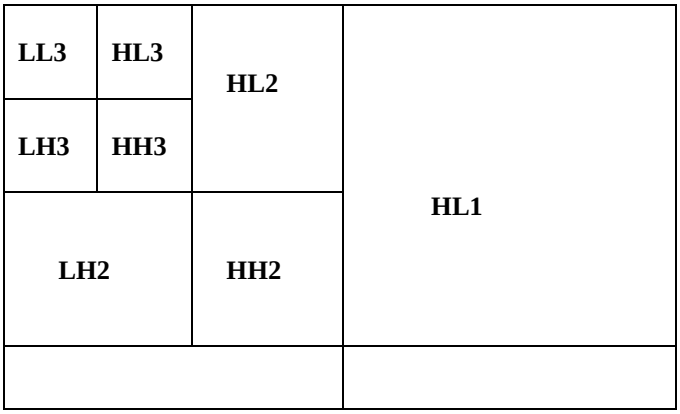
Fig 4 : Luminance (Y) Layer, Chrominance Blue (Cb) Layer, Chrominance Red (Cr) Layer

STEP 4 : Performed transformation on each three layers of frames of video sequences

Selection of transformation technique should be such that its inverse transformation should be possible. In this paper we are taking two different techniques i.e. Discrete Wavelet Transform and Discrete Cosine Transform and combine their parameters.

A. DISCRETE WAVELET TRANSFORM

The Discrete Wavelet Transform passes an image, through a pair of filters, i.e., a low pass filter (LPF) and a high pass filter (HPF) where low pass filter yields low resolution image and high pass filter yields the dissimilarity in an image. The outputs of both filters are down-sampled by two. The down-sampled output images have the identical number of bits as the input image. The original image is reconstructed, when the up-sampled output of the LPF is added to the up-sampled output of the HPF. The output of the HPF is fed into another pair of filters and the process repeated [3].



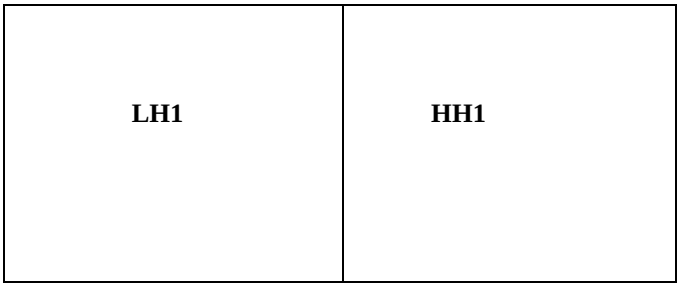


Fig 5 : Sub-band images

B. DISCRETE COSINE TRANSFORM

A discrete cosine transform (DCT) states a sequence of many data points in terms of a sum of cosine functions at different frequencies. A discrete cosine transform (DCT) helps to split the image into parts (or spectral sub-bands) of differing importance (with respect to the image's visual quality). The DCT transforms a image from the spatial domain to the frequency domain. The basic operation of the DCT is as follows:

- The input image is N by M.
- f(k,l) is the intensity of the pixel in row 'k' and column 'l'.
- F(u,v) is the DCT coefficient in row k1 and column k2 of the DCT matrix.
- For most images, much of the signal energy lies at low frequencies; these appear in the upper left corner of the DCT.
- Compression is achieved since the lower right values represent higher frequencies, and are often small - small enough to be neglected with little visible distortion.
- The DCT input is an 8 by 8 matrix of integers. This matrix contains each pixel's gray scale level.
- 8 bit pixels have levels from 0 to 255 [2].

STEP 5 : Performed Arithmetic encoding

In arithmetic coding a source group is represented by an interval between 0 and 1 . Every symbol of the band narrows the interval. When the interval becomes lesser, the number of bits required to indicate it. Arithmetic encoding assumes an explicit probabilistic replica of the supply. It is a defined-word scheme which uses the probabilities of the source messages to successively narrow the interval used to represent the group. A high probability message narrows the interval less than a low probability message, so that high probability messages give fewer bits to the coded group. The method begins with an unordered list of source messages and their probabilities. The number line is divided into subintervals based on cumulative probabilities.

VI. RESULTS

Table 1 shows the result of PSNR (Peak Signal to Noise Ratio) of proposed method and compared the compressed size with original size frames. The proposed method of video compression has been simulated on MATLAB. Input video sequence has 69 frames. Original size of each frames is 225Kb and 320X240 dimension. For compression, proposed method is combination of DWT and DCT transformation technique followed by Arithmetic coding. Compressed size of each frame is 88 Kb and 320X240 dimension. PSNR of combined DWT and DCT approach is good as compared to other transformations.

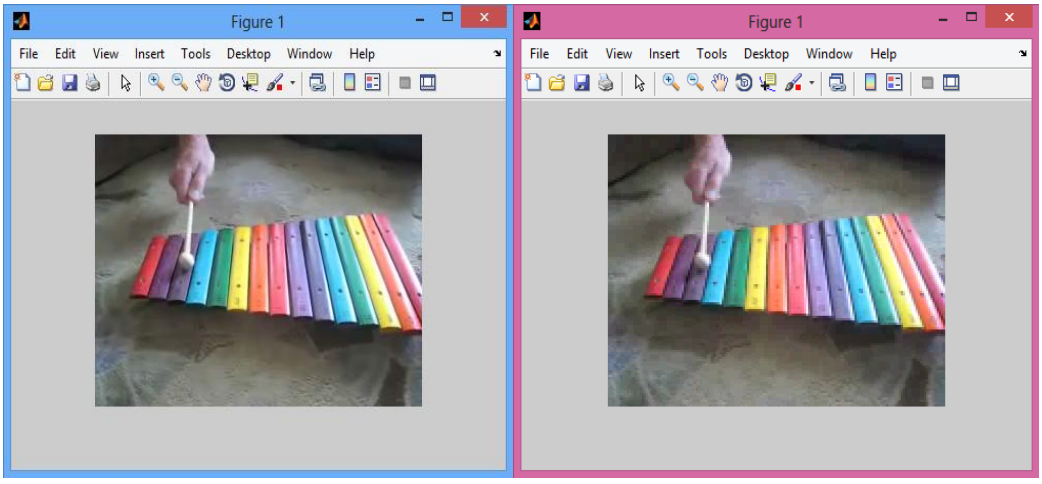


Fig 6 : Original Frame, Compressed Frame

As shown in above Fig.6 that coded frame is much similar to an original frame. Parameters of a compressed image is identical to an original frame. Quality of compressed frame is also good.

Table 1 : Comparison study

	DCT	DWT	DWT_DCT
ORIGINAL SIZE	225KB	225KB	225KB
COMPRESSED SIZE	200KB	204KB	88KB
MSE (approx.)	24.45	47.75	82.53
SNR (approx.)	14.01	12.51	11.36
PSNR (approx.)	34.25	31.34	28.96

MSE (Mean Square Error) should be larger as much as possible so that SNR (Signal to Noise Ratio) and PSNR (Peak Signal to Noise Ratio) value would be lower. PSNR value should be smaller because it represents the noise according to original image in an compressed image. According to above table, we can say that PSNR value of combined DWT and DCT approach is much better and smaller than individual DCT and DWT approach.

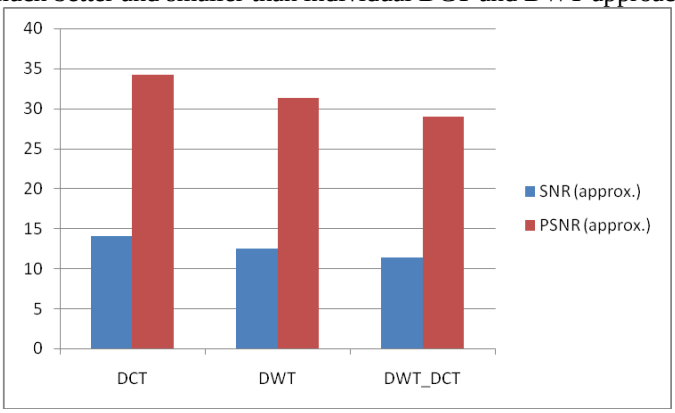


Fig 7 : Graph between SNR and PSNR

Fig. 7 shows graph between SNR (Signal to Noise Ratio) and PSNR (Peak Signal to Noise Ratio) for different transformation techniques of video frames. Blue bar shows the value of SNR and red bar shows the value of PSNR.

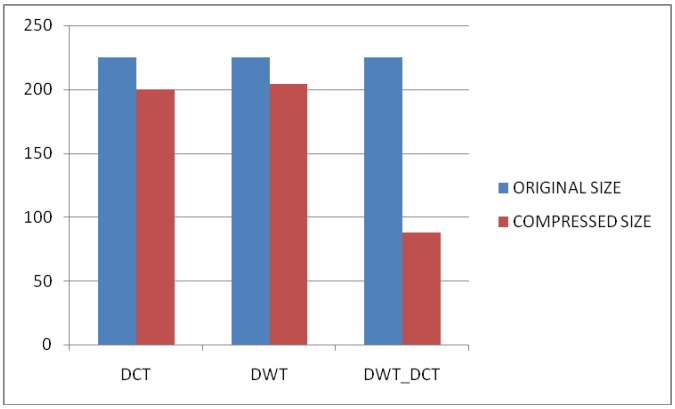


Fig 8 : Graph between original size and compressed size of frame

Fig. 8 shows graph between original size and compressed size for different transformation techniques of video frames. Blue bar shows original size of frame and red bar shows compressed size of frame.

V. CONCLUSION

In this paper, video compression technique using combined DWT and DCT is implemented in MATLAB 2010a version. This paper presents theoretical as well as mathematical background of compression techniques. According to the results, we can concluded that our given method of combined DWT and DCT shows better results.

VI. FUTURISTIC APPROACH

1. Implementation of combined DWT and DCT approach using MATLAB Simulink.
2. FPGA or ASIC Implementation of compression techniques.
3. Performed compression techniques on surveillance system.
4. Implement compression technique so that value of PSNR decreases and quality of video improves.

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