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The Discrete Trigonometric functions and Wavelet Transform for Adaptive Video Compression

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ABSTRACT
In order to reduce the amount of data needed for storage and transmission, videos are compressed. Popular transformations used for effective compression include the Discrete Cosine Transform (DCT) and the Discrete Wavelet Transform (DWT). DCT is efficient in compressing energy and uses little computational resources. The authors of this study offer a new approach to video compression by using a combination of discrete cosine transform (DCT), discrete wavelet transform (DWT), and arithmetic coding. By producing a code with the least amount of redundant information, arithmetic coding is used to improve the efficiency of a computer's processing of data. The experimental findings show that the suggested strategy achieves higher PSNR values and compression ratios than comparable approaches.

Keywords: Discrete Cosine Transform, Discrete wavelet transform.

INTRODUCTION
Virtual Multimedia programmes rely heavily on video content. Typically, the amount of storage space required for a video clip is rather large. The storage space needed for a 40-minute movie at a frame rate of 30 frames per second and a resolution of 750x570 is 1.39 GB. This uncompressed movie has extremely high needs for both storage space and transfer speed. There is a lot of repetition in both videos and pictures. The file size of a video is being compressed. There is a compromise to be made between the video quality and the quantity of compression produced throughout the video compression process. The quality of the reconstructed video will improve if the compression ratio is high. Both the discrete cosine transform (DCT) and discrete wavelet transform (DWT) are popular video compression methods. This is because the DCT has a high energy compaction characteristic and uses less computing resources than other methods. The ability of a technology to compress as much of the vital information signal into as few low frequency components as possible is known as its energy compaction feature. DCT's primary benefit is its ability to significantly reduce file sizes while preserving or even improving their

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quality. The primary goal of this study is to examine how well different degrees of compression work for a variety of picture and video applications using a proposed DCT DWT and Arithmetic coding technique.

Cosine Discrete Transform A. (DCT)

DCT is a computation-friendly alternative to the more involved Karhunen-Loeve Transform (KLT). As an added bonus, DCT is superior than DFT, DST, WHT, and DWT in terms of energy compaction. As a result, DCT is often used in the field of video and picture compression. Higher compression, however, results in blocking artefacts and outlining effects in the rebuilt picture. To add insult to injury, it is not the multi- resolution transformation method either.

DCT's high compression ratio comes at the cost of the following two drawbacks, though.

- Blocking artefacts: this distortion shows up as unnaturally big pixel blocks owing to increased compression. The obvious "blocking artefacts" across the block borders cannot be disregarded if a greater compression ratio is desired.
- False contouring: this distortion happens when an image with a smoothly shaded region is warped by an aberration that mimics a contour map. The improved quantization of the transform coefficients is the root cause of the phoney contouring effect.

Discrete Wavelet Transform (DWT)
The Discrete Wavelet Transform uses two filters—a low pass filter and a high pass filter—to transform a signal into a picture. As expected, the low pass filter causes a drop in signal clarity. A unique signal is produced by the high pass filter. These filters' outputs are halved in size by downsampling. The number of bits in the down sampled outputs is identical to that of the original signal. When the up sampled output of the low pass filter is combined to the up sampled output of the high pass filter, the original signal is replicated. High pass filter output is then sent into a second set of filters, and the process is repeated. The simplest kind of discrete wavelet transform is the Haar wavelet transform [1].

In recent years, the wavelet transform has been widely adopted for use in signal processing and picture compression. Wavelet-coding methods are well suited for applications that need both scalability and acceptable deterioration due to their multi-resolution nature. Just recently, the JPEG committee unveiled JPEG-2000, a new image coding standard built on DWT. In order to represent a signal using discrete wavelets, the discrete wavelet transform (DWT) is used.

C. Quantization
Once the transition is complete, quantization may begin. The optimal quantization method relies on the transform that was previously selected. Non-linear devices known as quantizes choose sample values for groups of transform input data, either sequentially (scalar quantization) or all at once (vector quantization).

The first stage in creating lossy compression is quantization. So that fewer bits are needed to represent the picture, the magnitude of the coefficients is reduced or rounded to the closest integer.

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Here, low image frequencies correlate to crucial picture characteristics, whereas high image frequencies connect to less crucial image elements. Pixels corresponding to high frequencies may be quantized extensively once a transform has isolated the different picture frequencies, whereas pixels corresponding to low frequencies should be quantized weakly or not at all. In this way, a transform may significantly reduce the size of a video file by discarding data solely related to the image's less crucial elements.

Correction for Movement (D)
Frames of a video may be understood individually. The MPEG-standard provides a method for decreasing temporal redundancy since consecutive frames of a video stream typically vary very little (unless during scene transitions). There are three different sorts of frames used: I-frames (intra), P-frames (predicted), and B-frames (relative) (bidirectional).

Key frames are the I-frames, which don't depend on any other frames and are compressed quite little. P-frames may be anticipated by looking at a previous I-frame or P-frame. Although P-frames need the same amount of storage as I-frames, only the differences need to be kept, thus they may be rebuilt without the referring frame [2]. The B-frames are like a mirror image of the P-frames, except they may be seen from any way (one forward frame and one backward frame). Due to the interpolation process, B-frames cannot be used as a reference in P-frames or vice versa. There are two types of coded frames in communications: inter, which refer to P- and B-frames, and intra, which refer to I-frames.

Coding using arithmetic means
For each bit, a codeword is substituted in a process known as arithmetic coding. The result is a single floating-point number in lieu of the input string. The key idea behind this method is to assign a range to each possible item of data [3]. While Huffman coding was the standard encoding technique for a long time, arithmetic coding has now replaced it. The information in a string may be processed using arithmetic coding as a single unit. If a and b are real integers between zero and one, then the message is represented by the half-open interval [a, b]. Initially, it's a range from 0 to 1. Having to represent a shorter interval with a greater number of bits is a problem when the message length rises.

RELATED WORKS

Multiple approaches have been presented employing DCT and DWT techniques for video compression. A novel method of video compression utilising DWT-DCT. This is a step forward in video compression technology, since it allows for a higher compression ratio with little loss of quality[4]. An approach to video coding scheme based on hybrid DWT- DCT transform, quantization, and generation of lowest redundancy code using the Huffman coding. Estimation utilising adaptive rood pattern search yields the suggested motion vectors, which are then globally compensated for their use. As a result of combining the benefits of the DWT and DCT approaches, the hybrid DWT- DCT transform may achieve higher compression rates. When sending the quantized, entropy-coded, Huffman-coded bit streams to the decoder, the hybrid compressed frame undergoes further compression [5].

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The Discrete Cosine Transform (DCT) technique is used to compress video. As video compression technology has improved, so too has video quality and content. When compressing videos, block matching methods are employed to estimate motion.

The goal of the saliency-preserving framework for region-of-interest (ROI) video coding is to keep the viewer's attention on the ROI parts of the frame, where the video quality is higher, by reducing attention-grabbing coding artefacts in non-ROI parts of the frame [6]. Quantization parameter (QP) matrices are calculated for each video frame using this method. So that, for a given goal bit rate, the saliency map of the coded frame is as close as possible to the saliency map of the original raw frame.

The Hybrid (DCT-DWT) algorithm for video compression was described. It is recommended that lossy compression methods be used when compressing videos. The compression method must be able to reduce the size of the original file while keeping the quality of the reconstructed video constant [7].

Image compression was much improved by a technique described, which included the use of mode-based k-means clustering to generate a vector quantization codebook. They presented an alternative approach that uses the vector quantization technique to compress medical pictures with varied codebook sizes for area of interest and non-region of interest. With the suggested technique, the quality of the rebuilt ROI picture is maintained despite the high compression ratio. When it comes to compressing images, many different approaches based on vector quantization and residual vector quantization have been developed. Combining the Haar-Wavelet Transform (HWT) with the Residual Vector Quantization (RVQ) methodology is a unique approach to medical image compression , and it produces a higher compression ratio than other medical image compression techniques without sacrificing picture quality. To further increase the quality of a compressed picture, a new approach of fractal image coding based on residual vector quantization has been presented.

DCT-DWT

Higher-quality videos may be compressed with more efficiency utilising a Hybrid scheme of transform methods [8]. In order to achieve a high compression ratio without sacrificing video quality, this work explores a new method of video compression that combines DCT-DWT with arithmetic coding.

The three-stage process that is suggested is explained below. In the first step, we use motion estimate and compensation to determine the dissimilarity between two input frames. In the next step, we use DCT-DWT transform and arithmetic encoding to obtain a compressed picture for use in the motion estimation frames. Using arithmetic decoding, a video with a compressed picture is rebuilt in the third phase.

At the outset, we take the time to transform the Input video into a count of frames. Two frames, the "present" frame and a "reference" frame, were chosen so that motion could be compensated for. The difference between the two frames is calculated using Mean absolute difference in Eq. once

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the chosen frames have been converted to binary representation (1).

where N represents the face of the macro bock. Frame1 and Frame2 are being compared in terms of the pixels Cij and Rij. For motion estimating methods that search for a best match in the region between two frames' worth of motion vectors, the block matching approach is utilised. Step two involves converting the [32x32] pieces that make up the motion estimate frame. Subsequently, we perform an independent transformation on each block. After applying a single level of DWT and throwing away all the coefficients save the LL's, the 32 × 32 block is reduced to 16 x 16. (i.e. LH, HH, and HL). The LL coefficients are subjected to a second round of 2D DWT, which results in a [8 x 8] block after deleting the LH, HH, and HL coefficients. This chunk is subjected to a DCT transformation. Because the quantization is performed on the DCT coefficients, this transformation via DCT results in lossy compression. To further improve compression, arithmetic coding is used to the DCT coefficients.

During the decoding process, the picture blocks that were previously encoded are processed using inverse DCT and inverse DWT. After that, comparable blocks from every two successive frames undergo motion correction [9]. In addition, motion estimation is used to verify the frame sequence's intended order. The video is created by splicing together individual shots. Specification of the algorithm for the suggested procedure (DCT-DWT) First, the encoding procedure. First, you need to watch the input video and read it. Next, you must convert the movie into a series of still images in the.png format.

The third step is to use motion compensation and estimating methods to pinpoint the difference between the input frames (frame1 and frame2).

The Discrete Cosine Transform and the Discrete Wavelet Transform, Phase 2. First, cut the frames into squares of size n by n. Second, convert the motion-corrected frames using the DWT-DCT. Third, quantify using a typical quantization matrix. Fourth, we compress the obtained coefficent using an arithmetic encoding.

Process of Decoding

First, decompress the picture. The second step involves using an arithmetic decoder on the compressed stream of blocks. Third, use inverse discrete cosine transform (DCT) on the picture blocks. In the fourth step, you'll use Inverse DWT on the generated picture block [10].

The fifth step is to do motion correction between each frame's two blocks. Motion estimate is used to verify the frame sequence's order, which brings us to step six. Reconstruct the images and turn them into a movie in Step 7.

CONCLUSION

In this study, we suggest a new approach to video compression by using DCT and DWT in tandem with motion estimation and compensation. The experimental findings demonstrate the effectiveness of the suggested strategy in terms of PSNR and compression ratio. In the future, this technique may be used for the compression of 3D video and other online streaming applications.

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REFERENCES

1. Wang, S., Zhang, X., Liu, X., Zhang, J., Ma, S., & Gao, W. (2016). Utility-driven adaptive preprocessing for screen content video compression. *IEEE Transactions on Multimedia*, *19*(3), 660-667.
2. Galteri, L., Bertini, M., Seidenari, L., & Del Bimbo, A. (2018, August). Video compression for object detection algorithms. In *2018 24th International Conference on Pattern Recognition (ICPR)* (pp. 3007-3012). IEEE.
3. Wang, X., Chowdhery, A., & Chiang, M. (2016, October). SkyEyes: adaptive video streaming from UAVs. In *Proceedings of the 3rd Workshop on Hot Topics in Wireless* (pp. 2-6).
4. Misra, K., Bossen, F., & Segall, A. (2019, November). On cross component adaptive loop filter for video compression. In *2019 Picture Coding Symposium (PCS)* (pp. 1-5). IEEE.
5. Bachu, S., & Chari, K. M. (2015, January). A review on motion estimation in video compression. In *2015 International Conference on Signal Processing and Communication Engineering Systems* (pp. 250-256). IEEE.
6. Parker, S., Chen, Y., Barker, D., De Rivaz, P., & Mukherjee, D. (2017, September). Global and locally adaptive warped motion compensation in video compression. In *2017 IEEE International Conference on Image Processing (ICIP)* (pp. 275-279). IEEE.
7. Shaw, M. Q., Allebach, J. P., & Delp, E. J. (2015). Color difference weighted adaptive residual preprocessing using perceptual modeling for video compression. *Signal Processing: Image Communication*, *39*, 355-368.
8. Guo, L., De Cock, J., & Aaron, A. (2018, June). Compression performance comparison of x264, x265, libvpx and aomenc for on-demand adaptive streaming applications. In *2018 Picture Coding Symposium (PCS)* (pp. 26-30). IEEE.
9. Ma, S., Zhang, X., Jia, C., Zhao, Z., Wang, S., & Wang, S. (2019). Image and video compression with neural networks: A review. *IEEE Transactions on Circuits and Systems for Video Technology*, *30*(6), 1683-1698.
10. De Queiroz, R. L., & Chou, P. A. (2016). Compression of 3D point clouds using a region-adaptive hierarchical transform. *IEEE Transactions on Image Processing*, *25*(8), 3947-3956.