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An Introduction on Video Compression and its Challenges

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Abstract- At present video has been an important medium for communication and entertainment. Video is a temporal of different frames. Each frame can be considered as an image comprising a spatial combination of pixels. At present time we have used several video compression standards, algorithms, and techniques that have been developed to reduce the data quantity and provide the acceptable quality as possible as can. Recently ITU-T and ISO MPEG video compression standard committees developed the H.264/AVC video compression standard. H.264/AVC video compression standard much better and efficient further video compression standard (i.e., MPEG-2, H.263, MPEG-4 part 2), but the present existing techniques have increased computational complexity and time complexity. For example, we have 720 x 480 pixels for every frame,30 outlines every second, add up to an hour and a half full-shading video, at that point the full information amount of this video is around 167.96 G bytes. This paper has been tried to compare the different standards of video compression, an overview of video transmission, present video compression technique, and a comparative analysis of all video compression standards.

Keywords: Video compression, PSNR, Perceptual Quality, H261, H264, H265, MPEG-1, MPEG-3, MPEG-4.

1. INTRODUCTION

Data compression is a compression technique that is used to compress data in small sizes. We can say data compression converts an input data stream to another data stream of small size. Data compression is mainly divided into lossless data compression and lossy data compression. Lossless data compression is used for document compression. In lossless data compression, we have to compress data without losing its quality, so that the process is reversible. Normally we have to use Lempel-Ziv (LZ) compression methods for lossless data compression. Lossy data compression is used for video compression, audio compression, etc. In lossy data compression, we have compromised with data quality and some loss of information is acceptable. We can say lossy data compression is the converse of lossless data compression. In lossy compression, raw data and uncompressed data are the same, because our eyes do not recognize the difference between raw data and uncompressed data.

Lossy image compression can be utilized as a part of computerized cameras, to expand capacity limits with insignificant loss of picture quality. Similarly, we can use the lossy MPEG-2 video coding format in DVDs for video compression. MPEG video compression technique is used in video compression. MPEG video compression technique is known as Moving Picture Experts Group.

In video compression, we have used many video compression standards for example H.120, H.261, MPEG (MPEG-1, MPEG-2, and MPEG-4 H.265), and H.264. At present, we have used the H.265 video compression standard. There are some benefits of video compression like reduced storage space of video files, reduces bandwidth, and lower communication cost.

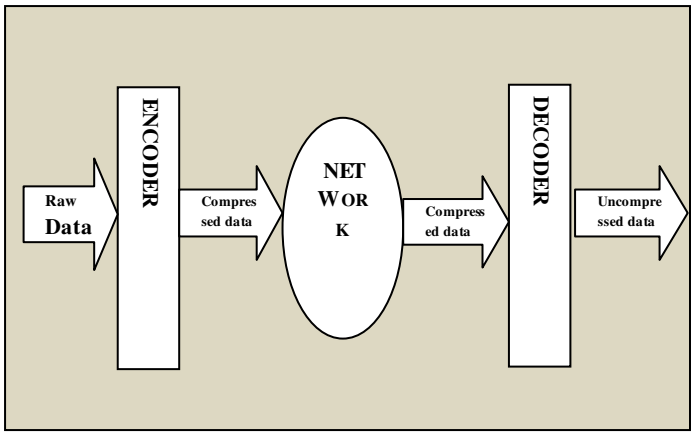

Figure 1: Data compression process.

2. VIDEO COMPRESSION TECHNIQUE

A. H.120: H.120 video compression technology was the first digital video compression standard developed by COST 211. H.120 video compression standard is published by the CCITT currently known as ITU-T (International Telecommunication Union-T). for NTSC (National Television System Committee) H.120 streams ran at 1544 Kbit/s and for PAL (Phase Alternating Line) its streams ran at 2048 Kbit/s. H.120 video compression standard launch in two versions. Version first launched in 1984 with conditional replenishment, scalar quantization, and variable-length coding features. Second version launch in 1988 added motion compensation and background prediction features.

H.120 video compression methods were bad quality for useful utilize but rather it has the great spatial determination,

however exceptionally poor temporal quality. H.120 video compression technique opens the door for a researcher to improve the video quality without exceeding target bitrates for the stream.

B. H.261: International Telecommunication Union-T launched the H.261 video compression standard in 1988, we can say it is an ITU-T video compression standard. H.261 video coding standard was the first video coding standard that was useful in practical terms. Popular implementations in H.261 are videoconferencing and video telephony. H.261 video compression standard coding algorithm supported video bit rates between 40 Kbit/s and 2 Mbit/s. This video compression standard supports two video frame sizes. First is CIF (Common Intermediate Format) as 352*288 luma with 176*144 chroma and second QCIF (Quarter Common Intermediate Format) as 176*144 luma with 88*72 chroma, both are using a 4:2:0 sampling scheme. At present all subsequent international video coding standards (MPEG-2, H.263, and H.264/MPEG-4 Part 10) have been more closely on the H.261 video compression design. H.261 video compression standard only specifies how to decode the video. It's supported by the free VLC media player and media player like multimedia players. H.261 video compression standard includes under the H.320 umbrella. This standard is made for video conferencing standards. Prediction, block transformation, quantization, and entropy coding are the main elements of the H.261 video compression standard. [1]

C. MPEG-1: MPEG-1 video compression standard is known as moving picture expert group phase 1. MPEG-1 has three components audio, video, and system. MPEG-1 compression standard is a lossy compression technique. It's used in both video compression and audio compression. MPEG-1 video compression technique mainly designed to compress a video home system (VHS). Quality input data or raw digital video and audio down to 1.5Mbit/s without quality loss. In the MPEG-1 video compression standard, the compression ratios of audio and video are respectively 6:1 and 26:1. Moving picture expert's groups compression technique used in making compact disc digital video, digital cable/satellite TV, and digital audio broadcasting.

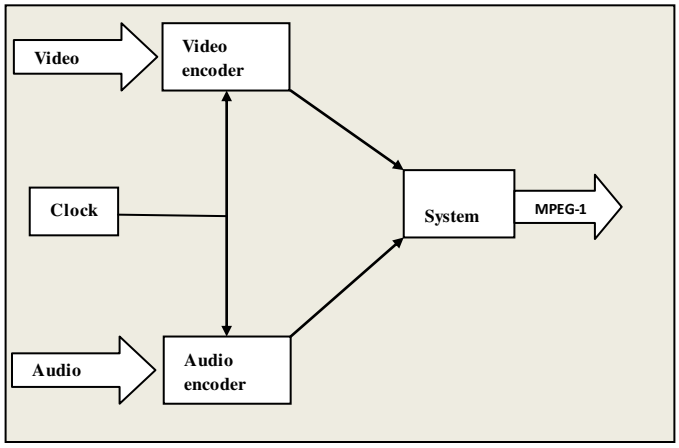

Figure 2: MPEG-1 video compression process

It is likely to dominate the encoding of CD-ROM based movies. At present time MPEG-1 is one of the most widely compatible lossy audio and video format in the world. With the help of MPEG-1, the VCR video quality 640*480 pixels has 368.64 Mbps in uncompressing form after performing the MPEG-1 video compression method it reduces to 1.5 Mbps. Coding and display order can be different in the MPEG-1 video compression standard.

D. MPEG-2: MPEG-2 was published by ITU-T and ISO/IEC in 1996. MPEG-2 is also known as moving picture experts groups phase two. It was compatible with MPEG-1. MPEG-2 video compression standard can play the same video in different resolutions and different frame rates. MPEG-2 was mainly developed for digital television. MPEG-2 is the second part of the ISO/IEC MPEG-2 standard. It is also known as H.262 video compression standard. MPEG-2 video compression is used in cable television, direct broadcast satellite, and high definition television.

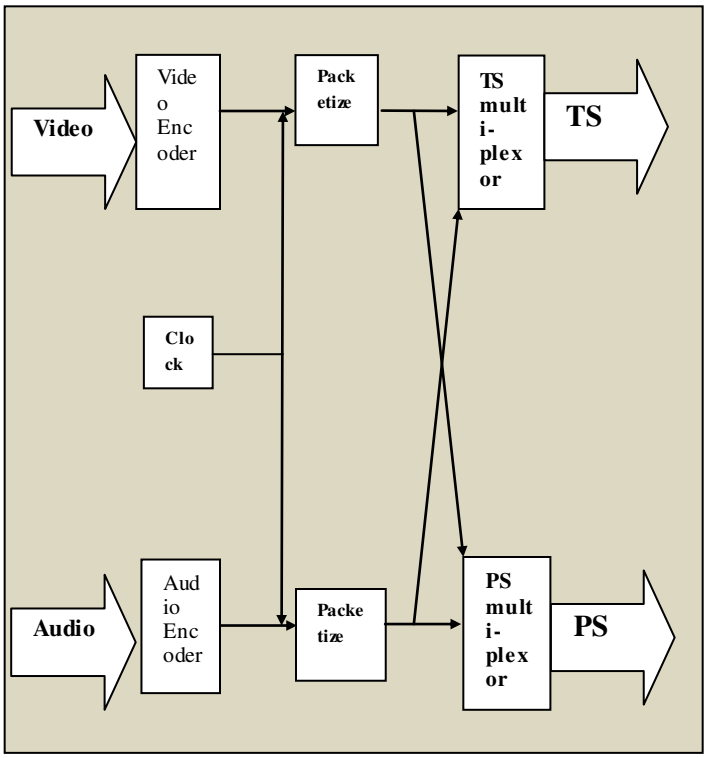

Figure 3: MPEG-2 video compression process

It provides resolutions up to 1920*1080. MPEG-2 includes intra-coded frames (I-frames), predictive-coded frames (P-frames), and bidirectional-predictive-coded frames (B-frames) basic types of coded frames. It does not support D-frames. MPEG-2 video compression standard supports four different resolutions and it's also supporting five different profiles for different applications. MPEG-2 video compression standard is better than its previous MPEG-1 video compression. This standard ISO used a better coding algorithm. MPEG-1 is easy to understand as compared to MPEG-2.

E. H.263: H.263 is a video compression standard published by the International Telecommunication Union in 1995. The H.263 video compression standard is the only recommendation of the ITU, not international standards. H.263 video compression standard is used in video conferencing. It was a member of the H.26x family. According to 3GPP specification, H.263 video is used in 3GP container format. It gives enhanced visual quality at very low bit rates around 28 Kbps. H.263 updated with new features in 2000.

F. MPEG-4: MPEG-4 is a video compression standard published by ISO/IEC in 1999. It is developed by the moving picture experts group in cooperation with international standards organization (ISO). MPEG-4 is a compression format for visual data. Visual data are video, still texture, synthetic images, etc. MPEG-4 is also known as MPEG-4 visual. In this video compression standard, several popular codecs include DivX, Xvid, and Nero digital. The first, second, and third editions of MPED-4 were released in 1999, 2001, and 2004 respectively. MPEG-4 has approximately 21 profiles for different applications. MPEG-4 is mostly used for multimedia representation and distribution. In this standard, we can identify and deal with separate audio and video objects in the frames. [2] In MPEG-4 users can interact with the video object. This is the most advanced feature of the MPEG-4 standard.

G. H.264/AVC: H.264 is a video compression standard published by ISO, ITU-T, Samsung, Sony, IEC, and Panasonic in 2003.

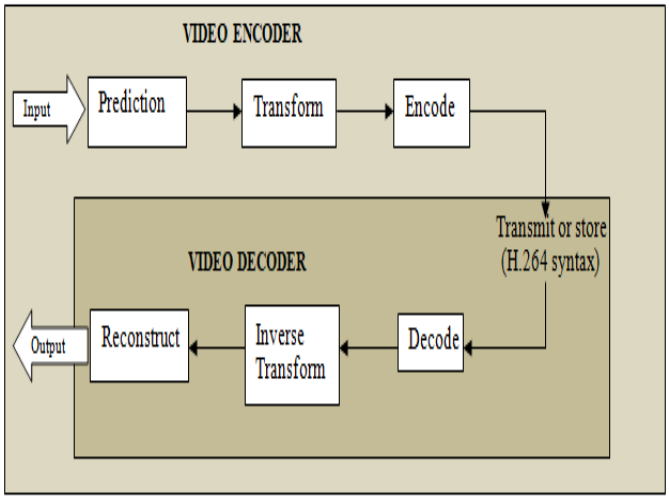

Figure 4: The H.264 video coding and decoding process

H.264 is referred to as MPEG-4 AVC (Advanced Video Coding). As of 2014 H.264, video compression standard is the most commonly used format for the compression, recording, and distribution of video content. H.264 video compression standard released in 25 versions and its last version launched in April 2017. Popular implementations of H.264 video compression standard are HD DVD, Digital Video Broadcasting, Apple TV, videoconferencing, and Blu-ray. According to the result, H.264 provides 50% better compression quality than MPEG-2 and 30% better than H.263. [3]

3. COMPARISION OF VIDEO COMPRESSION TECHNIQUES:

Video compression techniques provide a number of benefits during video communication. It can save data wasting and time due to video transferring and storing. At present, we can use several types of video compression methods and each method has a unique feature. The result of the simulation shows that H.264 outperforms in terms of peak signal-to-noise ratio (PSNR) and end-to-end delay which makes it perfect for video application over WAHSHs. The MPEG standard provides a range of compression formats that are suitable for applications that require higher bit rates. The H.261 and H.263 standards are suitable for carrying video over ISDN, so in this table, we can compare different tools of MPEG-2, MPEG-4, and H.265/AVC.

Table 1: Comparison of video compression method tools in MPEG-2, MPEG-4 part 2 and H.264/AVC.

S.No.	Tools	MPEG-2	MPEG-4	H.264/AVC
1.	I-,P-,and B-frames	Yes	Yes	Yes
2.	Flexible picture prediction structure and stored B picture	Basic, no stored B-picture	Basic, no stored B-picture	Yes, allowed
3.	Transform	8 x 8 DCT	8 x 8 DCT	Approximation of 4 x 4 DCT
4.	Motion vector prediction	Simple	Better, uses medium	Uses medium and segmented
5.	MC prediction 8x8	No	Yes	Yes
6.	Multireference prediction	No	No	Yes
7.	Adaptive VLC coding	No	Yes, uses 2 tables	Yes, more content-adaptive

8.	Adaptive arithmetic coding	No	No	Yes, very content adaptive
9.	Scalable coding support	Yes, temporal scalability, PSNR	Yes, temporal scalability	With some support on temporal and PSNR
10.	Intra prediction in blocks of intra MB	Fixed prediction of DC coefficient	Adaptive prediction of DC coefficient and first row/column of AC coefficients	Adaptive spatial prediction of 4x4 or 16x16 pixel blocks
11.	MC prediction 16x16 and 16x8	Interlace only 16x8	Interlace only 16x8	Yes, 16x16,16x8, 8x16
12.	MC prediction sub 8x8	No	No	Yes, 8x4,4x8,4x4
13.	Direct prediction mode in B pictures	No	1 mode only	2 modes only
14.	Global MC	No	Yes	No
15.	Unrestricted MV's	No	Yes	Yes
16.	Efficient quantizer overhead	No	No	Yes
17.	Arbitrary slice order and flexible macro block ordering	No	No	Yes
18.	Arbitrary object shape coding support	No	Yes, Binary shapes, related motion and texture, sprite coding	No
19.	Frame/field, frame/field scan stream switching, splicing and random access	Basic, intra pictures	Basic, intra pictures	Intra picture/slices, SI/SP switching pictures/slices
20.	Division-free decoding capability	Yes	No	Yes

4. METHODOLOGY

At present we can use many video compression standards like H.263, H.264, and MPEG-4. All of the video compression standards work the same; reduce the storage of video data. There are four factors in all video compression standards that are the same that are frame rate, color resolution, spatial resolution, and image quality. If we talk about all parts of the Moving Picture Expert Group (MPEG) some parts are similar. That is a system for storage and synchronization of video, audio, and other data together, video for compressed video content, audio for compressed audio content, conformance testing and reference software. In MPEG-1 we have required I-frame, B-frame, P-frame, and D-frame but in MPEG-2 we have not required D-frame. In all MPEG video compression standards display order of frames and coding order of frames can be different. Same as if we talk about the encoder and decoder of video compression standards then we can see the encoder can take time to do the encoding of data but the decoder has to be faster than the encoder. In H.263, H.264, and H.265 are block-oriented motion compensation-based video compression standards, so we can say the methodology of block-oriented motion compensation techniques are the same in all standards. These all standards developed by the ITU-T VCEG and ISO/IEC MPEG. H.265 exploits the same video compression principle as its predecessors. Each of the video compression standards is divided into a two-part video decoder and video encoder. In compression we can reduce the binary representation of a file and decompression is the reverse of compression it means the act of restoring a compressed file.

5. LITERATURE SURVEY: Video compression technique makes for easy video communications, transferring video from one place to another place. If we have a video that has 30 frames per second, 720*480 pixels per frame, and a total of 90 minutes of full high definition video, then the data quantity of this video is 167.97 G bytes. Thus, by using several video compression techniques we can reduce the data quantity [4].

Video compression techniques like H.264/AVC exhibit superior coding performance improvement over its last video compression standards like H.262, H.263, etc. Maybe the next generation standards are developed by both VCEG and MPEG [5]. The H.264 video compression techniques have been developed to fill significant improvements over MPEG-2 standard in terms of video compression. The basic coding framework of all video compression standards is similar, but in H.264 video compression standards have many new features [6]. In the present web video coding and timed-text and other visual overlays in ISO base, media file format is under development. MPEG-4 is developed by the Moving Pictures Experts Group and H.264 was developed by Video Coding Experts Group [7]. Scalable quality and scalable delivery of MPEG-4 video compression make it more user friendly as compared to other video compression standards.

6. RESULT AND DISCUSSION

There are two categories to implement video compression, hardware-based and software-based. Video compression standards are standardized by ITU-T VCEG and ISO/IEC MPEG. In this framework, the encoder is faster than the decoder [8]. In video compression, it is most important to maintain Peak Signal to Noise Ratio (PSNR). The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) are used to take a gander at picture weight quality. Peak Signal to Noise Ratio is an approach to quantify the perceptual nature of pictures. This fact opens the possibility of incorporating self-regulated compression parameters depending on the perceptual quality [9]. H.264 video compression technique is about 1.5 times more efficient than MPEG-2 encoding. If we use H.264 then it is possible to store more information on the same storage device as compared to MPEG-2. Compression basically is known as reducing image data. In any compression techniques, we can reduce color nuances within the image, reduce the color resolution, remove small, invisible parts of the picture, and remove details that are unchanged between two images. A good and user-friendly compression systemshould allow the user to instruct the video compression software and hardware on which parameters are most impotent.

7. CONCLUSIONS

This paper gives a brief introduction of the emerging H.264 video compression standard and transmission in terms of its applications, frame rate compared to the existing present most popular video compression standard. H.264 video compression standard is a new standard and a better compression method than the basic MPEG-2 video compression standard. H.264 video compression standard is 50% better than MPEG-2 video compression standard and 30% better than H.263. H.263 video compression standard performs up to 3dB more efficiently than H.261 video compression standard. In the field of video coding, the structure-from-motion method and model-based video coding are active research topics. The H.261 and H.263 video compression standards are only recommendations of the ITU, not international standards. Can all the present video compression standards work according to the user, but mostly work according to its algorithms.

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