

Video Coding Standards - A Review

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Abstract: In today's world, the usage of data in the form of video is increasingly rapidly which requires a large amount of data for storage. Video is a group of images or frames. Here the individual frames are transferred at a faster rate. Basically we transfer 25 frames per second for a movie. Instead of transferring frame by frame, only the difference between the frames has been sent which results in reduction of storage space and also saves the time which it is transmitted over the network. This paper gives the survey of various video compression techniques namely MPEG (Motion Picture Expert Group) and H. 26X Family, Which help us to know the features advantages and disadvantages of these techniques.

Keywords: MPEG1, MPEG2 MPEG4 H.261, H.263, H.264

I. INTRODUCTION

The compression in the video is achieved by removing the redundancies. The redundancies can be divided into four categories:

- Spatial Redundancy
- Temporal Redundancy
- Perceptual Redundancy
- Statistical Redundancy

Spatial Redundancy

Here the elements are duplicated within a structure, such as pixels in a still image and bit patterns in a file. This redundancy occurs in each and every frame.

Temporal Redundancy

In a video frame, a pixel having a same value in the same location is known as temporal Redundancy. It can be removed by using techniques like motion estimation and motion compensation.

Perceptual Redundancies

It refers to the details of a picture that a human eye cannot perceive.

Statistical Redundancy

Average code length can be reduced by assigning shorter code words to values with higher probability. Variable length coding is used to exploit these statistical redundancies and increase compression efficiency further.

II. VIDEO STANDARDS

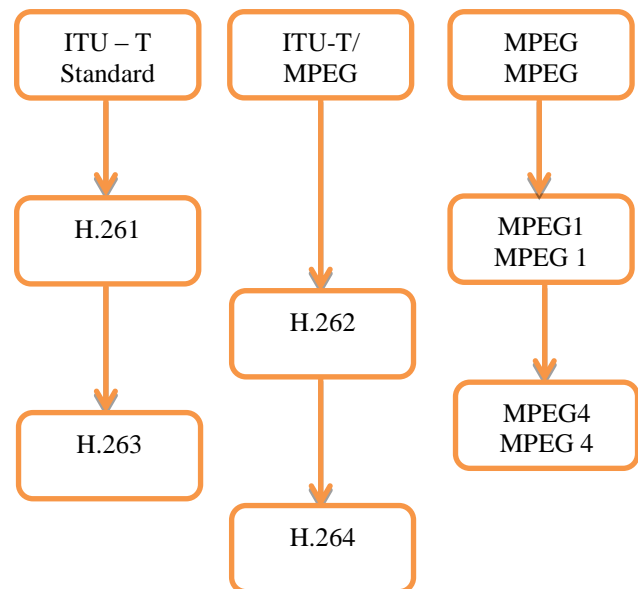


Fig: 1. ITU Recommendations and MPEG Standards

Generally there are two types of family standards.

- ISO/IEC
- ITU – T

ISO/ IEC are International Standard Organization and International Electro technical Commission. It was formed in 1987 and located in New York. The aim of this organization is to develop maintain and promote standards in the field of Information technology. It produced the MPEG standards which is one of the standard formats for video compression

ITU – T

International Telecommunication Union. It is committed to ensure the efficient and timely production of standards covering all fields of telecommunications on worldwide basis. It had developed H.26X family.

Video Compression Techniques

MPEG -1

This technique was developed in the year of 1993 by ISO/IEC. It is also known as ISO/IEC Standard 11172. It uses Motion Compensation for removing the temporal redundancy and it also includes Coefficient quantization, variable length coding and DCT transform. The MPEG-1 can be divided into three categories.

- ISO/IEC 11172-1 - The Multiplex Structure
- ISO/IEC 11172-2 - The Video Coding
- ISO/IEC 11172-3 – The Audio Coding

The main aim of this technique is to develop CDROM supporting the video files. It also support Mp3 format. Here the video is encoded at a data rate less than 1.5 Mbps.

MPEG – 2

This is an extended version of MPEG -1. It was developed in the year 1994. It is also known as ISO/IEC standard 13818. It can be divided it ten categories and most important of it are

- ISO/IEC 13818 -1 System, CAT, PAT, PMT
- ISO/IEC 13818 -2 Video Coding
- ISO/IEC 13818 -3 Audio Coding
- ISO/IEC 13818 -4 MPEG test and conformance
- ISO/IEC 13818 -6 Data Broadcast

The robustness and the flexibility of the design have permitted it to be for many applications including the development of MPEF4 and MPEG 7[1 – 5].

It uses higher bandwidth to cover big images and to achieve higher quality videos. This technique is used in television & telecommunication. Here the video compressed at a data rate of 10 Mbps.

MPEG – 4

This is also extended version of MPEG 2.It is also known as ISO/IEC standard 144961[6].The main aim of this technique is to encode the video and audio at very low bit rate. Here the bit ranges are classified into 3 types

- Ranges below 64 Kbps
- Ranges between 64 to 384 Kbps
- Ranges between 984 Kbps – 4 Mbps

The principal parts of MPEG - 4 are

- ISO/IEC144961 -1 Systems
- ISO/IEC144961 -2 Visual
- ISO/IEC144961 -3Audio
- ISO/IEC144961 -4 Conformance Testing
- ISO/IEC144961 -6 Delivery Multimedia Integration Framework

Here the video coding tools are much more similar to MPEG -2 coding techniques. The use of entropy coding and predictive coding improved the performance of MPEG-4 technique. It is used for compression of time varying streams, algorithms for spatial temporal and quality scalability in videos. It is also used for texture mapping of 2D and 3D images. The main purpose of this technique was to transfer video over the internet.

MPEG -7

This technique does not do any compression of image or audio. It deals with the media content descriptor. This technique is used for video surveillance. It uses XML for storing the metadata. The XML file which contains the metadata can be attached to the time code for tagging a particular event

Table 1: MPEG Standards & its Applications

S.No	Video Compression Techniques	Year Developed	Applications
1	MPEG -1	1991	Video CDROM
2	MPEG-2	1994	DVD, Digital Video Broadcasting
3	MPEG-4	1998	Video Over Internet , DiviX
4	MPEG-7	2001	Video Surveillance

H.261

H.261 is an ITU-T video compression standard [15]. It was designed for transmission over ISDN.H.261 supports two video format, namely CIF (Common Intermediate Format) and QCIF (Quarter Common Intermediate Format)[7]. The main concepts used in this technique are DCT (Discrete Cosine Transform) and motion compensation. Key concept used here are in the encoder are DCT, Prediction, Quantization, Inverse DCT, Inverse Quantization, Loop Filter, Frame Memory, Variable Length Coding, and Coding Control Unit. The syntax of this technique fallows hierarchical layered Structure from top to bottom such as Picture Layer, Group of blocks Layer, Marco block Layer, and Block Layer.

In H.261 two types of frame predictions are used.

- Intra Frame Prediction
- Inter Frame Prediction

Intra Frame Prediction

It is generally used for the first frame of a video sequence and the frame after a scene change [8]. It refers only the current frame. It is used to remove the redundant spatial data.

Inter Frame Prediction

It is used for a sequence of similar images. I refer to the current pixel and the previous pixel. It is used to remove the both spatial and temporal redundancy.

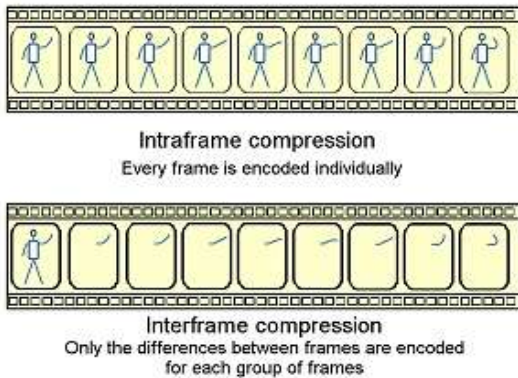


Fig 2: Intra & Inter Frame

H.263

It was developed by ITU-T Video Coding Experts Group. This technique was based on the H.261. This technique includes advanced features such as Unrestricted Motion Vector, Syntax based Arithmetic coding and advanced prediction. In H.261 they used full pixel precision and a loop filter but in H.263 only half pixel precision is used. The main components of the encoder in this technique are Block transform, Motion Compensation Prediction, Block Quantization and VLC. Five types of resolutions are supported by H.263. The types of resolutions are CIF (Common Interchange Format), QCIF (Quarter Common Interchange Format), SQCIF (Sub Quarter Common Interchange Format), 4CIF and 16CIF. The one of the most important application of H.263 is video conferencing. Other applications of H.263 are Youtube video, Google Video, Video Telephony, Video Monitoring and Surveillance and MMS (Multimedia Messaging Services)[9].

H.264

It was developed by ITU-T video coding [10,11] expert group and ISO/IEC. It is also known as AVC (Advanced Video Coding). To increase the performance many new features and functions have been included in this technique which results in increasing the computational complexity. H.264 includes several processing stages such as motion estimation, Intra Prediction, Transformation, Inverse Transformation, Quantization, Inverse Quantization, Loop Filter, Entropy Coding. Motion Estimation is used to perceive and eradicate the temporal redundancies that are present in it. It also includes another feature called multiple reference frames. It is used to detect the motion three ways. Motion in periodic nature, Translating motion & occlusions, Alternative camera angles that can adjust between current and previous scenes. Intra prediction is used to remove the spatial redundancies. It tries to

predict the current block by inducing the neighboring pixel of the adjacent block. The transformation used here is DCT (Discrete Cosine Transform) like 4 x 4 integer transform. It also eliminates the rounding off errors. Quantization is used to avoid the perceptually unnecessary precision. It can also be used for rate control by adjusting the quantizer to maintain a same bit rate in output. There are three main types of Entropy encoding. VLC (Variable Length Coding), CABAC (Context Adaptive Binary Arithmetic Coding), CAVLC (Context Adaptive Variable Length Coding). The Entropy coding assigns smaller number bits for frequently used symbols and larger bits for rarely used symbols. CAVLC performs better than other two coding techniques.

H.265

It was developed by the JCT-VC (Joint Collaborative Team on Video Coding). This technique was also known as HEVC (High Efficiency Video Coding). Even though it was developed in the year of 2010[12], still various modifications and up gradation are going on. The latest modification was done on December 2016. The main concept of this technique was to provide twice the efficiency of previous standard i.e H.264. Generally it tries to provide a half rate of compressed file given by H.264 and also comparing the compressed video to H.264 this technique gives a better visual quality. The compression model of H.265 includes enhanced hybrid spatial temporal prediction model and it introduces CTU (Coding Tree Units). Moreover the intra prediction uses 35 directional modes for prediction. The entropy coding used here is CABAC (Context Adaptive Binary Arithmetic Coding) [13 14].

Table 2: H.26x Standards & its Applications

S.No	Video Compression Techniques	Year Developed	Applications
1	H.261	1990	Video Conferencing, Video Communication
2	H.263	1995	VLC, Quick Time, Windows Media Player, Multimedia Players.
3	H.264	2003	Broadcasting of Television channels (Cable, Satellite, Terrestrial)
4	H.265	2010	Action Camera, Blue-ray disk, Mobile DTV tuner, 8K TV Display[15]

III. CONCLUSION

The paper gives an outline of the MPEG series and H.26x Series of various compression techniques. It gives the details about various existing video compression techniques such as Mpeg 1, Mpeg 2, Mpeg 4, Mpeg 7, H.261, H.263 and H.264.

Even though each has some pros and cons they are specialized in some areas and in some applications. The above techniques are not the final work of the video compression still many research works are going on to reduce the number of bits and also to improve the video quality.

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BIOGRAPHIES



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