Video Compression Standards: A Survey

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Abstract— This paper reviews various techniques involved in the compression of a digital video sequence. In order to ensure compatibility among video codec from different manufacturers and applications, efforts have been taken to define a video sequence. The data quantity of a video is very large and storage is insufficient for the transmission on a spectrum. So, this is practically not possible to store a video without processing. For this reason, Video compression standard and techniques had been developed to reduce the data quality and increase the picture quality of a digital video. Various video compression techniques are MPEG standards, H.261, H.263, H.264 and also new developing standard H.265.In this paper we are going to survey on different video standards and differences between them like calculating compression ratio, bit error rate, picture quality etc.

Keywords— **Video compression techniques, Mpeg standards, H.26x standards, compression ratio, bit error ratio, picture quality**

I. INTRODUCTION

Compression is a process of reducing the size of data files. Video compression reduces the quality and quantity of data used to represent various frames of digital video, making the video files smaller and lesser with small perceptible loss in quantity. Digital video has become main stream in many applications and it is widely used in DVD, digital VT, HDTV, video telephony and teleconferencing. These videos are feasible because of rapid growth in video compression standards and also improvement in today's multimedia sectors and communication sectors. Over the past decades Video compression technologies have become an integral part of the way it creates, visuals and communicate. Thus, several video compression standards, techniques and algorithms had been developed to reduce the data quantity and provide the acceptable quality as possible as can. A video is essentially sequence of pictures displayed at a time or in series [1],[4] and [16]. Each picture of a video is sequenced in 2D projection in the 3D world and these series of picture are sequenced and sampled in space and time domain form from an analog video signal. A frame or a picture of a video is seen in 2D array of pixels. Each pixel value represents the color and intensity values of a specific location at a specific time. The RGB (Red-Green-Blue) color space is typically used to capture any display specific image. Each pixel is thus represented by one R, G, and B components. The 2D array of pixels that constitutes a picture is actually three 2D arrays with one array for each of the RGB components. A resolution of 8 bits per component is usually sufficient for typical consumer applications [2] and [8].

MPEG is known as "MOVING PICTURE EXPERTS GROUP". It was established under the direction of two international standards. They are International Electro-Technical Commission(IEC) and Internal Standards Organization(ISO). This International standard works on the standards for the efficient coding of moving pictures and its relative audio. Precisely the MPEG standards works on the fully encoding of the digital and key frames through the JPEG algorithm and by calculating the motion changes of these digital and key frames [2], [12] and [6]. Small information bits are sent for every four or five frames, as a result, reduction in the bits are required to estimate the image results. The compression ratios are about 100:1 can be easily obtained. The MPEG encoder is very complex compared to JPEG and it places a very heavy computational load for the motion estimation. The MPEG standards uses asymmetric scheme. Decoder is much easier and can be computed using today's Desktop CPUs [3] and [17].

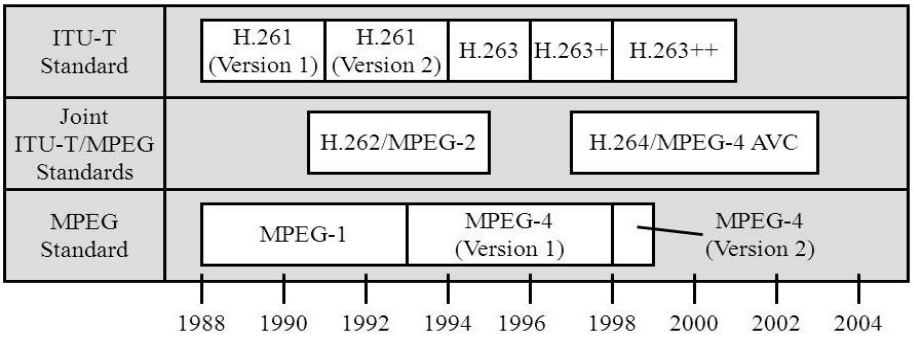

Figure 1: Evolution of Video coding standards

The Evolution of various video standards introduced in different years is shown in figure 1. In the year 1998-2002, the MPEG standards were introduced to reduce the complexity of memory in storage devices to store videos. The MPEG-1 is used to store the data on CD's and Mpeg-4 provides low reliability on storage devices. In 1990-2003 The H.262/MPEG-2 and H.264/Mpeg-4 is introduced by the Joint International Telecommunication Unit(ITU) for the processing of video in low bit streams over transmission line and there are still some standards which are been implementing for high picture quality [2] and [14].MPEG-2 is used to store the data or videos on the DVD's whereas H.264 provides HDTV broadcast over terrestrial, cable and satellite.H.261 was the first practical digital video standard and transmits data over ISDN or telephone lines whereas H.262 provides coding of audio video servicesi.e., coding of moving video. H.265 provides high definition videos like 1080p, 4k, 8k resolution videos.

II. EXISTING STANDARDS

The standards for the video compressions are decided by two main international organizations, ITU-T and ISO/IEC. ISO/OEC standards includes Mpeg-1, Mpeg-2, Mpeg-3, Mpeg-4, Mpeg-7 and Mpeg-21. The ITU-T standards includes H.26x series i.e., H.261, H.263, H.264 and H.265.It gives future applications with the different video coding standard.

1. MPEG-1

The first introduced standard by the MPEG Committee was MPEG-1 standard. This compression standard uses efficient transmission or coding of video sequence. This is used for the storing of data on CD's. In this standard the video sequence of new parts is identified, transmitted and coded. In this the compression ratio is important then the picture quality. It mainly focuses on the bit streams of the video sequence. This process has reduced bandwidth to great extent [2] and [16].

2. MPEG-2

MPEG-2 was known as Generic Coding of Moving Pictures and Associated Audio. The Mpeg-2 standard is used for the transmission of digital video on high data rates. It gives high picture quality than Mpeg-1. This standard is an extension of previous standard by decoding the Mpeg-1 by Mpeg-2 decoder. Combining of audio, video and different data streams on a single multiplex stream is specified by Mpeg-2. The DVD's are compressed using Mpeg-2. TV stations, TV receivers are often designed by using this standard [3] and [20].

3. MPEG-3

MPEG-3 is designed to HDTV and EDTV at 1080p. Mpeg-3 was launched to handle the HDTV while the work on Mpeg-2 is going on simultaneously. But later it was discovered that MPEG-2, with a slight modification, at high data rates can accommodate HDTV. For this reason, the work on Mpeg-3 was stopped [4] and [23].

4. MPEG-4

Mpeg-4 was designed for compression of audio and video sequence at high bit rates with better picture quality than the previous standard. The better with Mpeg-4 is it consumes less bandwidth. This standard is mostly widely used for the security purposes. Uses of Mpeg-4 include compression of AV data for web (streaming media) and CD distribution, voice (telephone, videophone) and broadcast television applications. Initially Mpeg-4 was developed to work on a low bit rate video communication. Later it was expanded to a multimedia application [5] and [7].

5. MPEG-7

MPEG-7 is a multimedia content description standard. It does not deal with the coding of moving pictures and audio. This standard will be associated with the content itself. It allows fast and efficient searching of the information that the user is looking for. Mpeg-7 is normally called as *Multimedia Content Description Interface.* Mpeg-7 is used for surveillance applications as it could tag the contents and events of audio and the video streams for intelligent processing in video management software or video analytical applications. The combination of Meg-4 and Mpeg-7, together called as MPEG-47. It uses XML to store the multimedia data [9] and [13].

6. MPEG-21

MPEG-21 is a standard that defines an open framework for multimedia applications. This standard shares permissions, rights and restrictions for the digital video content. This standard is not particularly suited for the video surveillance applications. XML-based standard is developed to the distribution of digital video content illegally [9],[13] and [2].

7. H.261

H.261 is a ITU-T video compression standard. This was originally designed to transmit the video bit streams over ISDN lines on which data rates are multiple of 64kbit/s. It gives better improvement in the video quality but requires high processing power and time. When H.261 controller performs the compression, by block-by-block basis not by picture-by-picture basis. This algorithm is based on Discrete Cosine Transform(DCT) [17] and [11].

8. H.263

H.263 was originally designed as a low bit rate video compressed format on video conferencing. H.263 gives better picture quality than H.261 at bandwidth under 100kbps. For low resolution images half pixels gives better improved images. It gives technical specifications like Multimedia Messaging Service (MMS) and Transparent End-to-end Packet Switched Streaming Service (PSS) and IP Multimedia Subsystem(IMS). H.263 video is usually used in 3GP container format [19] and [21].

9. H.264

H.264 or MPEG-4 Part-10 is known as *Advanced Video Coding* (MPEG-4 AVC). This standard is based on picture wise processing and it has better picture quality in low bit rates than previous standards without increasing the complexity of the design. It has new emerging features than previous one. This provide enough flexibility to be applied on a wide variety of applications and streams at high and low bit data rates, low and high-resolution video, broadcast, DVD networks, packet networks and video telephony systems. It specially used for lossy compression technique but it can also be used for lossy-coded regions with lossy-coded pictures and full encoding of video using lossy-coded format. This is broadly available in network cameras, video encoders and video management software, system designers and integrators [10], [2], [5] and [7].

10. H.265

High Efficiency Video Coding(HEVC) is also known as H.265 or Mpeg-H Part 2 is a video compression standard. It improves the video with at least four times the pixels of today's 1080p standard. This standard is now in the final stage of standardization, is expected to be twice as good as H.264. It can match its image quality with half bits per second. It is struggling to bring better image quality with less bandwidth [22] and [18].

III. THEORETICAL ANALYSIS OF VARIOUS STANDARDS AND SURVEY

Table 1: Comparisons of Various Coding Standards

Standard	***Application***	***Bitrate***
MOTION JPEG	Still image compression	Variable
MJPEG 2000	Improved still image compression	Variable
MPEG-1	Video on digital storage media (CD-ROM)	1.5Mb/s

MPEG-2	Digital Television	2-20 Mb/s
MPEG-3	HDTV	1411kb/s
MPEG-4	Object-based coding, synthetic content, interactivity	Variable
MPEG-7	video surveillance	80Mbps
MPEG-21	sharing digital rights, permissions on digital video	
H.261	Video conferencing over ISDN	P x 64 kb/s
H.263	Video telephony over PSTN	33.6kb/s
H.264	Improved video compression	10's to 100's kb/
H.265	twice as good as H.264	50%-bit rate saving

The comparison of different video standards is given in Table 1 and the comparisons are made in terms of applications and bit error rate. From the survey, it has been known that there is higher improvements and advantages in H.265 compared to other standards.

The image compression standards are not used for video compression because of blockage of moving images while processing and the picture quality is dull which results in blur image. The video compression standard H.261/H.263 is not suitable for the processing a video because they lack some features for efficient bandwidth. From the survey, it is not possible to compress a video using image compression standards because of wastage of bandwidth. For this reason, image compression standards are not used for video compression. Each of the image compression standards is described below which cannot be used for video compression.

1. Motion JPEG

The video sequence can be represented as a series of JPEG pictures. The advantages are same as with single still JPEG pictures, that is flexibility both in terms of quality and compression ratio. The main disadvantage of Motion JPEG is that since it uses only a series of still pictures and it makes no use of video compression techniques. That results in the lower compression ratio compared to the real video sequence [6] and [15].

2. JPEG 2000

JPEG 2000 is the extension of JPEG compression standard with better compression ratios and new advances are added in the picture compression. Instead of DCT transformation format, it uses the Wavelet transformation. But this gives low video quality and produces blur images [2] and [16].

3. Motion JPEG 2000

Alike JPEG and Motion JPEG, JPEG 2000 can also be used to represent a digital video sequence and has advantages same as JPEG 2000. This produces slightly better compression ratio compared to JPEG. But it reassembles the Motion JPEG. It gives lower compression ratio compared to real video sequence and it does not take any advantage of video sequence compression. The Motion JPEG 2000 has never been successful as a video compression technique [19] and [13].

4. H.261/H.263

The H.261 and H.263 are not International Standards but only Recommendations of the ITU. But they lack some features that MPEG techniques really provide for the efficient bandwidth usage. They are designed for video conferencing over telephone lines with low bandwidth. So, they are not suitable for usage in general digital video coding [2], [19] and [6].

IV. CONCLUSION

In this paper, a brief survey on different video compression standards has been presented. From the survey of different video standards, it has been observed that H.265 has many improvements compared to previous video codec standards in terms of flexibility, robustness, bit error rate, picture quality etc. H.265 is still being formulated to achieve 50% lower computational power and improvement in compression ratio by 25% compared to H.264 standard. As per the requirements, there will be always enhancements in the video compression standards and hence new standard is being developed. From the review of various video compression standard techniques, it can be seen that there are still lack of possibilities for the advancements and developments which are necessary in standards to meet the future requirements.

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