Research Paper Engineering

Survey on the General Concepts of MPEG-Moving Picture Experts Group

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KEYWORDS

Introduction of MPEG

In 1987 the International Electro technical Commission and International Organization for Standardization (IEC& ISO) created a working group of experts for tasked them to standardize the compression of digital video and audio. This group became known as the Moving Picture Experts Group (MPEG). In May1988 When the first official MPEG meeting was held; digital television broadcasting was no more than a vision.

The development of audio CDs had proven that analog signals could be digitized to produce high-quality sound and the implications of digitization combined with compression stretched as far as television, where decreased bandwidth requirements would make room for more programs, internet services, and interactive applications. Developing a method to successfully compress and then transmit digital programs would require extensive research. To make the transition from analog to digital television would impose on the industry completely new approach to broadcasting with new technology, new equipment & new international standards. The MPEG series of protocols answered the need for digital broadcast standardization. [1]

A new standard IEEE 802.11e [2] has been specified to support the varying QoS (Quality-of-Service) requirements of emerging applications. This standard defines four access categories that have different transmission priorities. The transmission priority is the probability of successfully earning the chance to transmit when individual ACs (access categories) is competing to access the wireless channel; the higher the transmission priority, the better is the opportunity to transmit. Well for a wireless channel, the unavoidable burst loss, excessive delays, and limited bandwidth become challenges for efficient multimedia transmission over wireless network. Most of the proposed mechanisms improved the performance by adjusting the operation of 802.11e MAC, such as Contention Window size and data transmission rate.

But For video traffic, the impact of the encoded video data varies. The priority transmission of hierarchical coding video plays an important role in supporting multimedia service in a wireless network. The standard 802.11e provides QoS through traffic distribution where all video data in the same access category. MPEG SBR (Spectral Band Replication) is the newest compression technology of MPEG standards that combined with MPEG Advanced Audio Coding (AAC) and improves coding efficiency by more than 30%. Thus the resulting scheme is called High-Efficiency AAC (HE AAC). The SBR technology itself as well as the implications on systems based on MPEG-4 technology. [3]

Few years ago internet services was not very popular media. Nowadays the demand of internet services increase day by day. People in anywhere depend on internet for any information such as books, news, audio, video, interactive TV *etc*. Before few years when we open any web pages that pages were simple that is those web pages contains only text and some images. But in this time most of the web pages contain video file that are playing automatically or play by user request. Video file is a large file so it difficult to transmit video data from one end to another. If one of the video data packets is lost then the corresponding video file may be corrupted. For that reason several video standard has been developed for different purposes such as MPEG-2, MPEG-4, MPEG-7, H.261, H.264 etc.

MPEG-4 supports low data rates as compared to the MPEG-2. In this research, we have used two kinds of network, one is best-effort network and another is Quality of Service (QoS) network. MPEG-4 video has been used to transmit video data over both of those networks and the Peak Signal Noise Ratio (PSNR), throughput, packet and frame statistics have been measured. The term Quality of Service (QoS) is defined as the set of parameters that define the properties of media streams. There are four layers of QoS user QoS, application QoS, system QoS and network QoS.

The user QoS parameters describe requirements for perception of the multimedia data at the user interface. The application QoS parameters describe requirements for the application services, possibly specified in terms of media quality (high end-to-end delay) and media relations. Application layer QoS controls how to from the media object (or scene description). The layer is responsible with the synchronization of the elementary streams belonging to a particular presentation scene [4].2.2.4 Multimedia Layer The type of information identified in each stream must be retrieved at decoder (respectively the encoder must provide it).

MPEG Video Compression

Image Sequence Compression

An image sequence has to be significantly compressed for efficient storage and transmission and also for efficient data transfer among various components of a video system like Motion Picture and HDTV.

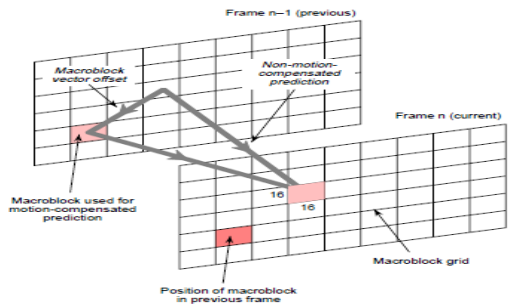
Approaches to Image Sequence Compression

Intraframe compression –

It treats each frame of an image sequence as a still image. This type of compression when applied to image sequences it reduces only the spatial redundancies present in an image sequence.

Interframe compression –

It employs temporal predictions and thus aims to reduce temporal as well as spatial redundancies, increasing the efficiency of data compression as temporal motion-compensated predictive compression. Some of the application have specific requirements, such as random access capability at all frames, may require the use of intraframe compression rather than interframe compression. [5]



Motion-Compensated Interframe Prediction [6]

Standards Relevant to Image Sequence Compression

JPEG-Joint Photographic Expert Group(CCITT-ISO) it is Primarily designed for still images and also Applicable to intraframe coding of sequences.

H.261-it is Recommendation of CCITT (International Committee on Telegraph and Telephones) Expert Group on Visual Telephony & Designed for ISDN applications.

MPEG- Moving Picture Expert Group.

MPEG has three versions of itself

MPEG 1: Storage and retrieval of video + audio at about 1.5 M bits per sec (International Standard status in November 1992.).

MPEG 2: Storage and retrieval of video + audio at higher bit rates (International Standard status in November 1994).

MPEG 4: Video &Audio compression at very low data rates (from 4800 baud) (Final version October 1998 & Second Version December 1999)

MPEG-7: Describe various forms of multimedia. It will also standardize ways to define other descriptors as well as structures for the descriptors and their relationship. MPEG-7 will also standardize a language to specify description schemes. (July 681).

Now let's go through about some overview of **MPEG-1, MPEG-2, MPEG-3, MPEG-4** and **MPEG-7 [1].**

Horizontal picture size	≤768 pixels
Vertical picture size	≤ 576 lines
Number of macroblocks	≤ 396
Number of macroblocks × picture rate	≤ 396 × 25 = 9900
Picture rate	≤ 30 pictures/s
VBV buffer size	≥ 2,621,440 bits
Bit rate	≤ 1,856,000 bits/s

MPEG-1 is the original MPEG standard for audio and video coding. This standard is published in 1993 that defines digital audio and video coding at bit rates up to 1.5 Mbps. It is a frame-based standard for delivering a single program on a CD-ROM and its quality is comparable to that of video home storage (VHS) cassettes. MPEG-1 has also been used for digital radio broadcasts.MPEG-1 was also used in early video-on-demand and has become almost universally PC media players.

MPEG-1 Constraints

MPEG-2 *was developed as a frame & field-based standard that allows digital broadcasting applications to deliver multiplexed programs very efficiently.MPEG-2 is backward compatible with MPEG-1, like MPEG-2 decoders can process MPEG-1 video streams. It is a set of standards for building a single digital transport stream which can carry a dozen of programs or more depending upon the level of compression used and the communications bandwidth is available. It Offers resolutions of 720x480 and 1280x720 at 60 fps, with full CD-quality audio. This is sufficient for all the major TV standards, including HDTV. It is more powerful format than MPEG-1 as it supports interlaced video.*

MPEG-3*: Was designed for HDTV but was abandoned in place of using MPEG-2 for HDTV. A proposed MPEG-3 standard, intended for High Definition TV (HDTV) was merged with the MPEG-2 standard when it became apparent that the MPEG-2 standard met the HDTV requirements.*

MPEG-4 represents the latest discovery in audio/visual coding. It allows for equivalent coding of synthetic and natural objects and sound, this technology has given service providers more options for creating games and other multimedia applications. It also extends interactive possibilities by allowing the user to manipulate such things as views and the viewing perspective.

MPEG-7 which is formally called Multimedia Content Description Interface will provide standardized descriptions for searching, filtering, selecting, and handling audio/visual content. These descriptions are called metadata and it will allow users in various applications to search and manage volumes of audio and video files. Applications include digital libraries, multimedia directory services, broadcast media selection and multimedia editing. [1]

MPEG-4 Overview

MPEG-4 (Motion Pictures Expert Group-4) standard was introduced in late 1998. This standard enables the compression of audio-visual data. Initially this standard was concerned with a similar range of applications to those of H.263, each running over very low bit rate channels ranging from 4.8 to 64 Kbps. Later its scope was expanded over the internet and various types of networks [8]. The encoding algorithm- ACE (Advanced Coding Efficiency) used in this standard, MPEG-4 provides highest efficiency during encoding [7].

The major functionalities that this standard provides
- Content-based interactivity
- Compression
- Universal access

MPEG-4 is one of the latest (audio and video) compression method standardized by MPEG group, designed especially for low-bandwidth (less than 1.5MBit/sec bit rate) video/audio encoding purposes. Probably the best-known MPEG-4 video encoders are called DivX and XviD, which both are nowadays fully standard-compliant MPEG-4 encoders. Unlike MPEG-1 and MPEG-2, the MPEG-4's predecessors, MPEG-4 itself isn't just one unified encoding mechanism, but rather a group name for several flavors of video and audio encoding methods that share certain same characteristics. MPEG-4 group has standardized several new layers - most important ones are h263+ which is used widely in mobile phones, named as 3GP and h.264 often also called as AVC. [8]

It provides technologies to view access and manipulate objects rather than pixels at a large range of bit rates. Application areas of MPEG-4 range from digital television, streaming video, to mobile multimedia and games. Its natural video standard consists of a collection of tools that support these application areas. The standard provides tools for shape coding, compensation and motion estimation, texture coding, error resilience & scalability. [9]. A graphics and video compression algorithm *standard that is based on MPEG-1 and MPEG-2 and Apple QuickTime technology* **Motion estimation for different frames** *[10]*

With MPEG-4 Digital video is replacing analog video in many existing applications. A prime example is the introduction of

digital television. Another one is the progressive replacement of analog video cassettes by DVD. MPEG-4 should provide the capability to represent arbitrarily shaped video object and each object can be encoded with different parameters, having different qualities to support various functionalities.

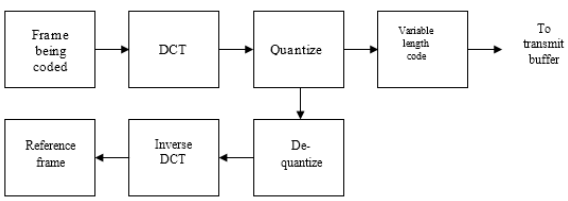
The MPEG-4 visual standard has been optimized for three bit rate ranges

- Below 64 Kbit/sec
- 64 - 384 Kbit/sec
- 4 Mbit/sec

Hierarchy of MPEG

The six layers of MPEG video bit stream are

- Sequence Layer
- Frame Layer
- Slice Layer
- Macro block Layer
- Block Layer



Reconstructing a reference frame that, same as at the decoder:

MPEG-4 Video Structure

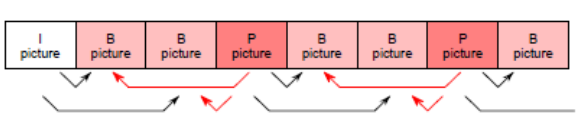
The MPEG-4 standard defines three types of video frames for the compressed video stream.

I (Intra-coded) frame- The MPEG I frame is encoded independently and decoded by it. An I picture must exist at the start of any video stream and also at any random-access entry point in the stream.

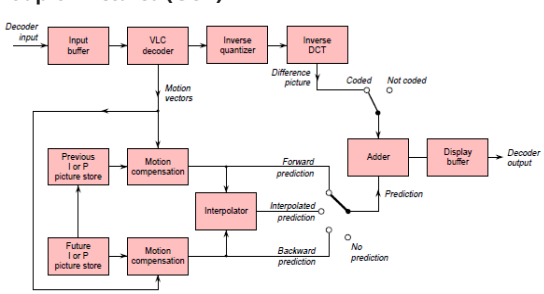
P (Predictive-coded) frame- This type of frames are coded using Motion Compensation from a previous I or P frames.

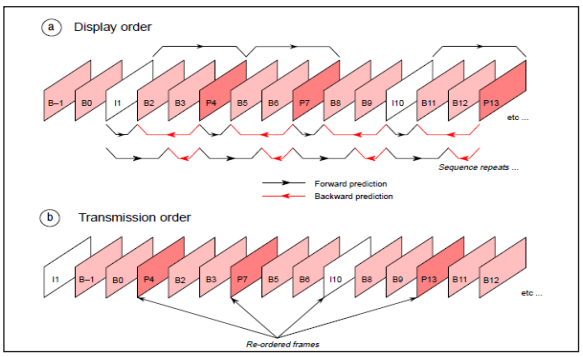
B (Bi-directionally predictive-coded) frame- The B frames are Coded by Interpolating between a previous and a future I or P frames.

This process is sometimes referred to as bidirectional Prediction. The video sequence can be decomposed into smaller units, GOP (Group of Picture)as shown in Figure. A GOP pattern is characterized by two parameters, G (N, M): N is the I-to-I frame distance and M is the I-to-P frame distance [11] [12].



Group of Pictures (GOP)





Decoding a "B" Macro block [6]

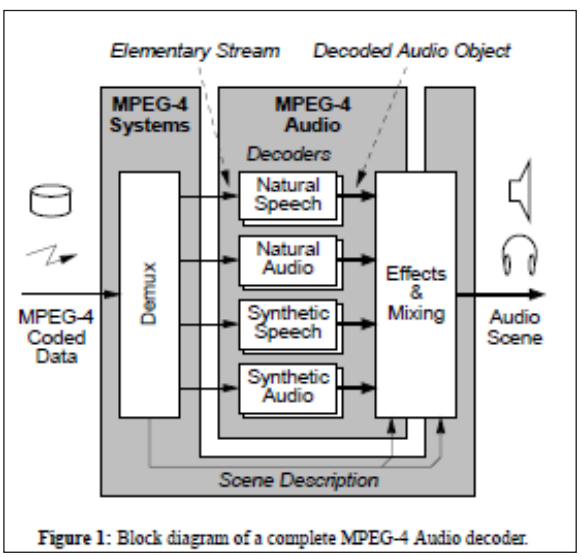


Figure 1: Block diagram of a complete MPEG-4 Audio decoder.

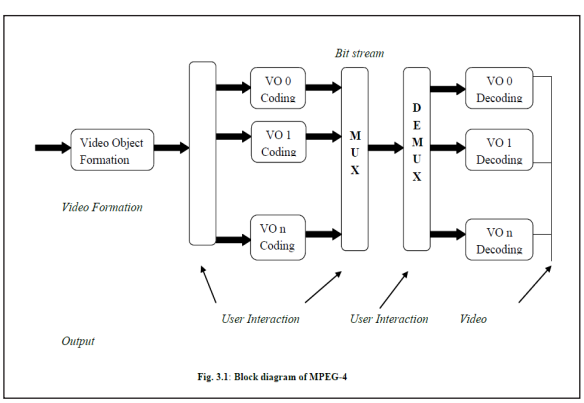


Fig. 3.1: Block diagram of MPEG-4

Fig. 3.1 shows the general block diagram of MPEG-4 encoding and decoding based on the notion of video objects. In fig. 3.1 each video object is coded separately. Video objects are coded via their corresponding video object planes in a hybrid coding scheme. This scheme is similar to previous MPEG standards [13].

There are more advantages this standard provides

- Low bit rate
- Provide DVD-like video

There are various standards that are supported by MPEG-4 and MP4 is a one of the standard that is specified as a part of MPEG-4. MP4 is not a standard method of coding the audio or video information. Instead it uses codecs that it describes how the audio or video will be coded. An MP4 is a media container that concerned with how the video and audio data are stored within the file as well as other relevant information like subtitles, chapters, etc that is encoded by an MPEG4[14][15][16]

An MPEG4 encoded video stored in an MP4 file could have been encoded by any of the various codecs; DivX, Xvid, QuickTime, and x264. In our thesis work we have worked on MPEG-4 video with file extension .mp4

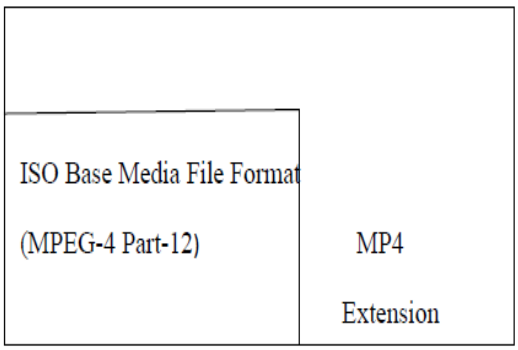


Fig. 3.3: MPEG-4 Part-14 - MP4 File format

The concept of fragmentation of packets in MPEG-4 Traffic is very important to understand. As in OSI layer model which is basically consists of seven layers and each layer has specific function and function of transport and network layer is very useful for us.

Basically the transport layer decides whether transmission should be parallel or single path, multiplexing, splitting the data, to break the data into smaller units for efficient handling. Transport layer protocols are divided into two categories: TCP (Connection- Oriented) and UDP (Connection-less).

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