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Study on Video Compression

Chandana Pandey[1], Deependra Pandey[2]

chandana.pandey@gmail.com, dpandey@lko.amity.edu

Abstract

Video compression is essential for multimedia communication. Without using video compression, it is impossible to provide fast video transmission over the wire and wireless transmission medium. Widely used video coding standard is the Moving Picture Expert Group (MPEG) which is used in digital video applications such as Digital Video Disc (DVD) and High Definition Television (HDTV). This review paper discusses the basics of video compression i.e. its need, feasibility and the quality measurement of video frames. Moreover it also explains the various video compression techniques such as MPEG 1, MPEG 2 and MPEG 4. Finally theoretic comparison of these algorithms is done and their limitations are discussed in brief.

Keywords

Video compression, Video coding standards, MPEG standard, PSNR.

Introduction

Video compression finds its application in different fields of education, medical, agriculture and entertainment. Therefore a lot of research has been done to develop efficient techniques of video compression. Out of various methods available, the most famous and apply technique is Moving Picture Experts Group (MPEG). This is a standard developed by an ISO/ITU for video compressing. MPEG is a lossy method of compression. In this method DCT is used to transform the digital frames from time domain to frequency domain. Finally Huffman encoding is performed to encode the bits. These standards are asymmetric in nature, it means they are complex at encoder side than the decoder and take longer time to compress the video than to decompress [1].

A. Need For Video Compression

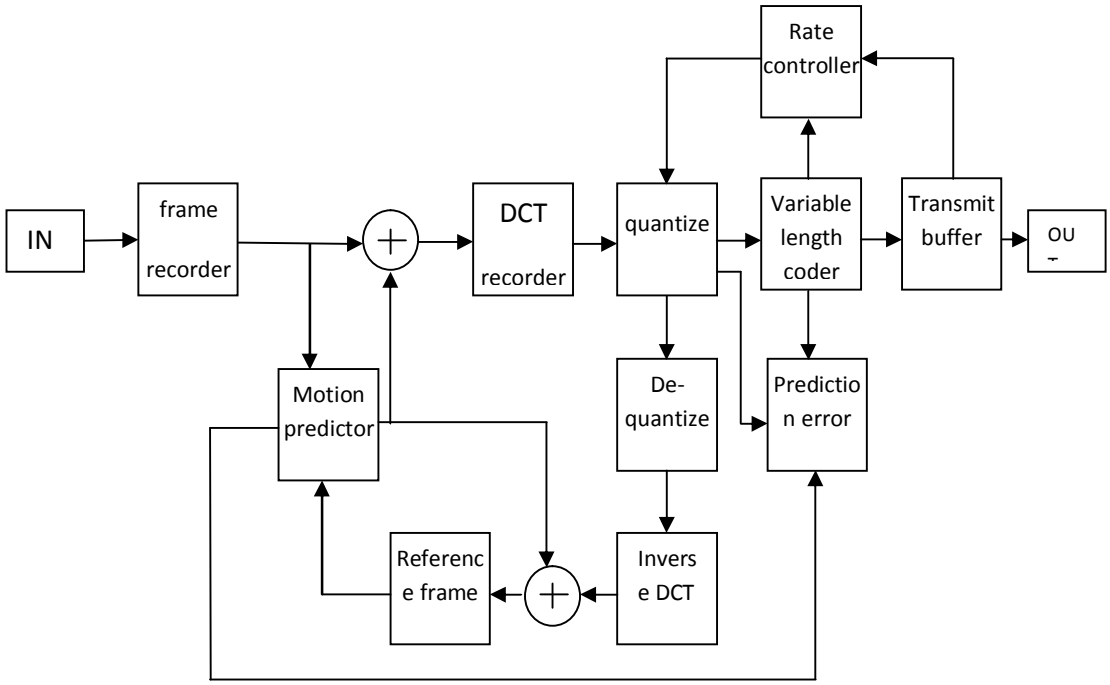
Videos are widely utilized in our daily lives. Examples include videophony, videoconferencing, high definition TV (HDTV) and the digital video disk (DVD) [2]. Videos are the sequences of video frames therefore they involve a huge amount of data and require large bandwidth for transmission [2]. For example, a image of 320 x 240 pixels in an RGB format playing at full speed of 30 fps will produce transmission rate of 6.9 million bytes per second (MB/s). This data rate is not possible therefore video compression is used for real-time playback [3].

B. Feasibility of Video Compression

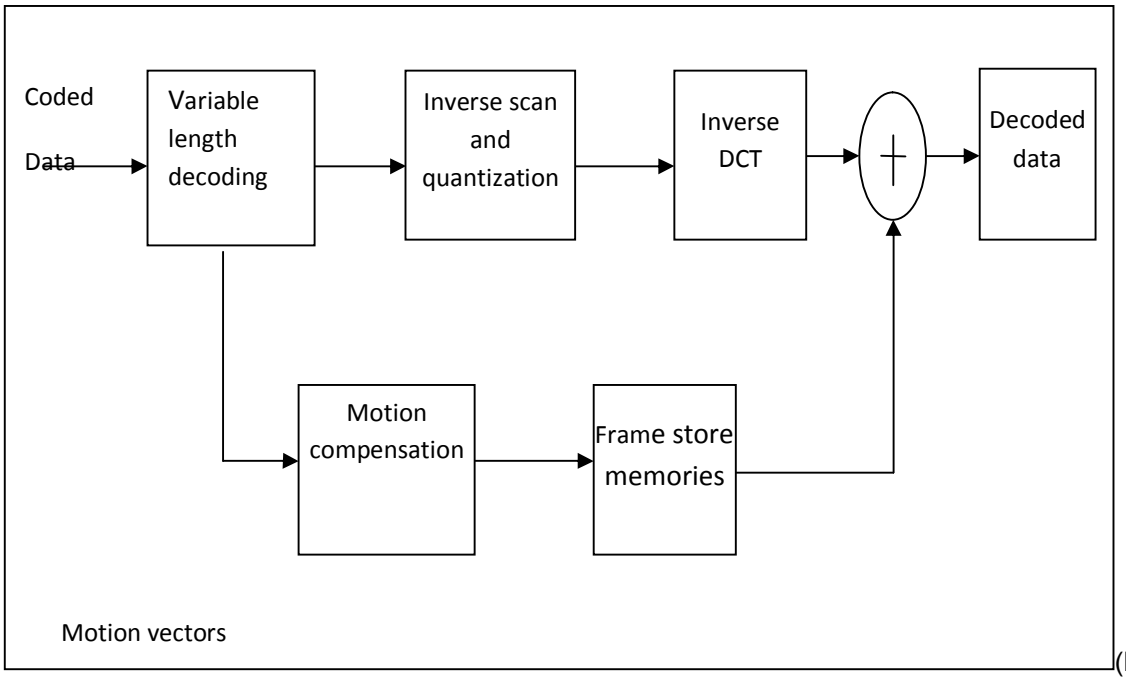
Video compression is not only a necessity for the rapid growth of digital visual communications, but it is also feasible. The video frame contains redundancies. These redundancies are either present in between the frames or in the frame itself. Hence, we have two types of redundancies one is called statistical redundancy and the second type is called psycho-visual redundancy. By removing these two, we can achieve video compression [4].

Statistical redundancy is of two types: inter-pixel redundancy and coding redundancy. In psycho-visual redundancy some information which are not of importance and their absence does not affect the visual information, can be eliminated to compress the video.

The entire compression and decompression process consist of an encoder and a decoder. The encoder compresses video at a target bit rate for transmission while the decoder decompresses the video signals to be viewed by the user. The process of encoding and decoding of video frames is shown in fig.1.



(a) MPEG Video Encoder



MPEG Video Decoder

Figure 1: MPEG video encoder (a) and video decoder (b)

The next sections of the review paper presents, description of various MPEG techniques available for the video compression, strategies for video quality measurement, comparative study of MPEG 1, MPEG 2 and MPEG 4 standards, their limitations, application and conclusion.

MPEG Video Compression Standard

There are many standards in multimedia world. MPEG's standards are well-known and are used everywhere. This organization of Moving Picture Experts Group was established in 1988. MPEG family's standards discussed in this paper are: MPEG 1, MPEG 2 and MPEG 4.

MPEG 1

This standard codes the moving pictures and associated audio for digital media at up to 1.5 Mbit/s. It is a layered standard and gives VHS quality compressed video. It became an international standard in 1993. MPEG-1 is developed for storage of digital video on CDs [5]. It supports picture resolution of 352x288 and 352x240. In MPEG 1 slice concept is very important for the recovery of error. Different quantization tables are used for intra and inter coding. This standard focuses on compression rate. It is remarkable achievement. The typical compression ratio of I-frame is 7:1, P-frame is 20:1 and B-frame is 50:1.

Drawbacks of MPEG-1- MPEG-1 standard are optimized for stored digital video in storage medium such as video CDs. It is designed for progressive video and does not support interlaced scanning. So, it is not used for TV broadcasting. [6]

MPEG 2

MPEG 2 is developed for the applications which require bit rates of about 100 Mbps. It is a generic coding method of moving pictures and associated audio information. It was started in 1990 and became an international standard in 1995. In this method, raw frames can be coded into three kinds of frames; intra frames (I-frame), predictive frames (P-frames), and bidirectional-predictive frames (B-frames). The main goal of MPEG 2 is to improve the audiovisual quality of MPEG-1, to support digital TV and to have compatibility with MPEG-1. MPEG 2 brought us DVD and HDTV [7]. The MPEG-3, whose goal was enabling HDTV, was abandoned and it was merged with MPEG 2.It has 4 profiles and 4 levels that correspond to the quality and resolution.

MPEG 4

It is a method for coding of audiovisual object. It became an international standard in 1998 (version 1). The latest video codec of MPEG 4 is Advanced Video Codec (AVC). The main goal of MPEG 4 is to provide high quality audiovisual over a large range of bitrates and to enable higher level of interaction with media content. In this same interactive programming can be used on different channels. MPEG 4's scope is to satisfy the needs of content authors, service providers and the end users [12]. The most popular features of this standard is to use "media object" to represent audiovisual content, to facilitate content-based interaction, to improve the video compression efficiency and to work in a wide range of bit rate ranging from 64kbps to 4mbps. It also provides robustness to information errors and loss. MPEG 4 supports resolution scalability and object scalability [10]. It provides outstanding compression efficiency than any other codec.

Visual Quality Measurement

A. Subjective Quality Measurement

In this method reconstructed videos are judged by human viewers because they are the receivers of these videos. Therefore in this quality measurement technique a set of video frames is generated with varying coding parameters and observers are invited to subjectively evaluate the visual quality of these frames. These observers rate the pictures by giving some measure of picture quality. Sometimes observers are also requested to provide some measure of impairment to the pictures [5].

B. Objective Quality Measurement

Objective quality measurement [6] uses the concept of signal-to-noise ratio (SNR). The interpretation of the SNRs is that the larger the SNR (SNRms, SNRrms, or PSNR) the better the quality of the processed image.

$$\mathrm{PSNR} = 10\log_{10}\left(\frac{255\text{^}2}{\mathrm{MSE}}\right) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Comparison

MPEG-1/2/4 all aim at coding of audiovisual content. MPEG-1/2 is frame-based and MPEG-2 compatible with MPEG-1. MPEG-4 is media object-based [11].

TABLE I: COMPARISION OF MPEG 1, MPEG 2 AND MPEG 4

	First edition	Targeted usage	Max. bit rate	Picture width (pixels)	Picture height (pixels)	Frame rate (fps)	ISO/IEC standards
MPEG 1	1993	It is used for coding of moving pictures and associated audio for digital storage media. Its data rate is commonly limited to about 1.5 Mbit/s.	1,86	352	288	30	ISO/IEC 11172
MPEG 2	1995	It generally does the coding of moving pictures and associated audio information.	15	720	576	30	ISO/IEC 13818
MPEG 4	1999	Coding of audio-visual objects	15	720	576	30	ISO/IEC 14496

Limitations

Motion JPEG does not take advantage of temporal redundancy. Therefore in order to make use of temporal redundancy MPEG-1 algorithm is employed, but it do not provide a lossless coding scheme. Also MPEG-1 standard is optimized for stored digital video in storage medium such as video CDs. It is not designed for progressive video and does not support interlaced scanning. So, it is not used for TV broadcasting [8].

MPEG-2 for digital TV and HDTV applications at bit rates between 2 and 30 Mbps. cannot provide Object-based coding. Hence for Object-based coding MPEG-4 was developed but it do no support videophony and videoconferencing. Then standards H.261 and H.263 was developed for videophony and videoconferencing [9].

Applications

These standards for Image and video compression is now being deployed for a variety of applications, which include high-definition television (HDTV), teleconferencing, direct broadcasting by satellite (DBS), interactive multimedia terminals and digital video disk (DVD) [13].

Conclusion

Video compression is essential for transmission and storage of multimedia signals. The success of the MPEG-1 and MPEG-2 standards seems clear, given their high level of flexibility. MPEG-2 and MPEG-4 have scalable profiles, but this feature is not widely adopted by the industry. Hence, in this paper we have reviewed various MPEG video compression standards. After comparative study MPEG -4 is found better compression algorithm than MPEG-1 and MPEG-2.

References

[1] Tekalp A. Digital video processing, Prentice Hall, PTR, 1995.

[2] Jain J. and Jain, A. Displacement Measurement and its Application in Interframe Image Coding. IEEE Trans on Communication, COM- 29, 1981: 1799-1808.

[3] Netravali A.N. and Robbins J.D. Motion compensated television coding: Part I.ll Journal of Bell Syst Technical, 1979, 58: 631-670.

[4] CCITT SG XV. Recommendation H.261-Video codec for audiovisual services at p*64 kbits/s. Tech. Rep. COM XV-R37-E, 1990.

[5] MPEG ISO CD 11172-2: Coding of moving pictures and associated audio for digital storage media at up to about 1.5 M bits/s, 1991.

[6] Kappagantula S. and Rao K.R. Motion compensated interframe image Prediction. IEEE Trans Commun. COM, 1985, 33: 1011-l015.

[7] Shen J.F., Chen L.G., Chang H.C., Wang T.C. Low power full-search block matching motion estimation chip for H.263+. IEEE International Symposium on Circuits and Systems, 1999, 4:299-302.

[8] Cho-Chun Cheng, and Wen-Liang Hwang, “Subjective and Objective Comparison of Advanced Motion Compensation Methods for Blocking Artifact Reduction in a 3-D Wavelet Coding System,” IEEE transactions on circuits and systems for video technology, VOL. 16, NO. 9, SEPTEMBER 2006

[9] Rajeshwar Dass, Lalit Singh, and Sandeep Kaushik, “Video Compression Technique,” International journal of scientific & technology research, Volume 1, ISSUE 10, NOV 2012

[10] Xinghao Jiang, Wan Wang, Tanfeng Sun, and Atal, “Detection of Double Compression in MPEG-4 Videos Based on Markov Statistics”, IEEE Signal Processing Letters, VOL. 20, NO. 5, MAY 2013.

[11] Ms. Bhavina Patel, and Dr.R.V.Kshirsagar, “Review And Comparative Study Of Motion Estimation Techniques To Reduce Complexity In Video Compression,” International Journal of Advanced Research in Electrical, Electronics and Instrumentation Vol. 2, Issue 8, August 2013.

[12] R. C. Gonzalez and R. E. Woods. “Digital Image Processing”. 2nd ed.Prentice Hall, 2002.

[13] John C. Russ, “The Image Processing Handbook, Third Edition,” Copyright © 1996-2000 EarthWeb Inc, Pub Date: 07/01/98.

Author's Profile

Ms. Chandana Pandey is presently pursuing M.Tech in Electronics and Communication Engineering from Amity University, Uttar Pradesh, Lucknow. She has completed her B.Tech in Electronics & Communication Engineering from Integral University, Lucknow in 2013. Presently, she has focused her working area within the various aspects of the video processing using MATLAB as simulation software in the vicinity of implementation of some highly efficient and accurate algorithms for motion estimation. Her research interests also include video compression.

Dr. Deependra Pandey obtained his Ph.D. in Electronics from RML Avadh University, Faizabad. He has over twelve years of teaching experience at B.Tech. and M.Tech. level. He is presently working as an Assistant Professor in the Dept. of Electronics and Communication Engineering, ASET, Amity University Uttar Pradesh Lucknow Campus. His area of interest includes Analog Signal Processing, VHDL, FPGA Implementation of Image Compression and Speech Recognition on FPGA. He has published several research papers in International/National Journals/Seminar/Conference. He is also involved in organizing number of National Conferences and Seminars.