Chapter 29
Block-Based Motion Estimation: Concepts and Challenges

Shaifali Madan Arora
MSIT, India

Kavita Khanna
NCU, India

ABSTRACT

Recent years have witnessed a great technological evolution in video display and capturing technologies leading to the development of new standards of video coding including MPEG-X, H.26X and HEVC. The cost of computations, storage and high bandwidth requirements makes a video data expensive in terms of transmission and storage. This makes video compression absolutely necessary prior to its transmission in order to accommodate for different transmission media's capabilities. Digital video compression technologies therefore have become an important part of the way we create, present, communicate and use visual information. The main aim behind a video compression system is to eliminate the redundancies from a raw video signal. The tradeoff involved in the process of video compression is between the speed, quality and resource utilization. The current chapter explores the techniques, challenges, issues and problems in video compression in detail along with the major advancements in the field.

INTRODUCTION

Recent years have established a great technological evolution in video display and capturing technologies. Ease in accessibility of digital technology has made it possible to use digital camera, cable, sound, and video by the common people in day today applications. Revolutionary development in mobile phones has made video production a common task. Gone are the days when video production was possible only for specialized studios. In fact, digital video has paved way towards the development of various challenging real-time applications.

DOI: 10.4018/978-1-7998-3016-0.ch029

The transmission of video involves the conversion of analog video into its corresponding digital domain. In a NTPC signal 30 frames (Huckfield, 1992) are transmitted per second in 4:2:2 YUV format with 858×525 luminance samples, $429 \times 525 \times 2$ chrominance samples, and 8 bits per samples.

$$\text{bit rate} = 30 \times 8 \times ((858 \times 525) + (429 \times 525 \times 2)) = 216.216 \text{ Mbps}$$

As above mentioned bit rate, transmission rate of 216 Mbps is required for a single digital television signal in NTPC format (Barbero et al., 1992). But for practical applications this bit rate is very high. Consider the example of local area networks (LANs) for which the data transmission rate is on the order of 10 Mbps, and for wide area networks (WANs) this transmission rate is even lower than this. Although high bandwidth data networks are developing, still distributing an uncompressed video bit stream over these networks is quite expensive. This clearly indicates that the video data must be compressed (encoded) before its transmission in order to adjust as per the varying capabilities of different transmission media.

So transmission of video data is expensive with respect to the number of computations, requirement of storage space and bandwidth. Video compression techniques therefore have become a fundamental part of the way the visual information is created, presented and communicated.

The use of video data has shown its growing applicability in digital television, personal computers, hand held devices and other multimedia applications, and it seems that this growth is not slowing down. Need of pervasive, good-quality digital video with high compression has become the aim of companies, researchers and standard bodies (Richardson, 2003). It has therefore emerged as an important field for research and development for the last three decades.

Digitization of synthetic/ real-time video scenes was an inevitable step. Digital video is easier to transmit, virtually immune to noise, and is capable of providing an interactive interface to users. Digital video coding has outperformed analog video coding in terms of higher compression rates without much deterioration of subjective video quality (Mistretta et al., 1981). It thus eliminates the high band-width requirement of transmitting analog videos. This significant feature has led to the development of many application areas for example, video playback using compact disk, set-top box, P2P video delivery, video conferencing over IP networks, mobile TV broadcasting, and video surveillance. Thus, the specifically designed nature of video applications has helped towards the development of various video compression techniques with different quality, size, power consumption, performance and cost.

Latest advancement in the technology of mobile phones has given us a new generation of small devices which can process videos with limited power supply and channel bandwidths (O'Hara et al., 2007). The enormous use of video information in these devices has raised the need for efficient video compression.

Also, the new emerging technologies such as 3-D television, high definition (HD) and ultra HD videos have resulted in the transmission and processing of large amounts of video data (Javidi & Okano, 2002). All these emerging video applications and availability of limited bandwidth of networks has made video compression a fundamental and essential component of a video processing system. The diagrammatic representation of a video processing system is shown in figure 1.

Figure 1 show that a basic video processing or a video coding system comprises of an encoder which converts a raw input video sequence in to its compressed form which may be used for transmission or for storage. The decoder on the other hand performs the opposite function to encoder. Video compression forms an integral part of any video processing system as large amount of information is involved in raw video signal.