Chapter XXVI
Pattern Based Video Coding

Manoranjan Paul
Monash University, Australia

Manzur Murshed
Monash University, Australia

ABSTRACT

People's demands are escalating with technology advances. Now, people are not happy with only text or voice messages, they like to see video as well. Video transmission through limited bandwidth, for example, an existing telephone line, requires an efficient video coding technique. Unfortunately, existing video coding standards have some limitations due to this demand. Recently, a pattern-based video coding technique has established its potentiality to improve the coding compared to the recent standard H.264 in the range of low bit rates. This chapter describes this technique with its background, features, recent developments, and future trends.

INTRODUCTION

Video conferencing, video telephony, teleteaching, telemedicine, surveillance, and monitoring systems are some of the video coding applications that have attracted considerable interest in recent years. The burgeoning Internet has increased the need for transmitting (nonreal-time) and/or streaming (real-time) video over a wide variety of different transmission channels connecting devices of varying storage and processing capacity. Stored movies or animations can now be downloaded and many reality-type interactive applications are also available via Web-cams.

The video itself is a series of still images (or frames) taken at some specific frame rate. Considering that the frame rate has to be fast enough to exploit the persistence of vision in creating the illusion of smooth motion as well as natural colour, the digital information content of a video can pose a significant challenge in the areas of efficient digital storage and transmission. For example, a 30 *frames*

per second (fps) video with 24-bit per pixel true colour frames of moderate resolution (352×288 pixels) generates more than 70 mega bits per second. In order to cater to devices with limited power and storage with stringent transmission bandwidth requirements, these raw digital video data need to be compressed in the order of 10 to 10,000 times depending on the applications.

One way for video coding technology to facilitate the amount of video data compression needed is by eliminating redundant and visually insignificant data. Intraframe spatial redundancy is usually eliminated by run length encoding, while interframe temporal redundancy is eliminated by skipping a block of data. Insignificant data are usually eliminated by applying spatial subsampling by dropping some intermediate pixels from each frame, temporal subsampling by dropping some intermediate frames, and quantisation. The efficiency of these elimination processes is usually significantly improved by using block-based *motion estimation* (ME) and *motion compensation* (MC), and transforming pixel-level information to energy (frequency) domain.

Another problem which also effects the video data compression is the limited transmission bandwidth. For example, the low cost common networks like *public switched telephone network* (PSTN), *integrated services digital networks* (ISDN), and many computer networks normally allow for only several *kilo bits per second* (kbps) transmission. Even wireless transmission systems using cellular phones or *personal digital assistants* (PDA) operate under similar bandwidth restrictions. *Very low bit rate* (VLBR) video coding mandates bit rates between 8 and 64 kbps to facilitate video communications over these kinds of transmission media. Therefore, an efficient encoder is indispensable to enable the transmission of video. In this chapter we like to emphasise those video coding schemes which enable limited battery power and processing capacity devices, such as mobile phones and PDAs, to encode live video data in real-time and achieve significant improvement in coding efficiency so that the encoded steams could be transmitted cost-effectively at a much lower bit rate.

BACKGROUND

Reducing the bit rate by maintaining acceptable image quality has been a continuing effort for researchers over a long period of time. Block-based very low bit rate video coding addresses this trend at the extreme level where sacrificing quality to meet a more stringent bit rate is inevitable. A graceful degradation of quality while attaining the highest possible quality for the operating bit rate remains a challenge for the research community. There are two ways to reduce the video data. One is a trivial and simple way which can be applied with any other modern video coding technology with sacrificing video quality; another is a standard way which must be used for any professional or commercial purpose.

Simple Way of Compression

The simple ways to reduce the bit rate for a video sequence in generic coding paradigm are by extending the group of picture, down sampling the image size, skipping frames, nonmotion compensated blocks, residual-error-compensation, and by increasing quantisation values. These bit reduction techniques will be presented in the rest of the section.

- During the video coding, a video sequence is divided into a group of picture (GOP) 0. A GOP consists of one intracoded frame (I-frame), one or more predicted coded frame (P- frame), and one or more bidirectional coded frames (B- frame). This classification depends on what reference frames are used for encoding. No reference frame is used for I-frame, previous I- or P-frames are used as reference frames for P-frame, and previous and next I- or P-frames are used as reference frame for B-frames. The length of a group