Textbook: H.264 and MPEG-4 Video Compression
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Outline of Chapter 1

1.1 The Scene
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1.1 The Scene

1.2 Video Compression

1.3 MPEG-4 and H.264

1.4 This Book
1.1 The Scene

- **Video Compression Standards of Next Generation**

1. **MPEG-4**: Interactive on-line world bringing together synthetic, natural, video, image, 2D and 3D ‘objects’

2. **H.264/AVC**: highly efficient and reliable video communications, supporting two-way, ‘streaming’ and broadcast applications and robust to channel transmission problems.
The interested parties include entertainment, communication and broadcasting companies, software and hardware developers, researchers and holders of potentially lucrative patents on new compression algorithms.
1.1 The Scene

**Issues of the Digital Video Systems**

- **Main Issues of the Multimedia Systems**: Huge data size and computation power requirements

- **Data Size Analysis**: For VGA@30fps, 16bit@64khz

  \[
  640 \times 480 \times 30 \times 8 \times 3 \text{ (bit/sec)} + 16 \times 64000 \text{ (bit/sec)} \\
  = 22118400 + 1024000 \\
  = 22220800 \text{ (bit/sec)} = 27776000 \text{ (byte/sec)} \\
  = 27 \text{ MB/sec}
  \]

- Huge data size hurts the data storage and the multimedia communication first

- The data compression is the main challenge for multimedia systems !!
1.1 The Scene

- **Digital Video Systems:**
  - **Multimedia System:** System with audio and video functions, such as for MPEG-1 (VCD-Sunplus) and MPEG-2 (DVD-MTK)
  - **Future Multimedia System:** System with A/V and any available functions, such as computer graphic ... etc. For example MPEG-4, MPEG-21, ...
MPEG

- **MPEG**: Moving Picture Experts Group
- **Objective**: A working group, established in 1988, of ISO/IEC in charge of the development of standards for coded (or compression) representation of digital audio and video.

- **Current Standards**: MPEG-1, MPEG-2, MPEG-3, MPEG-7, MPEG-21 ... etc.
1.1 The Scene

- **MPEG Standards**
  - **MPEG-1**: Video CD and MP3 for CD-DOM driver with a lower communication bandwidth < 1.5Mb (for low picture resolution/low video quality)
  - **MPEG-2**: Digital television, set top boxes, and DVD for DVD-DOM driver with a higher communication bandwidth (high picture resolution/high video quality)
  - **MPEG-4**: Standard for multimedia for the fixed and mobile web. A wide range (or video quality) and very low bit rate data compression.
  - **MPEG-7**: Standard for description and search of audio and visual content.
  - **MPEG-21**: A new era multimedia codec standard
Comparisons

- **Compression Ratio:**
  
  MPEG-4 part 2 < H.264/AVC

- **License Cost:**
  
  H.264/AVC > MPEG-4 part 2
1.1 The Scene
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1.2 Video Compression

- **Reasons of Video Compression**

- Possible to use digital video in transmission and storage environments: Internet, DVD

- Video compression enables more efficient use of transmission and storage resources: Send high-resolution compressed video or multiple compressed video channels in the same communication bandwidth
1.2 Video Compression

- **Features of Video Compression**
  - **Compression**: Removing redundancy from the signal
  - **Lossless Compression**: original signal can be perfectly reconstructed at the receiver.
  - **Video Compression**: Lossy compression
  - The goal of a video compression algorithm is to achieve **efficient compression**
1.2 Video Compression

- Redundancy in Video Compression
  - Temporal Redundancy
  - Spatial Redundancy
  - Frequency Domain Redundancy
1.2 Video Compression

- Temporal Redundancy

Showing examples of homogeneous regions
1.2 Video Compression

- **Frequency Domain Redundancy**: Human eye and brain are more sensitive to lower frequencies.

low-pass filtered background
1.2 Video Compression

- **Temporal Redundancy:**

  Video frame 2
1.3 MPEG-4 and H.264

1.1 The Scene
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Coded representation (or syntax) describes visual data in a compressed
Decoding the syntax to reconstruct visual information.
1.3 MPEG-4 and H.264

- Standards: Do not define

- Encoder Procedure and Architecture

- Decoding method and Architecture: Manufacturers are free to develop its design
1.3 MPEG-4 and H.264

- Standards History in ISO vs. ITU-T

ISO

- MPEG-1
- MPEG-2 (H.262)

ITU-T

- H.261
- H.263
- VCEG
- H.26L
- H.263 V.2

MPEG

- MPEG-4
- JVT
- MPEG-21
- MPEG-4 p2 (MPEG-4 Visual)
- H264/AVC (MPEG-4 p10)

Year

1.3 MPEG-4 and H.264

- MPEG-4 part 2 vs. H.264/AVC
  - MPEG-4 part 2: Move away from a restrictive reliance on rectangular video images and to provide an open, flexible framework for visual communications that uses the best features of efficient video compression and object-oriented processing.
  - H.264/AVC: More pragmatic vision, aiming to do what previous standards did (provide a mechanism for the compression of rectangular video images) but to do it in a more efficient, robust and practical way, supporting the types of applications that are becoming widespread in the marketplace (such as broadcast, storage and streaming).
Profiles in H.264/AVC

- **Baseline profile**: For “conversational” applications such as videoconferencing.
- **Extended profile**: Adds extra tools that are likely to be useful for video streaming across networks.
- **Main profile**: Includes tools that may be suitable for consumer applications such as video broadcast and storage.