Codierung visueller Inhalte: Standards, Trends und Anwendungen

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Compression as enabling technology

- Computer animation
- Live Content
- Recorded Content
- Post production
- Media Encoder
- Archive
- Storage Media
- Transmission
- Lossless or near lossless
- Media Encoder
- Focus of this talk
- UNICAST, MULTICAST, BROADCAST

Lossy
What are desirable compression ratios?

Let’s take an example:

A highly esteemed „e-teacher“ in action...
What are desirable compression ratios?

Let’s take an example:

- 1280 x 720 @ 25Hz: 
  - VDSL ~ 25 Mbps
  - ~ 15 : 1

- 640 x 360 @ 25Hz: 
  - DSL ~ 2.5 Mbps
  - ~ 150 : 1

- 320 x 180 @ 25Hz: 
  - UMTS ~ 250 kbps
  - ~ 1,500 : 1

- size of 1/16 w.r.t. original
  - ~ 100 : 1
Outline

1. From Principle to Standards

2. H.264/AVC - Core Coding Technology and Applications

3. Scalable Video Coding Extension: More Functionality and Adaptability

4. A New Frontier: 3D Video
Transform coding + predictive coding

Difference image (with motion compensation)

DCT-encoder

channel

DCT-decoder

Motion compensation

Motion estimation

Motion vectors
Milestones in Video Coding

- **Variable block size (16x16 – 4x4) + quarter-pel + multi-frame motion compensation (H.264/AVC, 2003)**
- **Variable block size (16x16 – 8x8) (H.263, 1996) + quarter-pel motion compensation (MPEG-4, 1998)**
- **Half-pel motion compensation (MPEG-1 1993, MPEG-2 1994)**
- **Integer-pel motion compensation (H.261, 1991)**
- **Intraframe DCT coding (JPEG, 1990)**

**Foreman**

- **10 Hz, QCIF**
- **100 frames**
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H.264 / AVC: A Brief Historical Review

- **1997**: ITU-T VCEG – Video Coding Experts Group started standardization activity H.26L (“L” = long term; H.26P → H.263)
- **August 1999**: 1st Test model (TML-1) chosen among 4 technical proposals from Telenor, Nokia, Strathclyde University, and HHI
- **December 2001**: Formation of the **Joint Video Team (JVT)** between VCEG and MPEG (Moving Pictures Experts Group): joint project – **H.264 / AVC (Advanced Video Coding)**
- **May/July 2003**: Approval of **Version 1**
- **Sept. 2004**: Approval of **Fidelity Range Extensions** (“FRExt”)
- **July 2007**: Approval of **Scalable Video Coding (SVC) Extension**
- **January 2008**: Final draft of **Multiview Video Coding (MVC) Ext.**
Main Innovative Features

- Video coding layer of H.264/AVC is similar in spirit to other standards but with important differences
- New key features are:
  - Enhanced motion compensation
    - Better block segmentation
    - Multiple reference pictures and generalized B pictures
  - Adaptive transform block sizes
  - Enhanced entropy coding (CABAC)
- Substantial bit rate savings (typically around 50%) relative to any other standard for the same perceptual quality
- But: New design typically demands for more computing resources – rough guess: 2-3x the requirements of MPEG-2 for decoding, 3-4x for encoding (depends on profile, etc.)
H.264/AVC Profiles* and Related Tools

*not including Professional Profiles
HHI Contributions* to H.264/AVC

*plus: substantial administrative support (e.g., management, editing, SW)
H.264/AVC-Based Product Examples

- **Mobile TV** (use of Baseline profile)
  - Digital Video Broadcasting – Handheld (DVB-H)
  - Digital Multimedia Broadcasting (DMB)
  - Multimedia Broadcast/Multicast Service (MBMS)

- **SDTV / HDTV Broadcast / IPTV** (use of High/Main profile)
  - **DVB**: revised implementation guide TS 101 154 (DVB-C/S/T)
  - **Direct-to-home broadcast satellite**, e.g.,
    - DirecTV, Dish Network (USA)
    - Sky HD, BBC HD (UK and Ireland)
    - Premiere, ProSiebenSat.1 (Germany)
  - **Terrestrial HDTV** pay-TV services in France

- **Media Storage** (High profile)
  - **HD-DVD** specification of the DVD Forum
  - **BD-ROM** specification of the Blu-Ray Disc

- **Mobile Phones & Players** (Baseline/Main/High)
  - Nokia, Sony PSP, Apple iPod

- **Internet Streaming** (Baseline/Main/High)
  - Apple Quicktime, Adobe Flash Player, YouTube, etc.
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Scalable Video Coding (SVC) - Principle

- **SVC encoder**
  - 128 kbit/s
  - 256 kbit/s
  - 512 kbit/s
  - 1024 kbit/s

- **H.264/AVC decoder**
  - QCIF@ 7,5 Hz

- **SVC decoder**
  - CIF@ 15 Hz

- **SVC decoder**
  - CIF@ 30 Hz

- **SVC decoder**
  - TV@ 60 Hz

**Scene**
Functionalities and Applications

• One single encoding process to produce the scalable bitstream
  – **Encode once** and then customize the stream to access content
  – Cost in terms of *coding efficiency loss* < 10% typically

• **Partial decoding of the scalable bitstream allows:**
  – *Graceful degradation* when the “right” parts of the bitstream get lost
  – Bit rate adaptation
  – Format adaptation
  – Power adaptation

• **Potential Applications**
  – Format enhancement services: e.g., upgrade from 720p to 1080p
  – Robust video delivery in internet/mobile networks
    • combine with unequal error protection
    • guarantee base layer delivery
Mobile TV without graceful degradation

Video Sequence

Quality

Mean value = 27.33326

Frame Number

Quantity
Mobile TV with **graceful degradation**

**Video Sequence**

**Quality**

![Graph showing quality over frame number](image)

- Mean value = 32.164235
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This talk is not about 3D TV with glasses
Autostereoscopic 3D Display

- 3D impression without glasses
- Automatic head and gaze tracking with built-in cameras
- Automatic adjustment of 3D rendering due to user motion
Multiscopic / Multiuser 3D Display

3D flat panel displays for viewing stereoscopic or 3D images without special eye glasses

Provides up to 9 different views by using a system based in lenticular lenses

E.g., Philips 3D LCD display – shown at IFA 2006
3D Video: 2D Video + Depth

- Generation of 2 views for each eye from one 2D video plus one map with per pixel depth information

- Rendering of a stereo pair at the decoder and displaying on a special 3D display
3D TV Transmission over DVB-T

- Demonstrated first time at IBC 2004 in Amsterdam
- Two 3D programs (each with video + depth) in one MPEG-2 TS
- Video (MPEG-2 @ 3 MBit/s), depth (H.264/AVC @ 300 kbit/s)

**MPEG-C Part 3**: Defines a simple container format
- Backward compatible to existing MPEG video coding standards
- Includes 2D video + depth + auxiliary data (stereo config)
Conclusions

- **H.264/AVC Video Coding Standard**
  - Successful both in terms of technical and commercial aspects
  - Used in all video application areas (except for Digital Cinema)

- **SVC Extension**
  - Next step in Video over IP
  - Will also be used in Broadcast (e.g., 720p to 1080p)

- **3D TV**
  - Next step is extension towards 3D TV: high-quality multiscopic displays need to be available
  - Efficient video coding for 3D TV is still a topic of research

- **Videoconferencing**
  - Demo: seeing is believing
Videoconferencing heute

• Raumsysteme für Konferenzräume
  – Keine Adhoc-Besprechungen möglich
  – Multipoint nur mit teurer MCU
  – Keine Zusammenarbeit per Application Sharing
  – Polycom, Tandberg

• Webconferencing
  – Sehr schlechte Integration von Video und Audio
  – Daher meist mit paralleler Telefonkonferenz
  – WebEx, Netviewer
Wer oder was ist daViKo?

• 2001: Gründung der daViKo GmbH
  – Spin-off der Fachhochschule für Technik und Wirtschaft Berlin

• Kernkompetenzen
  – Software Video-Codec Entwicklung
  – Netzwerkprotokoll

• daViKo-Videoconferencing
  – reine IP-basierte Software-Lösung
  – Multipoint Konferenzen ohne teure MCU
  – Präsentation und Zusammenarbeit durch Application Sharing
  – Aufzeichnung und Wiedergabe von Konferenzen
  – Hohe Audio- und Video-Qualität mit Software-basierten Codecs (H.264)
Thank you for your attention!