

Course Code 005636 (Fall 2017)

Multimedia

Video Compression Principles

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Video Compression

- Video is a temporal combination of frames
- Each frame can be considered as an image comprising spatial combination of pixels.

Two Basic principles

- Motion JPEG
- MPEG

Motion JPEG

- Motion JPEG (M-JPEG or MJPEG) is a video compression format in which **each video frame** a digital video sequence is **compressed separately as a JPEG image**.
- Originally developed for multimedia PC applications.
- M-JPEG is now used by video-capture devices such as digital cameras, IP cameras, and webcams.
- It is natively supported by the QuickTime Player, the PlayStation console, and web browsers such as Safari, Google Chrome, Mozilla Firefox and Microsoft Edge.

MPEG

Format Uncompressed 720 8-bit ▾
Resolution 1280x720
Frame rate 30 ▾
Video length

Total space: 23.17 GB



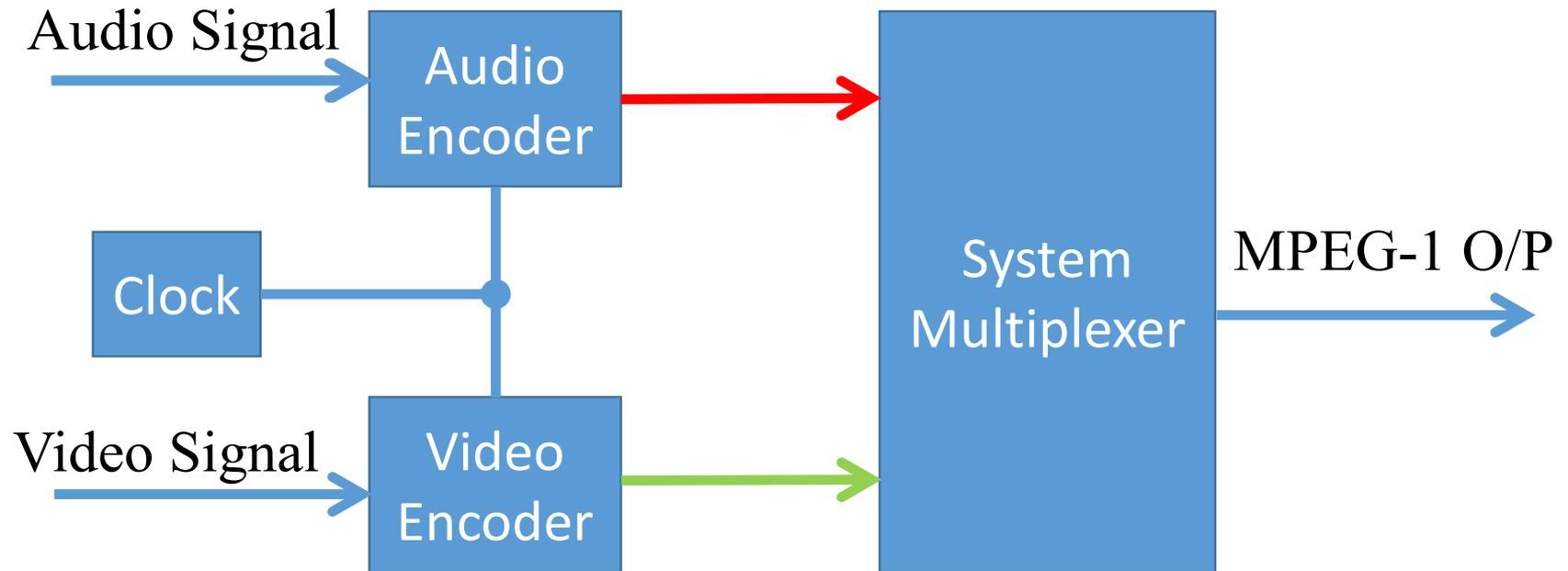
100 times!!

Format MPEG-2 6.2Mbps fixed rate ▾
Resolution 720x486
Frame rate 30 ▾
Video length

Total space: 232.5 MB

- The first standard to be finalized for video compression was MPEG-1 for interactive video on CD and for digital audio broadcasting

MPEG-1



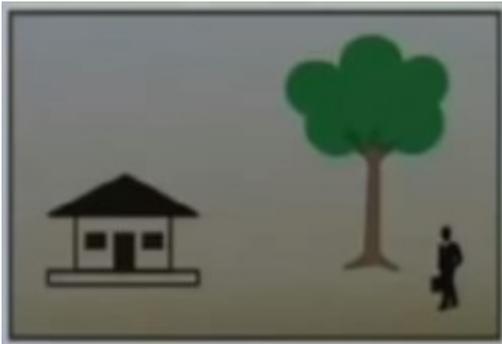
- MPEG-1 Components: Audio, Video and System
- 90 KHz clock: Provides the current time value (timestamps)

Principle of MPEG-1 Video Compression

- Exploiting spatial redundancy as of JPEG
- Exploiting the temporal redundancy of a video.
- Since the frame rate of the video is often relatively high (e.g: > 15 frames per second) and the camera parameters (focal length, position and viewing angle) usually do not change rapidly between-frames, the contents of consecutive frames are usually similar, unless certain objects in the scene extremely fast.
- Temporal redundancy is often significant and it is exploited, so that **not every frame of the video needs to be coded independently as a new image**. Instead, the difference between the current frame and other frame(s) in the sequence is coded.

Example: Temporal redundancy

- Consecutive frames are often almost identical



MPEG-1 Frame Types

- **I (Intracode) Frame:** Self-contained JPEG encoded, appears periodically.
- **P (Predictive) Frames:** Block-by-block difference with the preceding I or P frames.
- **B (Bidirectional) Frames:** Differences with the preceding and the following I or P frame.
- **D (DC-coded) Frame:** Block averages used for fast forward.

Example: Motion Prediction

Temporal Redundancy



I Frame

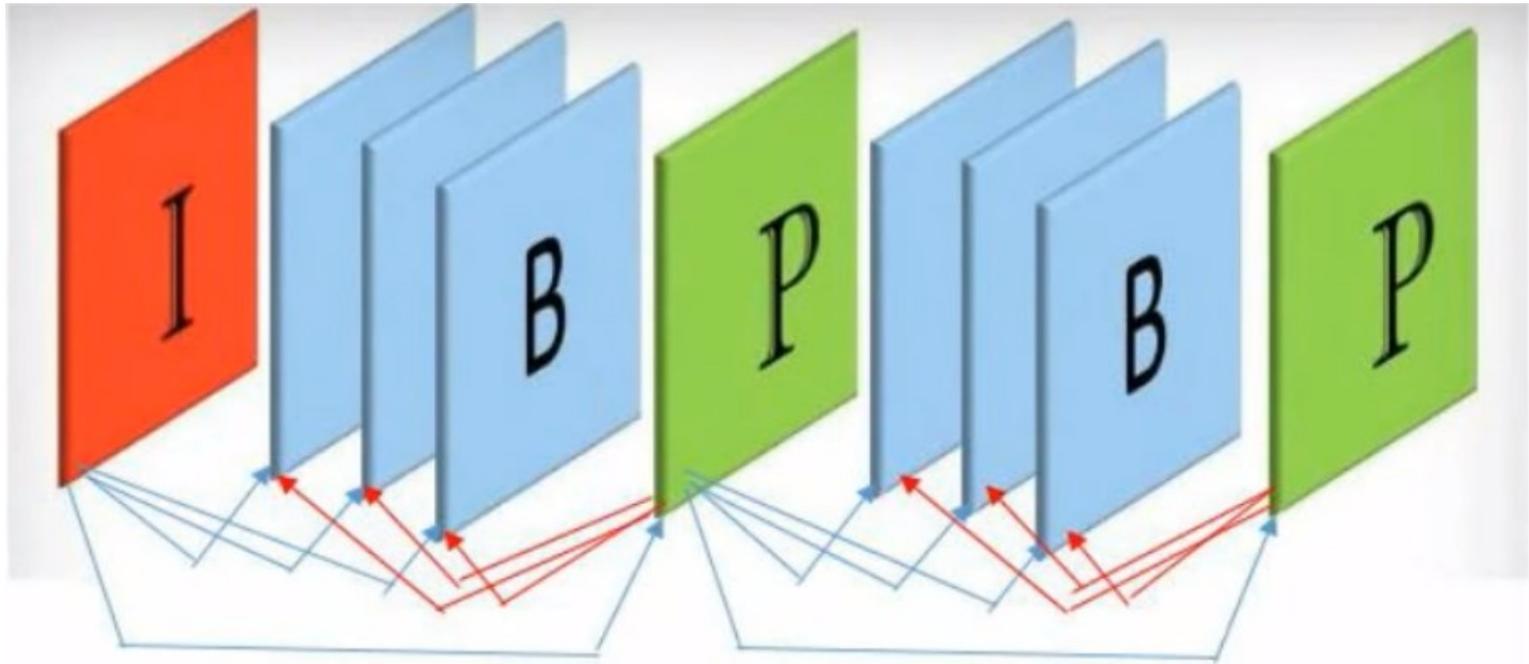


B Frame



P Frame

Sequence of Frames: Forward and Backward Predictions

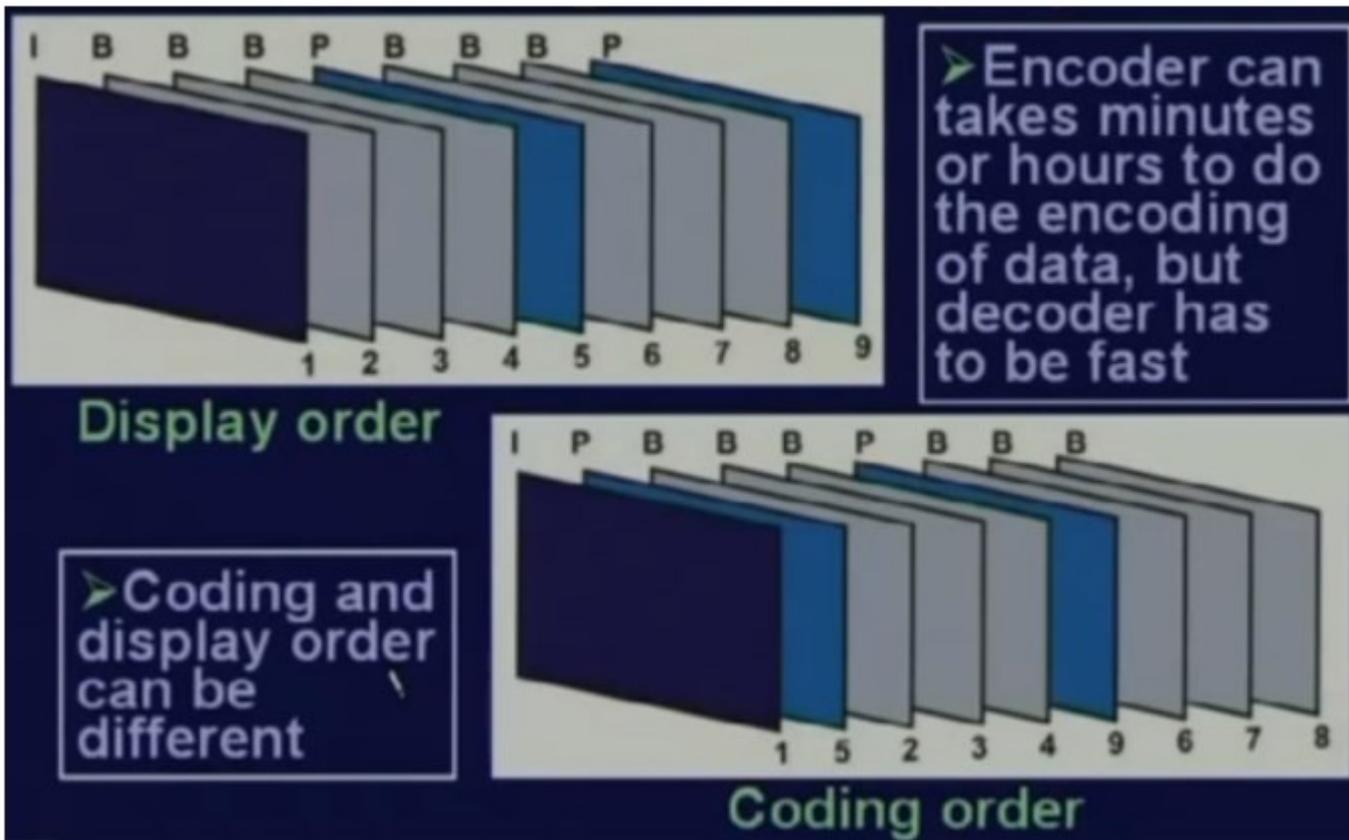


Forward prediction of P frames

Forward prediction of B frames

Backward prediction of B frames

Display Order and Coding Order



MPEG-2

- Similar to MPEG-1, but developed for digital TV.
- Difference
 - D-frames are not supported
 - DCT is 10x10 for better quality
 - Supports higher resolutions
 - Support five different profiles

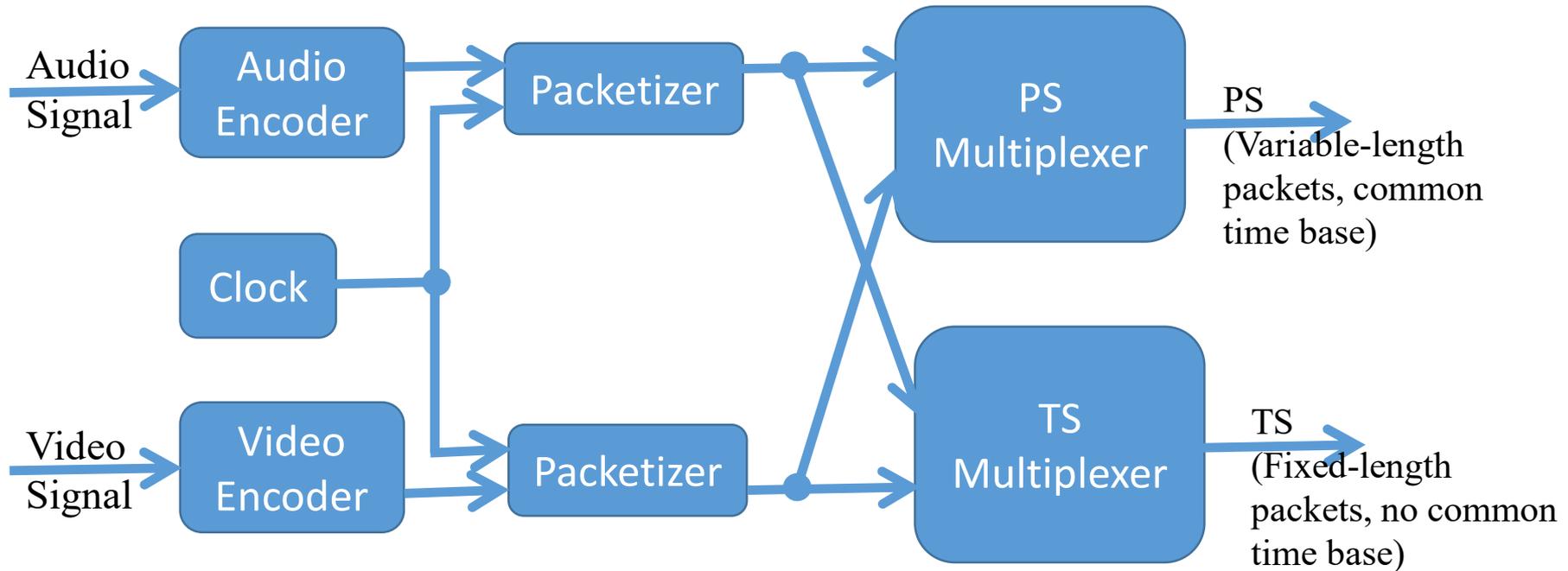


MPEG-1: VCD/VCR
MPEG-2: DVD

MPEG-2

HDTV	1920	1080	24 bits/pixel	60 fps	2986 Mbps	25-34 Mbps
TV	720	576	24 bits/pixel	25 fps	498 Mbps	3-6 Mbps

MPEG-2



- More general way of multiplexing
- Each streams are packetized with time stamps
- The output of each packetizer is a packetized elementary system (PES) having 30 header fields.

MPEG-4

- Started as a standard for a very low bitrates for use in portable applications like videophones.
- It includes much more than just data compression

MPEG-4

Important Functionalities

- Content-based MM access tools
- Content-based manipulations and bit-stream editing.
- Hybrid natural and synthetic data coding
- Improved temporal random access; and Improved coding efficiency
- Coding of multiple concurrent data streams
- Robustness in error-prone environment
- Content-based scalability.

H.261

- Was developed as a standard for digital telephony for ISDN services
- Limits the image of just two sizes:
 - The common intermediate format (CIF)
 - Quarter CIF (QCIF)

CIF	352	288	8 bits/pixel	15 fps	24.33 Mbps	H.261 112 Kbps
QCIF	176	144	8 bits/pixel	10 fps	4 Mbps	< 64 Kbps

- Both encoder and decoder should be fast they operate in real-time.
- Like MPEG: 8x8 DCT and zigzag order.

Q&A

