Week 7: Digital Video Data

DIGITAL ASSET DEVELOPMENT

Contents

- Video standards
- Video compression
- Working with video

Digital Video Technology

- Video is among the most processor-intensive of digital assets
- Storage and transmission of digital video are major challenges
- Important to be able to:
  - Capture and edit high quality video
  - Compress video data significantly
  - Stream video for simultaneous playback

Video Parameters

- Video in this context simply refers to moving picture data
- The basic properties of digital video largely follow from those of images
- Key parameters:
  - Frame size: height and width in pixels
  - Bit depth of uncompressed data
  - Frame rate (frames per second or fps)
  - Aspect ratio

Understanding Video

- All this seems straightforward in theory
  - However, there are various complications, many of which arise for historical reasons
- Digital video content largely originated in other forms
  - Film and TV
  - These used a variety of frame sizes, frame rates and aspect ratios
- Hence there are many ways of defining video formats

Frame Rate and Resolution

- Standard frame rates are 24, 25 and 30
  - 24 fps for cinema film
  - 30 fps for TV in US (and some other areas)
  - 25 fps for UK and European broadcast TV
- Cinema film comes in a variety of (high resolution) frame sizes
- NTSC and PAL (standards for US and UK television) use different resolutions
  - HD formats complicate matters still further

Aspect Ratios

- Image aspect ratio: width/height ratio
  - Typically 4:3 (1.33:1) for standard TV formats and 16:9 (1.78:1) for widescreen HD
  - Cinema typically uses either 1.85:1 or 2.39:1
- Pixel aspect ratio: describes the shape of individual pixels
  - PC monitors have square pixels
  - Some video standards use other values
  - 1.33:1 pixel ration is used for some widescreen HD video

Progressive / Interlaced Scan

- Pre-HD television broadcast systems used interlacing to build up a picture
  - Due to old cathode ray tube technology
  - Odd lines if the frame were scanned and then the even lines
  - Doesn’t apply to cinema film or PC monitors
- HD TV is usually progressive scan (all frame lines scanned sequentially)
  - Denoted by p or i suffix on format name

Video Standards

- Many generic video standards, often defined by hardware manufacturers
- Examples:
  - DV PAL: standard for UK non-HD television
  - HDV: defines standard HD resolutions
  - AVCHD: generic format for HD camcorders
  - DVCPRO: created by Panasonic
  - XDCAM: created by Sony
- All very complicated!

Video Compression

- Compression of video data has been an ongoing issue for many industries
  - The Web, mobile video and digital TV all rely on efficient video compression
- Obviously, we can compress a single image using (eg) JPG compression
- Most video compressors also look at the changes between single video frames
  - Known as temporal compression

MPEG Compression

- Motion Picture Expert Group: open standard; very commonly used
- MPEG contains three types of frame
  - I-frames, P-frames and B-frames
- I-frames (short for intra-coded) are compressed as normal JPGs
  - See earlier lecture for details
  - Typically, every 12th or 15th frame in an MPEG file will be an I-frame

MPEG Predictive Coding

- P-frames use predictive coding
  - Only changes from the previous frame are recorded
  - Areas of a frame that are static are ignored
- For B-frames we only record differences from either the previous or next frame
  - This method gives the highest level of compression
  - Known as bidirectional predictive coding

Results of MPEG Coding

- Frames are arranged into sequences called Groups Of Pictures (GOP)
  - Specific orderings of I, P and B-frames
  - eg. IBBPBBPBBPBB(I)
  - I and P-frames known as anchor frames
- Works well for (eg) “talking head” shots with a static background
- Fails when we have too much motion in scene (picture goes “blocky”)

Video and Audio

- Most video has an audio soundtrack
- Audio within digital video is also compressed
  - Thus, we have to store both types of data in a single file
- Video formats are therefore examples of container formats
  - Support different kinds of data streams
  - Flash movies and some 3D and game formats are other examples

Container Formats

- A container format is one which can store data using a range of codecs
- A typical container format:
  - Supports multiple codecs
  - Can handle different data types (for example, audio plus video streams)
  - Can interleave these data streams
  - Can be extended, for example to support streaming or searchable data

Example Codecs

- Audio:
  - MP3 (MPEG Audio Layer 3)
  - AAC (Advanced Audio Coding)
  - ATRAC (Adaptive Transform Acoustic Coding)
- Video:
  - MPEG 1, 2 and 4 (open standards)
  - H.264 (widely implemented standard)
  - DivX, Xvid,… (implementations of MPEG-4)
  - Sorenson (used for QuickTime downloads)
  - Cinepak (old “legacy” codec)

Example Container Formats

- Two of the major video container formats are AVI and QuickTime
- AVI (Audio Video Interleave) files can use a wide choice of codecs
  - DivX/MPEG-4, Cinepak, uncompressed
  - File size varies greatly due to this
  - Standard for Windows video tools
- QuickTime acts as a similarly generic container format for MacOS systems

Working With Video Data

- Editing and processing video assets has significant hardware requirements
  - Large amounts of storage space
  - PC with a lot of RAM
- There is also the issue of capturing video (and audio) at suitable quality
- The other major problem is choice of format and codec
  - Capture, storage and output formats

Software Tools for Video

- Obviously, a package such as Premiere is essential for editing work
- There are other useful (free) tools
  - VLC is very handy as it plays most video
  - K-Lite Codec Pack: wide array of codecs
  - Media Player Classic: has very handy feature for exporting stills from a video clip
  - Format Factory: reads and converts a huge variety of video and audio formats

Video Editing

- The key to modern video editing tools is that they are non-destructive
- Premiere uses this approach
  - Video clips are handled by reference
  - The project file consists of a series of instructions to be applied to the video data
  - Thus, the project file is very small
- Premiere is also a multi-track editor
  - Separate streams of video and audio data