BITM 1113
Multimedia System

Week 7 – Video (Revamped)
Since first silent movie flickered to life, people have been fascinated with "motion" picture
To this day, motion video is the element of multimedia that can draw gasps from a crowd and hold a student’s interest in a computer-based learning project.
Video vs.
Other Media

Of all the multimedia elements, video places the highest performance demand on computer and its memory.
Video vs. Other Media

Video size can be as big as 108 gigabyte per hour; moving all this picture data from computer memory to the screen at that rate would challenge the processing capability of a supercomputer.
Video vs. Other Media

Some of the research effort today deal with compressing this digital video image data into manageable streams of information.
“Since multimedia gives you the ability to present information in a variety of ways, let the content drive the selection of media for each chunk of information to be presented. Use traditional text and graphics where appropriate; add animation when “still life” won’t get your message across; add audio when further explanation is required; resort to video only when all other methods pale by comparison...”
Basic Rules

Carefully planned, well-executed video clips can make a dramatic difference in a multimedia project.

A short clip in video and sound is more compelling than a scrolling text field containing the same speech.

However, before adding video to your project, it is essential to have an understanding of the medium, its limitations and its cost.
"From today, painting is dead!" exclaimed painter Paul Delaroche in 1839

"From today, analog video is dead!"
Analog VS Digital Video
Video which exists on videotape (i.e. VHS, 3/4" S-VHS, Beta-SP formats) is called "analog" video.

That's because the signal bears an exact, continuous relationship to the original information (it's analogous to the original).
Analog signals suffer because of their need to be amplified. Each time a video tape is copied, the analog signal must be amplified.

This amplification process injects a certain amount of noise or graininess into the image. (With audio tape it’s called "hiss").
And, this noise occurs every time a copy is made. So, a copy of a copy of a copy suffers greatly because of the need to amplify the signal each time a copy is made.

This is referred to as *generational loss.*
Introduction

Analog video records 30 individual still images on tape each second. Playing these images back in succession helps create the illusion of movement.
Generational Loss

The loss in audio or video quality resulting from making a copy (or "dub") in traditional analog recording media (audio or video "tape").
The original recorded material is called "first generation." A copy of the original is called "second generation." A copy of this copy is called "third generation" etc. (Much like making a paper photocopy of a photocopy).

Each successive copy results in greater and greater loss of video and audio quality. Digital storage media don't suffer this type of "generational loss".
Digital Video
Digital Video uses binary numbers to represent each pixel of each frame.

Since zeros and ones are the equivalent to "on" and "off" electrical states, binary numbers are largely immune to the loss associated with amplification in analog signals. (noise and hiss).
Due to the need for at least an 8-bit representation for each pixel in each frame of a video, the amount of data needed for moving video is incredibly large.

For this reason, the bit-speed (or rate of information transfer) is critical.
In order to do digital video and audio, computer and transmission equipment must be able to handle and transmit enormous amounts of data per second.

The amount of data the transmission equipment can handle is referred to as bandwidth.

The challenge is much greater than for analog video and audio.
Digital Video Recording (DV)

There are two hallmarks of digital video (DV)—quality and ease-of-use.
Like all camcorders, DV camcorders use CCDs to capture the moving images, but they store the images in a high-quality, endlessly reproducible, easily edited, digital format.

The logo indicates Mini DV. It means it is a digital camcorder. (Sony Digital8 cameras have a different logo.)
DV Advantages


Capture videos equal to or better than professional analog cameras costs 10 times more.

A digital camcorder slips into the video capture/playback without disturbing any of the other elements - play back the tapes from the camcorder.
4K Camcorder
Model: FDR-AX100E/B

Features
- 4K XAVC S Format
- Exmor R™ CMOS 1" Sensor
- 29.5mm Zeiss® Vario-Sonnar T* Lens
- Manual Function
- XAVC S Format
- 20.8MP Still Image

SOFTWARE UPDATE

Choose a model

Suggested Retail Price
RM 7,419.00
(exclusive of GST)

BUY NOW

Get Support
DV
Advantages

Video editing is greatly simplified because the video can be transferred to the computer without conversion, digitally edited online, and then copied back to a digital tape.

No loss of image quality as there is in the analog world.

Easily send short clips as e-mail attachments or post them on Web sites.

Digital is the universal format.
Digital Audio/Video File Size

As stated earlier, digital video requires a tremendous amount of storage space.
Using just 8-bits for each pixel only gives 256 useable colors for each frame of video. Good quality video requires 24-bits or 3-bytes per pixel (which allows around 16-million available colors).

Add to this the need for C.D. quality sound (which is digitized at 44.1 Khz)...and the problem is a bit greater..
File Size Considerations

Several elements determine the file size, in addition to the length of the video.
**Frame rate**

- Number of images displayed within a specified amount of time to convey a sense of motion

- Usually measured in frames per second

- Standard video movie → 30 fps, movie film → 24 fps

- Video digital → at least 15 fps
Frame or Image size

- **8K UHD**: the width and height of each individual frame or image determines the quality of the image displayed and the processing involved to display that image.

- **4K UHD**: standard full screen resolution is subjective. But today for LED, it is 1920x1080 pixels.

- **FHD**: video screen display is one fourth the size of the full window screen (320x240) but today 1920x1080 pixels.

- **SD**: or 480
Colour depth/Resolution

Number of colours displayed on the screen at one time

Ranging from 1 bit to 8 bit, 16 or 24 bit per pixel
Others

Quality directly related to frame size, image size and colour depth.

Quality also depends on content. Motion picture needs higher frame rate.
File Size Approximation Calculation

File size = frame size * frame rate * Color Depth * time
File Size

• Video
  • 640 X 480 pixels = 307,200 pixels per frame
  • 307,200 X 30 frames per second = 9,216,000 pixels per second
  • 9,216,000 X 3-bytes per pixel = 27,648,000 bytes per second (27 Megabytes per second)

• Audio
  • 44,100 kilohertz or KHz (sample quality in bytes per second) X 2
  (Stereo - 2 channels) = 88,200 bytes per second
  • (88,200 X 16-bit sample size)/8 = 176,400 bytes per second (just over 1/5th of a Megabyte)

Audio & Video

27,648,000 Video
176,400 Audio

27,824,400 bytes or
28 MEGABYTES TOTAL FOR 1 SECOND OF VIDEO
Video Formatting

Several elements determine the file size, in addition to the length of the video.
The number of vertical scan lines dictates the capability to produce a detailed image.

A standard way of specifying the clarity of a video image is by its lines of *horizontal resolution*.
It is obvious at this point that the larger the number of vertical scan lines, the more detailed the image.

By this standard, the DV format really stands out. It has 500 lines, about twice the resolution of VHS and 8mm video and 25% better than S-VHS or Hi-8.

However, within the current arena of video, the number of vertical scan lines is fixed within a system. The current analog video systems are NTSC, PAL, and SECAM.
NTSC

NTSC is based on a 525-line, 60 fields/30 frames-per-second, at 60Hz system for transmission and display of video images.

This is an interlaced system in which each frame is scanned in two fields of 262 lines, which is then combined to display a frame of video with 525 scan lines.

NTSC is the official analog video standard in the U.S., Canada, Mexico, some parts of Central and South America, Japan, Taiwan, and Korea.
PAL

• PAL is the dominant format in the World for analog television broadcasting and video display and is based on a 625 line, 50 field/25 frames a second, 50HZ system.

• The signal is interlaced, like NTSC into two fields, composed of 312 lines each.

• Several distinguishing features are:
  • better overall picture than NTSC because of the increased amount of scan lines
  • since color was part of the standard from the beginning, color consistency between stations and TVs are much better

• There is a down side to PAL however, since there are fewer frames (25) displayed per second, sometimes we can notice a slight flicker in the image
SECAM

• The SECAM (Sequential Couleur Avec Memoire or Sequential Colour with Memory) standard was introduced in the early 1960's and implemented in France.

• SECAM is the "outlaw" of analog video standards. Like PAL, it is a 625 line, 50 field/25 frame per second interlaced system, but the color component is implemented differently than in either PAL or NTSC.

• Countries on the SECAM system include France, Russia, Eastern Europe, and some parts of the Middle East
**Differences between NTSC, PAL & SECAM TV Systems**

(NTSC vs PAL vs SECAM : Comparison Table)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>NTSC</th>
<th>PAL</th>
<th>SECAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed/adopted in</td>
<td>US</td>
<td>Europe(UK)</td>
<td>France</td>
</tr>
<tr>
<td>Number of lines</td>
<td>525</td>
<td>625</td>
<td>625</td>
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<tr>
<td>Frames/second</td>
<td>60</td>
<td>50</td>
<td>50</td>
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<tr>
<td>Color info transmission</td>
<td>U &amp; V or I &amp; Q are used</td>
<td>U &amp; V are used</td>
<td>Db &amp; Dr are used</td>
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<tr>
<td>Sub-carrier Frequency</td>
<td>3.58 MHz</td>
<td>4.43 MHz</td>
<td>4.25 or 4.4 MHz</td>
</tr>
<tr>
<td>Color Burst</td>
<td>9 cycles of sub-carrier frequency</td>
<td>10 cycles of sub-carrier frequency</td>
<td>burst cycles of red and blue sub-carrier frequency</td>
</tr>
<tr>
<td>Variants</td>
<td>4.43, J, M</td>
<td>B, D, G, H, I, N, M &amp; Nc</td>
<td>B, G, D, K, K1, L</td>
</tr>
<tr>
<td>Cost</td>
<td>Medium Cost</td>
<td>Most Expensive</td>
<td>Least Expensive</td>
</tr>
<tr>
<td>Studio Mixing</td>
<td>Easiest</td>
<td>Medium Ease</td>
<td>Difficult</td>
</tr>
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</table>
Analog vs Digital Transmission

Standard analog TV is transmitted in a manner similar to radio. In fact, the video signal of analog television is transmitted in AM, while the audio is transmitted in FM.
Analog TV

Analog TV is subject to interference, such as ghosting and snow, depending on the distance and geographical location of the TV receiving the signal.

The amount of bandwidth assigned to an analog TV channel restricts the resolution and overall quality of the image. The current analog TV signal standard is referred to as **NTSC, PAL & SECAM**.
Digital TV

Digital TV, or DTV is transmitted as data bits of information where the signal is basically "on" or "off".

The intent of DTV technology is that the viewer either sees an image or nothing at all. There is no gradual signal loss as distance from the transmitter increases.
Digital TV

If the viewer is too far from the transmitter there is nothing to see.

DTV has been designed from the ground up to take all factors of the television signal into consideration: B/W, color, audio and can be transmitted as an interlaced or progressive signal. As a result, there is greater integrity and flexibility of signal content.
Traditional Analogue

HD-SDI 1080p Full-HD

650TVL Analogue Camera 2.7-12mm Lens
Recorded at D1 25fps

1080p Full-HD Camera 3-9mm Lens
Recorded at 1080p 15fps
Analog Terrestrial

Isi siaran dikirim langsung melalui signal UHF

UHF/VHF Antenna

Digital Terrestrial

Isi siaran di-Digital-kan dan di-encode sebelum dipancarkan

Data dikirim lewat signal

Penerima Digital
Television transmission

On February 17, 2009, television stations will turn off their analog channels and broadcast exclusively in digital. How do the signals differ?

Analog Signal
- If signal is weak, picture is weak, lots of static
- Both signals weaken over distance

Digital Signal
- As long as TV is receiving a signal, picture is perfect

Definition:

Analog Signals
- Continuous
- Infinite range of values
- More exact values, but more difficult to work with

Digital Signals
- Discrete
- Finite range of values (2)
- Not as exact as analog, but easier to work with

Example:
A digital thermostat in a room displays a temperature of 72°. An analog thermometer measures the room temperature at 72.482°. The analog value is continuous and more accurate, but the digital value is more than adequate for the application and significantly easier to process electronically.
Since the DTV signal is made up of "bits", the same bandwidth size that takes up a current analog TV signal, can accommodate not only a higher quality image in digital form, but the extra space not used for the TV signal can be used for additional video, audio, and text signals.

In other words, broadcasters can supply more features, such as surround sound, multiple language audio, text services, and more in the same space now occupied by a standard analog TV signal.

Another advantage to the ability of a Digital TV channel's space; the ability to transmit a High Definition (HDTV) signal.
Another difference between Digital TV and Analog TV is the ability to broadcast programming in a true widescreen (16x9) format.

The shape of the picture more closely resembles the shape of a movie screen, which enables the viewer to see the movie as the filmmaker intended.

A 16x9 TV can display widescreen images without a large amount of picture space taken up by black bars on the top and bottom of a widescreen image, which is what you see if such images are shown on a standard TV.
Interlaced / Non-Interlaced video

Interlacing is a characteristic of displaying and capturing video. Interlaced video refers to video that is divided into two fields (upper and lower).
Interlaced

Video standards that use interlacing are NTSC, PAL, and SECAM.

In interlaced video, an image is drawn on the screen in two separate passes.
Non-Interlaced

Non-interlaced video (also called *progressive scan*) displays video by drawing it on the screen in a single pass from top to bottom.
If working with digital video (for computer displays), then we won’t have to worry about field settings. Computers display video on a monitor as a sequence of complete frames (non-interlaced). So, video formats designed for computers don’t use fields.
E.g. NTSC

An NTSC picture is comprised of 29.97 frames per second. Each frame consists of two 'fields' for each frame.

In other words, NTSC picture is 60 'fields' per second. Each of these fields in nothing more than a series of visual horizontal lines which alternate every other line...

When lines 1, 3, 5, 7, 9, etc. off your video image (from top to bottom) are drawn first, they are in top field (or odd) dominance. (see basic figures below)
• When 2, 4, 6, 8, etc. are drawn first, they are in bottom (or even) field dominance.

• 'Dominance' meaning that this 'field' is drawn first
Aspect Ratio

4:3

16:9
Cables and connections
Introduction

IEEE 1394 ports called IEEE 1394 (named after the Institute of Electrical and Electronics Engineers), FireWire™ (a registered trademark of Apple), and i.Link™ (a trademark of Sony Electronics, Inc).

They are used to transfer videos from the camcorder to the computer or between two camcorders.

It’s ability to transfer up to 400 Megabits per second makes it the fastest available connection between camcorders and other digital video hardware such as computers.
Maximum Speed: Next Generation 802.11ac USB 3.0 vs. 2.0

USB 3.0: 867 Mbps (Theoretical Data Rates)
USB 2.0: 480 Mbps (Data Transfer Rate Limit)

5Gbps (Theoretical Data Rates)
**S-video**

*S-video* output is used to play a digital video on a regular TV, or transfer a digital video onto an analog VHS tape.

*S-video* differs from composite in that it carries the brightness (luminance) and color (chrominance) signals on separate lines within the same cable and gives a better image.

An *S-video* cable has a plug with four connections and a guide that makes it easy to align them when plugging it in.
Composite video output is not as good as S-video but it's far more common on TV sets and VCRs. It's a single RCA-type yellow plug.

Usually the cable consist of Composite video (yellow) and audio cables (red and white).

Stereo audio jacks, the red and white plugs are used to feed the audio to an amplifier.
**Analog line in** lets you connect a TV, VCR, or analog camera to your digital camera to capture or transfer video and audio from older analog tapes to a digital format.

When you copy a video to a Mini DV Cassette, the copy can then be duplicated without further image degradation.

Since you are able to make any number of perfect digital copies from the original copy, be sure you don’t violate any copyrights.
Up to 18 Gbit/s in HDMI 2.0
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<td>Blu-ray Disc and HD DVD video and audio at full resolution(^a)</td>
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<tr>
<td>Signal standard</td>
<td>Max resolution and Frame Rate</td>
<td>Signal Type</td>
<td>Notes</td>
<td>Connector</td>
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<tr>
<td>DVI-D</td>
<td>2560 × 1600 @ 60fps 3840 × 2400 @ 33fps</td>
<td>RGB @ 10-bit color (single)</td>
<td>Uncompressed video, Max cable length 10m, 3.96 Gbps, Disbanded</td>
<td>![DVI-D Connector]</td>
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<tr>
<td>HD-SDI</td>
<td>1920x1080 4:4:4 @ 60fps</td>
<td>Y′CbCr @ 12-bit color (dual), RGB 4:4:4</td>
<td>Single 1.5Gbps, Dual 3 Gbps, uncompressed video, 100m cable length</td>
<td>![HD-SDI Connector]</td>
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<tr>
<td>HDMI</td>
<td>4096 × 2160 @ 24fps (30fps for Ultra HD) 1920x1080 @120 fps</td>
<td>RGB, Y′CbCr @ 16-bit color</td>
<td>HDCP, 15m cable length, 8.16 Gbps</td>
<td>![HDMI Connector]</td>
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<tr>
<td>DisplayPort</td>
<td>3840 × 2160 @ 60 fps 2560 × 1600 @ 120 Hz</td>
<td>RGB, Y′CbCr @ 16-bit color</td>
<td>HDCP and AES, 33m cable length, 17.28 Gbps, 2m at full resolution</td>
<td>![DisplayPort Connector]</td>
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Others
Digital video is recorded on a tape called a **Mini DV Cassette** (DVC) that occupies less than half the volume of a 8mm cassette.

It holds one hour of video—an amazing 11GB of data on a tape 65 meters long.

It’s this small cassette size that makes possible much smaller and more portable camcorders.

Currently 30, 60, and 80-minute DV Mini tapes are available and an 80-minute tape in LP mode will hold two hours of video.
OLD SKOOL STUFF!!!


The card represents a 1,000-fold capacity increase over the past decade
Video CODECs

Video CODECs which stands for compression/decompression are comprised of an encoder and a decoder. The encoder performs compression (CO) and the decoder performs the task of decompression (DEC).

Video CODECs are used to compress video so that it takes up less space, enabling video transmission. The original digital video size is enormous (270Mbps) and it cannot be saved or transferred for use in any currently available consumer technology.
The concept behind video CODECs is simple; the encoder takes an incoming video stream, compresses the signal, removing superfluous or duplicate information, and sends it out. On the receiving side, the decoder decompresses the signal and displays it on the display screen.
Video Codecs

VIDEO ENCODER

1. Prediction
2. Transform
3. Encode

VIDEO DECODER

1. Reconstruct
2. Inverse Transform
3. Decode

Compressed H.264 syntax

Scope of H.264/AVC standard

Source: Iain Richardson, www.xcodex.com, copyrighted by Iain Richardson.
Digital video formats
Digital video formats

MPEG / MJPEG
Files with a .mpg extension

Apple QuickTime
Files with a .mov or .qt extension

Microsoft AVI
Files with a .avi extension
MPEG Standards

MPEG which stands for Moving Picture Coding Experts Group, is the nickname given to a family of international standards used for coding audio-visual information in a digital compressed format.

MPEG exists to produce standards mainly for coded representation of moving pictures, audio and their combination.

The MPEG technology provides high end compression for digital media while still preserving its quality.
Digital video formats

MPEG has produced:
MPEG-1, a standard for storage and retrieval of moving pictures and audio on storage media (approved November 1992); products such as Video CD and MP3 are based on it

MPEG-2, a standard for digital television (approved November 1994); Digital Television set top boxes and DVD are based on it

MPEG-4 version 1 and 2, a standard for multimedia applications (approved October 1998 and December 1999, respectively), for the fixed and mobile web

MPEG-7 a content representation standard for multimedia information search, filtering, management and processing
MPEG compression example

A simple scene showing a car moving across a desert landscape.

Only the difference between the current and next frame needs to be stored.

This is called intraframe coding.
QuickTime

- Developed by Apple, Inc.
- Primarily for playback without any hardware assistance
- Can achieve compression ratios of 25 to 200:1
- The QuickTime format can also store audio, graphics, 3D and text making it more versatile for multimedia applications
Microsoft AVI

- Audio Video Interleave format
- Interleaving is a technique used to embed two or more things into the same stream of information
- In every chunk of information you will find some video data and some audio data

```
001001010010010101010011110101...
001001010010010101010011110101...
...
001001010010010101010011110101...
```

8, 16 or 24 bits

- Video information
- Audio information
H.265