INTERACTIVE AND DIGITAL MEDIA NOTES

Don Ritter 2012.4.23

Interactive Environments

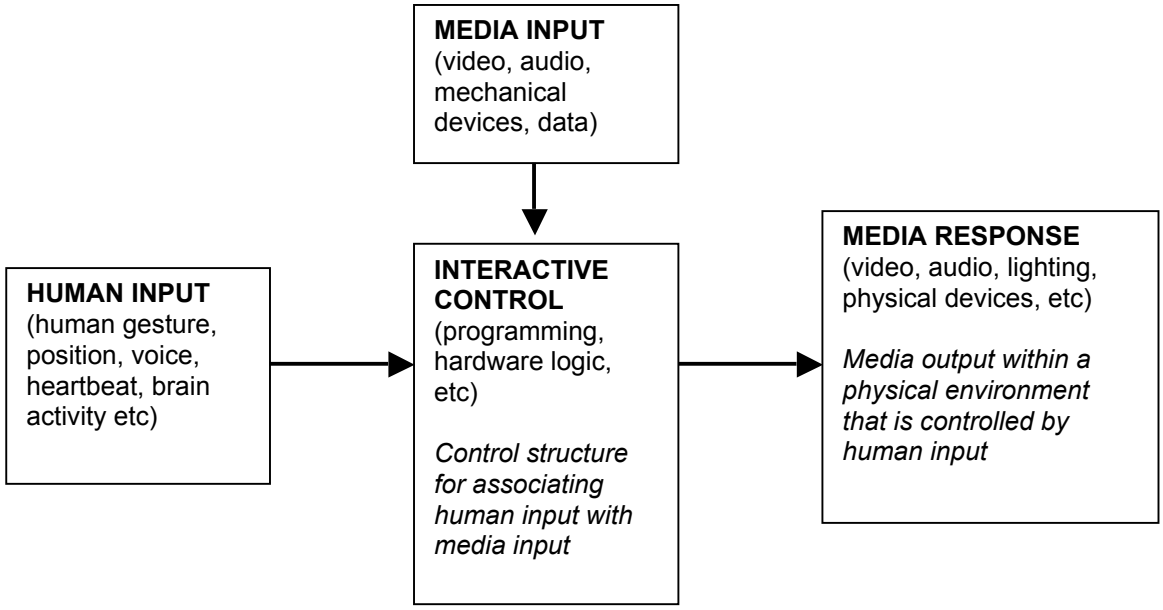
Definition of an Interactive Installation

1. An interactive installation is a physical environment that uses real three-dimensional space as an aesthetic feature: it has an architectural component. The room surrounding the installation is a conceptual aspect of the work, not only a physical space for containing the work.
2. In order to experience the work, an audience must make certain physical actions with their bodies, limbs, voices, brainwaves, breath, or whatever.
3. The work is interactive, its physical form changes in response to certain physical actions of its audience. A change in form could be physical shape, position, colour, brightness, sound frequency, sound loudness, or whatever.

Definition of an Interactive Performance

1. It is presented to an audience within a performance environment using human performers.
2. The performance has a specific duration with a specific beginning and end.
3. Certain perceptual aspects of the work are controlled by the performers through their bodies, limbs, voices, brainwaves, breath, or whatever.
4. The performance is interactive, its physical form changes—other than the performers—in response to certain physical actions of the performers. A change in form could be physical shape, position, colour, brightness, sound frequency, sound loudness, or whatever.

Primary Elements of an Interactive Environment: Installations or Performances



Composing Interactivity

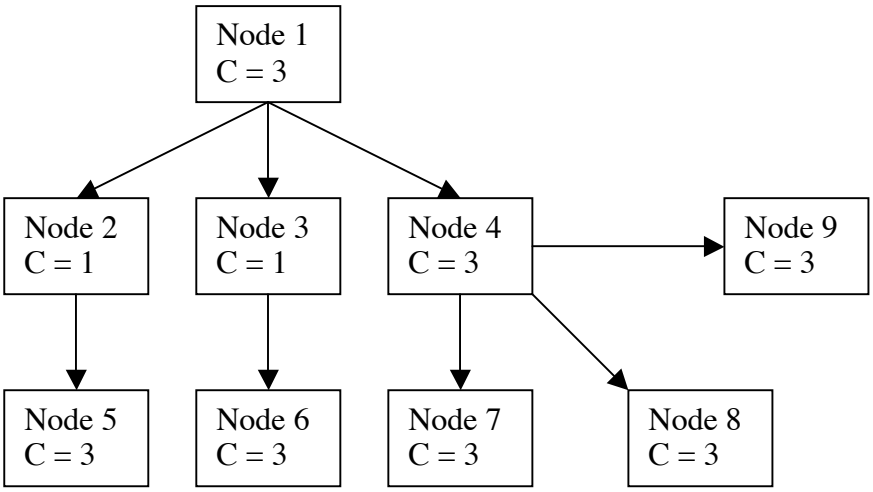
Interactive Relationship
The interactive relationship refers to the physical and conceptual and relationship existing between the human input and the media response. Potential relationships include direct, indirect, and conceptual interactivity

Direct Interactivity Relationship
The gesture expressed by the person is physically related to the media response. For example, a person moves from left to right in the installation and in response a light moves from left to right, always corresponding with the position of the person.

Indirect Interactivity Relationship
The gesture expressed by the person is not physically related to the media response. For example, a person moves from left to right in the installation and in response different video images appear on a projector. Water imagery appears when the person is on the left side of the room, a mountain appears when the person is in the middle of the room, and a truckload of bananas appears when the person is on the right side of the room.

Conceptual Interactivity
When conceptual interactivity is used, a conceptual relation exists between the interactivity and the concept of the work. Example, TV Guides installation: when a person moves the Television will switch off. The interactivity reflects the concept of the installation: *Television is controlling its audience*.

Degree of Interactivity
degree of interactivity = (N1C) + (N2C) + (N3C) ... / number of nodes
N#C: number of choices available at a node decision point in an interactive system



Degree of interactivity = (3) + (1) + (1) + (3) = 8

The *degree of interactivity* refers to the amount of interactivity as determined by the number of decision points (nodes) a person has within an interactive environment, and the number of decisions (choices) at a node. For example, the LOCATION of a person could be used to control some form of media response (color of a projection). If the interactive system recognizes 300 LOCATION positions, this node provides 300 choices. If the person can scream at any LOCATION, and the VOLUME of the scream is measured in 100 levels, each corresponding with a media output (size of the projection), each VOLUME provides 100 choices.

Degree of interactivity = 300 + 300 + 300….(100 nodes) = 30000

Developing the Interactive Installation or Performance

General Procedure for Development
1. Write a description of idea
2. Create 2D floor plan with details
3. Decide interactivity activity
4. Create 3D visualization
5. Create animated 3D visualization with sound, if present
6. Select technical components within the interactive system
7. Create physical or software prototypes
8. Create actual media
9. Assemble technical system
10. Write control software
11. Set up system, test and look for errors
12. Make changes where necessary
13. Finalize work
14. Create documentation

Useful Tools for Visualizing an Interactive Installation or Performance

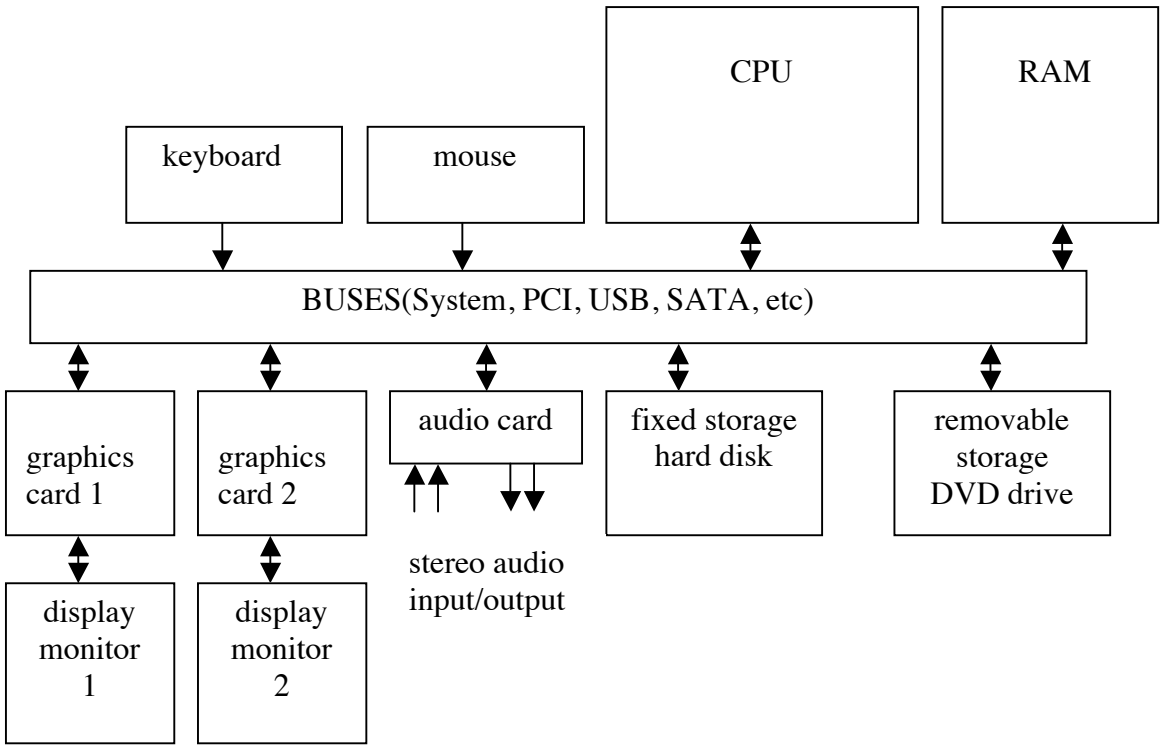
1. Photographic images (DSLR)
2. Photo libraries (Wikipedia commons)
3. Photo editing software (Photoshop)
4. Page layout software (InDesign) -> 2D visualization
5. 3D computer animation software (3d Studio Max)
6. Libraries of 3D objects
7. Libraries of video footage
8. Video camera
9. Sound libraries
10. Sound editing software (Peak)
11. Video compositing software (After Effects)
12. Video editing software (Final Cut) -> video visualization

Primary Tools for Creating an Interactive Installation or Performance

1. Money
2. Physical space
3. Video hardware: cameras, projectors, monitors, digitizers, video interfaces, etc
4. Video software: video editing, video compositing, special effects, etc
5. Audio hardware: microphones, audio interfaces, amplifiers, mixers, speakers
6. Audio software: mixing, editing, audio processing
7. Sensors(ultra sonic, infrared, video, audio, etc)
8. Sensor interfaces(midi, DMX, Arduino, etc.)
9. Programming software: Max/MSP/Jitter, Isadora, etc

Computer Technology

Typical Components of a Computer System
(*with two computer monitors and a stereo sound card)*



Computer Graphic Technology

A bitmapped computer graphic image (also called a raster image) is comprised of pixels; each pixel is a unit of data representing a single rectangle of a specific colour.

Bit Depth
A pixel is represented by certain collection of bits(1/0). More bits permit the representation of more grey levels and more colors. Low quality computer graphic images may use only 8 bits (256 colours maximum), while higher quality images use 24 bits (16.7 million colours) or more. 24 bit computer graphic images are usually represented by 8 bits of red data, 8 bits of green data, and 8 bits of blue data. The combination of RGB permits different grey levels and different colors.

RGB: 0,0,0 = black
RGB: 128, 128, 128 = grey
RGB: 255, 255, 255 = white
RGB: 255,0, 0 = red; RGB: 0, 255, 0 = green; RGB: 0,0, 255 = blue
RGB: 255, 255, 0 = yellow
RGB: 255, 0, 255 = magenta
RGB: 0, 255, 255 = cyan

Alpha Channel
An alpha channel may be present in some computer graphic images, enabling a specific RGB value to be transparent and thereby permitting high quality compositing. An image file with an alpha channel is sometimes called a 32 bit image. An alpha channel can be created with certain 3D software or with compositing and editing software using masks, colour keying, chroma keying, or by manually specifying which areas will be an alpha channel. Only certain image formats can accommodate an alpha(TGA, PSD),

Resolution
The resolution of a computer graphic image refers to the number of horizontal(X) and vertical pixels(Y) in an image. Higher resolution provides more clarity, but the file size is larger.
example:
720 x 480 = 345,600 pixels (standard definition[SD] digital video frame)
1920 x 1080 = 2,073,600 (high definition[HD] digital video frame) *6 times larger than SD*

Computer Graphic File Formats and Compression
The file format of a computer graphics file typically indicates its compression type(method for reducing the amount of data). Two primary forms of compression are available: lossless and lossy. Lossy formats discard data and reduce the quality of the image, but the file size is small(example: JPG). This reduction may or may not be perceivable. A lossy format typically has different levels of compression, each reducing the file size and visual quality to different degrees. Lossless compression creates a smaller file size than an uncompressed image, and it provides no reduction in image quality(example: TIFF with LZW compression)

lossy formats: JPG (small file size)
lossless formats: TIFF(with LZW compression) , TGA(with RLE compression)
uncompressed formats: TIFF, TGA, PSD, proprietary formats: .CR2 RAW

Vector Graphics
Vector graphics are image files that are comprised of data that define attributes of geometrical primitives rather than pixels, such as points, lines, curves, squares, etc. (example format: SVG). Vector graphics images can be modified without a decrease in quality that would be present with bitmap graphics, such as enlarging. Vector graphic images are typically comprised of flat planes of colour or lines.

Analog Audio Technology

sound: the sensation produced by stimulation of the human hearing system that is created through vibrations in air pressure; typical range of hear in humans is 20-20Khz

primary characteristics of an audio signal: frequency and level

audio: electrical representations of sound using analog or digital electronic signals
primary characteristic of sound: pitch and volume

Analog Audio Hardware

microphone: converts sound into an audio signal

audio speaker: converts an audio signal into sound

amplifier: increase the amplitude of an audio signal, typically to a level that is appropriate for an audio speaker

equalizer: enables amplification of specific frequency ranges within an audio signal

mixer: enables combining multiple audio signals into one or more audio signals; typically contains equalization

audio processor: modifies various qualities within an audio signal

Common Analog Audio Connectors

Connectors differ according to gender(male or female), number of signals (mono, stereo, multi-channel), and type

CONNECTOR NAME	mono or stereo	genders available	typical use
mini jack	mono and stereo	female and male	consumer audio
RCA	mono	female and male	consumer audio
1/4 inch	mono and stereo	female and male	professional audio
XLR	Mono (balanced)	female and male	professional audio

Digital Audio Technology

Definition: digital audio is a digital representation of an analog audio file

Analog Audio to Digital Conversion(AtoD): converting a analog audio signal into a digital audio file(digitizing)

Digital to Analog Audio Conversion(DtoA): converting a digital audio file into an analog audio signal

Characteristics of a Digital Audio File
duration: length of clip
Tracks: 1 track mono, 2 tracks for stereo, multiple tracks
Bit depth: 16bit or 24 bit or whatever (number of bits used to represent the audio level at a certain point in time
Sampling rate: number of times per second that an audio level is represented by a digital number (44.1Khz for CD, 48Khz video for DVD and many video formats)
compression: uncompressed or compressed

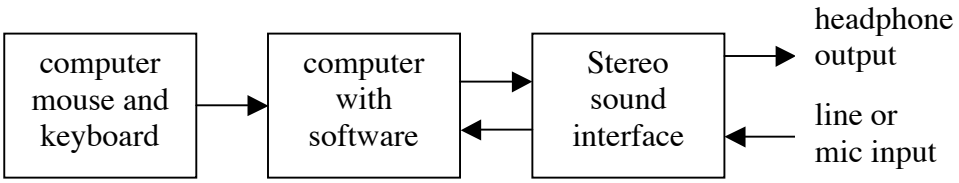
Audio Formats and Codecs
common uncompressed formats: AIFF, WAV, SDII (all use PCM)
common compressed lossless format: FLAC,
common compressed lossy formats: MP3, AAC

no difference in quality between AIFF, WAV and SDII
AAC(Advanced Audio Coding) is considered to provide higher quality audio than MP3 when file size is the same.

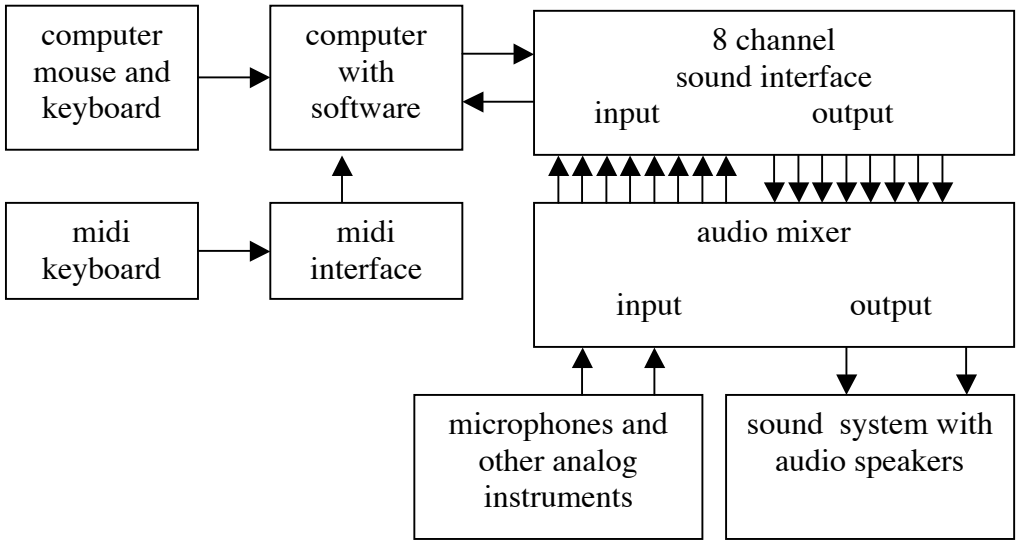
Digital Audio Hardware
MIDI interface
Audio interface/sound card
Audio sampler
Audio Synthesizer

Popular Audio Software
Playback and library software: iTunes, Windows Media Player, QT Player
Sound Editing Software: Peak, Sound Forge, Audacity, Soundbooth
Mixing Software: ProTools, Logic, Adobe Audition, Audacity
Multi-feature composition: Ableton Live
Audio programming software: Max/MSP

Digital Audio Workstation-DAW
A digital audio workstation is a system, typically computer based, that is dedicated to creating, editing and playing digital audio. The typical components of a DAW are: computer, computer monitor, computer keyboard and mouse, sound interface/sound card, and digital audio software. Additional components may include music input devices, such as a MIDI keyboard, and a hardware mixer and audio speakers. During recording, the sound interface converts analog audio to digital audio(A to D), and during playback it converts digital audio to analog audio (D to A). The computer mouse and keyboard or MIDI keyboard can be used to control audio and musical input to the DAW. Simple audio interfaces will provide 2 channels of audio for input and output(stereo). Most computers have simple sound interfaces built into their hardware. External sound interfaces are connected to computers using USB, Firewire or PCI interfaces. Larger sound interfaces can accommodate 8 channels or more of audio input and output. More information at:
http://en.wikipedia.org/wiki/Digital_audio_workstation



minimal components of a DAW



typical components of a professional DAW

MIDI TECHNOLOGY

MIDI(Musical Instrument Digital Interface) is a protocol(standardized communication format) that enables communication between computers, electronic instruments, digital audio devices, and numerous other sensing or control devices that are capable of communicating through MIDI. MIDI hardware devices communicate with each other through MIDI cables. Some software permits exchange of MIDI data through internal data connections, such as a MIDI programming language directing a software synthesizer. MIDI data is transmitted over 16 separate channels(channel 1 to 16). MIDI data is either transmitted or received by a MIDI device.

Primary MIDI data includes:

Note ON: designates that note starts to play
Note OFF: designates that a note stops playing
Note # (1-127): designates the pitch of a musical note to be played, #60 is middle C
http://tonalsoft.com/pub/news/pitch-bend.aspx
Velocity: 0-127: designates the loudness of the note, 0 is silence and 127 is maximum
Program Change: designates a certain voice to be played on a receiving MIDI device

Control Change: designates a parameter associated with a controller

Midi devices include:

MIDI interface: a hardware device that connects to a computer, often through USB, that enables MIDI communication with MIDI hardware devices. A MIDI interface is often built into an audio interface

MIDI controller: a hardware device that produces MIDI data, such as a MIDI keyboard which resemble a piano keyboard but produces only MIDI data and no sound

VST(Virtual Studio Technology): software interface that enables intercommunication between software synthesizers, effects, and audio editing software.

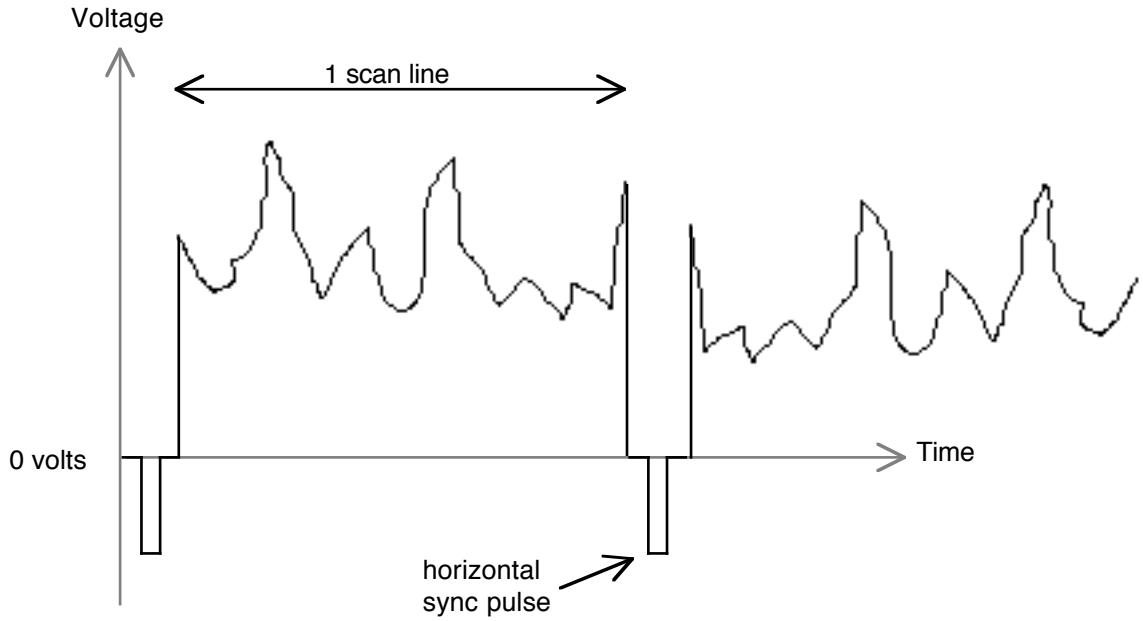
Analog Video Technology

Analog Video Signal

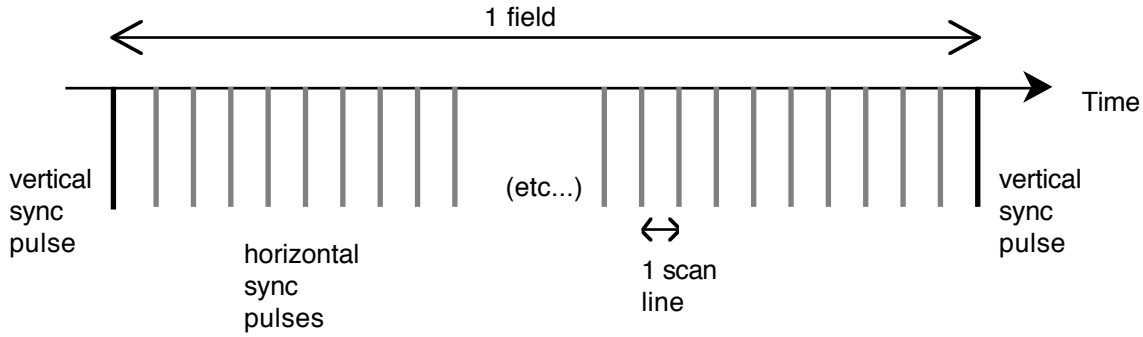
analog video signal: electronic information that represents visual imagery for use by video hardware. A video signal consists of electrical waves that describe moving imagery as a series of static frames. Each frame is identified within the signal by voltage levels and frequencies located between the vertical sync pulses of the signal. Between the vertical sync pulses are horizontal sync pulses which are located around voltage levels and frequencies which indicate changes in brightness and colour for a particular scan line. Within a video monitor, the video signal controls an electron gun which "sprays" electrons at a phosphorus covered screen. Areas of the screen will "glow" momentarily dependent on the direction and strength of the beam. Higher quality video monitors are capable of displaying more scan lines.

scan line: a single horizontal line from one vertical border of a video image to the other
field: a collection of scan lines which cover an entire screen
odd/even field: a collection of odd or even numbered scan lines which cover an entire screen(eg. first, third, fifth, etc.)
frame: complete picture consisting of odd and even numbered fields
interlacing: creating a video frame using two fields; one field contains all the even numbered scan lines, the other contains the odd numbered scan lines
horizontal sync pulse: component of a video signal indicating the beginning or end of a scan line.

components of a scan line:



components of a field:



Analog Video Standards

A video standard refers to the technical method for carrying visual information within an analog signal.

NTSC: standard used in North America and some Asian countries
(29.97 frames per second, 482 lines)
PAL: standard used in some Europe and some Asian Countries (25 frames per second, 525 lines)
SECAM: standard used in some European countries (25 frames per second, 525 lines)
Standard listing by country: http://countrycode.org/tv-standards

DV tape and DVD disc videos are digital representations of an analog video standard (DV-NTSC or DV-PAL and DVD-NTSC or DVD-PAL)

Analog Video Signals

composite: format using one electrical signal to describe the video image; lowest quality
S-Video(Y/C): video signal using 2 electrical signals to describe the video image: luminance(Y), and chrominance(C); middle quality

component: video signal using 3 electrical signals to describe the video image: luminance(Y), red difference(R-Y) and blue difference(B-Y); highest quality

RF: format in which video and audio signal are modulated onto a specific radio frequency(used for television transmission)

There will always be degradation in a video signal when it is passed from one piece of computer hardware to another.

Analog Video Hardware

analog video camera: translates light through al lens into an analog video signal with particular standard(NTSC, PAL); outputs one or more signals(composite, S-video, component)

analog video monitor: translates an analog video signal into a moving image on a projected screen; accepts a signal with particular standard(NTSC, PAL) through one or more inputs(composite, S-video, component)

video projector: translates an analog video signal into a projected moving image on a screen; accepts a signal with particular standard (NTSC, PAL) through one or more inputs(composite, S-video, component) Video projectors often accept digital video signals also(DVI, HDMI)

television: consists of a TV tuner and a video monitor; the tuner demodulates a television signal containing numerous TV channels into a signal that is translated by the monitor into visual imagery

analog video tape recorder: records an analog signal onto a specific analog tape format(VHS, S-VHS, Hi8, Umatic, Betacam); accepts a signal with particular standard (NTSC, PAL) through one or more inputs (composite, S-video, component)

analog video tape player: translates an analog signal from an analog tape format into a signal with particular standard (NTSC, PAL) through one or more outputs (composite, S-video, component)

time base corrector: hardware used to improve quality of an analog video signal

special effect generators: hardware used to drastically change characteristics of the video signal(hue, brightness, contrast)

Common Analog Video Connectors

CONNECTOR NAME	number of signals	genders available	typical use
F	1 (television signal)	female and male	cable television and antenna
RCA	1 (composite video)	female and male	consumer video
SCART (IEC 933-1)	21 pin (contains composite, RGB and S-Video; bidirectional)	Female and male	Consumer video in Europe
S-VIDEO	2 (chroma and luma)	female and male	professional and consumer video
BNC	1 (composite video or 1 of component signal)	female and male	professional video

Analog Video Tape Formats

ANALOG TAPE FORMATS	SIGNAL TYPE
8mm	Composite
VHS	Composite
3/4" (Umatic)	Composite
Hi8	S-Video
S-VHS	S-Video
Betacam	Component
BetcamSP	Component
MII	Component

Digital Video Technology

Digital Video File Characteristics

1. Container Format

Def: "A container or wrapper format is a meta-file format whose specification describes how different data elements and metadata (data about data) coexist in a computer file"

Common container formats:

QuickTime File Format: Apple container format for audio and video
extension: .mov

AVCHD: HD format developed by Sony and Panasonic, uses MPEG-4 AVC/H.264
extension: .m2ts

AVI (Audio video interleave): Microsoft container format: file extension: AVI

MP4: standard audio and video container for M-PEG codecs, including H.264
(file extension: .MP4)

ASF: originally a container for WMV, file extension: ASF

FLV(FV4): Flash Video, file extension: .FLV

WMV: video compression format that contains several proprietary codecs by Microsoft, WMV1…WMV9, usually not called a container; file extension: .WMV

MPEG-2: used with Blue-Ray disc (file extension: .mp2v)
(Mpeg-2 can also be a codec)

MKV: known as Matroska; is an open standard free container format that can hold an unlimited number of video and audio tracks in one file. Often used to store films and TV programs. MKV for video, MKA for audio, MKS for subtitles and MK3D for stereoscopic video

MXF: container format for professional digital video and audio media

2. Tracks

def: type of media within the file
audio track (A#) or video track(V)
track combinations: video only; video and audio; video with multiple audio tracks

3. Audio track

duration: length of clip
tracks: 1 track mono, 2 tracks for stereo, multiple tracks
bit depth: 16bit or 24 bit or whatever (number of bits used to represent the audio level at a certain point in time
sampling rate: number of times per second that an audio level is represented by a digital number (44.1Khz for CD, 48Khz video for DVD and many video formats)

4. Audio codec

popular uncompressed formats: AIFF. WAV, SDII
popular compressed formats: MP3, AAC

5. Video track

duration: length of clip (in minutes/seconds
or SMPTE time code hours: minutes:seconds:frame example: 01:11:32:18
resolution: X•Y
DV-NTSC: 720x480 (standard definition)
DV-PAL: 720x525 (standard definition)
720p: 1280x720, progressive (high definition) *720i does not exist*
1080i: 1920x1080, interlaced (high definition)
1080p: 1920x1080, non-interlaced, progressive (high definition)
frames per second(fps): 25, 30, etc
progressive (non-interlaced) vs interlaced
picture aspect ratio: 4:3(SD), 16:9(HD), etc
pixel aspect ratio: square or rectangular pixels

6. Video Codec

codec(compress/decompress): computational process used to reduce the size of a files(compression is used when the file is create: data reduced; decompression is used when the file is played: data increases)

lossy vs lossless codec: lossy codecs remove detail in the imagery to reduce file size, lossless codecs do not(uncompressed video)

hardware vs software codecs: hardware codecs use dedicated hardware for compressing or decompressing the files, such as a DV converter box or for HD http://www.blackmagic-design.com/products/intensity/

data rate: amount of data over time, higher data rate: higher quality image

Interframe vs intraframe codecs: with interframe codecs the frame is created from a collection of images—only differences are recorded--with intraframe codecs the frame contains the entire image. Interframe codecs produce a smaller file size, but need more processing to decompress. Intraframe codecs produce a smaller file size, but need less processing to decompress. Examples of interframe codecs: H.264. Mpeg-2; Examples of intraframe codecs: DV25 and PhotoJPG.

Common Video Codecs

DV25-NTSC *intraframe codec,* 25 Mb/sec(3.1 MB/sec)
Digital representation of NTSC analog video standard
Intended for Mini-DV tape

DV25-PAL *intraframe codec,* 25 Mb/sec(3.1 MB/sec)
Digital representation of PAL analog video standard
Intended for Mini-DV tape

DV50 NTSC *intraframe codec,* 50Mb/sec(6.2 MB/sec)
720x480 resolution, used by DVCPro and D-9

DV50 PAL *intraframe codec,* 50Mb/sec(6.2 MB/sec)
720x576 resolution, used by DVCPro and D-9

Photo JPEG *intraframe codec*
Used in playback from computers within interactive works;
each frame is a JPG image

MPEG-2 *interframe codec*
used for DVD-Video(PAL and NTSC), HDV, and Blue-Ray discs

H.264/MPEG-4 AVC
interframe codec
also known as
H.264
MPEG-4
MPEG-4 part 10
MPEG-4 AV
AVC
AVC and H.264 are synonymous. The standard is known by the full names "ISO/IEC 14496-10" and "ITU-T Recommendation H.264". In addition, a number of alternate names are used (or have been) in reference to this standard.

VC-1 Microsoft codec used with WMV container; alternative to H.264/MPEG-4 AVC codec

Considerations when Selecting a Video Codec and Container Format

1. Some codecs are intended for specific media and hardware(eg. DV-NTSC and DV-PAL are intended for mini DV tape recorders/players and camcorders, not for playback on a computer screen)

2. Some media can only work with certain codecs (eg. DVD-video can only work with MPEG-2, mini DV tape can only work with DV-NTSCV or DV-PAL)

3. Certain codecs can only work with certain containers formats (WMV9 codec will only work with WMV)

4. Certain video editing and playback software can only work with certain video and audio codecs (eg. Quicktime player and Final Cut Pro cannot work with FLV, WMV or AVI, although though third party companies may write plugins to permit this. In general, MAC OS works with any codec supported by MOV and MS-Windows works with any codec supported by AVI or WMV. FLV is primarily used for streaming video on the Internet(eg. Youtube, Vimeo), and requires the Flash player plugin from Adobe. AVI and WMV do not support AAC audio codec. MP4 and MOV support AAC

5. Most versatile containers: MOV on Mac and AVI on MS-Windows

6. Changing a files audio or video codec within a file will probably reduce the quality of the sound or imagery, unless changing between lossless codecs

7. A codec is often inted for a specific use. Apple ProRes video is not meant to be played, but to be used within an editing process.

8. The speed of the storage device can limit the size of file that can be used; faster storage devices, such as hard drive, can play back larger files more quickly. CD_ROMS, DVD's and Flash Drivers are slower devices; different models of Hard drives and interfaces all have different maximum speeds)

USB1: 1.5MB/sec
USB2: 60MB/sec
Firewire400:50MB/sec
Firewire800: 100MB/sec
USB3:600MB/sec,

9. Certain codecs require more computer processing(power) in order to play back smoothly (H.264 requires a lot of processing)

10. Use an intraframe codec for interactive control of a video file because it enables stopping on any frame. Intraframe codecs requires less computer processing than interframe codecs, providing more computer power to process imagery

Technical Considerations for selecting Digital Media for Interactive Installations and Performances

Primary considerations: container format, video codec, video resolution, audio bit depth, audio sampling rate, audio codec

1. Which container formats and codecs are supported by the computers OS?

2. Which container formats and codecs are supported by the programming language being used?

3. What is the maximum resolution that can be supported by the graphics card in the computer?

4. What is the native resolution of the video display device: LCD monitor or LCD video projector? *The highest quality display with the smallest file size is obtainable by creating video footage that matches a device's native resolution.*

5. What is the maximum resolution that can be supported by the video display device: monitor or video projector? *Although a device's maximum resolution may be greater than its native resolution, higher resolution footage will be downsampled to the native resolution. There is no qualitative reason to use a device at a resolution higher than its native resolution.*

6. How fast is the storage device that will play the media file? Is it fast enough to play the files to be used? *A media file will not play correctly if its data rate is higher than the playback speed of its storage device*

7. How fast is the computer being used? Is it fast enough to decompress the media files?

Common Digital Media Formats

Audio

AIFF: uncompressed audio file, typically used for editing professional audio and interactive audio applications with Mac OS

WAV: uncompressed audio file, typically used for editing high quality audio and interactive audio applications with Windows OS. Often used with Digital audio recorders.

MP3: compressed, lossy audio file, typically used on MP3 players because of small file size

AAC: compressed, lossy audio file, typically used on Apple iPod and with HD video that uses H.264

Standard Definition[SD] Digital Video

Standard definition digital video formats are typically used with analog display devices, such as a video monitor, TV or video projector

DV-NTSC *only uses DV25 codec*; 720x480 resolution, IEEE-1394 interface used by MiniDV and DV Cam cameras; is a digital representation of NTSC analog video standard; interlaced; audio is 48Khz, 16 bit; uses hardware codec within camera, deck or media converter

DV25-PAL only uses DV25 *codec*; 720x576 resolution, 720x576resolution, IEEE-1394 interface used by MiniDV and DV Cam cameras; is a digital representation of PAL analog video standard; interlaced; audio is 48Khz, 16 bit; uses hardware codec within camera, deck or media converter

DVCAM same digital signal as DV25(NTSCor PAL), except more reliable format because of a physically stronger case, tape plays faster, and locked audio

DVCPRO similar to DV(NTSC or DV-PAL) except at 50 Mb/Sec compression

DVD-video-NTSC *usually uses MPEG2 codec*; 720x480 audio is 48Khz, 16 bit; uses hardware codec within DVD player

DVD-video-PAL *usually uses MPEG2 codec*; 720x576 audio is 48Khz, 16 bit; uses hardware codec within DVD player

Digital Betacam high quality, typically used in broadcast television; can store lossless or compressed(Betacam SX: MPEG2); digital representation of NTSC or PAL component signal

High Definition [HD] Digital Video

High definition digital video formats cannot be used with analog display devices, such as a video monitor or standard definition TV. They can only be used with HD monitors, HD TV, and video projectors that can accept an HD signal. However, some HD playback hardware will also provide an SD analog signal as output.

MOV/H.264 used with certain prosumer HD camcorders(Canon); uses H.264 codec; resolutions supported: 720p, 1080i, 1080p

MOV/MPEG2 used with certain prosumer HD camcorders; uses MPEG codec; resolutions supported: 720p, 1080i, 1080p

AVI/H.264 used with certain prosumer HD camcorders; uses H.264 codec; resolutions supported: 720p, 1080i, 1080p

AVI/MPEG2 used with certain prosumer HD camcorders; uses MPEG codec; resolutions supported: 720p, 1080i, 1080p

HDV high definition DV; uses MPEG2 codec; used with certain prosumer HD camcorders (Sony), records HDvideo onto a mini-DV tape; resolutions supported: 720p, 1080i, 1080p

MXF/MPEG2 used with certain professional HD camcorders(Canon); uses MPEG2 codec; resolutions supported: 720p, 1080i, 1080p; competitor to HDV

AVCHD Advanced Video Coding High Definition; used with certain HD camcorders(Sony, Panasonic); uses MPEG-4 AVC/H.264 codec

Blue-ray commercial format for distribution of HD video on optical media; uses H.264/MPEG4/AVC; MPEG-2, and VC-1 codecs; uses hardware codec with Blue-ray player; intended to replace standard definition DVD video format; maximum resolution:1920x1080p http://en.wikipedia.org/wiki/Blu-ray_Disc#Variations

HDCAM HD version of Digital Betacam; used in broadcast television; actual resolution is 1440 x1080 upsampled to 1920x1080 pixels

HDCAM-SR HD version of Digital Betacam; used in broadcast television; actual resolution is 1920x1080 pixels

DVCPRO-HD competitor of HDCAM

Extra High-Definition Video

2K	2,048 x1,536	Progressive
2160p	3,840 x 2,160	Progressive
4K	4,096 x 3,072	Progressive
2540p	4,520 x 2,540	Progressive
4320p	7,680 x 4,320	Progressive

DIGITAL VIDEO TAPE FORMATS	**INTERFACE**
miniDV	IEEE-1394 (also known as Firewire, I-Link)
DVCam	IEEE-1394
DVCPro	IEEE-1394
HDV _HIGH DEFINITION ON DV TAPE	IEEE-1394
DVCPro50	SDI (Serial Digital Interface)
D-9(Digital-S)	SDI

Digital Betacam	SDI (Serial Digital Interface)
HDCAM	SDI
DVPRO-HS	SDI

Common Digital Video Connectors

CONNECTOR NAME	**number of signals**	**genders available**	**typical use**
DV/FIREWIRE /IEEE1394	4 or 6 pins(with power); audio also	female and male	Input/Output from computer to DV deck or DV converter or DV camera
VGA or SVGA (video graphics array /super video graphics array)	15 pins	female and male	output from computer video card/input into computer monitor or video projector *(signal is actually analog)*
DVI (Digital visual interface)	24 pins	female and male	output from computer video card/input into computer monitor or video projector (true digital signal unlike VGA)
HDMI (High definition Multimedia Interface)	19 pins (also carries digital audio, and Ethernet data	female and male	Consumer HD video equipment, game, and computer equipment
SDI (Serial digital interface)	1 signal on BNC	female and male	Professional digital video equipment

Digital and Analog Camera Technology

The primary function of a camera is to convert light into a storage/permanent medium, to make a recording. The first photographic and moving image cameras were analog devices, and the image created was stored onto film-based media. Photo cameras are designed to create single images, while a movie cameras record a series of images that are used depict motion. A video camera is similar to a film camera, because they both record moving imagery, but a video camera provides an electronic recording of the imagery while a film camera provides a physical recording onto film. Photo or movie cameras are categorized as being analog or digital, according to the format for storing the recording.

The primary function of a video camera is to convert light into an analog video signal or into a digital video file. A video camcorder is comprised of a video camera and video recorder that is able to store the video signal or file onto a storage medium, such as an analog video tape, digital video tape, hard drive or SD(Secure Digital) chip.

Examples of analog photo cameras that use film:

35mm photo camera: Nikon F4, Canon AE-1, http://en.wikipedia.org/wiki/Nikon_F4
6x6cm photo camera: Hasselblad 500,
http://www.photoethnography.com/ClassicCameras/Hasselblad500.html

Examples of analog movie cameras that use film:

16mm movie camera(records onto film): Arriflex 16SR,
http://en.wikipedia.org/wiki/Arriflex_16SR
35mm movie camera: Panavision Gold GII,
http://www.panavision.com/content/gold-gii?l=1&c=1&p=110
65mm movie camera: Imax camera, http://en.wikipedia.org/wiki/File:IMAX_camera_1.jpg

Examples of analog video cameras:

consumer VHS video camcorder: Hitachi 1280,
http://www.oldvcr.tv/collection/index.html?Mode=View&Brand=Hitachi&Model=VM-1280E&Ref=2
prosumer Hi8 video camcorder: Canon L1,
http://www.findchicago.com/upload/goods/1034191095_37.jpg
professional video camcorder: Sony Betacam SP,
http://en.wikipedia.org/wiki/File:Betacam_SP_Camcorder_01_KMJ.jpg

Examples of digital photo cameras:

portable digital photo camera: Canon S90, http://www.dpreview.com/reviews/canons90/
DSLR photo camera: Canon D90, http://www.dpreview.com/reviews/nikond90

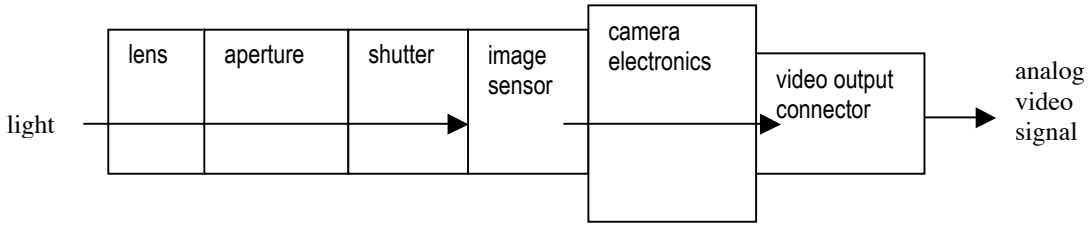
Examples of digital video cameras:

Portable Professional SD digital video camecorder: Panasonic AG-DVX100B
http://www.panasonic.com/business/provideo/AG-DVX100B.asp
Portable Consumer HD digital video camcorder: Con Vixia HF G10
http://www.bhphotovideo.com/c/product/749190-REG/Canon_4923B002_VIXIA_HF_G10_Flash.html
Professional digital video camera: Red One, http://www.red.com/products/red-one

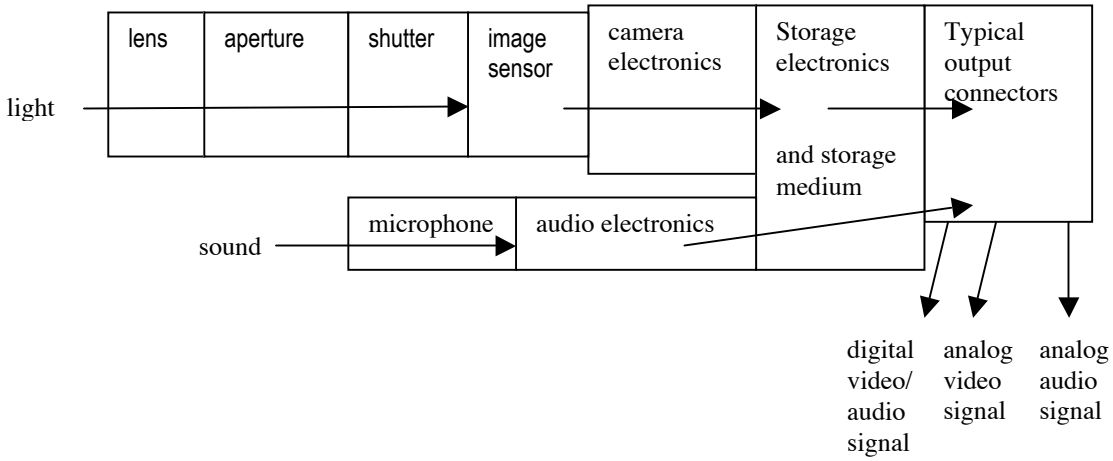
Examples of DSLR(digital single lens reflex) digital photo/video cameras:

Canon 550D, http://en.wikipedia.org/wiki/Canon_EOS_550D
Canon 5D Mark II, http://en.wikipedia.org/wiki/Canon_EOS_5D_Mark_II

Primary components of an analog video camera



Primary components of an digital video camcorder



Terminology related to digital video/photo cameras and video camcorders

lighting: refers to the amount, direction and colour of light within the environment being recorded by a camera. The quality of a recording made by a camera is primarily determined by the amount of light within the environment being recorded. Low quality cameras can make good recordings under sufficient lighting conditions, but high quality camera cannot make good recordings when the lighting is insufficient.

image sensor: the electronic component within a camera that converts light into an electrical signal. Different image sensors vary in the number and range of light levels that they can capture. Larger image sensors typically provide higher resolution imagery, are more sensitive to light, have a broader range of ISO settings, and are more expensive. The quality of imagery recorded by a digital camera is primarily based on the size and quality of the image sensor.

white balance: the setting in a camera that provides correct adjustment of colour recording depending on the type of light source used in a shot. Different light sources have different color temperatures, such as incandescent light being slightly orange. The white balance setting in a camera ensures that white subject matter will be recorded as white. White balance presets typically include: tungsten, incandescent, sunlight, florescent , flash, cloudy, shade, and auto white balance. The white balance setting of a camera is typically set to correspond with lighting conditions.

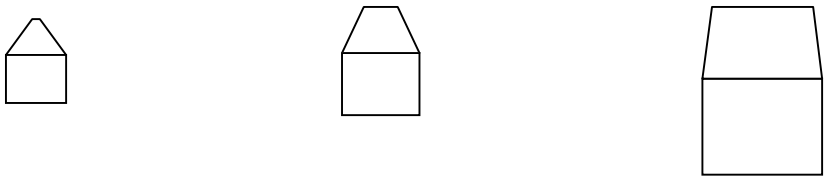
ISO: a term that originally referred to the light sensitivity of photographic film, it is also used to refer to the light sensitivity of a digital image sensor. A higher ISO number, such as ISO 1600, indicates that the sensor is more sensitivity to light, and a smaller ISO number, such as ISO 100, indicates less sensitivity to light. A lower ISO setting provides higher quality imagery than a higher setting.

correct exposure: refers to the amount of light striking the image sensor that will create the desired visual image. A correct exposure is subjective, but it will typically contain a wide range of exposure levels from black to white. A correct exposure is dependent on the following variables: lighting, characteristics if the image sensor, ISO, aperture, and exposure/shutter speed. Less expensive cameras are typically unable to get correct exposure under low light conditions.

camera lens: an optical device that focuses light onto the image sensor within a camera. A camera lens will typically contain an adjustable aperture and a mechanism that enables proper focusing of light onto the image sensor. Lenses vary in their focal length, indicated in *mm's*, and the maximum amount of light they carry to an image sensor, indicated as *1:max aperture*.

lens focal length: refers to the magnification characteristic, or point-of-view, of a lens. A short focal length lens, such as 20mm, has a wide point-of-view and a long focal length lens, such as 200mm, has a narrow point of view. A very short lens is called a wide angle or fish eye lens because straight lines will become curved. A long lens is also called a telephoto lens because it magnifies the subject. The shorter a lens is, the more perspective distortion is created. A 50mm provides the amount of perspective distortion that is approximately equivalent to the perspective distortion of the human eye. A shorter lens provides a larger depth of field than a longer lens.

Example of perspective distortion when shooting a cube with different lenses:



short lens with exaggerated perspective

medium lens with normal perspective

medium lens with flattened perspective

lens speed: the speed of a lens indicates its maximum aperture size(its minimum f-stop). Lenses are usually designated according to their lens speed and focal length, such as a lens being labeled as 50mm 1:1.8, meaning its minimum f-stop is f/1.8 and its focal length is 50mm. A lens with a small f-stop is called a fast lens because correct exposures can be achieved with less light or shorter exposure times.

prime lens: a fixed focal length lens, such as 50mm

zoom lens: a single lens which can be used at different focal lengths. A lens designated as 24-70mm f/2.8 can provide focal lengths ranging from 24mm to 70mm,

with a maximum aperture of f/2.8 A *variable aperture lens* is a type of zoom lens whose maximum aperture changes depending on its focal length, xxample: lens designated as 1:3.5-5.6, 18-55mm.

depth of field: the depth of field indicates the range of distances between the lens and the subject that are in sharp focus. The depth of field is determined by the following 3 factors:

1. *the focal length of the lens*
   shorter focal length: larger depth of field
   longer focal length : smaller depth of field
2. *distance between lens and subject*
   shorter distance to subject : smaller depth of field
   longer distance to subject : larger depth of field
3. *aperture/f-stop of the lens*
   large aperture(small f-stop) : smaller depth of field
   small aperture(large f-stop): larger depth of field

Samples: http://www.secondpicture.com/tutorials/photography/meaning_of_depth_of_field.html
calculator for depth of field: http://www.cambridgeincolour.com/tutorials/depth-of-field.htm

aperture/iris: the aperture, also called an iris, is an opening within a lens that controls the amount of light which passes through the lens onto the image sensor. A large iris passes more light and a small iris passes less light. The size of the iris opening is indicated with an f-stop number, such as f/4. A smaller f-stop provides more light than a large number, for example f/2 provides more light than f/4.
• small aperture(large f) produces a large depth of field and requires longer exposure
• large aperture(small f) produces a small depth of field and requires shorter exposure

shutter: is the physical device in a camera that controls the duration of light that will fall onto the image sensor.

shutter speed/exposure time: indicates the amount of time that the shutter is open to permit light from the lens to fall onto the image sensor. Shorter exposure times provide less light to the image sensor than longer exposure times. Some video cameras have a fixed shutter speed, but some are variable. The shutter speed cannot be longer than the duration of one frame. For example, if a video frame rate is 25 fps, the shutter speed can be 1/25 second or faster, it cannot be longer than 1/25 second. Longer shutter speeds will provide slightly blurred imagery for moving objects.

Typical Settings for DSLR Cameras

Automatic modes: DSLR cameras usually have various modes of operation, including fully automatic, fully manual, or a combination of manual and automatic. In fully automatic mode, the camera make selections for ISO, white balance, aperture and shutter speed. In manual mode, the user must select ISO, white balance, aperture and shutter speed. Partial automatic modes, such as shutter priority, permit a user to select the shutter speed and the camera will then determine a correct exposure by automatically selecting ISO and apertures.
• fully automatic: camera selects aperture, shutter speed and ISO

• shutter priority: user selects aperture and camera automatically selects the correct exposure time
• aperture priority: user selects aperture and camera a will automatically selects the correct exposure time
• ISO automatic: camera will automatically select the best ISO setting to get a correct exposure

ISO: use lowest number possible to get a proper exposure; use a higher ISO setting if unable to get sufficient light through exposure settings(Iris and shutter speed)
• low ISO setting : requires longer exposure time : higher quality imagery
• high ISO setting : requires shorter exposure time : lower quality imagery

White Balance: use setting that corresponds with lighting conditions

Relationship between Lighting, Subject Distance, Focal length, Aperture, Shutter Speed, ISO, Perspective Distortion, and Depth of Field

No universally correct settings exist for lighting, subject distance, iris, shutter speed and ISO because different combinations of settings can provide various acceptable results.

Greater amounts of light enable the following:
• use of a smaller aperture -> larger depth of field
• use of lower ISO settings -> higher quality image
• use of higher shutter speed -> ability to capture fast motion without a blur

Lower amounts of light enable the following:
• ability to create mood associated with low light
• option to use large aperture -> small depth of field

Greater distance between lens and subject enables the following:
• larger depth of field
• option to use long focal length lens -> less perspective distortion(flattening of image)

Small distance between lens and subject enables the following:
• smaller depth of field
• option to use short focal length lens -> more perspective distortion

Long focal length of the lens enables the following:
• ability to magnify the image in the shot
• reduction in perspective distortion (straight lines appear straight not curved)

Short focal length of the lens enables the following:
• ability for a larger point-of-view (fish eye)
• Purposely distort imagery
• distances exaggerated
http://farm4.static.flickr.com/3298/3411054616_5420afaa91.jpg

Smaller aperture (larger F stop setting) enables the following:

•larger depth of field
• ability to shoot in bright settings

larger aperture (small F stop setting) enables the following:
•smaller depth of field
• ability to shoot in low light settings

fast shutter speed enables the following:
• capture fast motion without blur
• ability to use large aperture -> smaller depth of field

slow shutter speed enables the following:
• capture fast motion with blur
• ability to shoot under low light
• ability to use smaller aperture -> larger depth of field

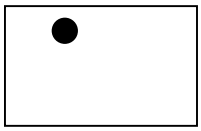
high ISO setting enables the following:
• lower quality imagery than possible with high ISO
• ability to obtain proper exposure under low light
• ability to use small iris ->larger depth of field
• ability to use fast shutter speed ->less blur

low ISO setting enables the following:
• higher quality imagery than possible with low ISO
• ability to obtain proper exposure under bright light
• ability to use large iris ->small depth of field

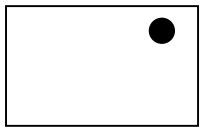
Animation and Motion Graphics Terminology

Digital animation and motion graphics permit the animation of various aspects of imagery. The most common spatial parameters to be animations are position, scale and orientation. Colour based parameters that are can be animated include transparency, hue, saturation, and value.

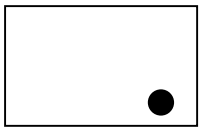
Keyframe: specifies the value of a parameter at a specific point in time, such as the XY position of an object at a certain time.



Keyframe 1: x=100 y =200
time = 0 sec



keyframe 2: x=300 y=200
time = 1 sec



keyframe 3: x=300 y=50
time = 3 sec

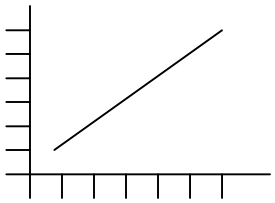
Interpolation: refers to the creation of data between two points in time, as specified by keyframes. In the above example, interpolation would create the xy locations of the object between keyframes 1 and 2 and between keyframes 2 and 3

Temporal interpolation: refers to the rate of change between keyframes over time; this rate can be constant or it can change over time

Spatial interpolation: refers to the rate of change between keyframes spatially; this spatial change be a straight line or be curved

Linear temporal interpolation: specifies that rate of change in a parameter is constant over time

parameter value (x position)

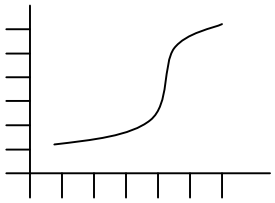


time

over time the parameter changes at the same rate, such as changing its x position at constant rate of 10 pixels per second

Non-linear temporal interpolation: specifies that rate of change in a parameter is not constant over time

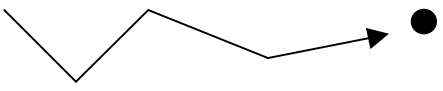
parameter value (x position)



time

Over time the parameter changes at varying rates, such as changing its x position

Linear spatial interpolation: the object moves between keyframes in straight line



Non-linear spatial interpolation: the object does not move between keyframes in straight line

DMX Lighting Technology

Protocol for controlling lights

Older systems used MIDI or custom protocols, but most current lighting systems use the DMX512 protocol

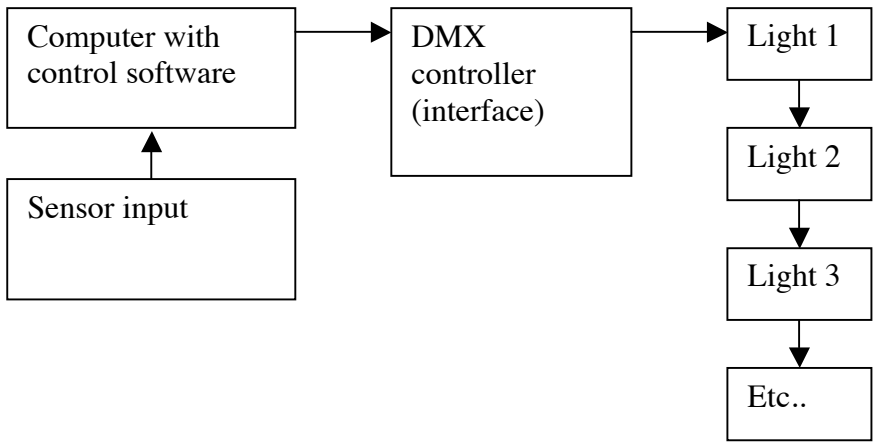
Different aspects of a light are controlled using channels, up to a maximum of 512 channels. Typical characteristics controlled by a channel include:

1. Light on/off (bulb is on or off)
2. shutter open/closed (bulb is on but no light transmitted)
3. light colour (red, green, blue, etc)
4. light brightness (value indicates brightness)
5. pan (X position for a moving light)
6. tilt (Y position for a moving light)
7. speed of pan
8. speed of tilt
9. Gobo (shape and motion)

To control a light a specific value is sent to the light down a specific channel. For example, sending number 6 down channel 3 would cause the light to become green. The specific channels and values will be different for different models of light. Simple DMX light may use few channels, such a 4, but more complicated light s may use 12.

Moving light or Moving yoke light can direct the light at certain positions in a room through automated panning and tilting.

Typical Hardware Configuration for Interactive Control of DMX Lights



Interactive Sensor Technologies

Def: A sensor is a device that measures a physical quantity and converts it into a signal that can be understood by an interactive system

What can be monitored in people:

- Body position
- Body motion
- physical gesture
- heartbeat
- breathing
- brain activity
- voice
- ?

Types of Sensors

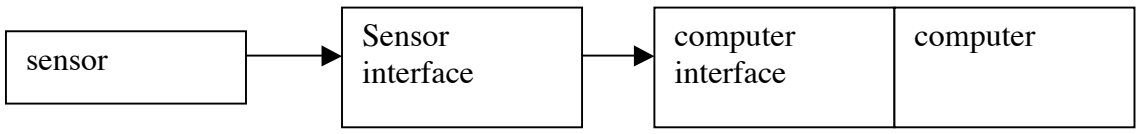
Encumbered: physical

- physical switches to activated by hand (light switch)
- physical switches activated by weight (floor mats)

Unencumbered: physical

- video(visible light): detects motion, color, position. *computer vision*
- video(infrared light): detects position
- ultrasonic: can detect motion and position
- infrared: collection of beams can be used to detect position

Typical Configuration for a Sensor in an Interactive System



Sensor: translates physical activity into a signal (eg. Ultra-sonic sensor)
Sensor interface: translates output of sensor into a format that can be understood by an interface on the computer(eg. Converts ultra-sonic output to USB)
Computer interface: interface on computer that enables communication with an external device (eg. USB connector)

Protocols

Def: a protocol is an electronic language that enables communication between different electronic devices
Common protocols:
MIDI: *Musical Instrument Digital Interface*, usually used for communication between musical instruments and a computer

DMX512: Digital Multiplex with 512 pieces of information, industry standard protocol that is typically used for communication between stage lighting equipment, lighting controllers, and computers
IP: Internet protocol, most common protocol for communication between networked computers, such as the Internet

Programming and Controlling Interactivity

General Features of Programming Languages

1. variable: location for storing data
    name: name of variable
    set: type of data contained in variable(eg. text/numeric)
    value: value of variable
    constants: a variable with a constant value(eg. x is 50)
    assignment statement(=): assigns value to a variable (x = 50)
    example:
    HEIGHT = 4 the assignment statement;
    variable name is HEIGHT set type is INTERGER NUMBER, value is 4;
    "=" is the assignment instruction

2. arithmetic expressions/operators: indicate basic arithmetic operations
    example: x + 2 ("x" and "2" are operands and "+" is the operator)

3. logical expressions/operators: indicate logical operations(examples: and, or, greater than, equal, etc)

4. input of data (eg. mouse click/position, video input, audio input, keyboard input)

5. output of data (video input, audio output, data output through Ethernet connection)

6. control structures: indicate order in which instructions of the program are executed
    a. sequential
    b. simple choice(2) eg. if...then...else
    c. case statement(greater than 2 choices)
    d. go to
    e. counted loop (eg. for...next)
    f. conditional loop (while...)
    g. subroutines(procedures:functions)
     activated with a call statement; passes values to a subroutine using parameters and arguments
        1. allows division of large tasks
        2. reduces typing(repeat similarities)
        3. transported between programs
    h. system functions
    i. recursion(function calls/invokes itself)

7. data structure: allows reference to a collection of data under a specific name

a. arrays: indicate array names, subscripts in an array, and range of permissible values
b. records: allows text and numeric data in the same array; can be simulated with parallel array
c. lists: sequential access; elements can be added/deleted from the list(eg. Lisp)

8. file handling:
read data from a stored file
write data to a stored file

9. graphic rendering: create graphics elements within program (circles, squares, etc)

10. audio rendering: create audio elements within program (pitch, volume, etc)

Pseudo Code

Definition: program written in understandable human language
Example: person's location in room control brightness of projected image

1. determine of person is in room, if yes PERSON = 1; if no PERSON = 0
2. if PERSON = 0, do instruction 1
3. if PERSON = 1, determine their physical location;
4. Y = person's position from the front wall
5. maximum value of Y is 100(maximum brightness)
6. minimum value of Y is 0
7. BRIGHT = Y (brightness of projected image(BRIGHT) has inverse correspondence with Y (as person gets closer to wall, projection become brighter)
8. if person leaves room, B = 0
9. do instruction 1

Elements of Structured Programming

1. top down design: generalize problem and become more detailed
2. modular program structure: hierarchical with one function per module
3. understandable
4. all modules are proper: single entrance and exit point; no endless loops
5. programs written in a structured fashion: use structures constructs
6. well commented and readable

Program Testing Suggestions

1. test individual modules
2. develop library of standard test routines
3. test how error conditions are handled

Unused

OTHER VIDEO TERMINOLGY

RGB Video: high quality method for encoding video information using four electronic signals describing the red, green, blue and sync components.

CRT/cathode ray tube: glass tube allowing images to be created by directing an electron beam(gun)onto a phosphorus covered surface within the tube

machine control: the ability for a video recorder or player to be controled by anotehr device, usualyy a computer

multisync monitor: video monitor capable of displaying an RGB video signal in non-interlaced mode; typically used to display a computer's output

video encoder: video hardware which transforms an RGB video signal into a composite video signal; the video quality of recorded computer animation is highly dependent on this device

video mixer: device capable of combining two analog or digital; video signals in real time

television: a video display device which decodes an RF video signal and displays an image on a CRT

video disc: medium in which video information is stored as concentric circles or spirals of data on an optical disk

video editing: process of combining various video and audio segments into a finished work

video edit suite: a room containing various equipment(eg. edit VCR's, switcher) allowing editing of video tape

The Analog Video Signal

VIDEO TAPE AND STORAGE FORMATS

Consumer Analogue Formats, VHS, VHS-C, SVHS, 8mm, Hi8
Low resolution formats (240 - 400 lines) which although now low cost offer little value to the amateur movie maker. Each generation results in a loss of quality so the formats are not well suited to editing and are now really only of use for point and shoot family video record keeping.

miniDV
The miniDV format is used in both consumer and professional equipment and resolves in excess of 500 horizontal lines. Capable of broadcast quality video, miniDV is routinely used by broadcasters for ENG and special assignments. Being a digital format it is ideally suited to non linear computer editing with virtually lossless quality across multiple generations. Digital camcorders using the miniDV format are the smallest and lightest available with their tapes being a similar size to a matchbox. The main difference between consumer and professional equipment is the quality of the lens, type and number of CCD's and the additional manual features built into the professional kit. The best quality miniDV equipment can produce results which better BetaSP equipment which until recently was the broadcast standard.

Digital8
Consumer format developed by and currently exclusive to Sony. Uses standard Hi8 tapes which are cheaper than miniDV. The max picture resolution is claimed to be similar to miniDV at 500 lines. Although audio is recorded in 16bit PCM stereo, Digital8 offers no audio dub facility .

DVCPro (Panasonic)
The full size version of DV implemented by Panasonic for broadcast use. 4:2:2 component digital, 3:3:1 compression. Panasonic VT machines can playback DVCPro, Sony DVCam and miniDV tapes.

DVCam (Sony)
Launched in 1996 for professional use its the Sony implementation of full size DV. Offers all the benefits of miniDV such as picture quality and multi-generation recording with increased recording time in a familiar professional package.

Digital S (JVC)
Broadcast format exclusive to JVC. Not compatible with other DV formats. Uses metal particle tapes which are more robust than the metal evaporated tapes used by DVCPro and DVCam but larger size.

Digital Betacam
Introduced in 1993 Digital Betacam has been adopted by hundreds of broadcasters worldwide for the creation of top quality material. Many Digital Betacam VT machines can playback Betacam and Betacam SP cassettes making an easy upgrade from broadcast analogue to digital production

DVCPROHD
*** http://www.adamwilt.com/DV-FAQ-tech.html#DV50%20formats

HDCAM

1080x1920 pixels
* 1080/24p (24 frames per second, non-interlaced)->for film projects
* 1080/60i, (30 fps second, interlaced)->for video projects
* SDI interface

VHS(video home system): composite signal recorded on tape 1/2 inch wide
VHS-C: small/compact VHS tape
SVHS: Super VHS component signal recorded on tape 1/2 inch wide
8mm: composite signal recorded on tape 8mm wide
Hi8: Super VHS component signal recorded on tape 8mm wide
3/4 inch: composite signal recorded on tape 3/4 inch wide
3/4SP: improved composite signal recorded on tape 3/4 inch wide
Betacam: component signal recorded on tape 1/2 inch wide running at high speed
Betacam SP: improved component signal recorded on tape 1/2 inch wide running at high speed
MII: component signal recorded on tape 1/2 inch wide running at high speed
1 inch: component signal recorded on tape 1 inch wide
D2: digital video