Course Overview

Multimedia Techniques & Applications

Yu-Ting Wu

1

1

Course Information

- **Meeting time:** 09:10 - 12:00, Monday
- **Classroom:** 資B1F-04
- **Instructor:** 吳昱霆 (Yu-Ting Wu)
- **Teaching assistants:** TBA
- **Course webpage:**
  - *https://kevincosner.github.io/courses/MMTA2022/*
- **Grading:**
  - Assignments: 35%
  - Report: 20%
  - Final Project: 40%
  - Participation: 5%

2

2

References

- **No specific textbook for this course**
  - We will use information from books, journals, and proceedings
  - If you still want some textbooks …

  - Some of the materials are borrowed from the course "*Digital Visual Effects*", by Prof. Yung-Yu Chuang, National Taiwan University

3

3

Copyright Statement

- We will use lots of materials from feature movies, games, capture or display devices, the copyrights belong to the producers and developers of the original content or devices

4

4

What is Multimedia ?

5

Multi --- Media

6

What is Media ?

7

Media

- The plural of medium
  - Communication channels for delivering information

newspaper

magazine


outdoor advertising


radio

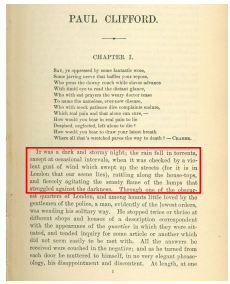

TV programs


internet

8

Media

- Example: *it was a dark and stormy night*



novel

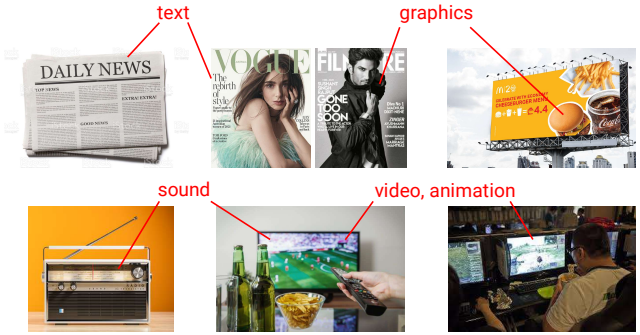
comic


video


radio


drama

Basic Components of Media



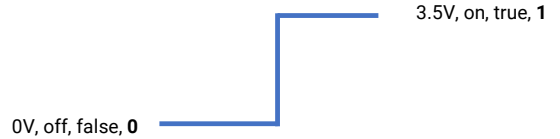
- We will introduce these components in the following courses

Digital Media

- In this course, we focus on ***digital media***, which can be represented ***digitally***
  - Structured as collections of bits
  - Manipulated by programs
  - Stored on disks and other storage devices
  - Transmitted over networks

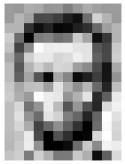
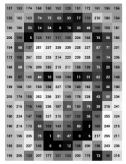
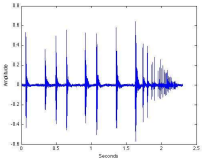
Recap: Digital Representation

- Computers are built out of devices that can only be in one of two states (well defined voltages)
- We usually say these devices store and operate in **bits**



Recap: Digital Representation (cont.)

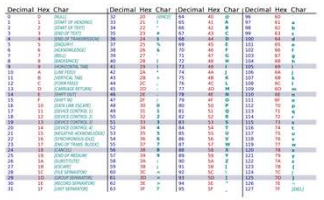
- Using the representation of 0/1, we can interpret the group of bits (bytes or words) into a number to base 2
  - Ex: 01100001 ➔ 97
- We can then express data using bits, bytes, or words

- We can also build electronic devices to perform the basic arithmetic operations
  - Addition, subtraction, multiplication, division, …

Recap: Digital Representation (cont.)

- We can also build mapping
  - ASCII code
  - Instruction set
  - …



		Target <tar>	
		4R or Mx	12R
INC	$0	-- C Z N	-- -- Z^2 N^2
DEC	$1	-- C Z N	-- -- Z^2 N^2
ADDC	$2	O C Z N	-- -- -- --
SUBB	$3	O C Z N	-- -- -- --
ROLC	$4	-- C^1 Z N	-- -- -- --
RORC	$5	-- C^2 Z N	-- -- -- --
AND	$6	-- -- Z N	-- -- -- --
OR	$7	-- -- Z N	-- -- -- --
XOR	$8	-- -- Z N	-- -- -- --
CMP	$9	-- C^4 Z^3 --	-- -- -- --
PUSH	$A	-- -- -- --	-- -- -- --
POP	$B	-- -- Z^5 N^5	-- -- -- --
JMP	$C	-- -- -- --	-- -- -- --
JSR	$D	-- -- -- --	-- -- -- --
NOP	$E	-- -- -- --	-- -- -- --
MOV	$F	-- -- Z^6 N^6	-- -- Z^7 N^7

- Program: sequences of instructions can be stored in memory and execute

Recap: Digitalization

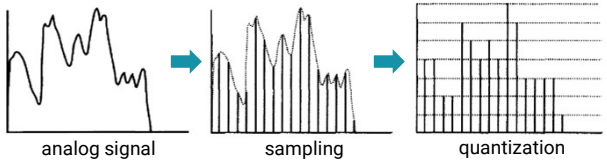
- Digitalization
  - Not all data are generated digitally



  - Transform the sensor inputs that make up images, texts, moving pictures, and sound into patterns of binary digits inside a computer

Recap: Digitalization (cont.)

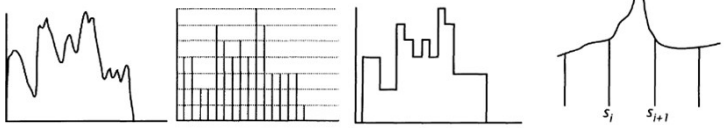
- Process
  - Sampling: measure the signal's value at discrete intervals
  - Quantization: restrict the value to a fixed set of levels



- Pros: fixed memory footprint and better noise tolerance
- Cons: some information will inevitably lose during the digitalization process

Recap: Digitalization (cont.)

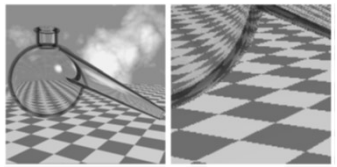
- Quality of digitalization
  - How closely the original signal can be reconstructed
  - Depends on
    - Reconstruction algorithms
    - Quality of the sampled data



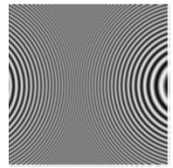
analog signal | sampled data | reconstructed signal using "sample and hold" | under sampling

Recap: Digitalization (cont.)

- Aliasing

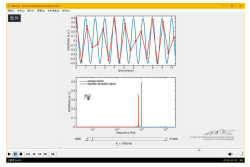


staircase pattern or jaggies



Moire pattern (x^2+y^2)

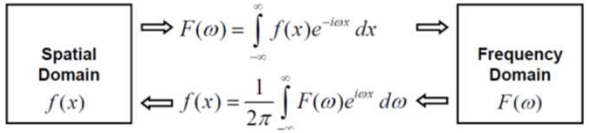
Wagon Wheel effect



change of sound pitch

Recap: Frequency Domain

- Most functions can be decomposed into a weighted sun of shifted sinusoids
- Each function (signal) has two representations
  - Ex: image
    - Spatial domain: normal representation
    - Frequency domain: spectral representation
  - The **Fourier transform** converts between the two representations

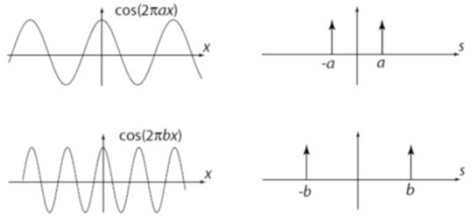


Recap: Sampling Theorem

- Claude Shannon [1949]

  "A signal can be reconstructed from its samples without loss of information **if the original signal has no frequencies above ½ the sampling frequency**"

  Nyquist frequency



Digital Media

- In this course, we focus on ***digital media***, which can be represented ***digitally***
  - Structured as collections of bits
  - Manipulated by programs
  - Stored on disks and other storage devices
  - Transmitted over networks

- The shared digital representation means that different media can be combined into ***Multimedia***

Combination of Different Media

- The integration of media is natural
  - We perceive the world through all the senses we have at once
- The idea is not new

AL JOLSON "The Jazz Singer" in 1927

Multimedia

- Multimedia is considered slightly different from multiple media or combined media
  - Multiple media or combined media require users to switch between modalities
  - True multimedia requires us to combine modalities at the same time
    - Can bring in new content, such as the pop music videos
    - Usually provide some interactivity
- In this course, we also focus on ***digital multimedia***, which can represent text, sound, and pictures using ***bits***
  - Control the order of each media component
  - Response to input from a user, thus being **interactive**!

Applications of Digital Multimedia

- Entertainment

games

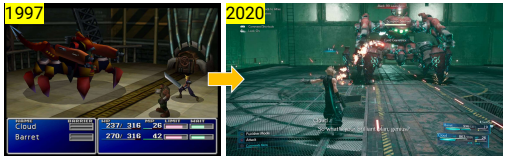
movies

music videos

Applications of Digital Multimedia

- Entertainment
  - The production can make extremely different experiences

Myst



Final Fantasy VII

Applications of Digital Multimedia

- Entertainment
  - The production can make extremely different experiences

Avengers (1978)

Applications of Digital Multimedia

- Entertainment
  - The production can make extremely different experiences

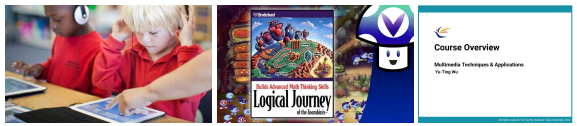
Avengers: Infinite War (2018)

Applications of Digital Multimedia

- Education

film clips and original recordings

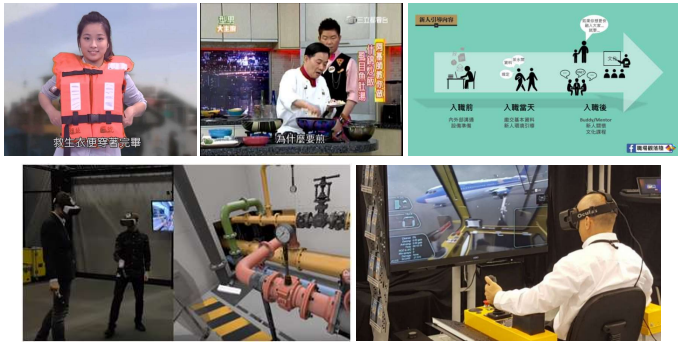
virtual experiments or surgery



teaching materials

Applications of Digital Multimedia

- Instruction or Training



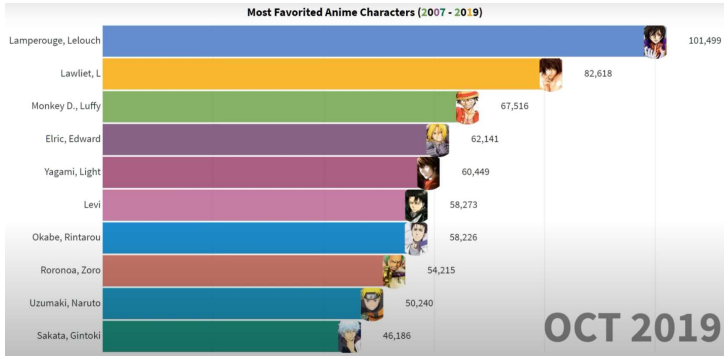
Applications of Digital Multimedia

- Presentation and promotions

sales presentation portfolio

Applications of Digital Multimedia

- Visualization



from https://www.youtube.com/watch?v=_CvtsaFgpfA

Applications of Digital Multimedia

- Forensic

Delivery of Digital Multimedia

- Get the material from its producer to its consumers
- Types of delivery
  - Offline
    - CD, VCD, DVD, BD, floppy disks, USB sticks ...
  - Online
    - Internet
  - Hybrid

Delivery of Digital Multimedia

- Offline delivery: removable storage medium
  - Still widely used in areas with low bandwidth to the internet

~150 KB
8-inch floppy disk
(since 1969)

~1.2 MB
5.25-inch floppy disk
(since 1976)

~2.88 MB
3.5-inch floppy disk
(since 1984)

650 MB
CD-ROM
[Compact Disc Read-Only Memory]
(since 1982)

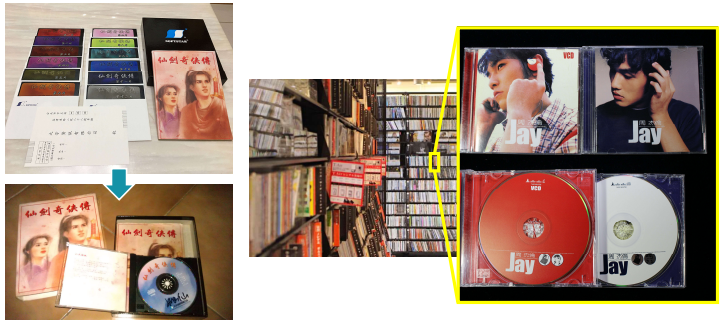
800 MB
MPEG-1
VCD
[Video Compact Disc]
(since 1993)

4.7 ~ 17 GB
MPEG-2
DVD
[Digital Versatile Disc]
(since 1995)

25 ~ 128 GB
MPEG-4
(H.264)
BD
[Blu-ray Disc]
(since 2006)

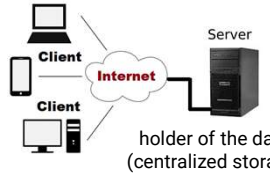
Delivery of Digital Multimedia

- The success of CD-ROM (and the following VCD, DVD) brings the surge in interest in multimedia



Delivery of Digital Multimedia

- Online delivery: network
  - Client – Server (most common)
  - Peer – to – Peer



holder of the data
(centralized storage)

- Online delivery offers opportunities which are not available offline
  - Video conferencing
  - Broadcast

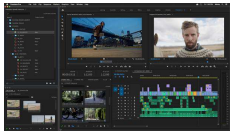
Delivery of Digital Multimedia

- Hybrid (of offline & online) delivery
  - Physical removable medium (main content) + online update / or downloadable content (DLC)

Production of Digital Multimedia

- The making of multimedia requires authoring systems
  - Preparation of individual media elements
  - Integration into a finished production

Adobe Photoshop



Adobe Premiere

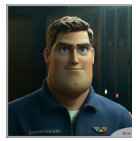
Blender

Unity / Unreal Engine

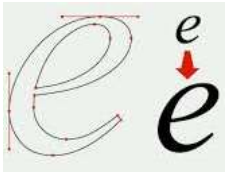
Topics We Plan to Cover

Graphics

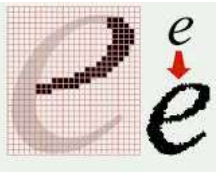


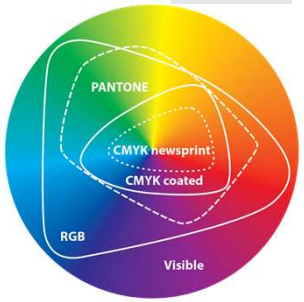

vector graphics

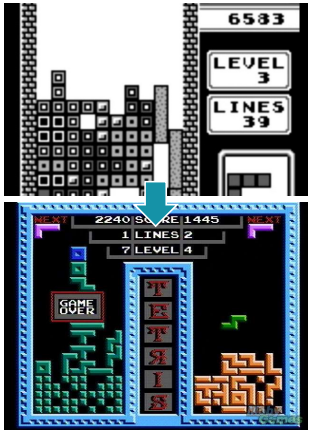


bitmapped graphics



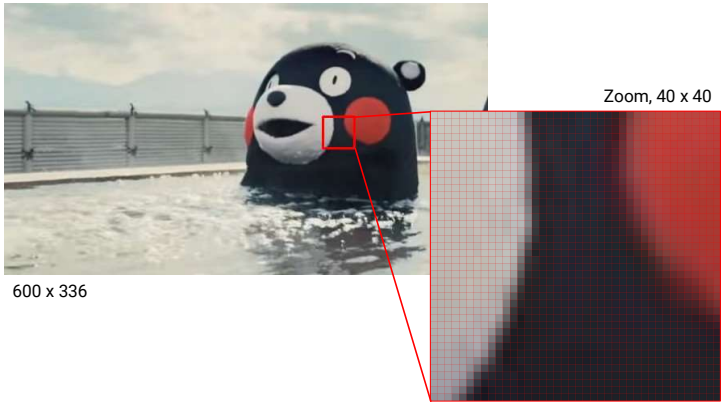
Color





41

Bitmapped Images



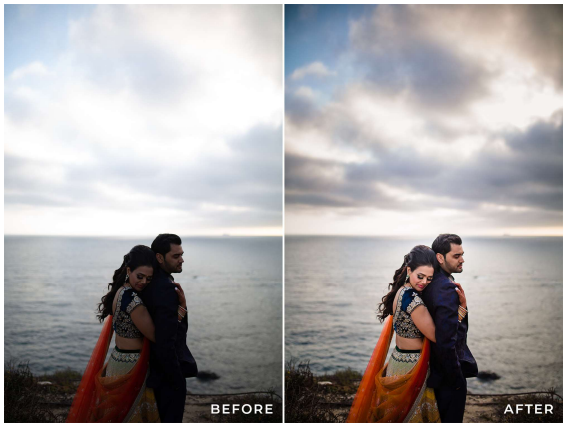
42

Camera

Note we are not teaching

43

High Dynamic Imaging



44

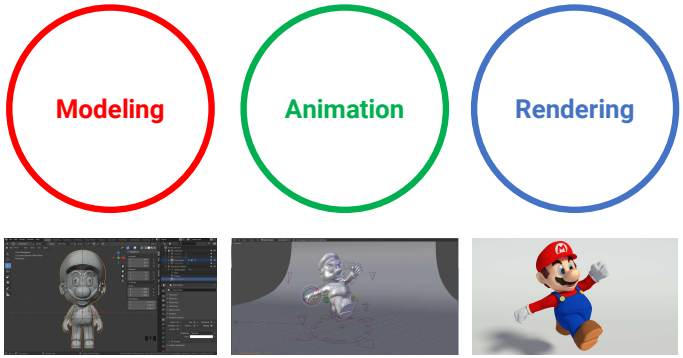
Panorama

45

Vector Graphics

46

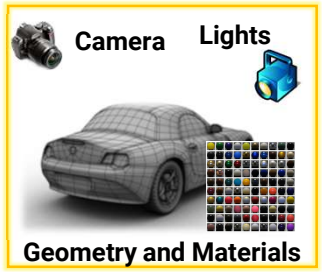
3D Graphics



47

3D Graphics

- Create the virtual 3D world description
- Create a 2D picture from the virtual 3D world description



3D description of a scene

output: 2D synthetic image

48

Text and Font

ASCII TABLE

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[END OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]

Lucida Bright goes well with *Lucida Bright italic,* ***and bold italic,*** but not nearly so well with Palatino.

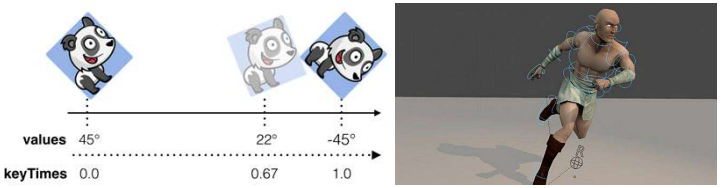
A Display Font: Bodoni Highlight

Display fonts are designed for short pieces of text, such as headlines. They are not intended for use in lengthy passages.

49

49

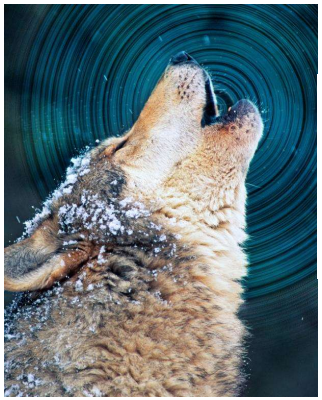
Video and Animation



50

50

Sound



51

51

Game Production

52

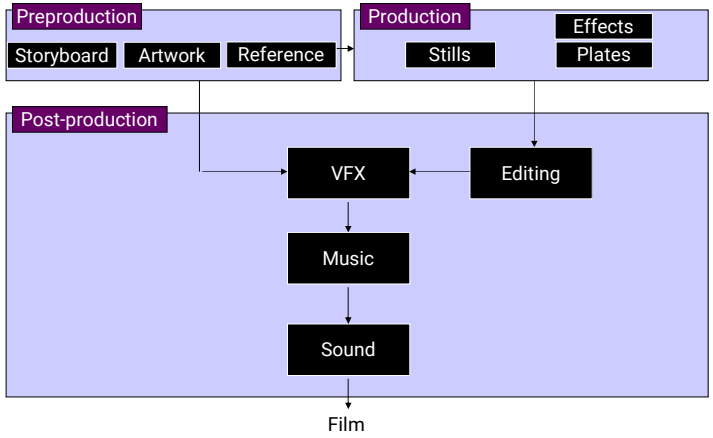
52

Game Engines

53

53

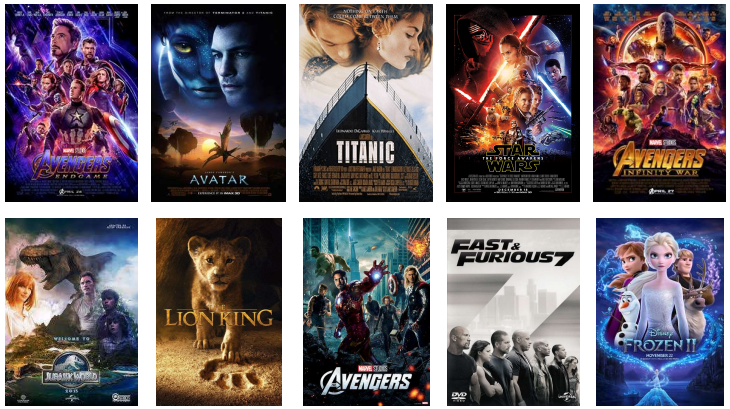
Film Production Pipeline



54

54

VFX: Top Selling Movies



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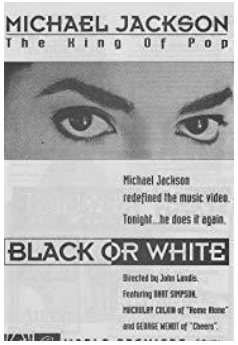
VFX: Image Morphing



Michael Jackson:
Black or White
(1991)

X-Men: Dark Phoenix (2019)

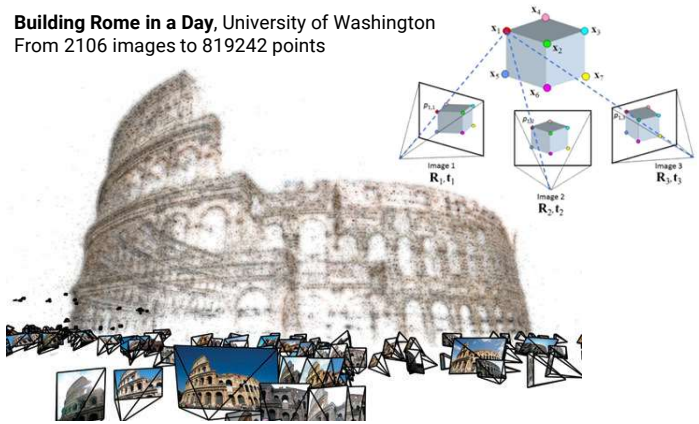
Captain Marvel (2019)

56

56

VFX: Match Move

Building Rome in a Day, University of Washington
From 2106 images to 819242 points



57

57

VFX: Match Move

Jurassic Park
(1993)

58

58

VFX: Matting & Compositing

59

59

VFX: Matting & Compositing

60

60

VFX: Matting & Compositing

61

61

VFX: Matting & Compositing

要把身材高大的甘道夫和小矮人們拍攝在一起，我們是沒法在同一個片場的。和我一起拍攝的只有柱子上貼著的13張他們的照片，後面還有一個小燈，哪個角色說話了燈就亮起來。想像一下你在拍一場和13個人一起演的戲，但你卻只有獨自一人。這真的會把你的演技推到極限。我哭了，真的，我當時真的哭了。然後我還說出了聲：我認真演了一輩子不是為了跟這些照片對戲啊！

62

62

Virtual Studio

63

63

Virtual Reality

64

64

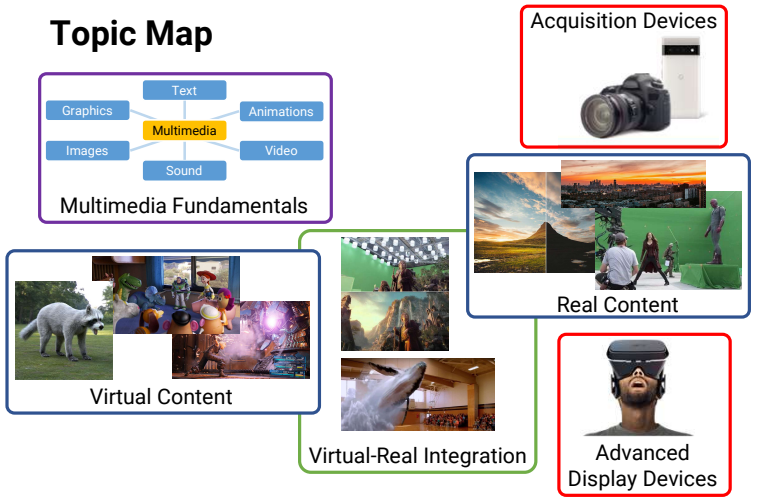
Mixed Reality

a promotional video by Magic Leap (2016)

65

65

Topic Map



66

66

Final Project

67

67

Final Project

- Group work (3 students)
- A short film that contains some techniques taught in this course
  - Image and video editing
  - 3D virtual objects manipulation
  - Matchmove
  - Matting and compositing
  - Text
  - Sound

68

68

Examples: 405 the Movie

- Created solely by two visual effects artists in the year of 2000
- Took over three months of nights, weekends and any spare moments that they could find
- https://en.wikipedia.org/wiki/405_(film)

Examples: 405 the Movie (cont.)

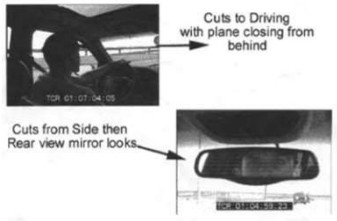
- Step 0: script and shooting plan

Shot#	Description	Full CG	CG	Length Frames
01	Title Animation	X	X	401
02	Freeway speeds beneath car			123
03	Speed Limit 65			120
04	LA Freeway from Overpass			238
05	Empty Freeway--Car enters frame	X	X	150
06	Pan From Freeway J looks at lack of traffic			237
07	Plane swings into landing position toward freeway	X	X	139
08	Hand on Gear shift			36
09	Plane lowers into view through rear window		X	84
10	Plane nears Car	X	X	65
11	J looks to side mirror--plane visible behind		X	84
12	Plane in sideview mirror		X	65
13	J looks from side view to rear view mirror -- plane behind		X	27
14	J eyes react in rear view mirror--remove traffic		X	33
15	Plane chases Car toward camera	X	X	77

Examples: 405 the Movie (cont.)

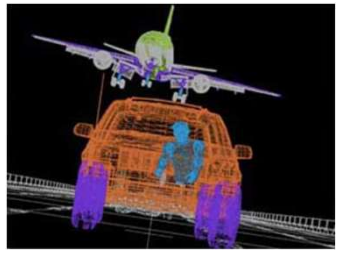
- Step 1: shooting
  - Two days with a Canon Optura DV camera with progressive mode
  - 70 minutes raw footage

initial editing and pickup shots



Examples: 405 the Movie (cont.)

- Step 2: building CG
  - Some shots are combined with VFX techniques



Examples: 405 the Movie (cont.)

- Step 3: compositing
  - Shots with vehicle standing still in a backyard

73

Examples: 405 the Movie (cont.)

- Step 4: fine touchup and music

74