

Multimedia Techniques and Applications 2022



Course Overview

Multimedia Techniques & Applications

Yu-Ting Wu

1

Multimedia Techniques and Applications 2022

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

Multimedia Techniques and Applications 2022

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

Multimedia Techniques and Applications 2022

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

1

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



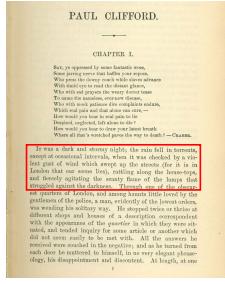
internet

8

2

Media

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



novel



comic



video



radio



drama

9

Basic Components of Media



- We will introduce these components in the following courses

10

9

10

Digital Media

- In this course, we focus on ***digital media***, which can be represented **digitally**

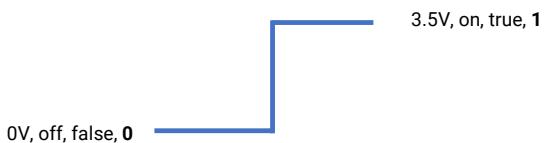
- Structured as collections of bits
- Manipulated by programs
- Stored on disks and other storage devices
- Transmitted over networks



11

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**



12

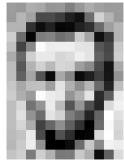
11

12

3

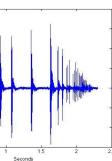
Recap: Digital Representation (cont.)

- 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



Decimal	Hex	Char
0	00	\0
1	01	\1
2	02	\2
3	03	\3
4	04	\4
5	05	\5
6	06	\6
7	07	\7
8	08	\8
9	09	\9
A	0A	\A
B	0B	\B
C	0C	\C
D	0D	\D
E	0E	\E
F	0F	\F

Decimal	Hex	Char
10	0A	\A
11	0B	\B
12	0C	\C
13	0D	\D
14	0E	\E
15	0F	\F



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

13

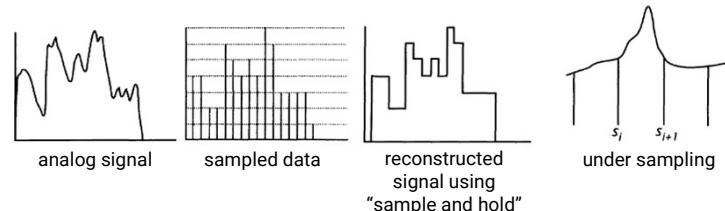
Recap: Digital Representation (cont.)

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

Decimal	Hex	Char									
0	00	\0	25	19	\Z	51	33	\a	97	61	\A
1	01	\1	26	1A	\Z	52	34	\b	98	62	\B
2	02	\2	27	1B	\Z	53	35	\c	99	63	\C
3	03	\3	28	1C	\Z	54	36	\d	100	64	\D
4	04	\4	29	1D	\Z	55	37	\e	101	65	\E
5	05	\5	30	1E	\Z	56	38	\f	102	66	\F
6	06	\6	31	1F	\Z	57	39	\g	103	67	\G
7	07	\7	32	20	\Z	58	3A	\h	104	68	\H
8	08	\8	33	21	\Z	59	3B	\i	105	69	\I
9	09	\9	34	22	\Z	60	3C	\j	106	6A	\J
A	0A	\A	35	23	\Z	61	3D	\k	107	6B	\K
B	0B	\B	36	24	\Z	62	3E	\l	108	6C	\L
C	0C	\C	37	25	\Z	63	3F	\m	109	6D	\M
D	0D	\D	38	26	\Z	64	40	\n	110	6E	\N
E	0E	\E	39	27	\Z	65	41	\o	111	6F	\O
F	0F	\F	40	28	\Z	66	42	\p	112	70	\P
10	0A	\A	41	29	\Z	67	43	\q	113	71	\Q
11	0B	\B	42	2A	\Z	68	44	\r	114	72	\R
12	0C	\C	43	2B	\Z	69	45	\s	115	73	\S
13	0D	\D	44	2C	\Z	70	46	\t	116	74	\T
14	0E	\E	45	2D	\Z	71	47	\u	117	75	\U
15	0F	\F	46	2E	\Z	72	48	\v	118	76	\V
16	10	\`	47	2F	\Z	73	49	\w	119	77	\W
17	11	\`	48	30	\Z	74	50	\x	120	78	\X
18	12	\`	49	31	\Z	75	51	\y	121	79	\Y
19	13	\`	50	32	\Z	76	52	\z	122	7A	\Z
20	14	\`	51	33	\Z	77	53	_	123	7B	_
21	15	\`	52	34	\Z	78	54	\,	124	7C	\,
22	16	\`	53	35	\Z	79	55	\,	125	7D	\,
23	17	\`	54	36	\Z	80	56	\,	126	7E	\,
24	18	\`	55	37	\Z	81	57	\,	127	7F	\,
25	19	\`	56	38	\Z	82	58	\,	128	80	\,
26	1A	\`	57	39	\Z	83	59	\,	129	81	\,
27	1B	\`	58	3A	\Z	84	60	\,	130	82	\,
28	1C	\`	59	3B	\Z	85	61	\,	131	83	\,
29	1D	\`	60	3C	\Z	86	62	\,	132	84	\,
30	1E	\`	61	3D	\Z	87	63	\,	133	85	\,
31	1F	\`	62	3E	\Z	88	64	\,	134	86	\,
32	20	\`	63	3F	\Z	89	65	\,	135	87	\,
33	21	\`	64	40	\Z	90	66	\,	136	88	\,
34	22	\`	65	41	\Z	91	67	\,	137	89	\,
35	23	\`	66	42	\Z	92	68	\,	138	8A	\,
36	24	\`	67	43	\Z	93	69	\,	139	8B	\,
37	25	\`	68	44	\Z	94	70	\,	140	8C	\,
38	26	\`	69	45	\Z	95	71	\,	141	8D	\,
39	27	\`	70	46	\Z	96	72	\,	142	8E	\,
40	28	\`	71	47	\Z	97	73	\,	143	8F	\,
41	29	\`	72	48	\Z	98	74	\,	144	90	\,
42	2A	\`	73	49	\Z	99	75	\,	145	91	\,
43	2B	\`	74	4A	\Z	100	76	\,	146	92	\,
44	2C	\`	75	4B	\Z	101	77	\,	147	93	\,
45	2D	\`	76	4C	\Z	102	78	\,	148	94	\,
46	2E	\`	77	4D	\Z	103	79	\,	149	95	\,
47	2F	\`	78	4E	\Z	104	7A	\,	150	96	\,
48	30	\`	79	4F	\Z	105	7B	\,	151	97	\,
49	31	\`	80	50	\Z	106	7C	\,	152	98	\,
50	32	\`	81	51	\Z	107	7D	\,	153	99	\,
51	33	\`	82	52	\Z	108	7E	\,	154	9A	\,
52	34	\`	83	53	\Z	109	7F	\,	155	9B	\,
53	35	\`	84	54	\Z	110	80	\,	156	9C	\,
54	36	\`	85	55	\Z	111	81	\,	157	9D	\,
55	37	\`	86	56	\Z	112	82	\,	158	9E	\,
56	38	\`	87	57	\Z	113	83	\,	159	9F	\,
57	39	\`	88	58	\Z	114	84	\,	160	90	\,
58	3A	\`	89	59	\Z	115	85	\,	161	91	\,
59	3B	\`	90	5A	\Z	116	86	\,	162	92	\,
60	3C	\`	91	5B	\Z	117	87	\,	163	93	\,
61	3D	\`	92	5C	\Z	118	88	\,	164	94	\,
62	3E	\`	93	5D	\Z	119	89	\,	165	95	\,
63	3F	\`	94	5E	\Z	120	8A	\,	166	96	\,
64	40	\`	95	5F	\Z	121	8B	\,	167	97	\,
65	41	\`	96	60	\Z	122	8C	\,	168	98	\,
66	42	\`	97	61	\Z	123	8D	\,	169	99	\,
67	43	\`	98	62	\Z	124	8E	\,	170	9A	\,
68	44	\`	99	63	\Z	125	8F	\,	171	9B	\,
69	45	\`	100	64	\Z	126	90	\,	172	9C	\,
70	46	\`	101	65	\Z	127	91	\,	173	9D	\,
71	47	\`	102	66	\Z	128	92	\,	174	9E	\,
72	48	\`	103	67	\Z	129	93	\,	175	9F	\,
73	49	\`	104	68	\Z	130	94	\,	176	90	\,
74	4A	\`	105	69	\Z	131	95	\,	177	91	\,
75	4B	\`	106	6A	\Z	132	96	\,	178	92	\,
76	4C	\`	107	6B	\Z	133	97	\,	179	93	\,
77	4D	\`	108	6C	\Z	134	98	\,	180	94	\,
78	4E	\`	109	6D	\Z	135	99	\,	181	95	\,
79	4F	\`	110	6E	\Z	136	9A	\,	182	96	\,
80	50	\`	111	6F	\Z	137	9B	\,	183	97	\,
81	51	\`	112	70	\Z	138	9C	\,	184	98	\,
82	52	\`	113	71	\Z	139	9D	\,	185	99	\,
83	53	\`	114	72	\Z	140	9E	\,	186	9A	\,
84	54	\`	115	73	\Z	141	9F	\,	187	9B	\,
85	55	\`	116	74	\Z	142	90	\,	188	9C	\,
86	56	\`	117	75	\Z	143	91	\,	189	9D	\,
87	57	\`	118	76	\Z	144	92	\,	190	9E	\,
88	58	\`	119	77	\Z	145	93	\,	191	9F	\,
89	59	\`	120	78	\Z	146	94	\,	192	90	\,
90	5A	\`	121	79	\Z	147	95	\,	193	91	\,
91	5B	\`	122	7A	\Z	148	96	\,	194	92	\,
92	5C	\`	123	7B	\Z	149	97	\,	195	93	\,
93	5D	\`	124	7C	\Z	150	98	\,	196	94	\,
94	5E	\`	125	7D	\Z	151	99	\,	197	95	\,
95	5F	\`	126	7E	\Z	152	9A	\,	198	96	\,
96	60	\`	127	7F	\Z	153	9B	\,	199	97	\,
97	61	\`	128	80	\Z	154	9C	\,	200	98	\,
98	62	\`	129	81	\Z	155	9D	\,	201	99	\,
99	63	\`	130	82	\Z	156	9E	\,	202	9A	\,
100	64	\`	131	83	\Z	157	9F	\,	203	9B	\,
101	65	\`	132	84	\Z	158	90	\,	204	9C	\,
102	66	\`	133	85	\Z	159	91	\,	205		

Recap: Digitalization (cont.)

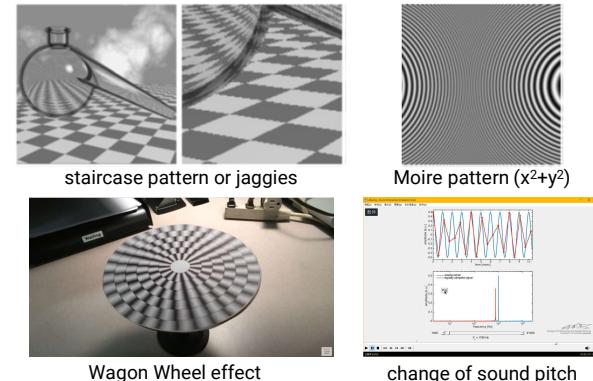
- Quality of digitalization
 - How closely the original signal can be reconstructed
 - Depends on
 - Reconstruction algorithms
 - Quality of the sampled data



17

Recap: Digitalization (cont.)

- Aliasing



18

17

18

Recap: Frequency Domain

- Most functions can be decomposed into a weighted sum 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

$$\begin{array}{ccc} \boxed{\text{Spatial Domain}} & \Rightarrow F(\omega) = \int_{-\infty}^{\infty} f(x) e^{-i\omega x} dx & \Rightarrow \boxed{\text{Frequency Domain}} \\ f(x) & & F(\omega) \\ \Leftarrow f(x) = \frac{1}{2\pi} \int_{-\infty}^{\infty} F(\omega) e^{i\omega x} d\omega & \Leftarrow & \end{array}$$

19

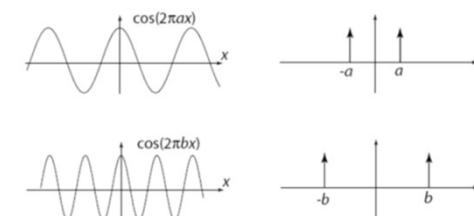
19

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 $\frac{1}{2}$ the sampling frequency"

Nyquist frequency



20

20

5

Multimedia Techniques and Applications 2022

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***

21

Multimedia Techniques and Applications 2022

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

22

Multimedia Techniques and Applications 2022

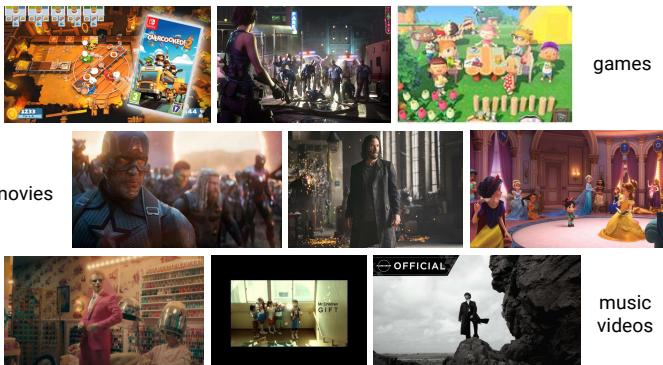
Multimedia

- 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!**

23

Multimedia Techniques and Applications 2022

Applications of Digital Multimedia

- Entertainment
 

games
movies
music videos

24

Applications of Digital Multimedia

- Entertainment

- The production can make extremely different experiences



25

Applications of Digital Multimedia

- Entertainment

- The production can make extremely different experiences



26

25

26

Applications of Digital Multimedia

- Entertainment

- The production can make extremely different experiences



27

Applications of Digital Multimedia

- Education



28

27

28

Multimedia Techniques and Applications 2022

Applications of Digital Multimedia

- Instruction or Training

29

Multimedia Techniques and Applications 2022

Applications of Digital Multimedia

- Presentation and promotions

sales presentation portfolio

30

Multimedia Techniques and Applications 2022

Applications of Digital Multimedia

- Visualization

OCT 2019

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

31

Multimedia Techniques and Applications 2022

Applications of Digital Multimedia

- Forensic

32

Delivery of Digital Multimedia

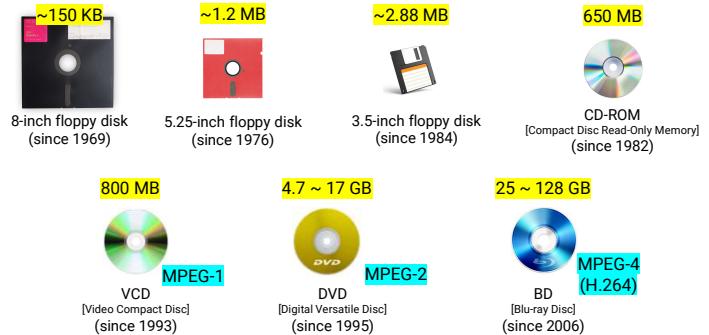
- Get the material from its producer to its consumers
- Types of delivery
 - Offline
 - CD, VCD, DVD, BD, floppy disks, USB sticks ...
 - Online
 - Internet
 - Hybrid

33

33

Delivery of Digital Multimedia

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



34

34

Delivery of Digital Multimedia

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

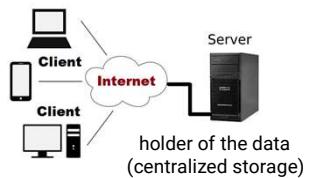


35

35

Delivery of Digital Multimedia

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



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

36

36

Multimedia Techniques and Applications 2022

Delivery of Digital Multimedia

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



37

Multimedia Techniques and Applications 2022

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

38

Multimedia Techniques and Applications 2022

Topics We Plan to Cover

39

Multimedia Techniques and Applications 2022

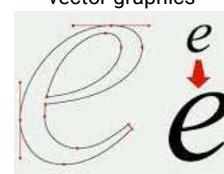
Graphics



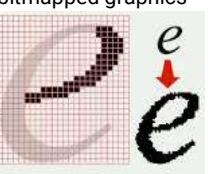




vector graphics



bitmapped graphics



40

Multimedia Techniques and Applications 2022

Color

Visible

PANTONE

CMYK newsprint

CMYK coated

RGB

41

41

Multimedia Techniques and Applications 2022

Bitmapped Images

Zoom, 40 x 40

600 x 336

42

42

Multimedia Techniques and Applications 2022

Camera

Nikon D800

Note we are not teaching

男友必學拍照技巧！手機就能拍高質感相片

43

43

Multimedia Techniques and Applications 2022

High Dynamic Imaging

BEFORE

AFTER

44

11

Panorama



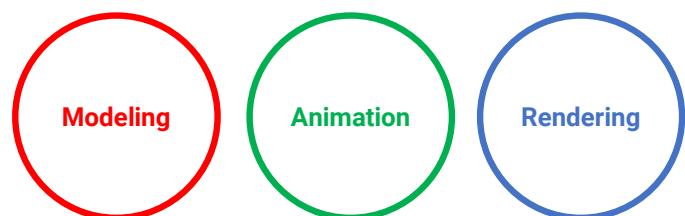
45

Vector Graphics



46

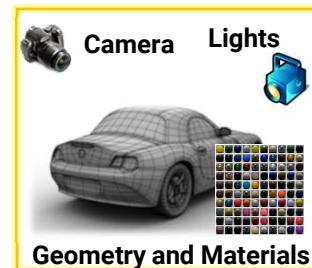
3D Graphics



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

47

48

12

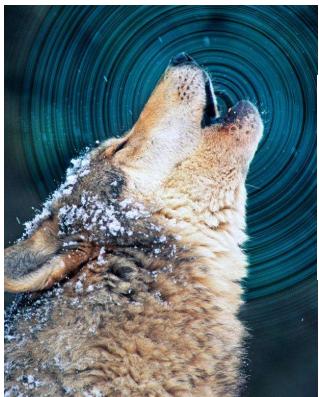
Text and Font

ASCII TABLE	
Decimal Hex Char	Decimal Hex Char
0 NUL	00 00
1 SOH (START OF HEADER)	01 01
2 STX (START OF TEXT)	02 02
3 ETX (END OF TEXT)	03 03
4 EOT (END OF TRANSMISSION)	04 04
5 ENQ (ENQUIRY)	05 05
6 ACK (ACKNOWLEDGE)	06 06
7 BEL (BEL)	07 07
8 SYN (SYNCHRONOUS IDLE)	08 08
9 DLE (DATA LINK ESCAPE)	09 09
10 DC1 (DEVICE CONTROL 1)	0A 0A
11 DC2 (DEVICE CONTROL 2)	0B 0B
12 DC3 (DEVICE CONTROL 3)	0C 0C
13 DC4 (DEVICE CONTROL 4)	0D 0D
14 DC5 (DEVICE CONTROL 5)	0E 0E
15 DC6 (DEVICE CONTROL 6)	0F 0F
16 GS (GROUP SEPARATOR)	10 10
17 GS (GROUP SEPARATOR)	11 11
18 GS (GROUP SEPARATOR)	12 12
19 GS (GROUP SEPARATOR)	13 13
20 GS (GROUP SEPARATOR)	14 14
21 GS (GROUP SEPARATOR)	15 15
22 GS (GROUP SEPARATOR)	16 16
23 GS (GROUP SEPARATOR)	17 17
24 GS (GROUP SEPARATOR)	18 18
25 GS (GROUP SEPARATOR)	19 19
26 GS (GROUP SEPARATOR)	1A 1A
27 GS (GROUP SEPARATOR)	1B 1B
28 GS (GROUP SEPARATOR)	1C 1C
29 GS (GROUP SEPARATOR)	1D 1D
30 GS (GROUP SEPARATOR)	1E 1E
31 GS (GROUP SEPARATOR)	1F 1F

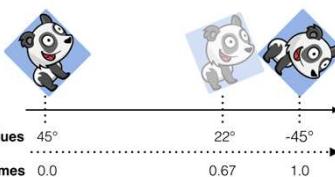
Lucida Bright goes well with *Lucida Bright italic*, **and bold italic**, but not nearly so well with Palatino.

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.



Video and Animation



© 2019 Pearson Education, Inc.

50



by Devin Pickell, G2

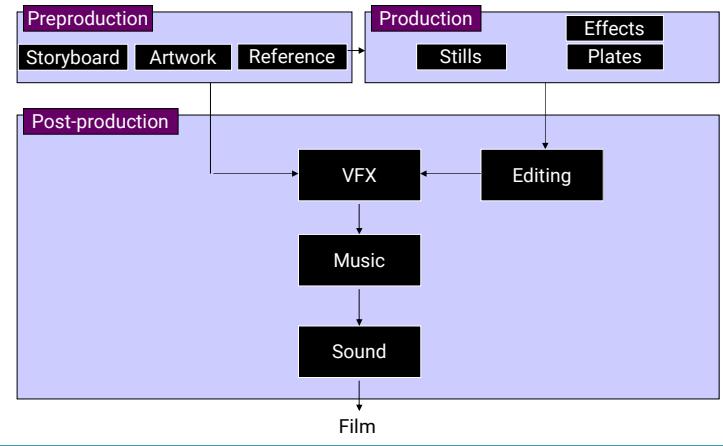


Game Engines



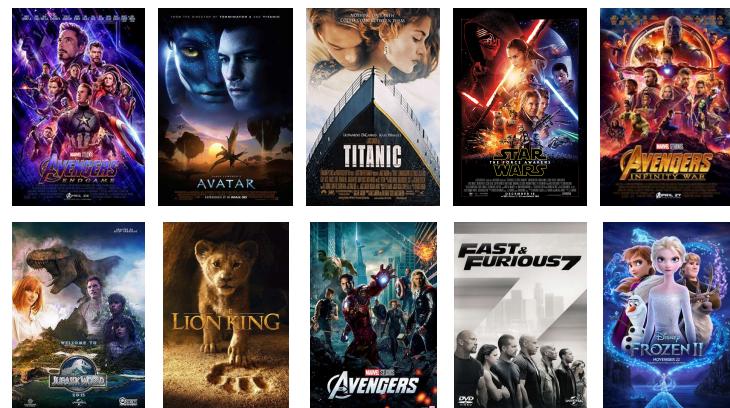
53

Film Production Pipeline



54

VFX: Top Selling Movies



55

VFX: Image Morphing



Michael Jackson:
Black or White
(1991)



X-Men: Dark Phoenix (2019)



Captain Marvel (2019)

56

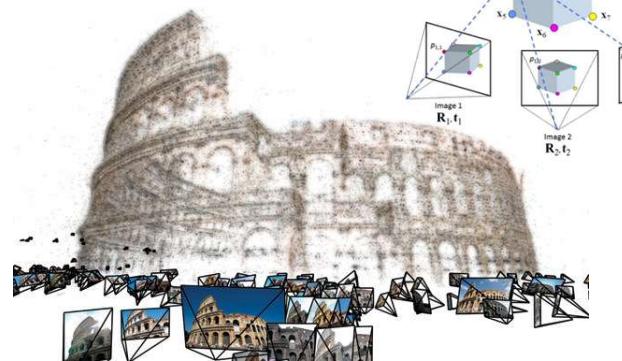
55

56

14

VFX: Match Move

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



57

VFX: Match Move



Jurassic Park
(1993)

58

VFX: Matting & Compositing



59

VFX: Matting & Compositing



60

59

60

15

VFX: Matting & Compositing

61

61

VFX: Matting & Compositing

62

62

VFX: Matting & Compositing

63

63

VFX: Matting & Compositing

64

64

16

Virtual Studio



65

Virtual Reality



66

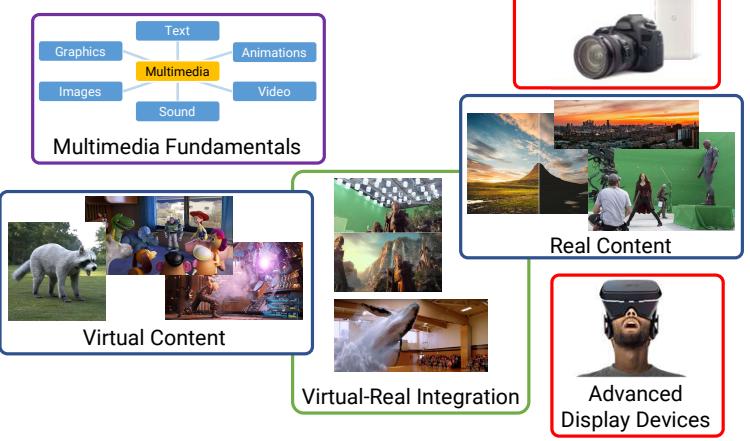
Mixed Reality



a promotional video by Magic Leap (2016)

67

Topic Map



68

67

17

Final Project

69

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

70

70

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_\(film\)](https://en.wikipedia.org/wiki/405_(film))



71

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	160
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 sidview 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

72

72

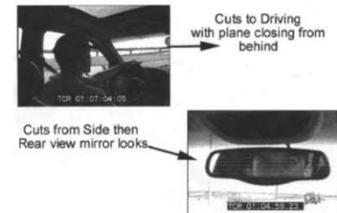
18

Examples: 405 the Movie (cont.)

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



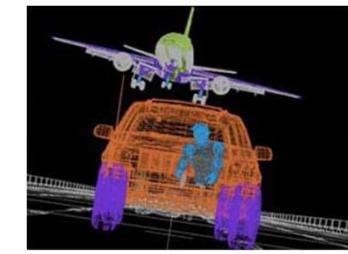
initial editing and pickup shots



73

Examples: 405 the Movie (cont.)

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



74

74

Examples: 405 the Movie (cont.)

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



75

Examples: 405 the Movie (cont.)

- Step 4: fine touchup and music



76

76

75

19