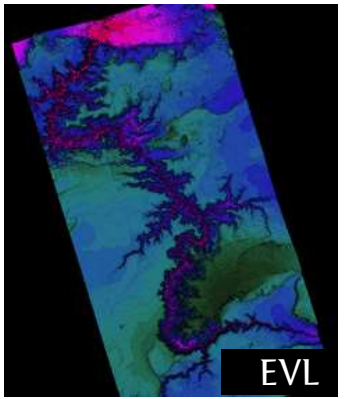
유니티(Unity)를 활용한

그래픽스 프로그래밍

02 Introduction to Computer Graphics

Computer Graphics Applications

- Computer Animation, Film
- CAD/CAM
- Games
- VR, AR, MR
- Medical Imaging
- Scientific Visualization



이미지 출처 : http://www.evl.uic.edu/
https://www.starwars.com/games-apps

Computer Graphics Main Theme

1 **Imaging**

Express 2D images effectively

2 **Modeling**

Form real or virtual 3D model objects that can be understood by computers

3 **Rendering**

Render into the 2D image from a 3D model (geometric model, volume rendering, image-based rendering)

4 **Animation**

Express the natural movement of objects, such as humans or anthropomorphic animals and plants, and robots over time

Modeling

Geometric Modeling

- Create 3D models using graphics toolkits such as Maya, 3DS Studio Max

Physically Based Modeling

- Realistically reproduce physical phenomena in nature such as water, smoke, fire and explosion through computer graphics

3D Scanning

- Project a laser or a specific pattern into a subject and resorting a 3D shape from the captured image

Image-based Modeling

- Create 3D model from multiple photos

Modeling

Rendering

- **Physically Based Rendering**
  - Render CG object realistically based on the physical interaction between light and object
  - Ray Tracing, Radiosity
- **Volume Rendering**
  - Render 3D representation of large volumes of data
- **Image-based Rendering**
  - Render the image generated at one point of view from the images at other points of view

Rendering

Rendering

Non-Photorealistic Rendering

- Contrary to photorealistic rendering, render the image generated by human hands
- Cartoon, Pencil drawing, Watercolor painting, Oil painting, mosaic, Oriental ink-and-wash painting

Real-Time Rendering

- Interactive graphics, Game, GPU

Rendering

Animation

Keyframe Animation

- An experienced keyframe animator sets keyframes for important object movement and then smoothly interpolates keyframes
- It is manually done by cell animation; automatically done by computer animation

Motion Capture

- Directly capture joint motion using optical camera, magnetic sensor, mechanical sensor, etc.
- It is widely applied to movie industries because it is possible to create the most realistic motion, but it is difficult to edit capture motion

Animation

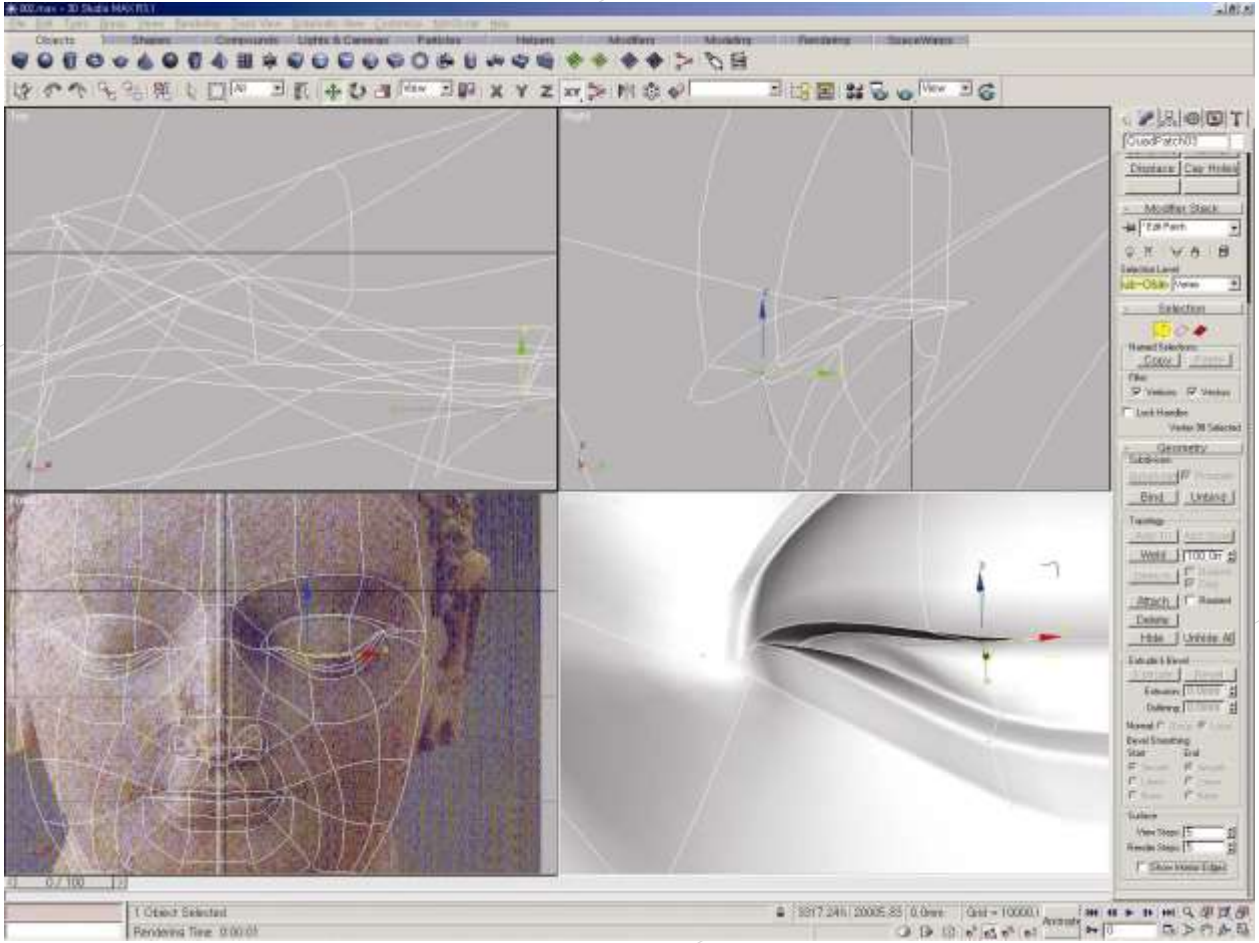
Physically Based Animation

- Create realistic interaction and animations through physically based animation

AI-based Behavior Animation

- Automatically create natural behaviors like real humans by giving the character intelligence and behavior

3D Studio Max



Physically Based Modeling and Animation

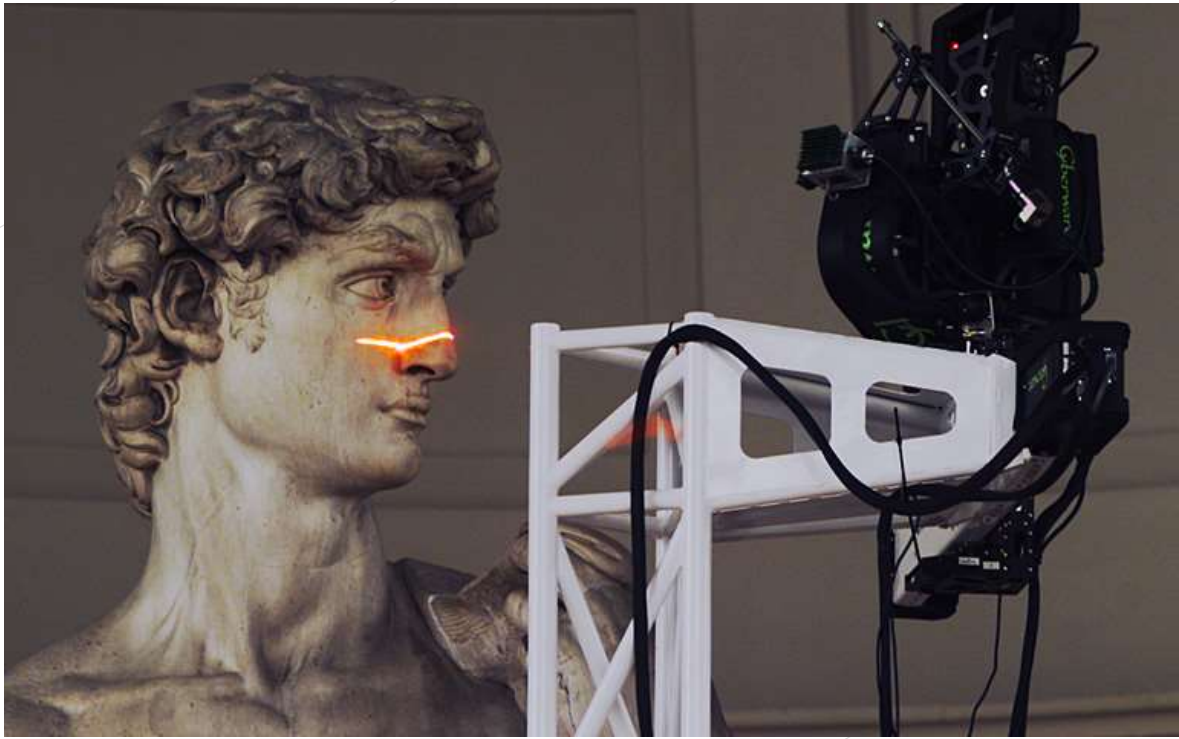
이미지 출처 : Cloth simulation, David Baraff and Andrew Witkin (1997)
http://www.cs.cmu.edu/~baraff/sigcourse/index.html

이미지 출처 : Fire, smoke, gas simulation
Duc Quang Nguyen,Ronald Fedkiw, Henrik Wann Jensen (SIGGRAPH2002)
http://graphics.ucsd.edu/~henrik/papers/fire

Image Based Modeling and Rendering

이미지 출처 :Façade, http://www.debevec.org/Research/
IBMR SIGGRAPH99, https://pdfs.semanticscholar.org/e1c3/65e0a83ad131a5ca2c6c754a49d95d54aba6.pdf

3D Scanning



이미지 출처 : Digital Michelangelo Project, Marc Levoy, Paul Debevec (1999)
https://graphics.stanford.edu/data/mich/

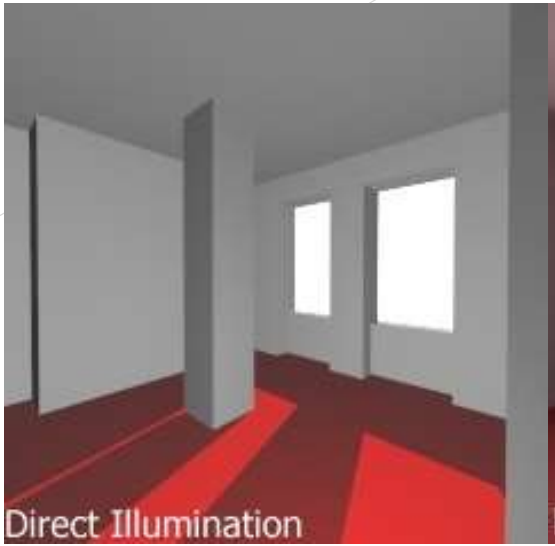
3D Scanning

이미지 출처 : 2006.4 - 3D scanning of wall reliefs of Angkor Wat temple in Cambodia

Photo-realistic Rendering

이미지 출처 :Monte Carlo Ray Tracer (CS488 Course Assignment 1999)
http://www.student.cs.uwaterloo.ca/~cs488/Contrib/a3patel/project/a3patel_index.html
Monte Carlo Ray Tracing (Lecture Note 2013)
http://www.cs.cornell.edu/courses/cs4620/2013fa/lectures/22mcrt.pdf

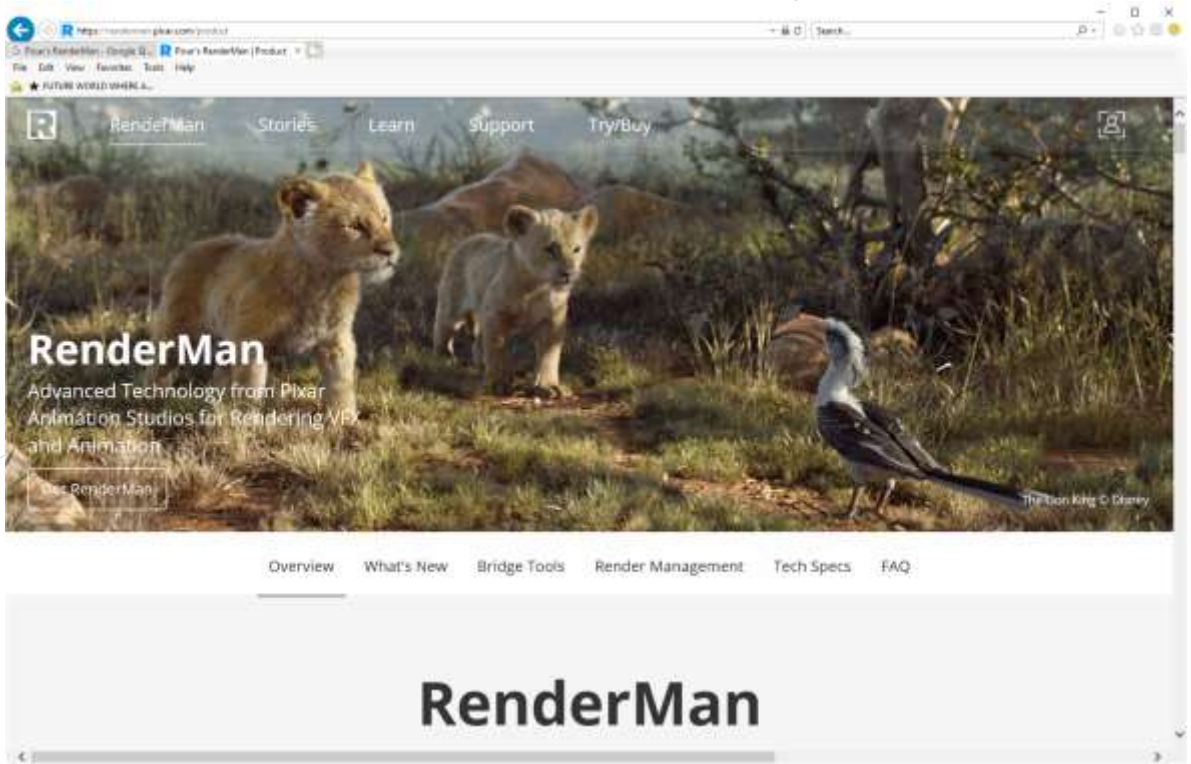
Photo-realistic Rendering



이미지 출처 :https://en.wikipedia.org/wiki/Radiosity_(computer_graphics)

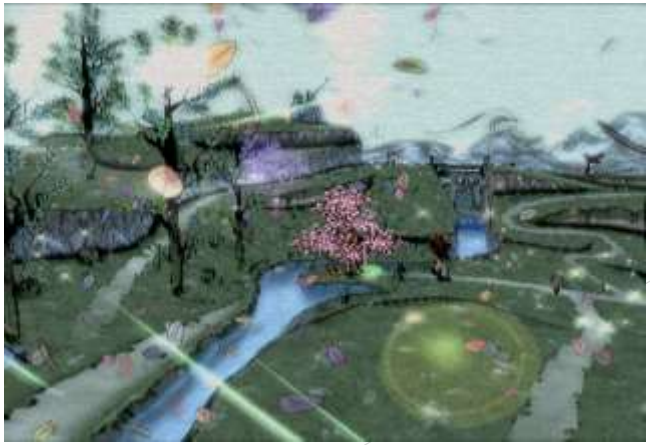
이미지 출처 :Radiosity on Graphics Hardware (SIGGRAPH 2005)
http://www.cs.unc.edu/techreports/03-020.pdf

Photo-Realistic Rendering



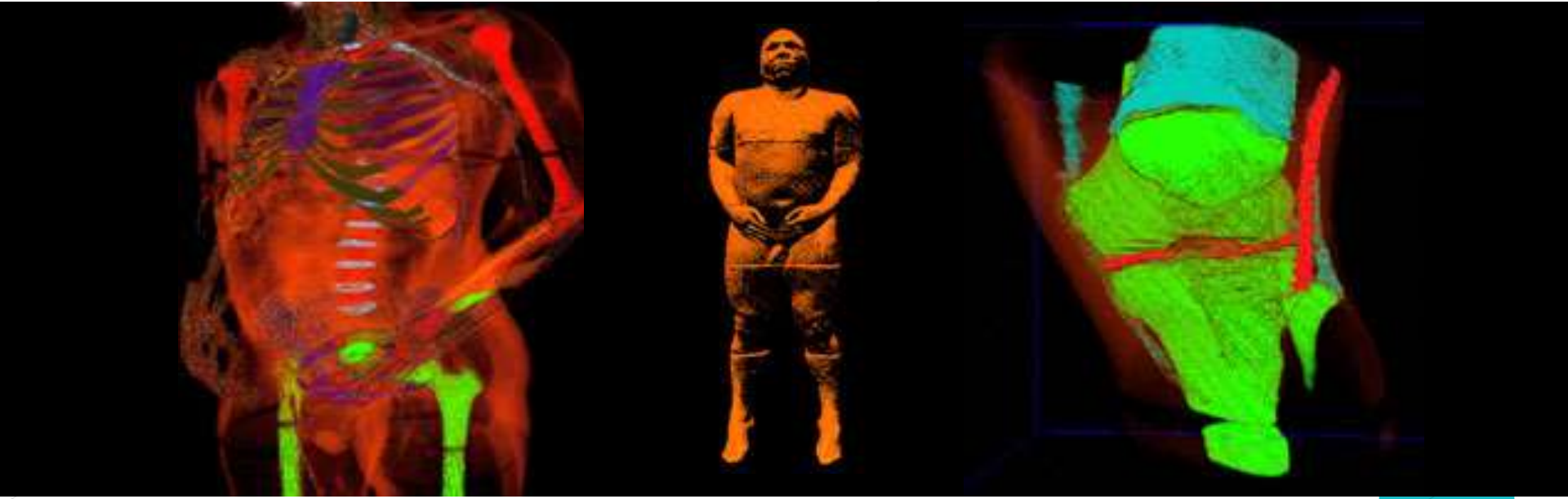
이미지 출처 : Pixar's RenderMan
https://renderman.pixar.com/

Non Photorealistic Rendering (NPR)



이미지 출처 : Oriental Ink Wash Painting Rendering Technique
Capcom's PS2 Game called Okami (released in 2006)

Volume Rendering

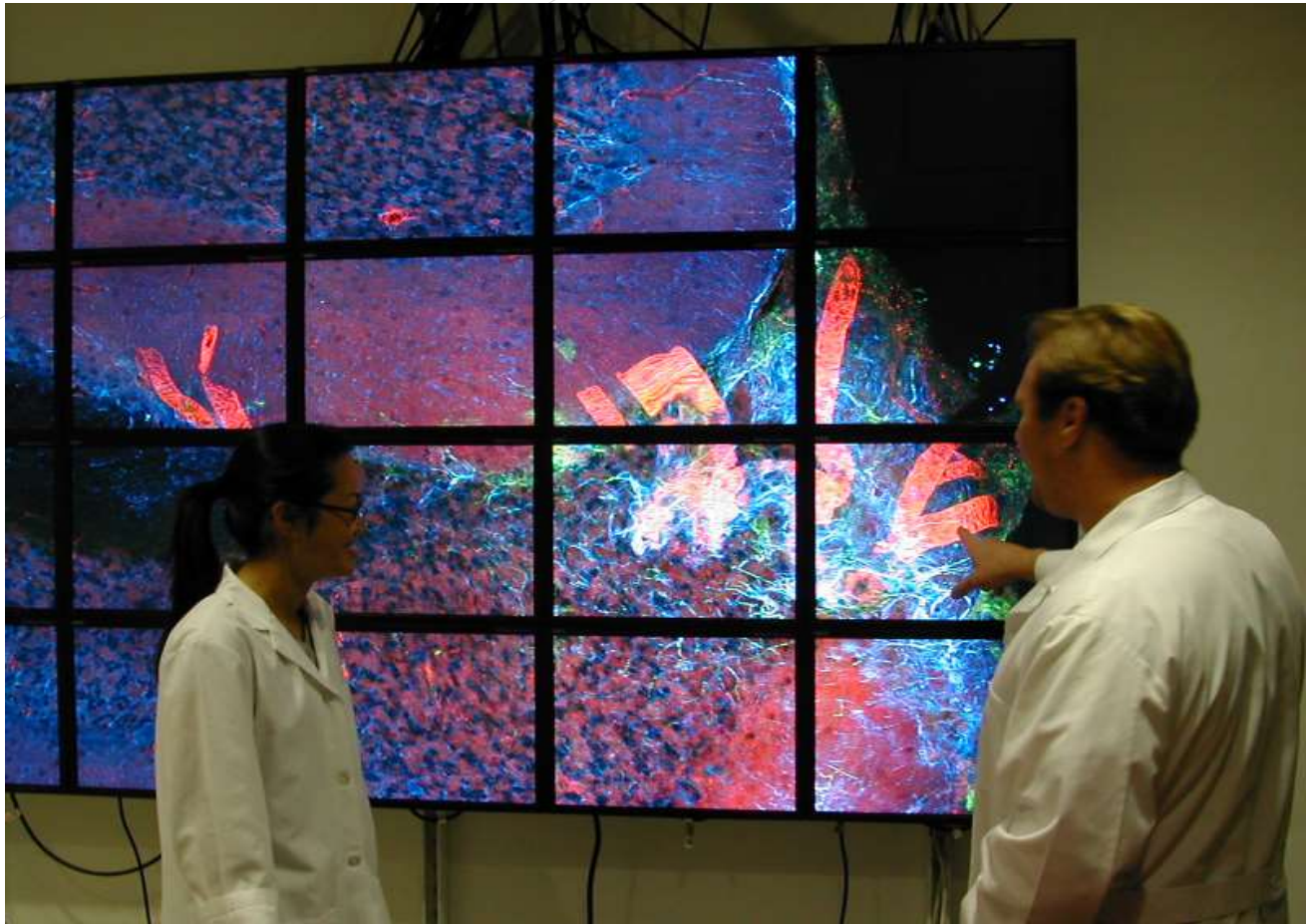


이미지 출처 :6.77GB Visible Male Data sets
The Visible Human Project https://www.nlm.nih.gov/research/visible/getting_data.html

Scientific Visualization

이미지 출처 : Typoon Maemi in 2003 Visualization/VOSS System
Korea Institute of Ocean Science & Technology

Scientific Visualization



이미지 출처 : Rat Cerebellum Microscopy (NCMIR) on Tiled Display
National Center for Microscopy and Imaging Research, UC San Diego
https://ncmir.ucsd.edu/press/in-the-news?news=9

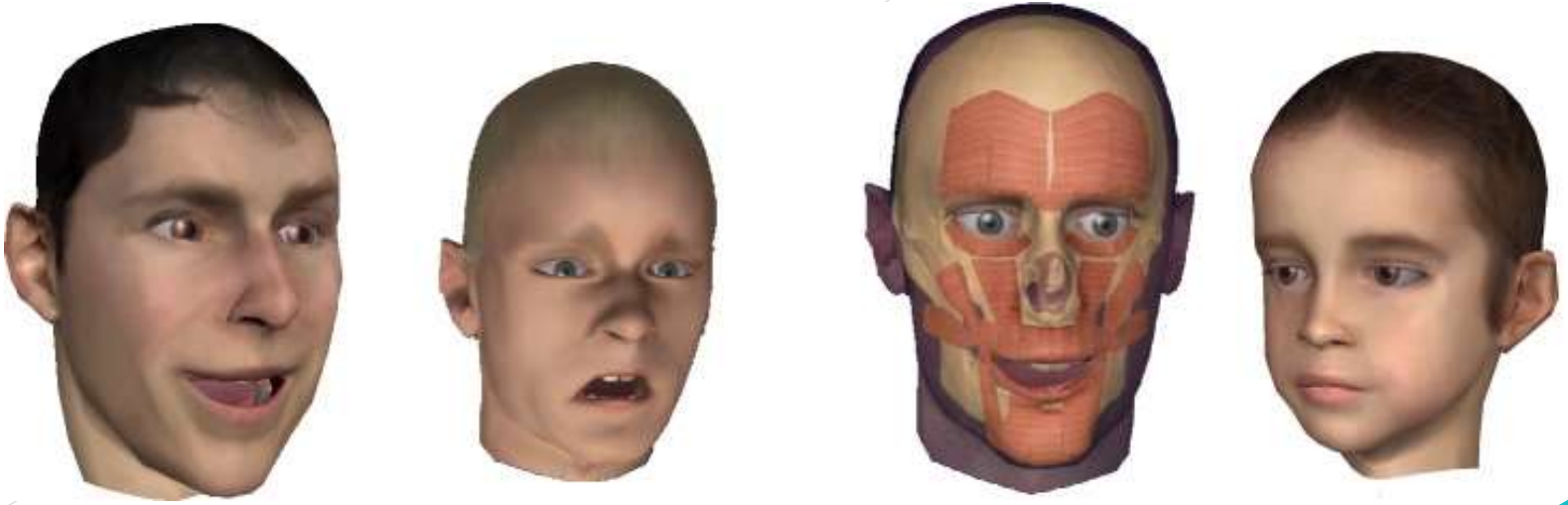
Motion Capture for Character Animation

OptiTrack

이미지 출처 :https://optitrack.com/support/accessories/motion-capture-suit-care.html

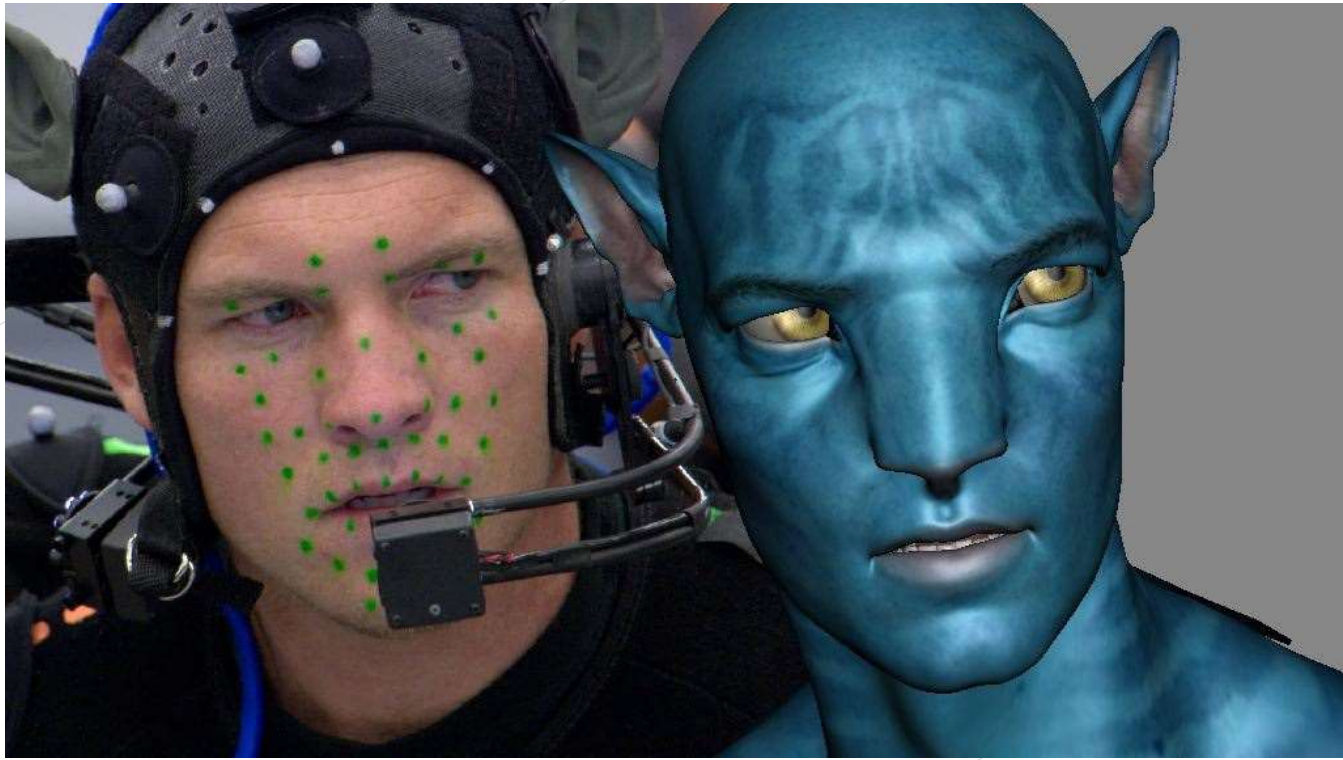
Motion Retargetting

Facial Expression Animation



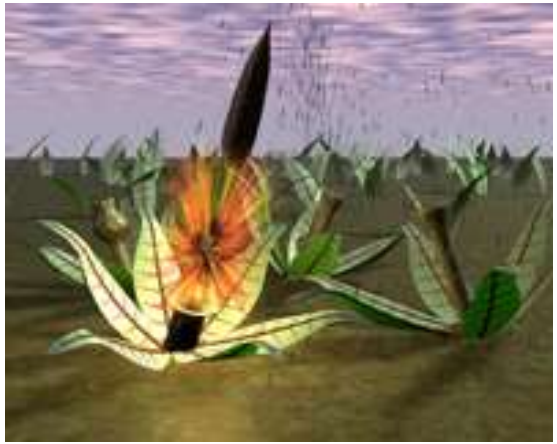
이미지 출처 : Facial animation and modeling, MPI Informatik (2001)
http://www.mpi-inf.mpg.de/resources/FAM/

Facial Expression Animation



이미지 출처 : More About Motion Capture (2013)
http://animationandvideogames.blogspot.com/2013/11/motion-capture-methods.html#!/2013/11/motion-capture-methods.html
Facial Motion Capture
https://en.wikipedia.org/wiki/Facial_motion_capture

AI-based Behavior Animation

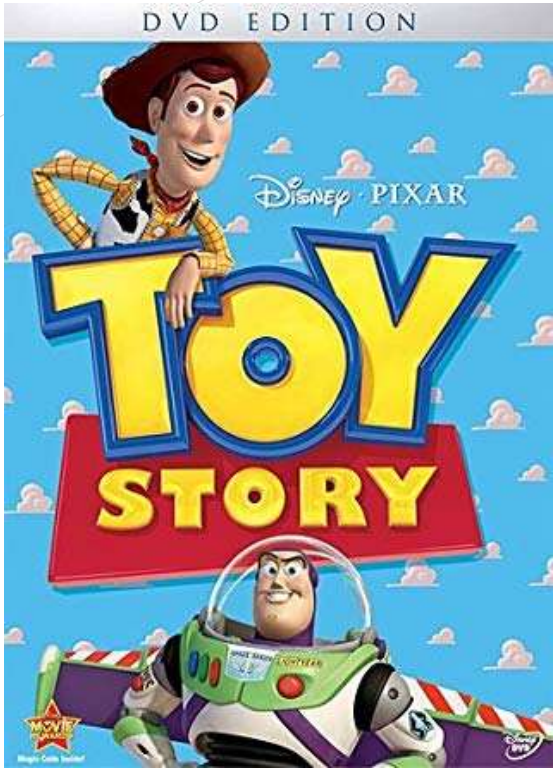


이미지 출처 :Panspermia, Karl Sims' Artificial Life (1990)
https://www.karlsims.com/panspermia.html

3D CG Animation

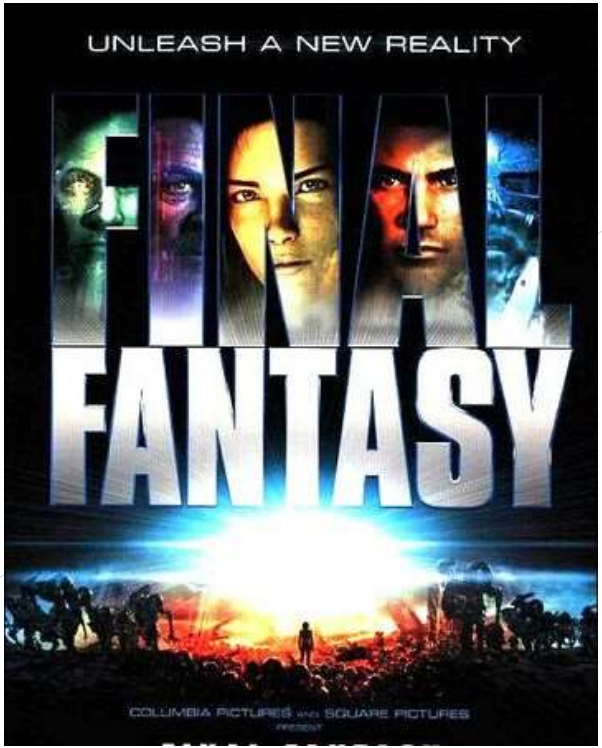
이미지 출처 : Pixar Luxo Jr.
(2 min, SIGGRAPH 1986)

Full 3D CG Film



이미지 출처 :Toy Story (81 min, 1995) First full 3D CG movie

Full 3D CG Film



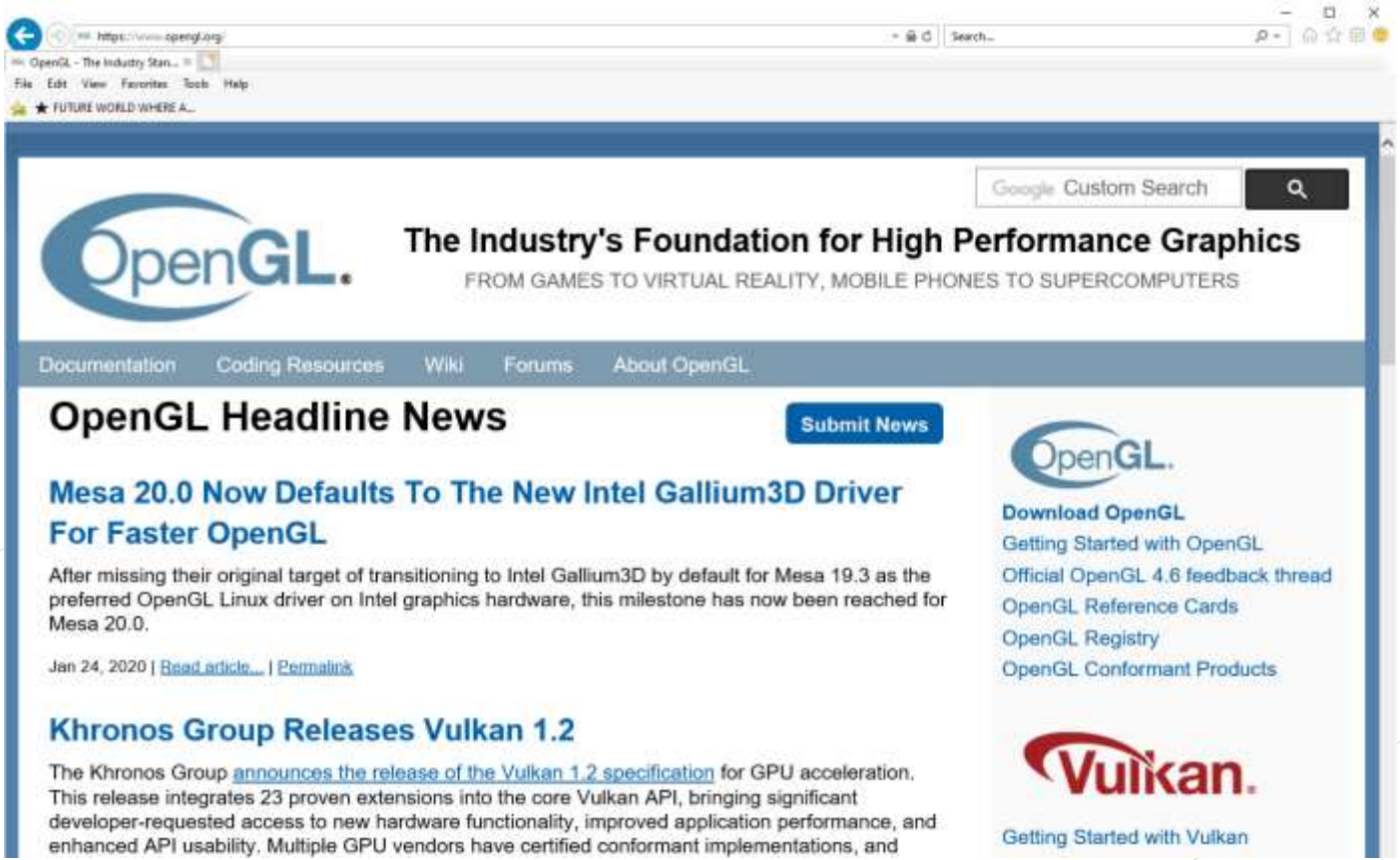
이미지 출처 : Final Fantasy: The Spirits Within (56:36 min, 2001)
First photorealistic computer-animated feature film

3D (Stereoscopic) Movie

이미지 출처 : James Cameron’s Avatar (161 min, 2009), 3D stereoscopic movie

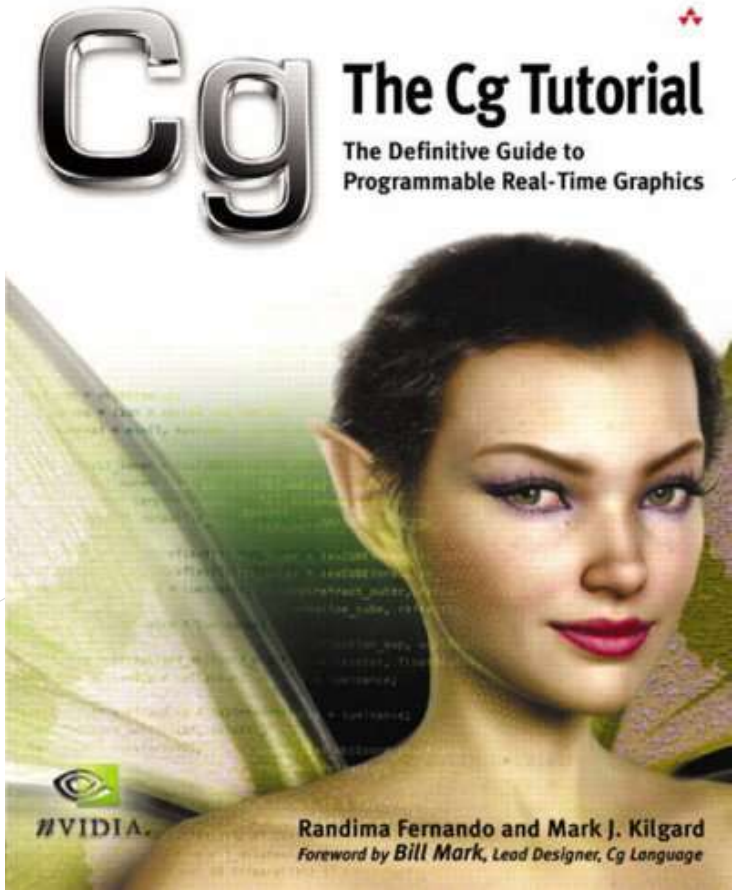
이미지 출처 : https://www.biznews.com/briefs/2015/01/20/big-data-tops-humans-picking-significant-films-study/attachment/visitors-wear-3d-glasses-as-they-watch-a-preview-of-the-upcoming-movie-avatar-during-the-40th-annual-comic-con-convention-in-san-diego

OpenGL



이미지 출처 :https://www.opengl.org/

Real-Time Graphics



GPU programming by nVidia Cg, OpenGL/GLSL, DirectX/HLSL

이미지 출처 :http://www.e-booksdirectory.com/details.php?ebook=2474

HDR (High Dynamic Range) Imaging

Original images

–4 stops | –2 stops | +2 stops | +4 stops

Results after processing

Simple contrast reduction | Local tone mapping

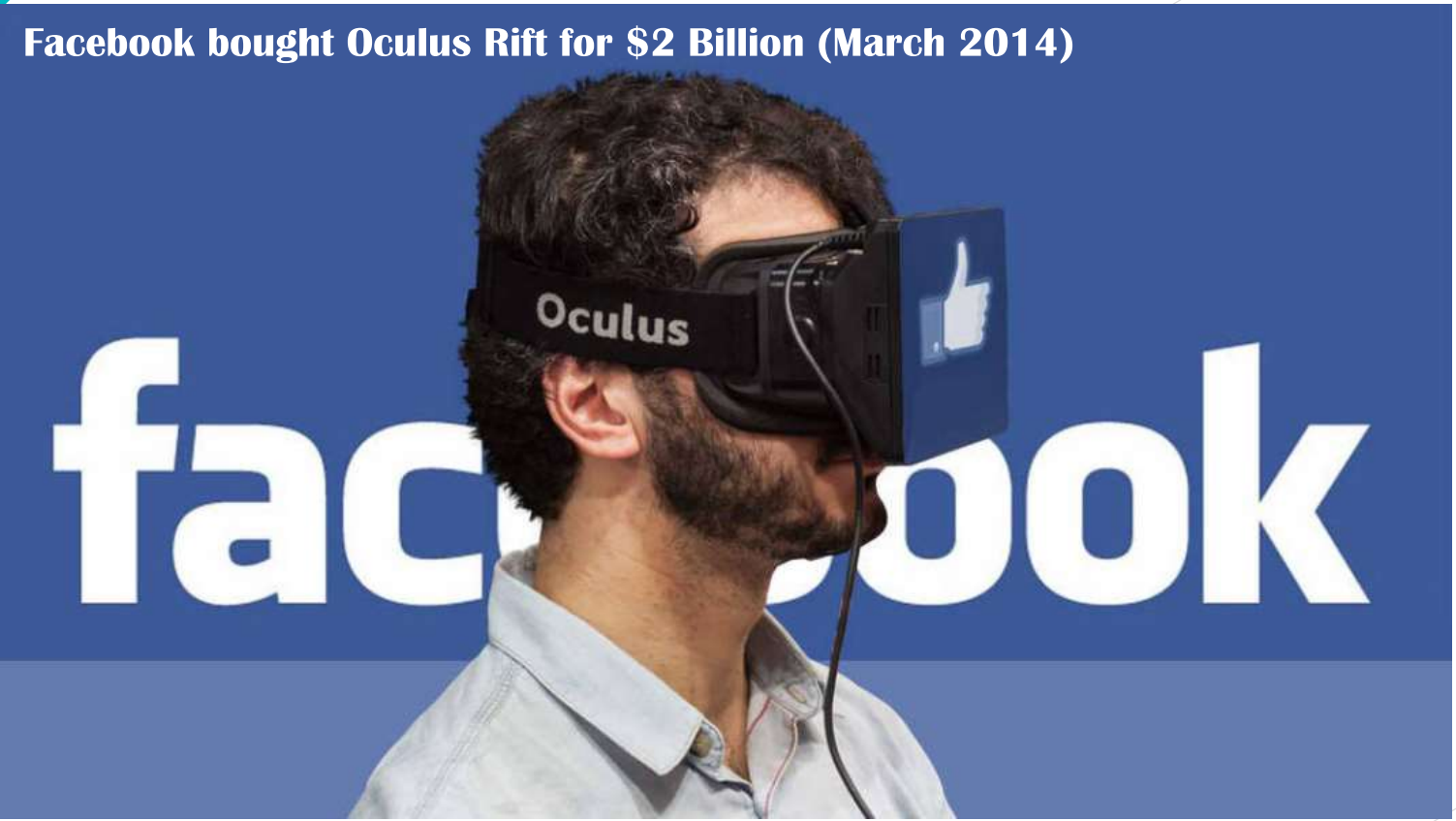
이미지 출처 :http://en.wikipedia.org/wiki/High-dynamic-range_imaging

Virtual Reality

Palmer Luckey, 22, inventor of the Oculus Rift, is one of the visionaries making virtual reality mainstream Photograph by Gregg Segal for TIME

이미지 출처 :Time Magazine (August 2015 Issue)

Virtual Reality



이미지 출처 :https://kevincorbett.com/why-facebook-bought-oculus-rift/

Samsung Gear VR

이미지 출처 :https://www.augmented-minds.com/en/augmented-reality/ar-hardware-devices

Virtual Reality

이미지 출처 :http://www.vive.com/

HTC Vive

Sony Playstation VR

이미지 출처 :-https://www.playstation.com/ko-kr/ps-vr/

Meta Oculus Quest 3

The best VR headsets 2023

https://www.pcmag.com/picks/the-best-vr-headsets

이미지 출처 :https://www.pcgamesn.com/oculus/quest-3-release-date-price-specs-meta

Augmented Reality

Pokemon GO(2016)

이미지 출처 :https://pokemongolive.com/

AR/MR Devices

The best smartglasses and AR specs 2023

https://www.wareable.com/ar/the-best-smartglasses-google-glass-and-the-rest

이미지 출처 :https://www.augmented-minds.com/en/augmented-reality/ar-hardware-devices

Magic Leap AR Glass

이미지 출처 :https://report.roa.ai/article/144176

Amazon Echo Frames

Unlike Google Glass they're not AR so you don't see anything, but play Alexa feedback via four directional speakers.

이미지 출처 :https://www.techradar.com/sg/reviews/amazon-echo-frames

Microsoft HoloLens

이미지 출처 :https://www.microsoft.com/microsoft-hololens/en-us

Samsung Odyssey HMD

Microsoft Windows Mixed Reality Platform

이미지 출처 :https://www.samsung.com/sec/support/model/XQ800ZAA-HC1KR/

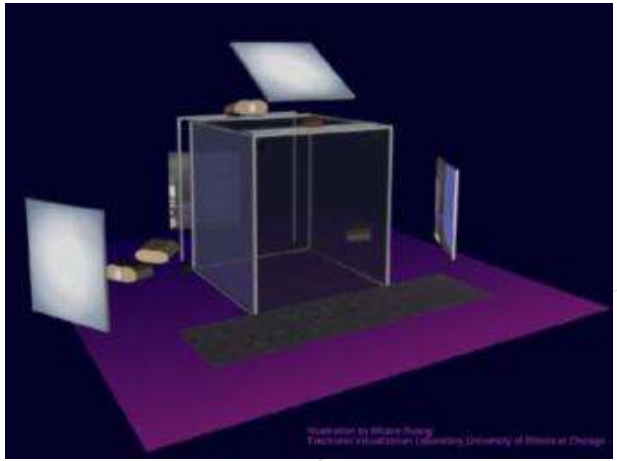
Apple Vision Pro(2024)

이미지 출처 :https://www.apple.com/kr/newsroom/2023/06/introducing-apple-vision-pro/

Gyeongju Expo VR Theater(2000)

이미지 출처 :8https://zdnet.co.kr/view/?no=20230316145102

Virtual Reality Environment



CAVE(1992)

이미지 출처 :https://en.wikipedia.org/wiki/Cave_automatic_virtual_environment/
https://www.evl.uic.edu/pape/CAVE/

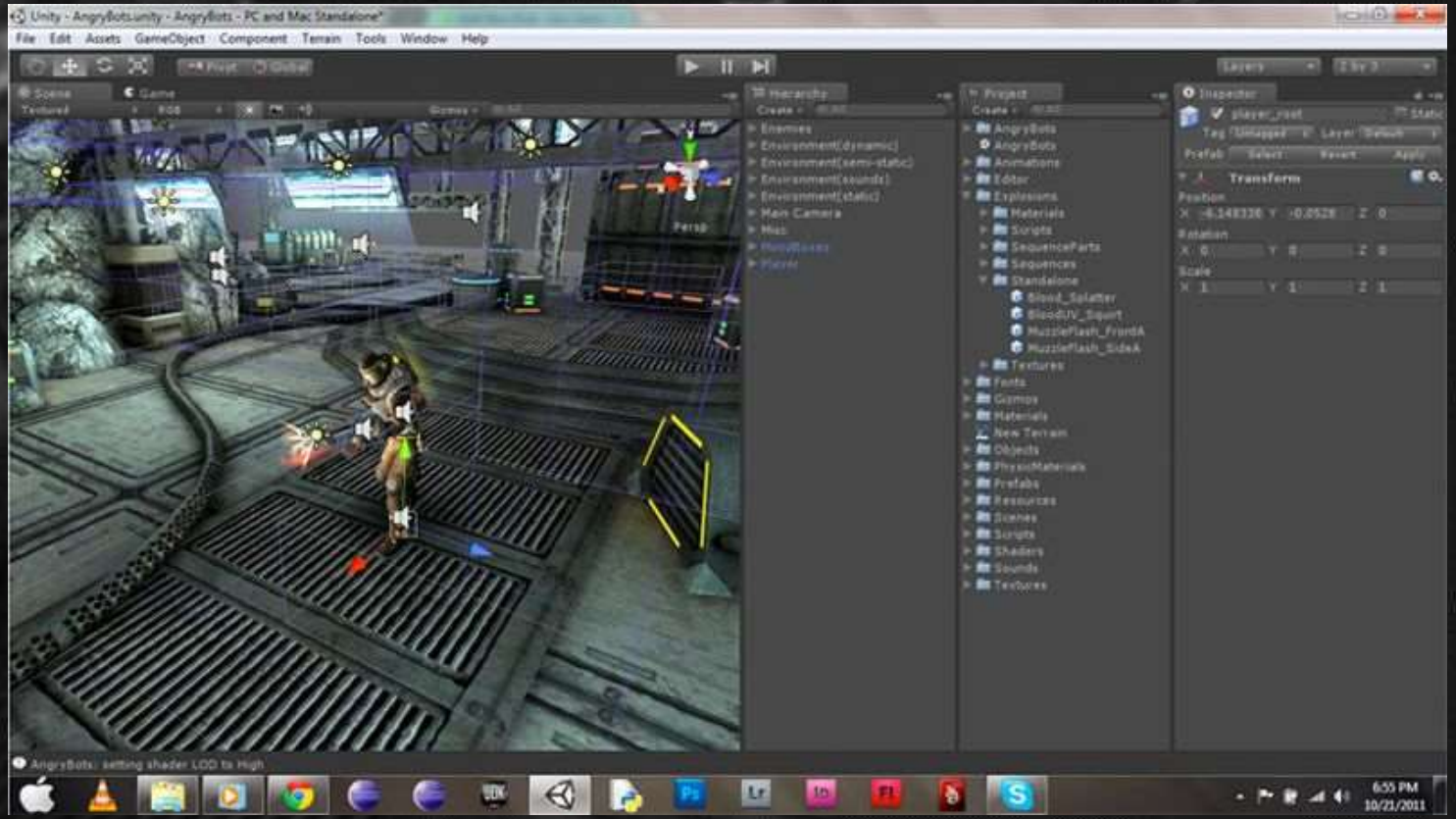
Virtual Reality Environment

이미지 출처 :https://www.evl.uic.edu/events/1078

LG's WAVE Display(CES2020)

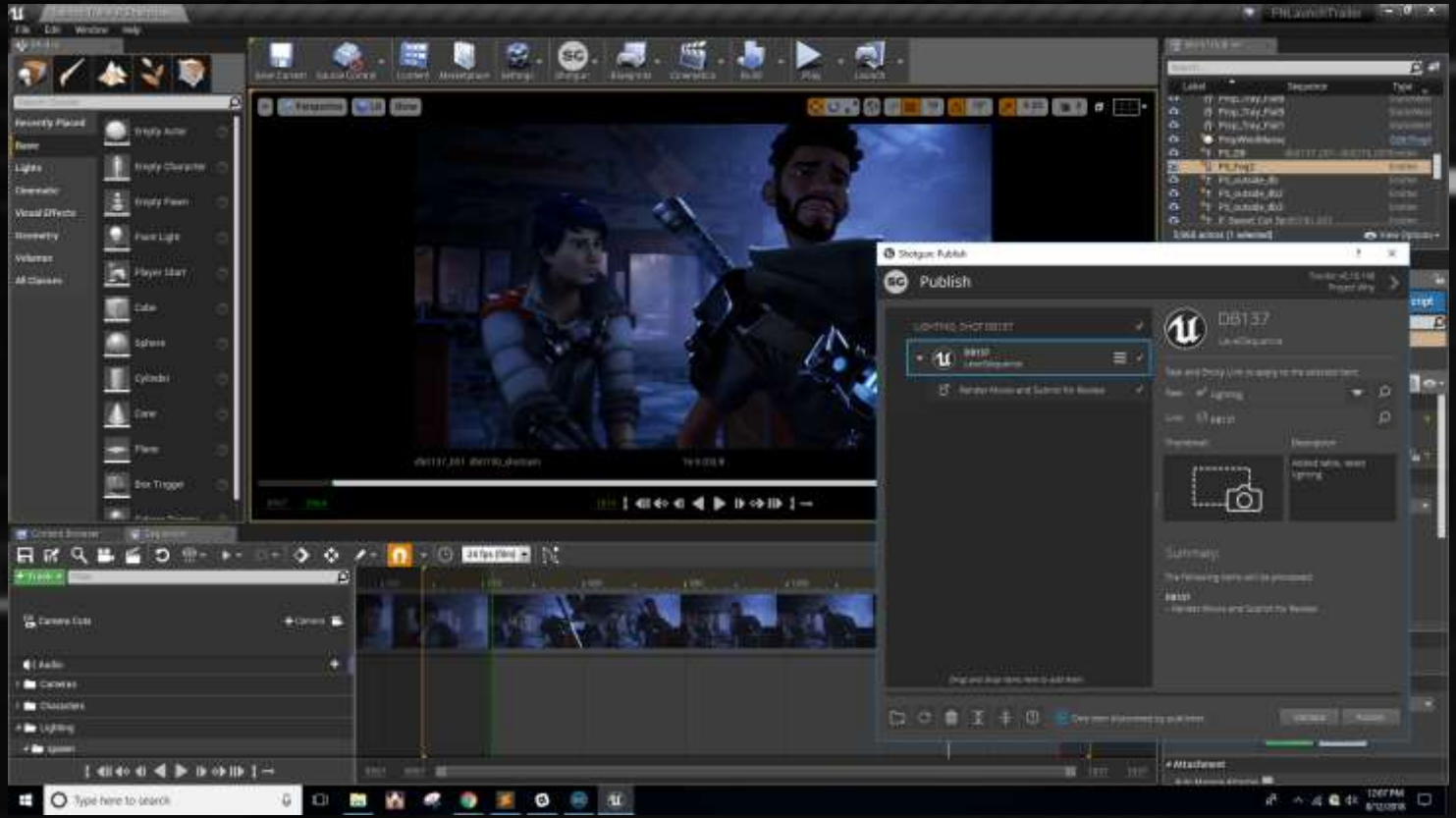
이미지 출처 : 교수님 제공

Unity3D



이미지 출처 :http://unity3d.com

Unreal



이미지 출처 :https://www.unrealengine.com/en-US/