360 Cinematic VR

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Outlook

- 360 Cinema
- VR / AR / XR
- Visual 3D Perception
- VR Locomotion

360 Cinema

360 Cinema

- NYT's Great Performers: LA Noir
- Google Spotlight Stories: HELP
- Jessica Brillhart's: Jump Movies

Spotlight Stories: Help

- first live-action Spotlight Story (2015)

Jessica's Jump Movies

- Beethoven's Fifth (2017)

VR / AR / XR

Virtual Reality

Evolution of VR

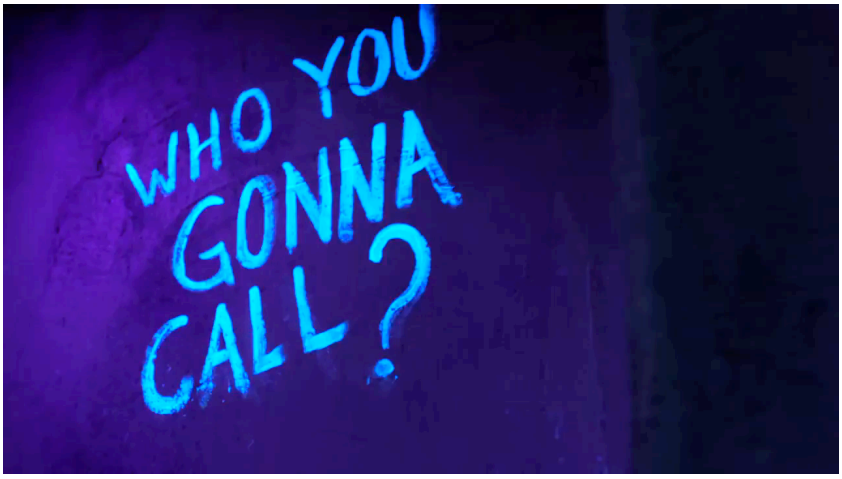
- Seminal Work
  - SketchPad, Ivan Sutherland / MIT (1968)
- Development Incubation
  - Research Labs (1990's / early 2000's)
- Consumer Age
  - Internet Media Companies / Games (2014 - ..)

HW State-of-the-Art

- Low End
  - Google Cardboard (*360 Movies* / *view rotation*)
- Middle
  - Gear VR (*3D Content, controllers* / *interaction*)
- High-End
  - Oculus, HTC Vive (*Games, positional tracking*)

Trends in Entertainment

- Multiplayer Shared-Location VR Experience



Augmented Reality

AR Outlook

- Characteristics
  - Overlays Virtual Objects on the Real World
  - Spatial Registration and Geometric Persistence
- Hardware Modalities
  - Mobile AR
    (Tablets / Smartphones)
  - Heads-Up AR
    (See-Through Displays / Smart Glasses)

Display Devices (Circa 2019)

liberating from the limitations of a rectangular 2D screen

- VR / AR / Plenoptic

VIVE Pro

Hololens 2

Magic Leap

Newer Display Devices (2025)

beyond the technology into the user experience

- XR / Holographic

Apple Vision Pro

Varjo

Meta Orion

Industry Solutions

- Dynamic AR Maintenance Guide

Mixed Reality

MR Roundup

- Requirements
  - Seamless Integration of Virtual Objects
    (*Anchor to 3D Environment* / *Illumination and Shadows*)
  - User Interaction
    (*Combined Virtual* / *Real Objects*)
- Display Technologies
  - Laser MEMS Holograms
    (MS Hololens 2)
  - Light Field Projection
    (*Magic Leap*)

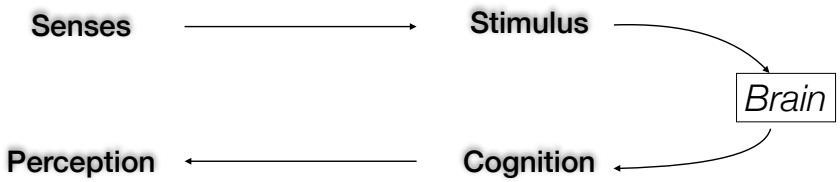
Personal Uses

- In Home Games

Visual 3D Perception

Human Perception

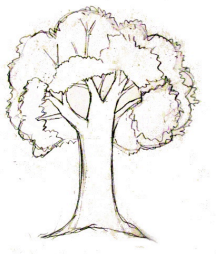
- Perceptual Mechanism



Dimensions & Embedding

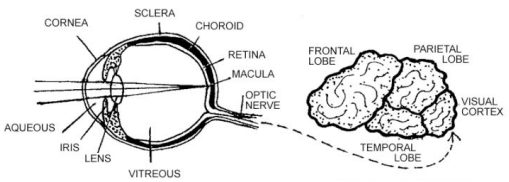
- Visual System

World



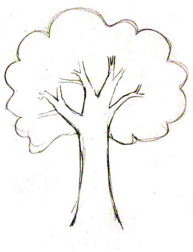
3D

Eye / Brain



2D

Reconstruction



"3D"

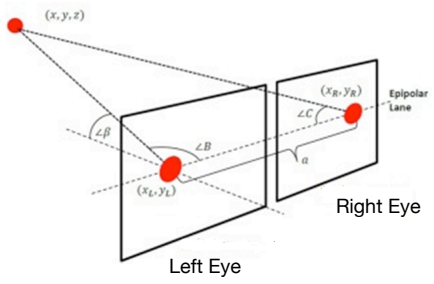
3D Vision

- Low Level (*eye*)
  - Stereopsis
  - Motion
- High Level (*brain*)
  - Structure
  - Context

Binocular Vision

- Stereo Reconstruction

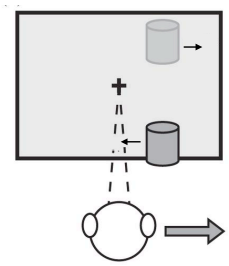
Triangulation



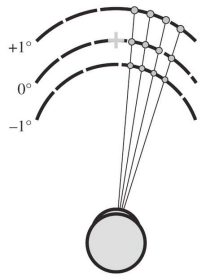
Depth from Motion

- Kinetic Depth Cue

Relative Motion



Eye Motion

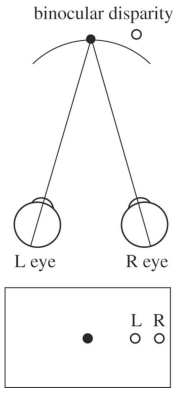


Object Motion

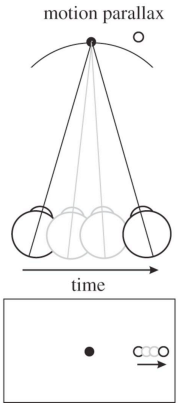
Disparity & Parallax

- Low Level Reconstruction

Integration



Spatial



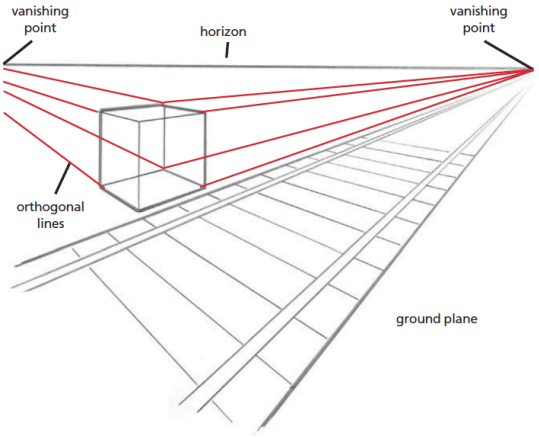
Temporal

Shape from Structure

- Knowledge of the World

Perspective Projection

Illumination

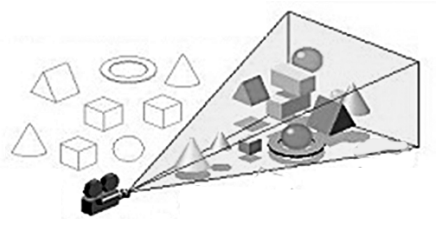


Depth from Context

- Global Object Relations

Occlusion

Shape Silhouette



3D in Virtual Reality

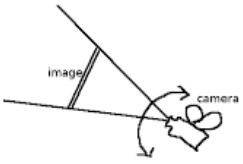
- Degrees of Freedom
- Content Generation
- Display Devices
- User Experience

Degrees of Freedom

- Imaging System Motion

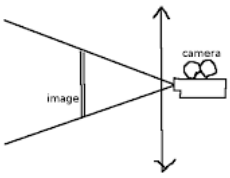
3D Transformations

Axial Rotation



No Parallax

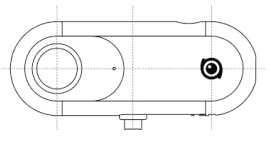
Translation



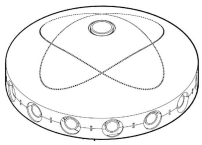
Parallax

Content Generation

- 360 Video
  - Omnidirectional Camera
  - Light Field Camera
- 3D Simulation
  - Game Engine



Ricoh theta spherical



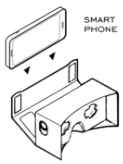
facebook surround 360 VR camera

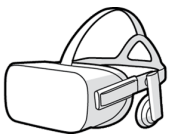
unity

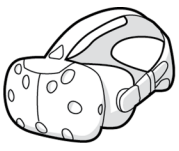
UNREAL ENGINE

VR Displays

- 360 Viewing
  - Rotation Only (2D)
- 360 Stereo Viewing
  - Rotation + Disparity (3D)
- Positional Tracking VR
  - Rotation + Translation (3D)







User Experience

- Content Generation + Display

Video 360	*Capture Independent of Viewer*	
	Fixed POV	Rotation Only
	Tele-transport (Cuts)	Rotation + Jumps

3D VR	*Generation at Viewer Position*	
	Full Motion	Translation + Rotation

VR Comfort

- Agreement between Senses and Perception
  - Visual System / 3D Cognition
  - Vestibular System / Motion Experience

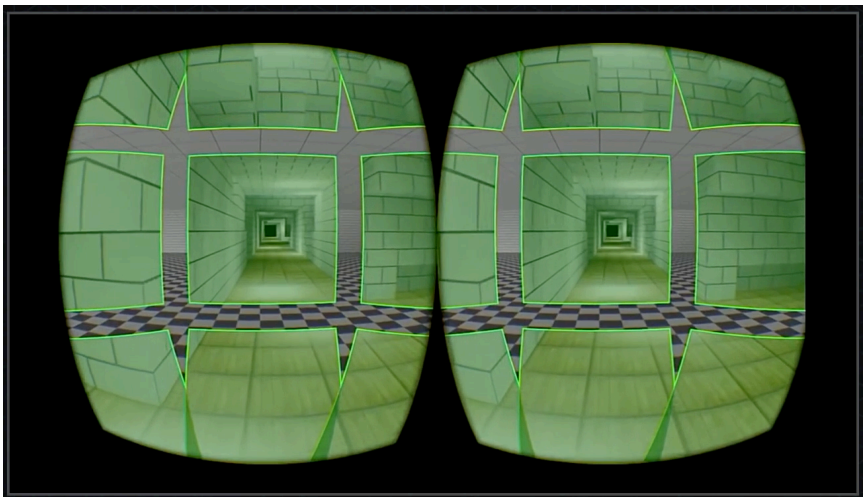
The Rules for Comfort

- Motion to Photon Latency
- Match Avatar Position to User
- Experience Duration
- User Movement

VR Locomotion

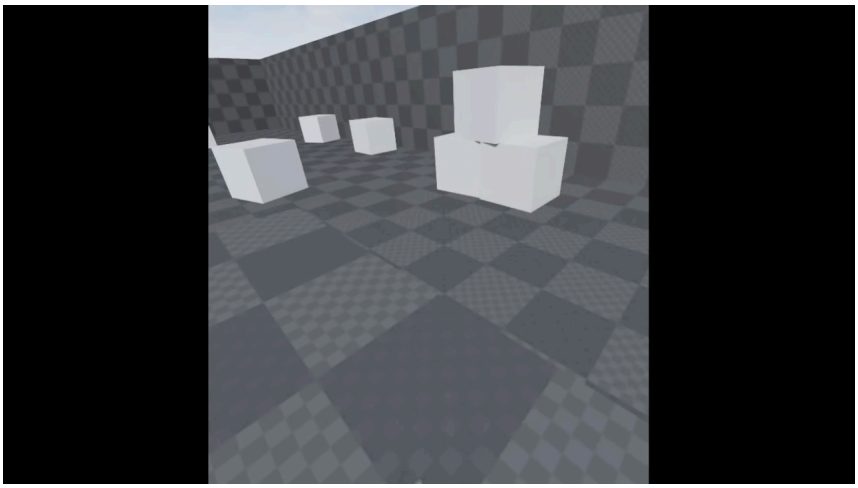
- Fixed Points of Reference
- Teleportation
- Beyond the Space

Frame of Reference



- Oculus Research SDK

Teleportation



- Unreal 4.13 Toolkit

Redirected Walking

- NVIDIA - Siggraph 2018