

Virtual Reality and Augmented Reality Overview

Phil Lelyveld

USC Entertainment Technology Center



1. What is Virtual Reality (versus Augmented Reality)
2. 3 VR viewing types
3. Different VR experience types
4. Markets for VR (and AR)
5. Emerging Language of VR
6. Equipment / Technologies
7. Who are the players
8. Timeframe

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What is Virtual Reality (VR)

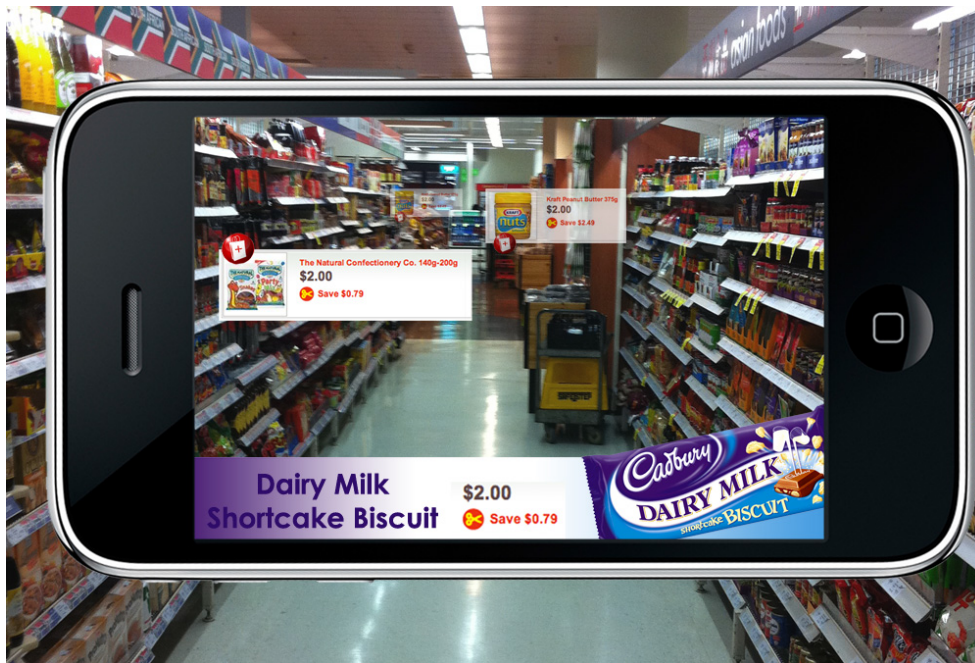
VR – Immersion in an experience unconnected to the physical world except for the input and output / display devices

No Frame



What is Augmented Reality (AR)

VR – Immersion in an experience unconnected to the physical world except for the input and output / display devices



AR (Augmented Reality) –
virtual content overlain on
the physical world



In Augmented Reality, the world that you would normally see if you walked down the aisle without the screen is being **augmented – enhanced, supplemented, added to** - with additional data and experiences.

In Virtual Reality you are **virtually – nearly, almost** – but not really there in the grocery store aisle.

The Continuum from Reality to Virtual



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Virtual Reality on Cellphone or Tablet

Swipe

Tilt and wave



Virtual Reality on Cellphone with Headphones



Wearality Sky



150 degree **field of view (FOV)**
Foldable; fits in pocket

Head Mounted Displays with Peripherals



Oculus Rift with Oculus Touch

Head Mounted Displays with Peripherals

HTC Vive HMD & Steam Valve software

- 2 IR sensors
- Hand position trackers
- virtually "touch" objects
- 90 frames-per-second video
- (HTC One M9 phone)

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Head Mounted Display

Technical Targets

4K-8K resolution per eye

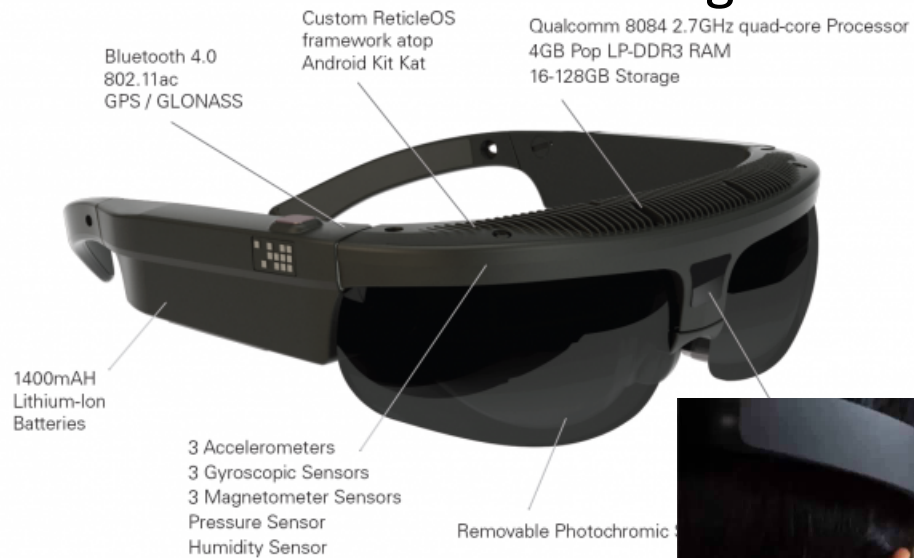
>90 frames per second

<20 msec latency

220° field of view (FOV)

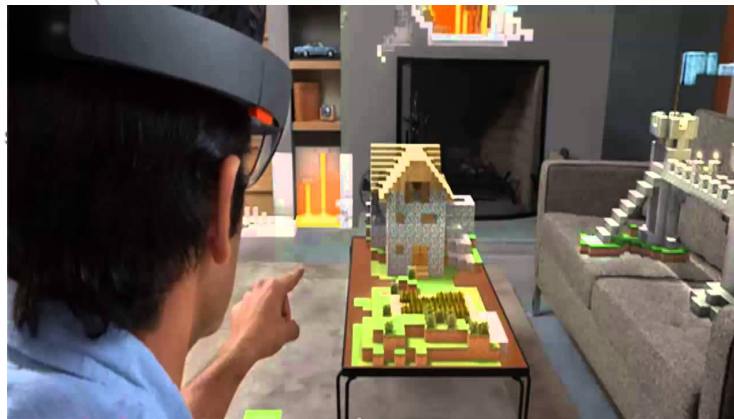
Augmented Reality glasses

ODG R-7 Android smart glasses



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Microsoft HoloLens



Daqri Smart Helmet

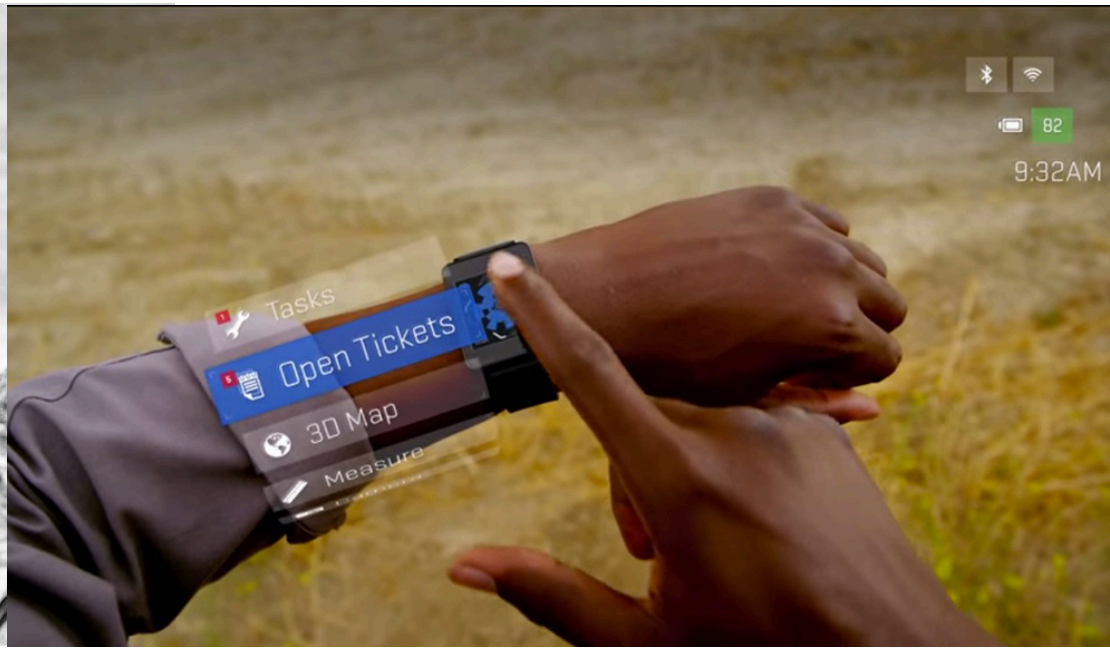
Object recognition and tracking Location recognition
Operations, Maintenance, Training, Education, ...



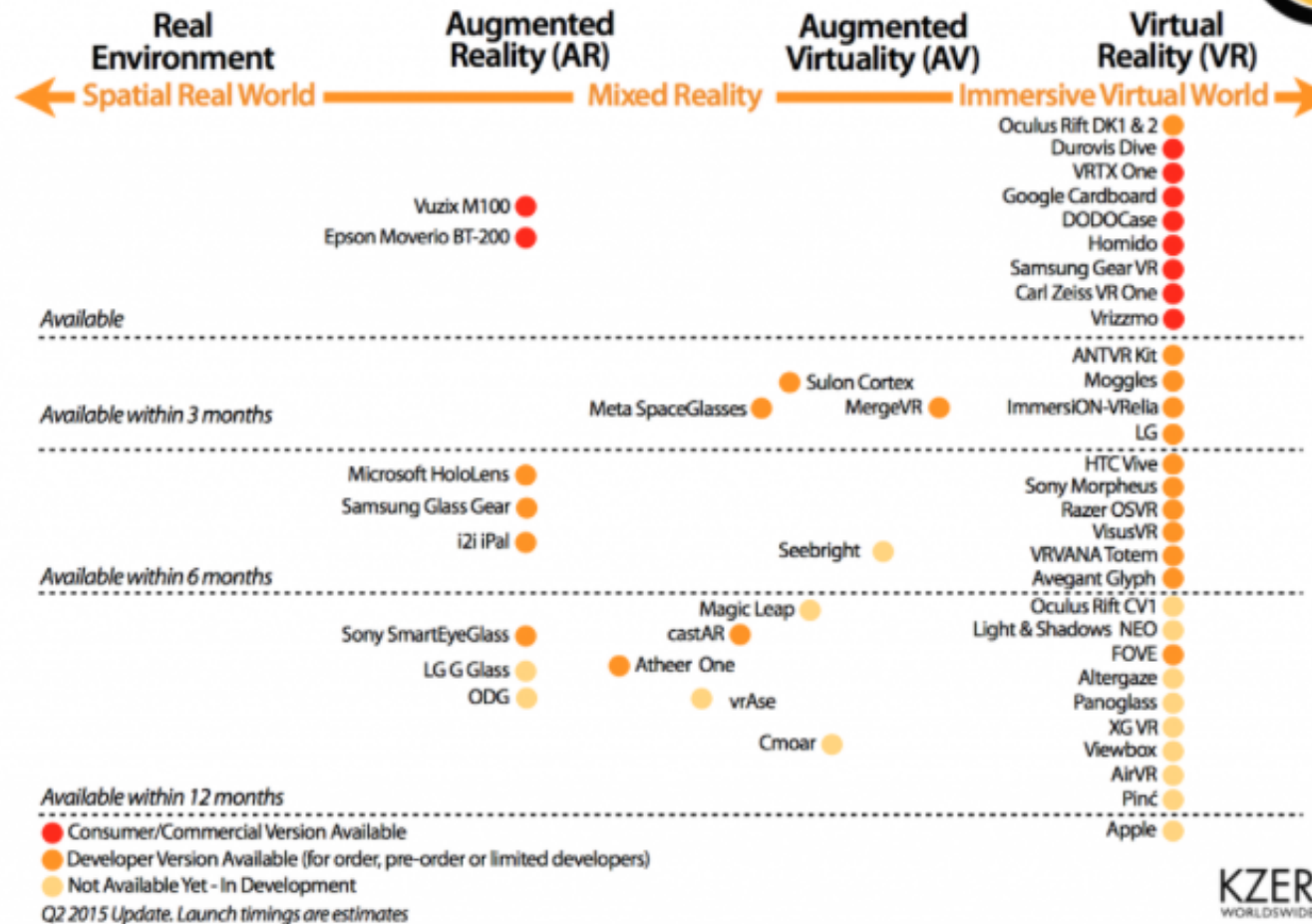
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Source; <http://daqri.com>

4D Studio – AR app SDK for helmet, tablets, phones, Glass, ...¹⁶

Augmented Reality Productivity Tool



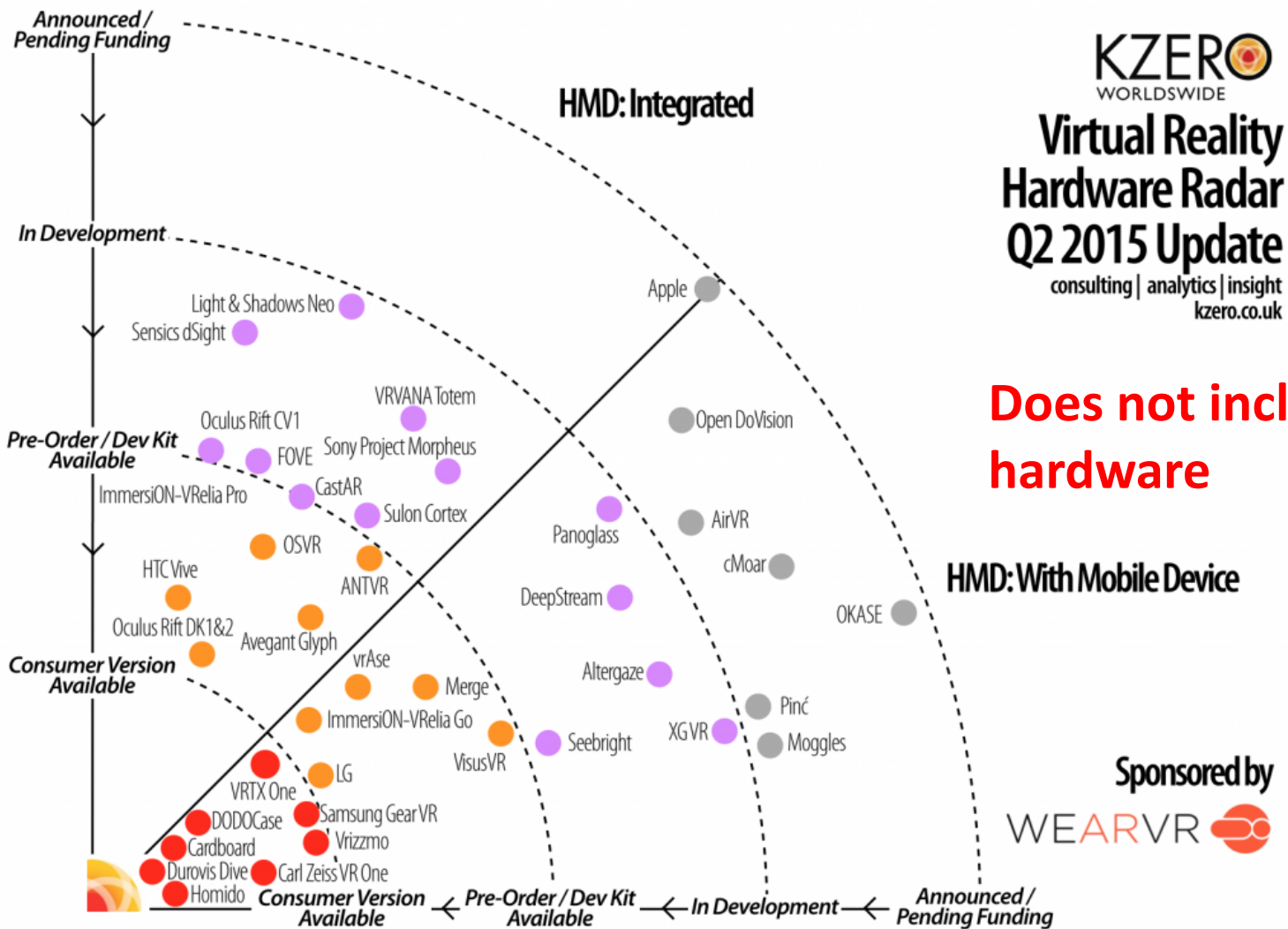
The Face Race: Virtual & Augmented Reality Headsets



Philip@

6/1/15

18



Philip@F

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Fundamental design choice

Camera-captured VR



The Mission, New Deal Studios

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Computer Rendered VR

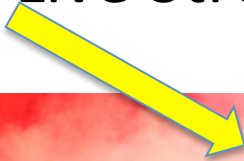


The Blu, WEVR



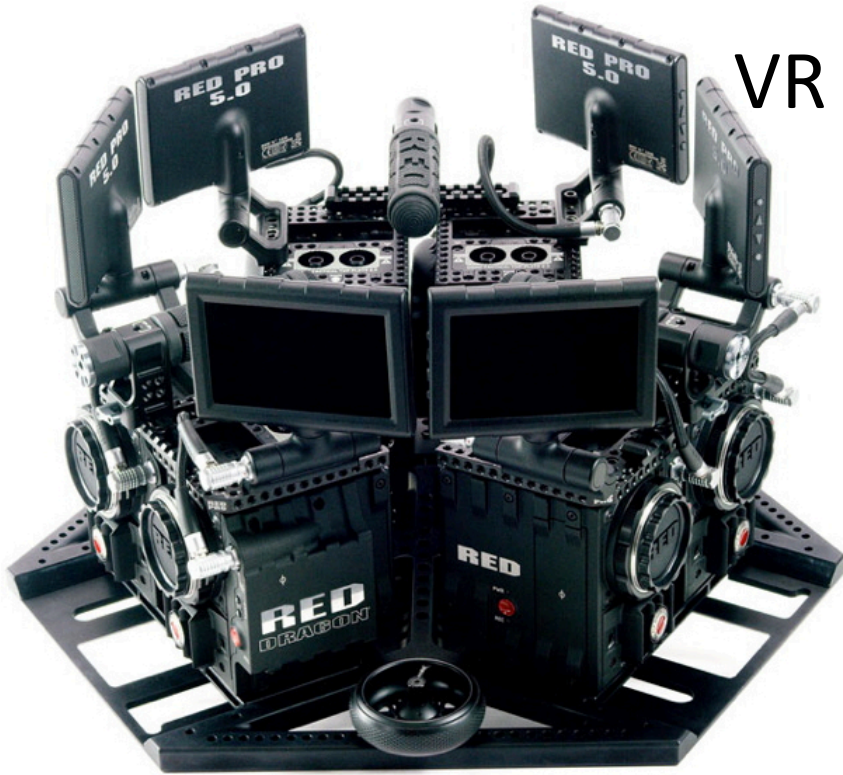
Camera-captured VR

Live Streaming or Post-Produced



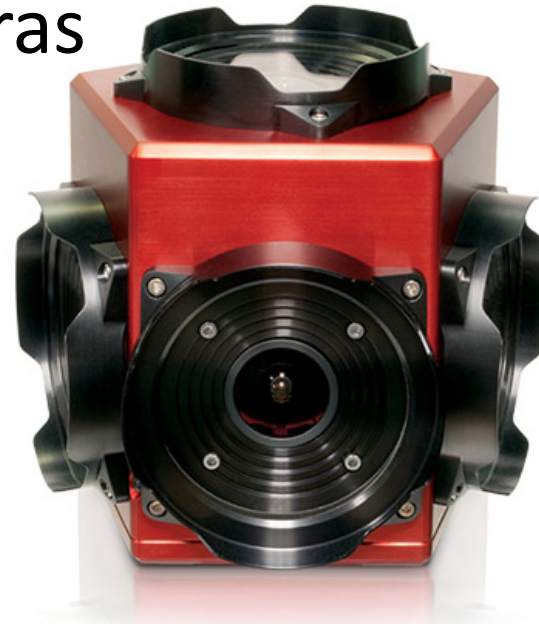
Concerts, Sports, News, Story Worlds...

VR Cameras



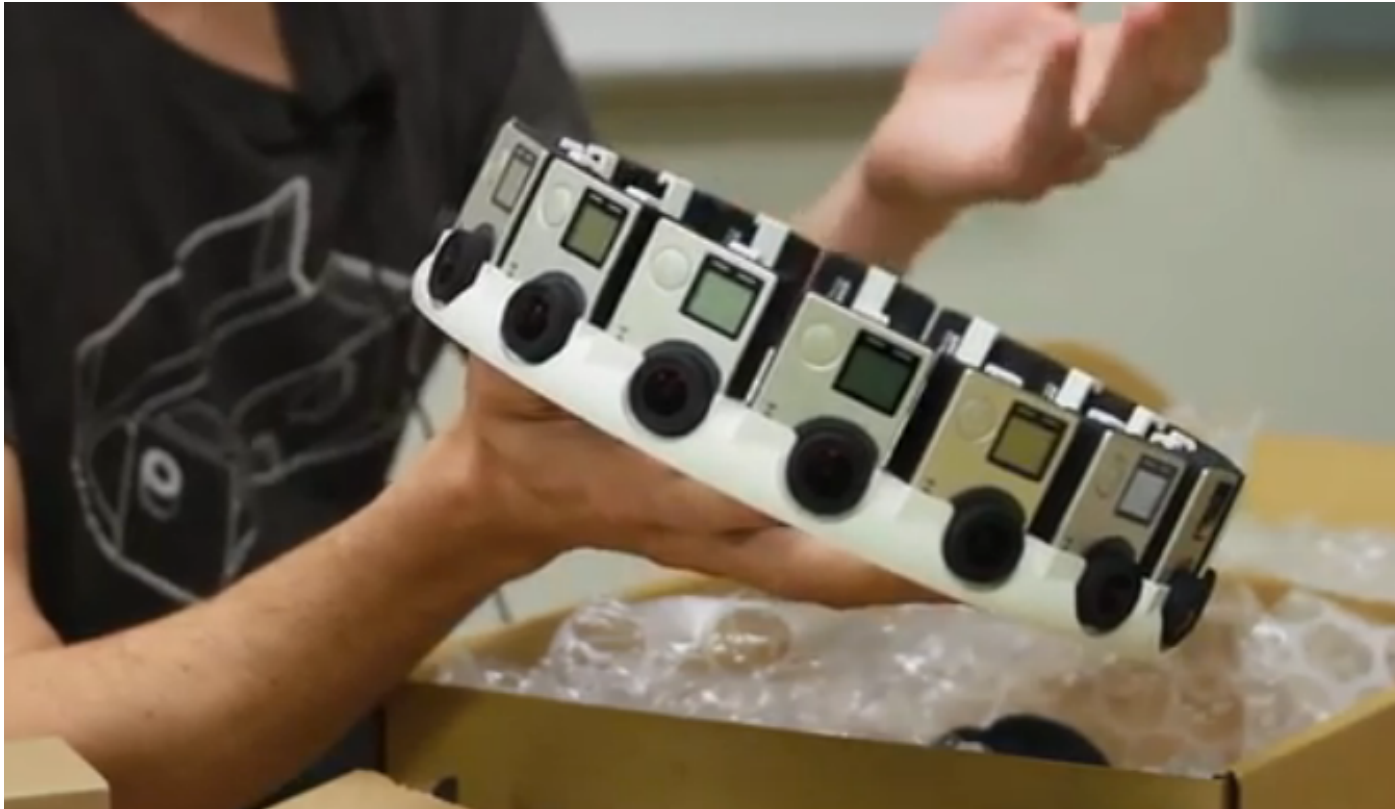
NextVR 360 3D Rig
6 Red Pro 6K cameras
60 fps
Spatial audio capture

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Ladybug 3 from Point Grey Research
Six 2/3" 5MP (2048x2448) Sony CCDs
10 fps at full resolution (lower is faster)
Industrial and prosumer **applications**

Stitching



Philip@PhilipLelyveld.com Jump from GoPro & Google

VR stitched panorama



Wild – The Experience, VR short from Fox (Reese Witherspoon, Laura Dern)

Sound



TetraMic



Chris Milk

Sound/audio design is a powerful storytelling element

Guide attention, tell the story, override primitive graphics

Blind Swordsman

**THEY COME TO KILL YOU
LISTEN VERY CAREFULLY
TAP TOUCHPAD TO STRIKE**

Bronze game winner, Oculus mobile VR Jam

Fundamental design choice

Live VR



The Mission, New Deal Studios

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Computer Rendered VR



The Blu, WEVR

Computer Rendered VR

Free to wander (Story world)

“Subtle coercion”



Computer Rendered VR

Social VR



Social VR



Social VR may be VR's killer App
...people want to share experiences with others...

Social VR company Altspace

Raised \$10.3 million to work towards a business plan that could include paid virtual gatherings with celebrities (7/29/15)



- users stay on the site for an average of 25 minutes
- most VR experiences last three to five minutes

World Building

Project Sansar, from Linden Labs



- Empower people to easily create, share, and monetize their own multi-user, interactive virtual experiences
- “Exceptional visual fidelity, 3D audio, and physics simulation.”
- Goal, “the Wordpress of VR”

Different VR experience types

Tethered versus Untethered

- Bandwidth Issue
- Compression
- Latency



Different VR experience types

Sitting, Standing, Walking

Different VR experience types

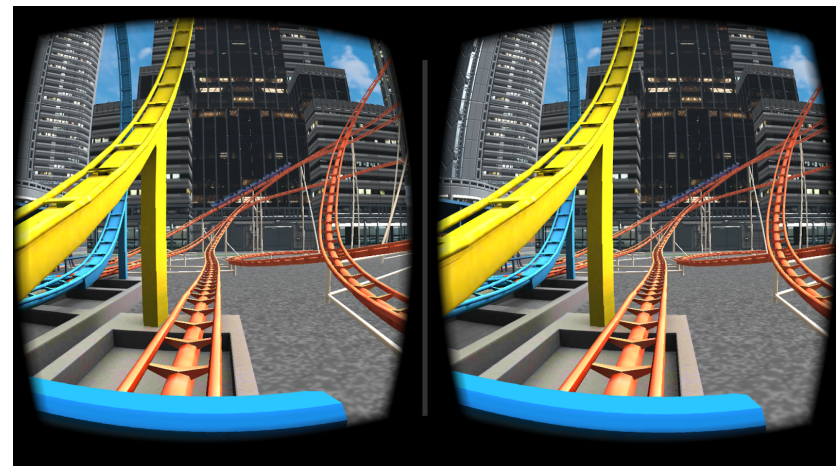
Does the VR world know you are there?

- Passive observer
- Active presence

Group VR

Presence

Multiple senses



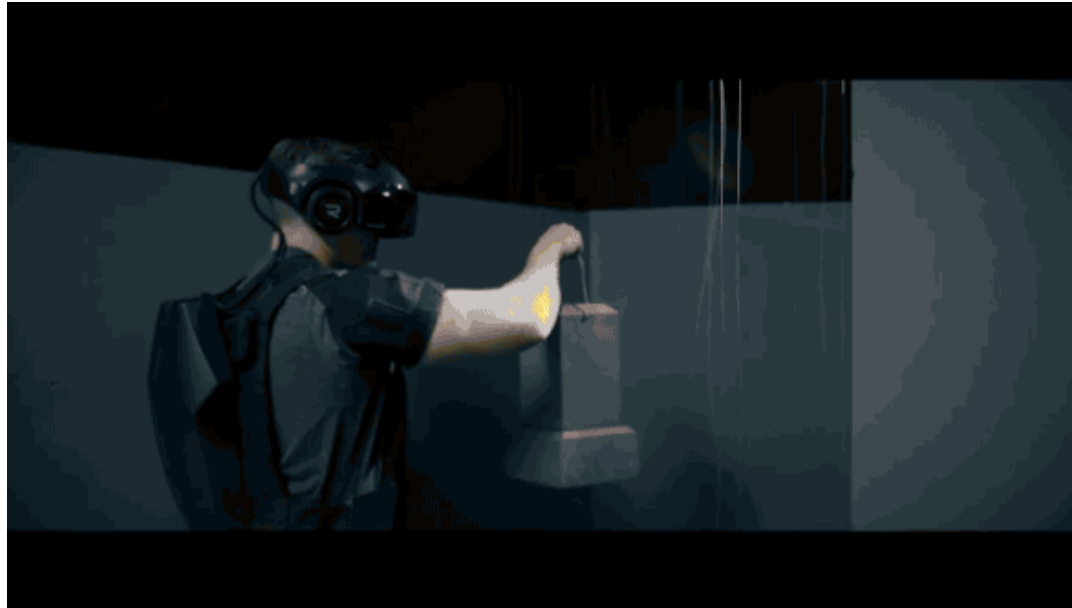
Group VR

Actual Rollercoaster with synched VR



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Location Based Entertainment



The VOID

- blended virtual and real play space
- infinitely reconfigurable

opening in Salt Lake City early 2016

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Story

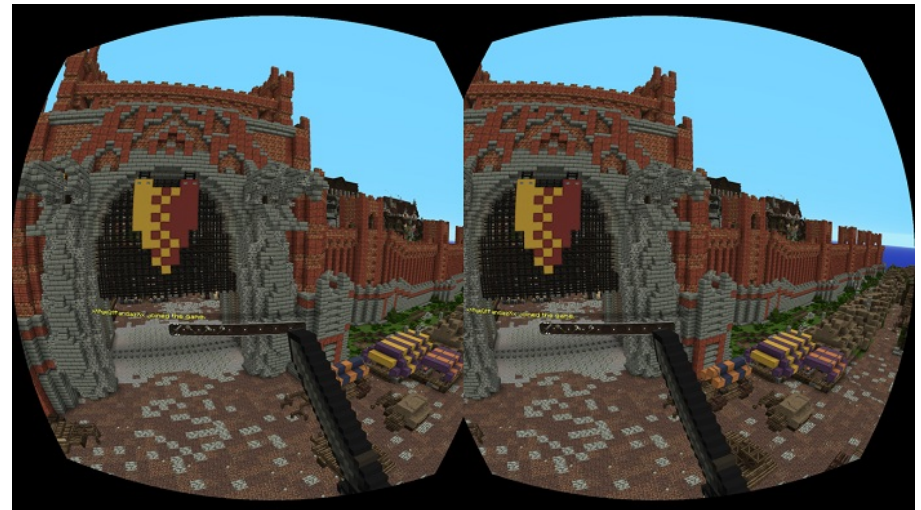


VR as an extension of game development (a 'next generation peripheral')



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Minecraft for the Oculus Rift



Concerts and events (paired with Social VR)



Education



Evaluating Balance in Glaucoma Patients



Health

Rehabilitation from stroke



Curing and Preventing PTSD



Aging

Social Engagement

Physical and Mental Health



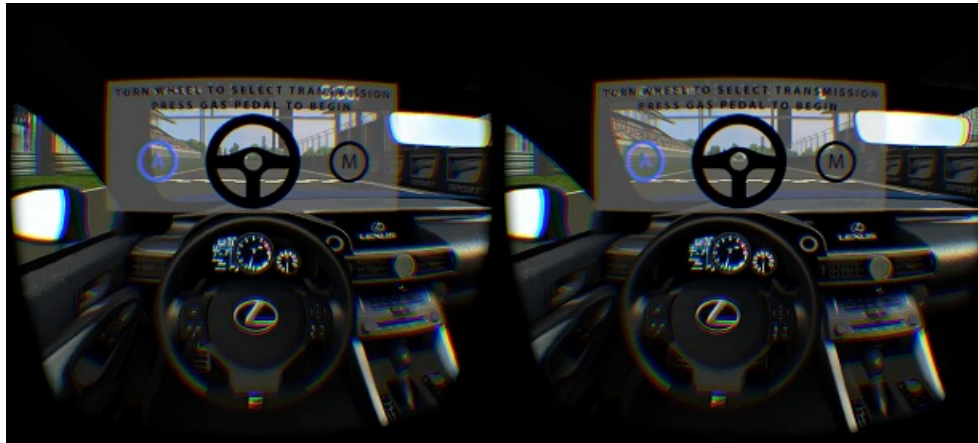
Exercise



VirZOOM

- Cambridge, MA start-up
- download a different route for each exercise session
- back wheel detects speed
- front wheel steers (incl. flying!)

Lexus 2015 Model RC F VR Driving Experience



Steering wheel and foot pedals
<8 weeks to create a 360 experience
Oculus Rift Dev 2 SDK
Traveling to US Auto Shows



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Source: Lexus creates an Oculus Rift-powered virtual test drive, Joystiq, 10/2/14

Travel and Tourism



Virtual Vacation



100 second experience by Marriott

HMD

Headphones

pneumatic pumps embedded in the booth's floor,

misting nozzles in the walls,

heat fans in the ceiling and floor,

a 'scent dispenser' and

a 1000-watt amplifier

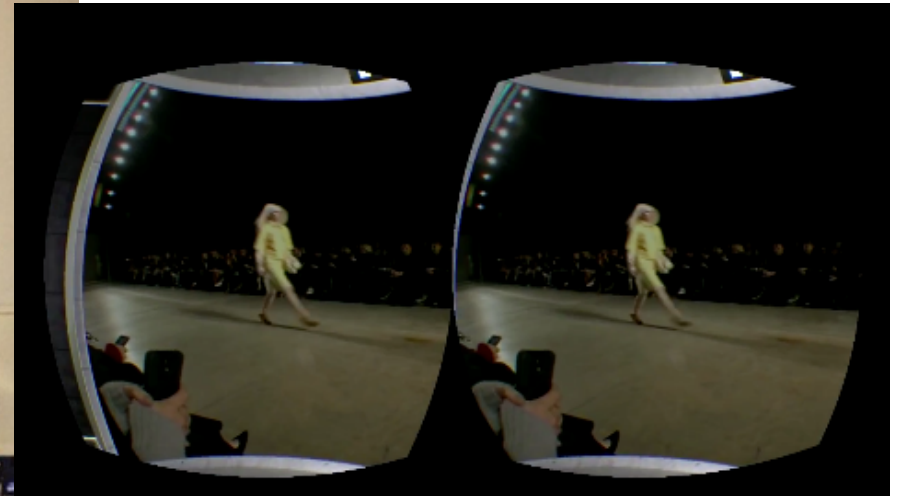
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Visit Hawaii's sandy beaches or

The top of London's Tower 42

50

Fashion and Retail

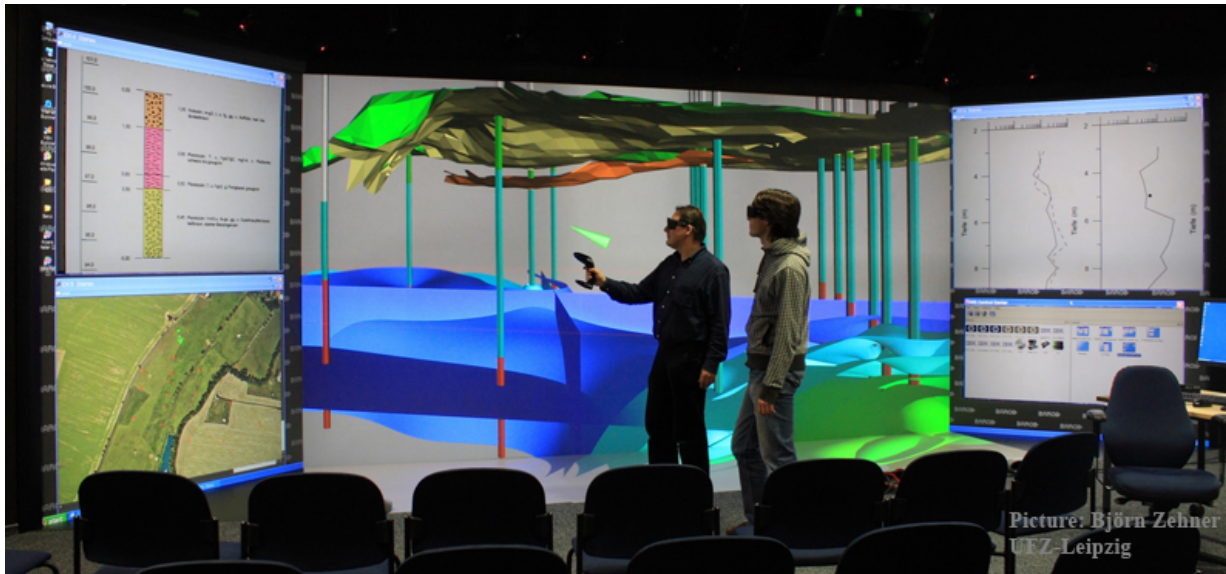


THE WORLD'S FIRST LIVE STREAM
IN VIRTUAL REALITY

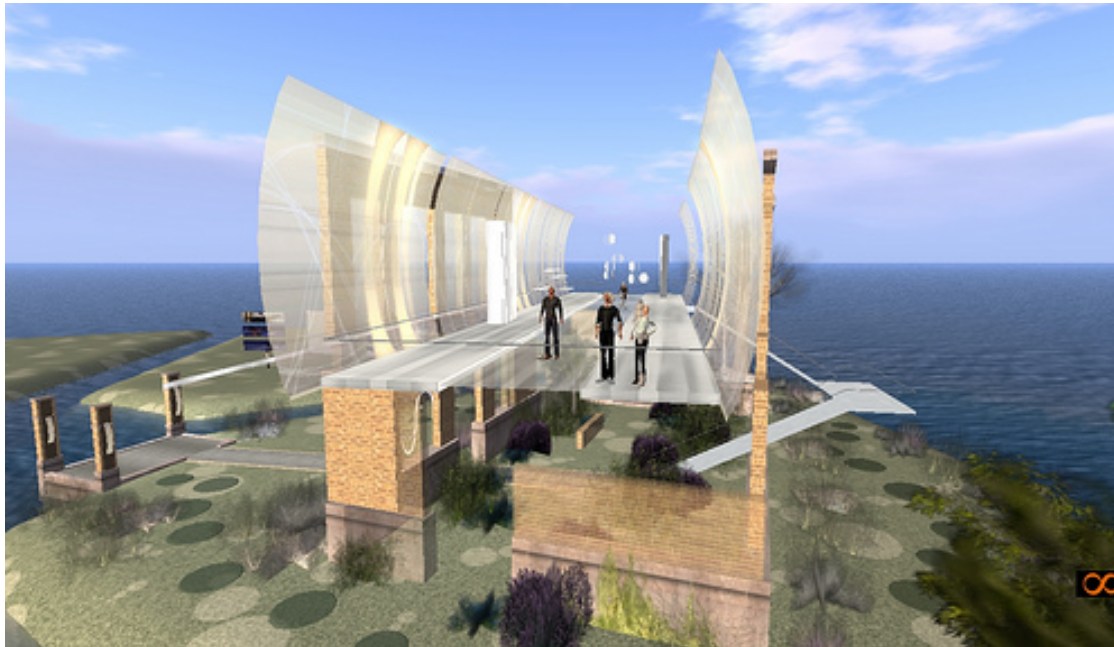
360° TopShop Catwalk

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Natural Resource Exploration and Management



Architecture and Design





Public Policy

*This tool **will help people to experience and understand** the lagoon proposals as accurately as possible, so their feedback can help us to develop a truly world-class facility.*

Tidal Lagoon (Swansea Bay, Wales) plc bid proposal includes a 3D virtual reality programme showing the proposed tidal energy lagoon in the context of Swansea Bay, Wales (7/4/13)

Business Productivity

Telepresence

- Meetings
- Interviews
- Training

Better executive time
management
with avatars!



*USC's Dr. Bolas – assymetric presence, avatar
in multiple places at once*

Professional Sports Training

- The cameras don't interfere with the plays.
- The technology is small, lightweight and easy to take on and off the field.
- "The game is about visualization from a practice standpoint, especially for quarterbacks," McCown said.



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Source: Virtual reality, cryotherapy chamber highlights new tech Saints use during training camp, 7/31/15

Engineering and Manufacturing Process Simulation Training



News

ABC News Says It's Taking Virtual Reality Seriously



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Jaunt processed and stitched the raw video files

ABC did all the narrative video editing

Medical Training Telemedicine



Remote
Robotics

Top Gun; The Neurosurgery Challenge
(American Society of Neurological Surgeons)

Marines Explore 'Augmented Reality'

AR "lets troops go through the actual, physical motions of the skill they're training for and build muscle memory, without restricting the targets and support units."



Philip@PhilipLelyveld.com Source: Breaking Defense, 9/1/15

VR and Drones



GoPro 360Hero rig



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Drone Racing League



Photo: Philip Newbold.com
Glyph HMD, “250 class” drone, 70 mph through interior space

Augmented Reality Productivity Tool



Remote expert support

Augmented Reality Productivity Tool



Philip@PhilipLelyveld.com Leap Motion hackathon winner

Augmented Reality Productivity Tool



GOOGLE TRANSLATE ADDS 20 LANGUAGES TO
AUGMENTED REALITY APP

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Have a reason to do VR!

Why create 360° if there is nothing to see in 270°?

JP_whooville_021.jpg



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Dr. Suess – visually busy all around

67

Sense of 'Presence'



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Place Presence



Into the Storm
VR Experience

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Mark Bolas, Director for Mixed Reality Research,
USC Institute for Creative Technologies

Plausibility Presence



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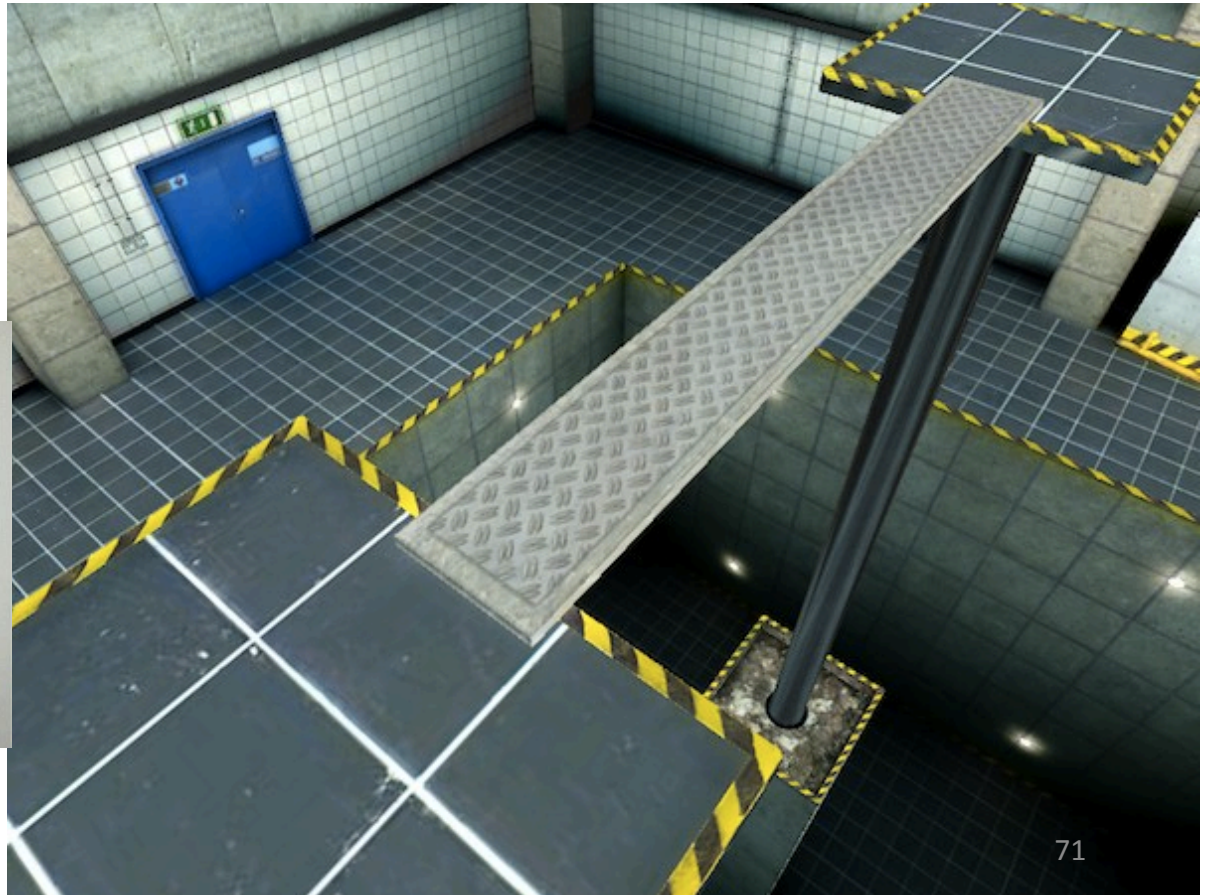


Mark Bolas, Director for Mixed Reality Research,
USC Institute for Creative Technologies

Suspension of disbelief over photorealism



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Heightened Sense of Empathy



Henry

Oculus Story Studio

7/28/15

Agency



Virtual Food Bank – Nonny de la Pena

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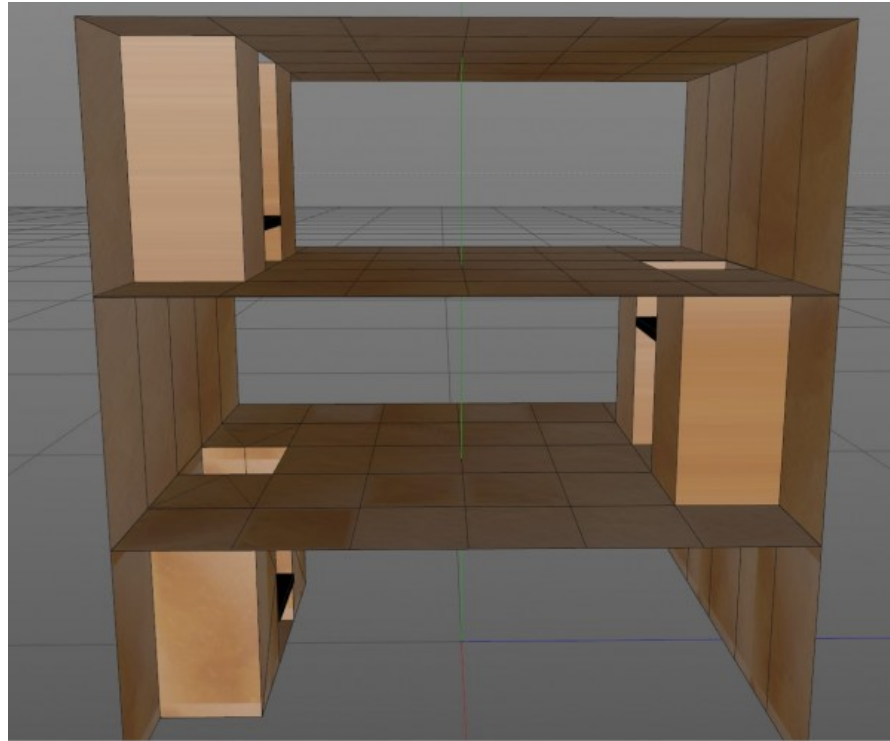
Tricks and tools

s Change 'Reality' where you are Not Looking!



Sightline, by Tomáš "Frooxius" Mariančík

Moving in VR



An elevator between worlds

Philip@PhilipLelyveld.com plays with the limits of the physical space

Language

Importance of Audio

Spherical, 360, 180, zoned?

3D or 2D?

How do you;

- move?
- direct attention?
- drive a satisfying story arc?

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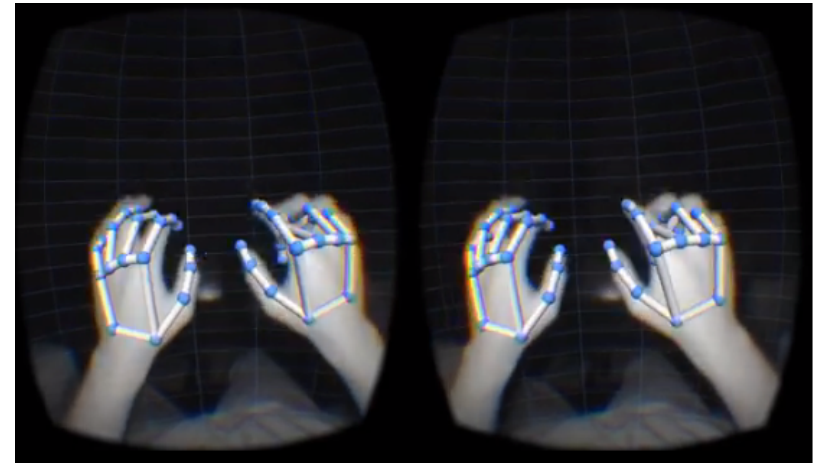
Language of VR

Content

User Interface (UI)

- Controls
- Information

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Camera-captured VR production workflow
August 4, 2015
1-5pm
USC Entertainment Technology Center

10 minute Case Studies

- Disney/ABC Television Group,
- Google,
- Jaunt,
- IM360,
- New Deal Studios,
- Two Bit Circus,
- Supersphere Productions, and
- HeadcaseVR with Mirada

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Breakout discussions
Networking / Demo



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Controllers Hand, Body, Feet



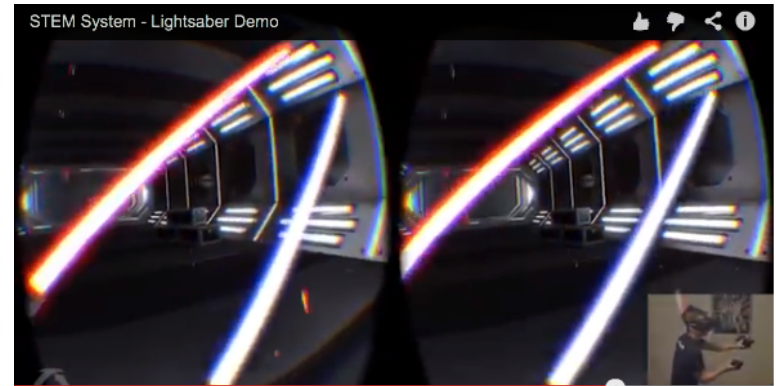
STEM by Sixence

Player can wear up to 5 wireless motion trackers

If game-enabled, can track arm and leg movement

Pre-order now (\$299 (2 trackers) to \$579 (5 trackers))

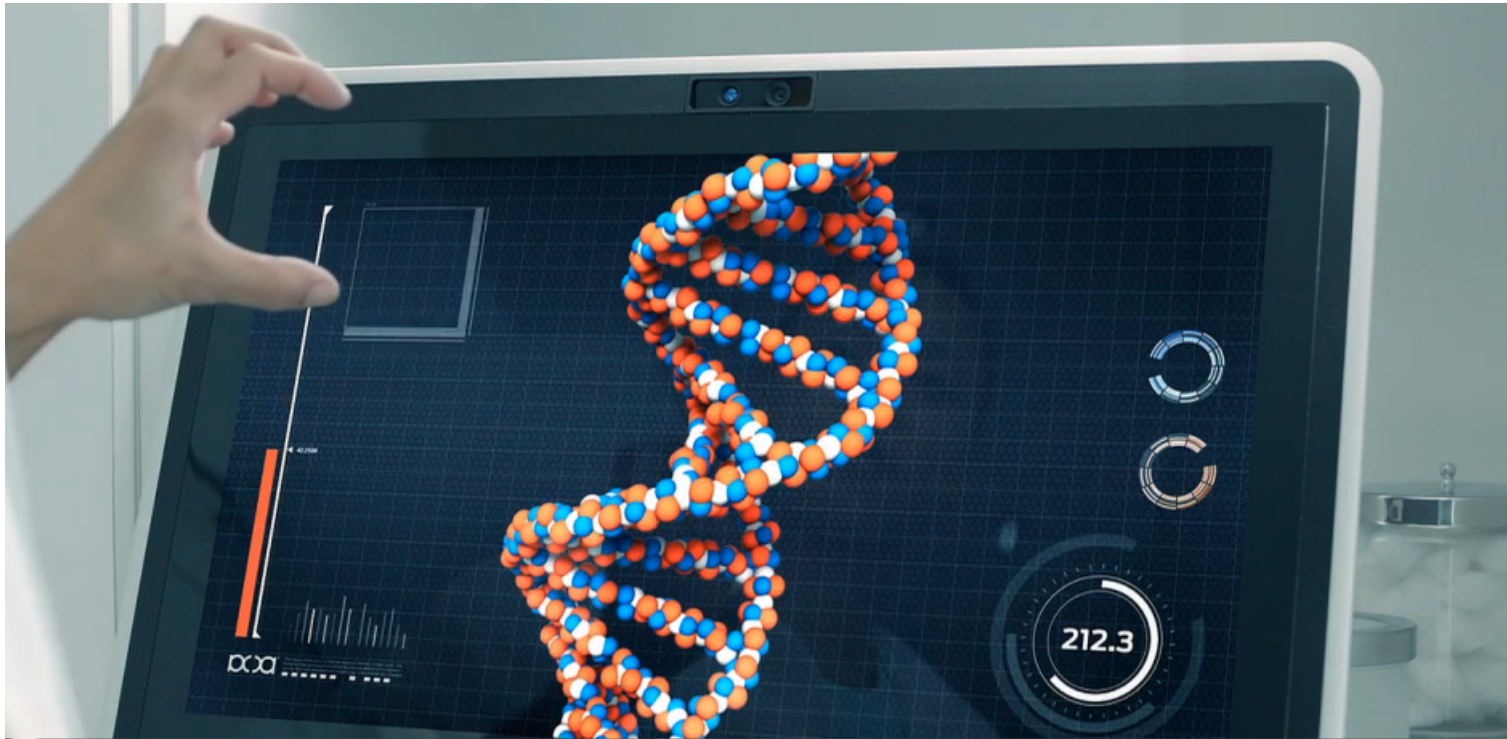
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STEM light saber demo



Controllers



Intel RealSense Technology SDK – hand and finger tracking

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Haptic Feedback Companies

Immersion

<http://www.immersion.com>

Touch Sense

Hardware and software



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Tangible Haptics

<http://tangiblehaptics.com>

Touchscreen surface lateral force haptics

Tactical Haptics

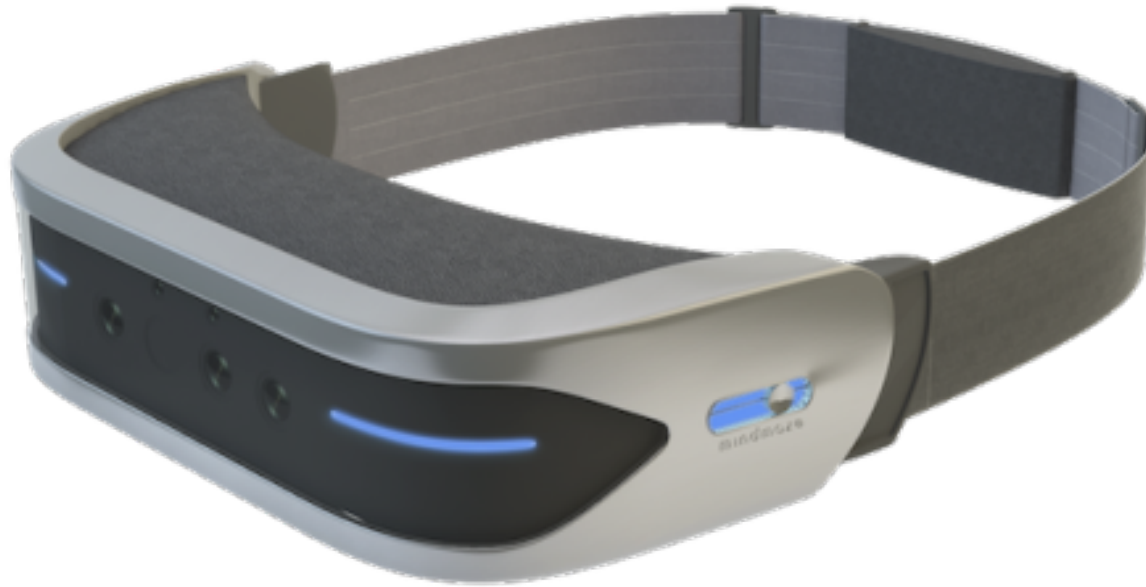
<http://tacticalhaptics.com/products/>

Reactive grip



NeuroGaming

MindLeap virtual reality game system runs on your brain waves – no controller needed



Tech developed for medical rehabilitation

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Under 20ms latency between thought and game response

Controllers Treadmill



Feelreal VR mask



- 8 scents (ex. jungle, flowers, ocean, burning rubber)
- Hot and cold blower
- Haptic motors for force feedback
- Ultrasonic ionizing system for mist striking your cheeks.

Controller: Haptics



KOR-FX Gaming Vest
korfx.com



Tesla Suit
aleksandrovich.wix.com



Reactive Grip
tacticalhaptics.com



iMotion
getimotion.com



About Face
Washable, hygienic, comfortable Oculus Rift liners



Starting at \$32

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Players

Ecosystems

Facebook / Oculus (VR Initiative)

Sony Playstation VR (formerly Morpheus)

Google Cardboard, YouTube, Jump camera, ...

Samsung Gear VR (with Oculus) Milk VR

HTC Vive (with Steam)

Players

Live Streaming VR

Content aggregators

LittlStar
Vrideo
Vantage TV

Social VR

Janus VR
High Fidelity
Altspace VR
IMVU

Studios

Production houses

Rig makers

Audio design houses

CE mftrs.

Peripheral mftrs.

Chip makers

VCs incubators accelerators

NextVR

IM360

LittlStar

Vantage TV

VRLive.TV

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TODAY

733

US PURE-PLAY
VR COMPANIES

1/5

BASED IN SOCAL

1/6

ARE FUNDED

9/15 - \$65M in Jaunt VR

\$795.6m

INVESTED IN VR TOTAL
SINCE 2010

200

INVESTORS

\$300.5m

INVESTED IN THE FIRST
8 MONTHS OF 2015

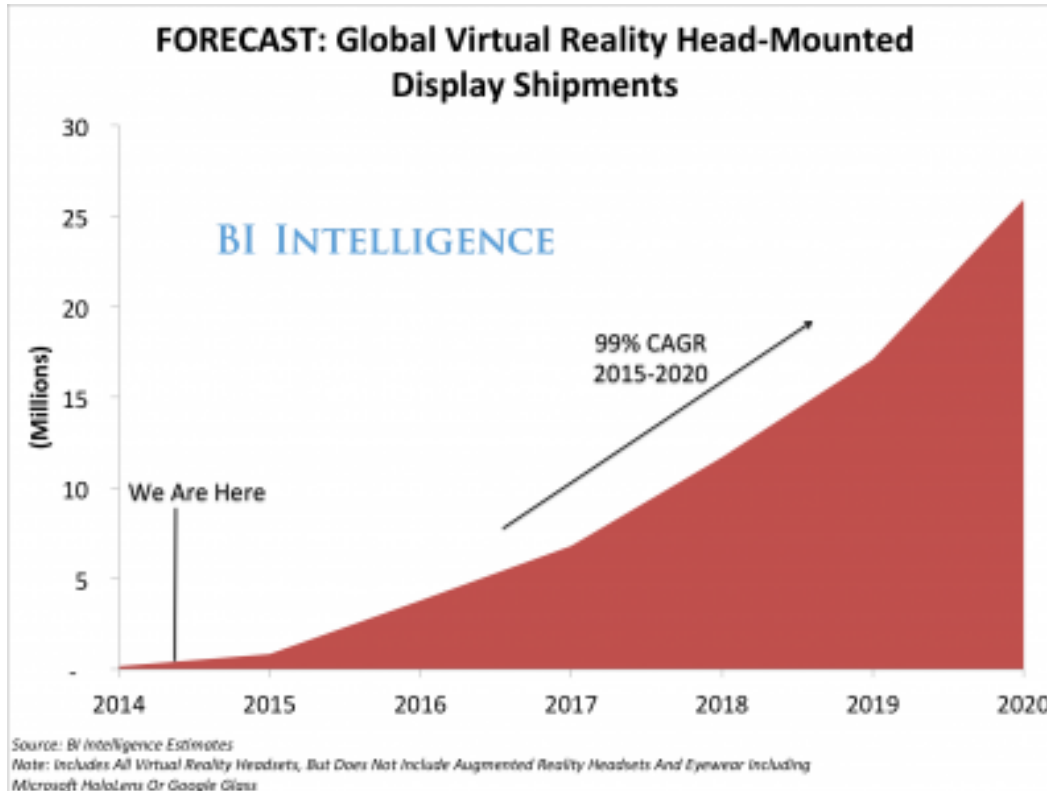
Des Moines Register Adds VR to News Reporting



VR Farm includes text, image, video
News story revealed by wandering

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Source: Des Moines Register Adds a Bit of Virtual Reality to News Report, Wall Street Journal, 9/22/14



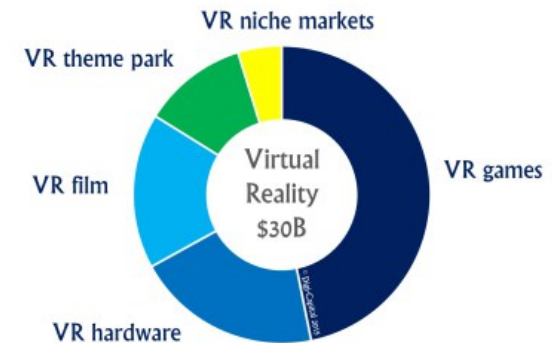
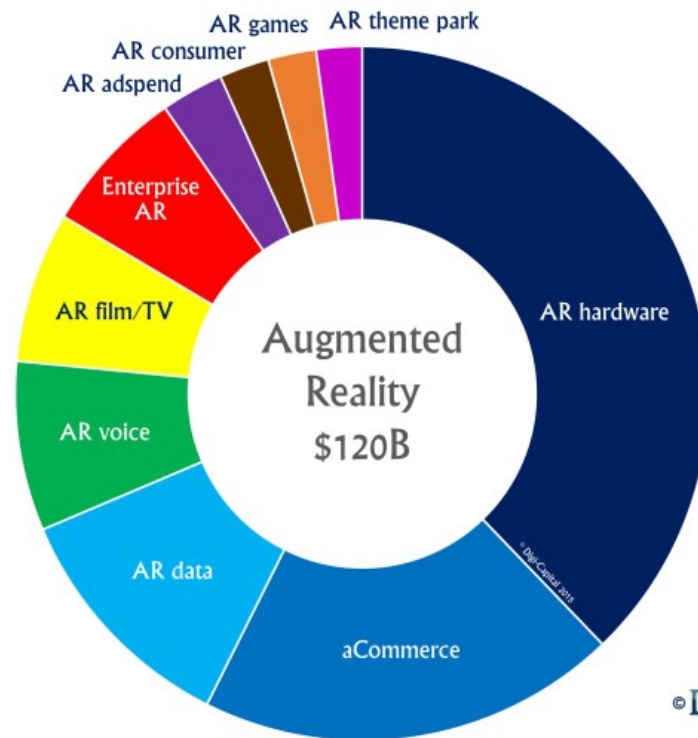
Does not include

- Software
- Services
- Peripherals
- Tablets and Phones

VR Headset shipments will grow 99% from 2015 to 2020
VR hardware: \$37M in 2015, \$2.8B in 2020

Philip@PhilipLelyveld.com
Source: BI Intelligence, August, 2015

Augmented/Virtual Reality Revenue Share 2020F



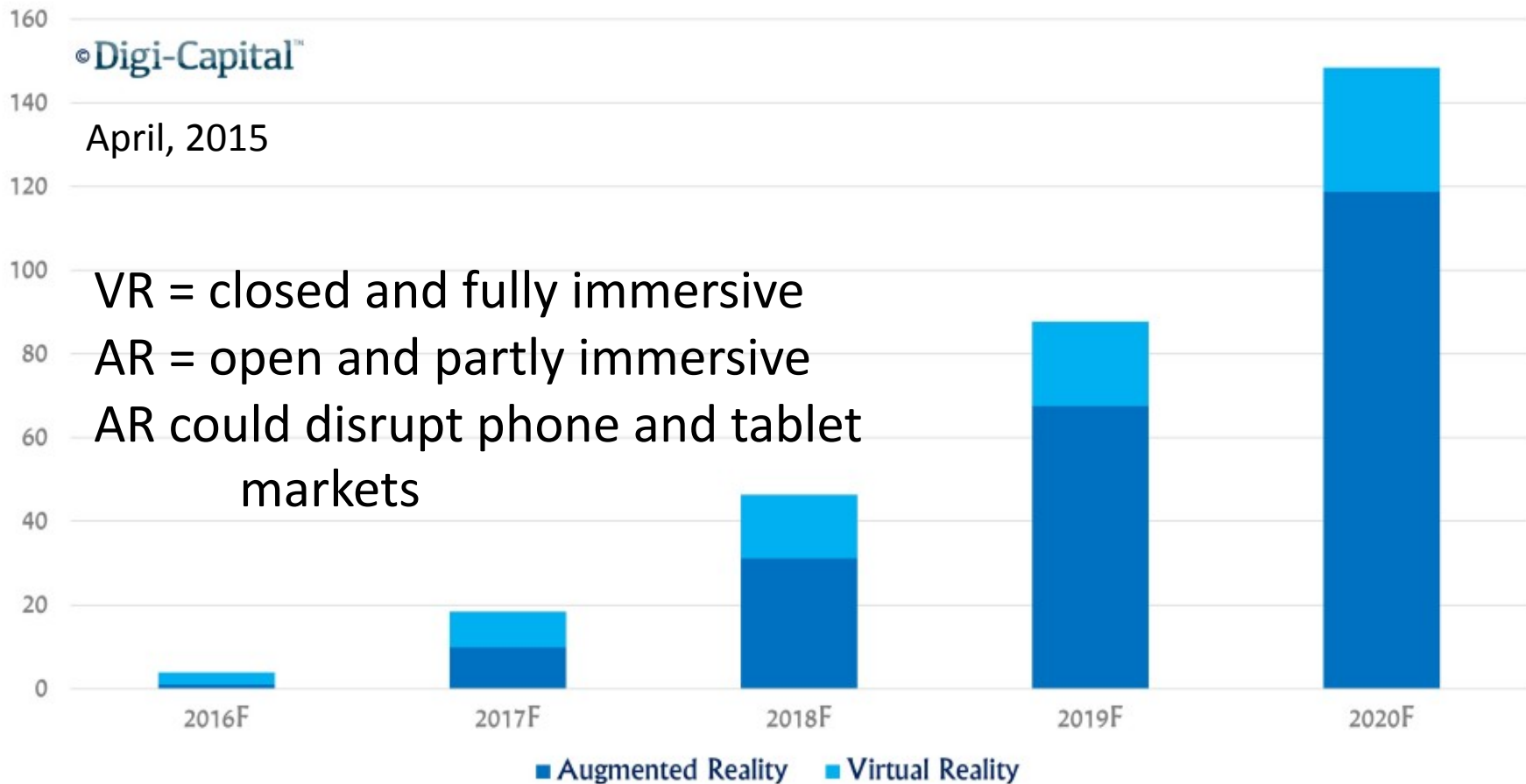
Augmented And Virtual Reality To Hit \$150 Billion,
Disrupting Mobile By 2020

Augmented / Virtual Reality Revenue Forecast (\$B)

© Digi-Capital™

April, 2015

VR = closed and fully immersive
AR = open and partly immersive
AR could disrupt phone and tablet
markets



Barriers to Acceptance

- **No killer app**
- Products are evolving quickly (hardware, software, content)
- Health concerns
- Child issues
- Standards, lack of
- Social barriers - style
 - isolates you from others
 - looks funny
 - fear of someone (little brother) doing something to you
- Patents

Occipital
Depth-sensing VR physical collision warning system



The "oh, we forgot about that" factor

Product Leapfrogging

Physical objects within 1.2m appear in the virtual world

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Health Issue

Health – Sim sickness

- Sensory conflict
- Stereopsis-induced sickness (3D)
- Unnatural movement



Health - Technical

- Latency
- Tracking registration

Live Streaming VR

VR, Presence, Empathy, Proximity, and
Children

IM360

(a joint **venture** between Immersive Media and Digital Domain)

Walker Stalker at Comic Con

organizers expect to involve thousands of fans who will be on the run
from zombies

Standards



Hardware
Software APIs
Software Plugins

>75 Supporting companies
and universities

OTOY
Jaunt
Oculus

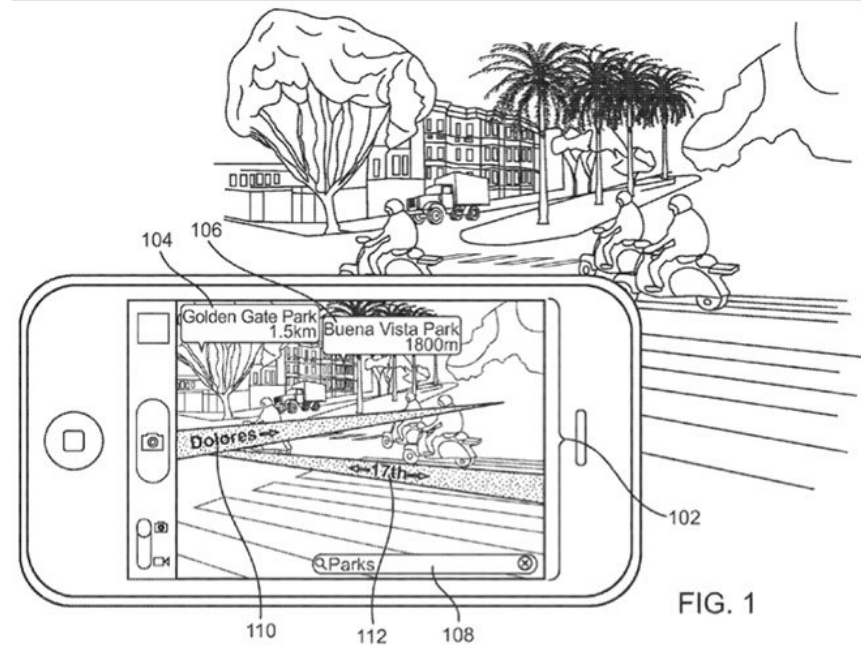
Unreal
Leap Motion
Unity

See <http://www.osvr.com/join.html>
for a breakdown by topic and company

Augmented Reality

“Style is key to widespread adoption”
Piper Jaffray analyst Gene Munster

Apple has hired a number of people from the fashion industry recently



Source: Piper Jaffray: Apple has augmented reality R&D team, could inject AR devices with much needed style. 3/18/15

Patents

How Magic Leap Is Secretly Creating a New Alternate Reality

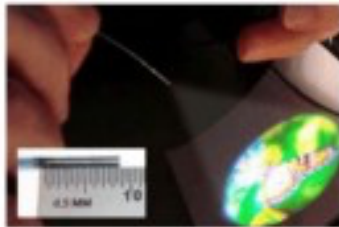


Figure 1. 1 mm x 9 mm scanning fiber projector.

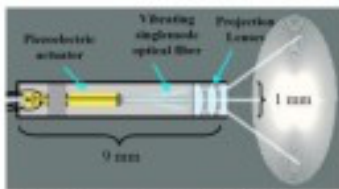
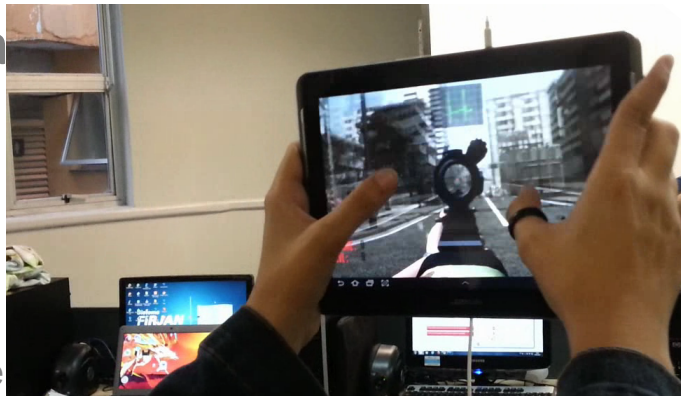


Figure 2. Inside the 1 mm projector: A piezoelectric actuator vibrates the tip of an optical fiber in two axes to create an area-filling spiral scan pattern.



Barriers to Acceptance

- No killer app
- Products are evolving quickly (hardware, software, content)
- Health concerns
- Child issues
- Standards, lack of
- Social barriers - style
- Patent



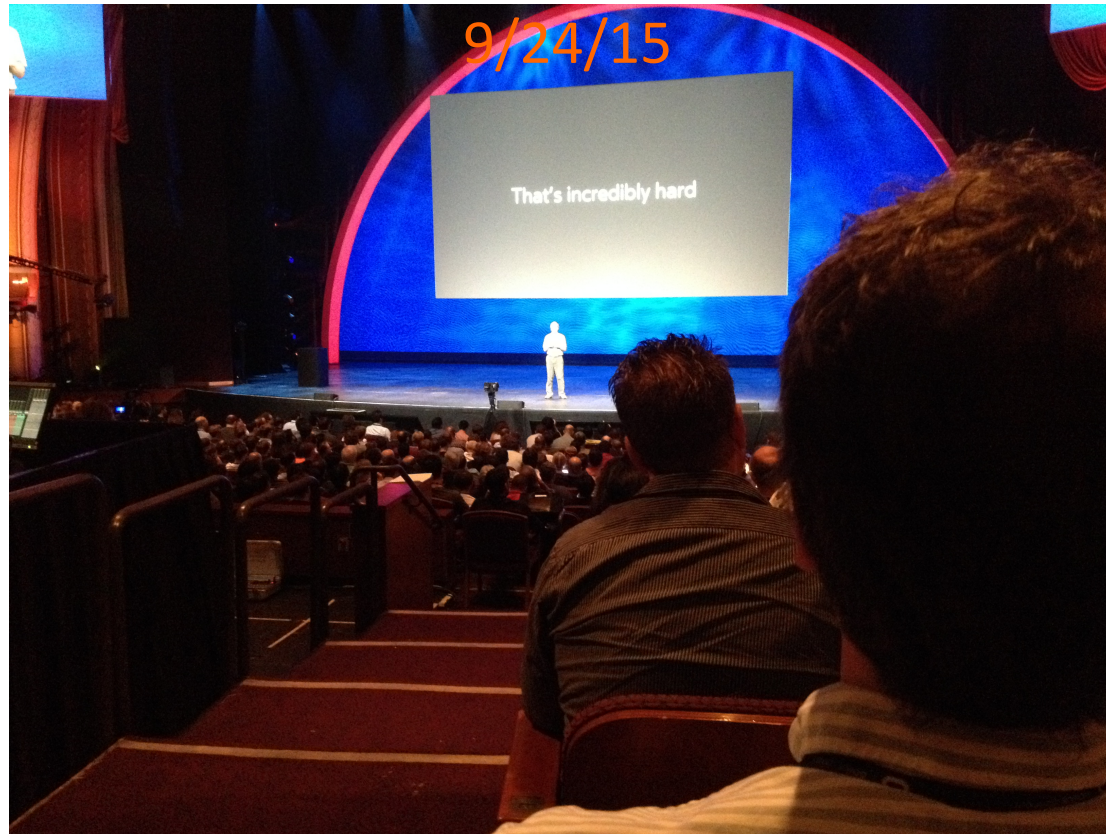
Philip@PhilipLe



Mostly impact HMDs

Oculus Connect Yesterday!

9/24/15



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A few comments on distribution technology...

Post-Produced Camera-captured VR

7 min. Cirq de Sole = 2.8GB 60 min =~40GB





NextVR is capable of *transmitting live high definition, three-dimensional virtual reality content over the Internet*

NextVR content preloaded onto Samsung Gear VR

Live Streaming VR at Comicon



WhiteRoom: 02BE

A Roddenberry 360 VR movie

Conan, Walker Stalker

Live Streaming VR





Option:

Distribute a 4K frame, then client warps it into a sphere.

Capture at high-resolution, distribute at what client-processing, bandwidth, and display tech allow.

Bandwidth and QoS

Compression

Latency

Processing power

Local buffer/storage ...

Google Fiber expressed
interest in streaming VR

The End-User VR Experience

Technical

Styles of VR experiences

- Swipe screen
- Tilt and wave screen
- Phone-based
- Wear HMD

Latency is sum of;

- Generate (cloud?)
- Transmit (telcos?)
- Render (display)
- Backchannel instruction

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Head Mounted Display

- 4K-8K resolution per eye
- >90 frames per second
- <20 msec latency
- 220° field of view (FOV)

Spatial Audio
Multisensory
User Interface

Peripherals

The End-User VR Experience

- Latency is sum of;
- Generate (cloud?)
 - **Transmit (telcos?)**
 - Render (display)

Telco Infrastructure;

- being upgraded for video anyway (business)
- VR could piggyback on (UHD / video) upgrade
- “Last mile” issue must be tackled

Verizon Venture Forum

Interactive Media & Entertainment

– A Day Spent Contemplating Business Models –

“Generally, social and cultural factors drive movements and trends, not technology. This raises the question of whether there is an **overemphasis on VR technology itself**, rather than the social and cultural ways that media can be deployed on it. **We expect winners in this space to be those that can effectively use these new mediums to provide unique experiences that connect with users at a visceral and emotional level.**”

9/14/15

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The End-User VR & AR Experience

Consumers buy experiences, not technologies

Storymaking

Social

Business

Gaming

Education



Thank you
Phil Lelyveld
UCS Entertainment Technology Center
School of Cinematic Arts

