# 증강/가상현실 분야의 기술 동향 및 발전 전망

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2016.10.26

# Intro.



CAVE 시스템 출처: christiedigital.com
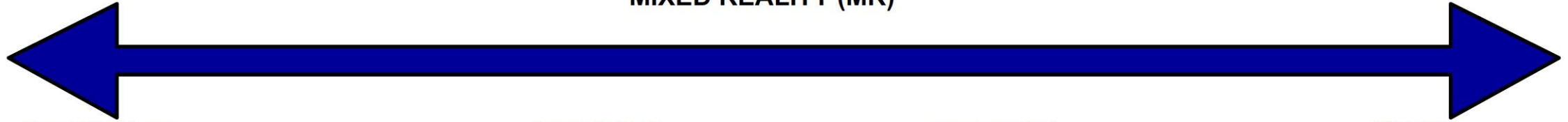


홀로렌즈(Hololens) 출처: 마이크로소프트

**REAL ENVIRONMENT**

**VIRTUAL ENVIRONMENT**

**MIXED REALITY (MR)**

**Tangible User Interfaces (TUI)**

A TUI uses real physical objects to both represent and interact with computer-generated information (Ishii & Ullmer, 2001).

**Augmented Reality (AR)**

AR 'adds' computer-generated information to the real world (Azuma, et al. 2001).

**Augmented Virtuality (AV)**

AV 'adds' real information to a computer-generated environment (Regenbrecht, et al. 2004).

**Virtual Reality (VR)**

VR refers to completely computer-generated environments (Ni, Schmidt, Staadt, Livingston, Ball, & May, 2006; Burdea & Coffet 2003)

Projection Augmented models (PA model) are a type of Spatial AR display, and are closely related to TUIs

**Spatial AR**

Spatial AR displays project computer-generated information directly into a user's environment (Bimber & Raskar, 2005).

**'See-through' AR (either optical or video)**

A user wears a head-mounted display, through which they can see the real world with computer-generated information superimposed on top (Cakmakci, Ha & Rolland, 2005; Billinghurst, Grasset & Looser, 2005).

**Semi-immersive VR**

A semi-immersive VR display fills a limited area of a user's field-of-view.

**Immersive VR**

Immersive VR, which uses either a head-mounted-display or a projection-based system, completely fills the user's field-of-view.



Using physical objects to create a virtual model (Ichida, Itoh, & Kitamur, 2004). As a user adds a physical 'ActiveCube' to the construction, the equivalent virtual model is automatically updated.
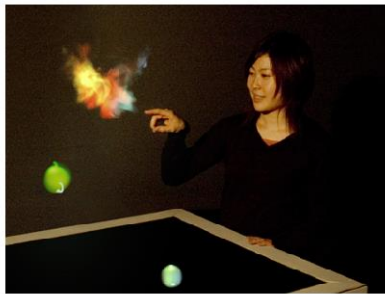
The 'Bubble Cosmos' – 'Emerging Technology' at SIGGRAPH'06. The paths of the smoke-filled bubbles are tracked, and an image is projected into them as they rise.

See-through AR: the butterfly is computer-generated, and everything else is real (Fischer, Bartz & Straßer, 2006; Kölsch, Bane, Höllerer, & Turk, 2006).

Semi-immersive VR using the Barco Baron workbench (Drettakis, Roussou, Tsingos, Reche & Gallo, 2004).
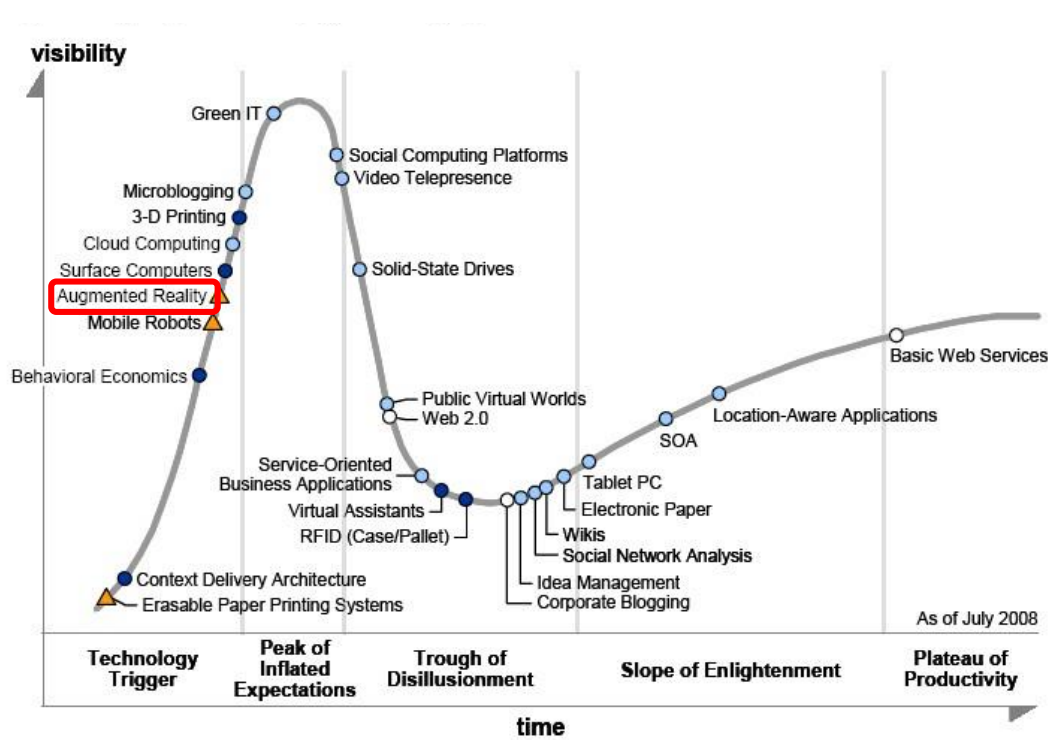
Projection-based immersive VR. The users are fully immersed in the 'CAVE' (FakeSpace, 2006; Cruz-Neira, Sandin & DeFanti, 1993).

# Intro.

- 페이스북의 오큘러스VR 인수를 시작으로 애플, 구글, 삼성 등 전세계 IT 대기업에서 증강/가상현실(AR/VR) 기술을 차세대 성장 동력으로 여겨 해당 기술 개발에 주력
  - 구글 Tango Project, DayDream Platform, MS의 홀로렌즈, 삼성의 GearVR, 애플의 메타이오 인수 등

- 게임, 교육, 훈련, 의료, 제조, 재난, 군사, 광고, 문화 유산, 관광, 스포츠 등 다양한 분야로 적용 예상

# Intro.



Source: Gartner (July 2008)



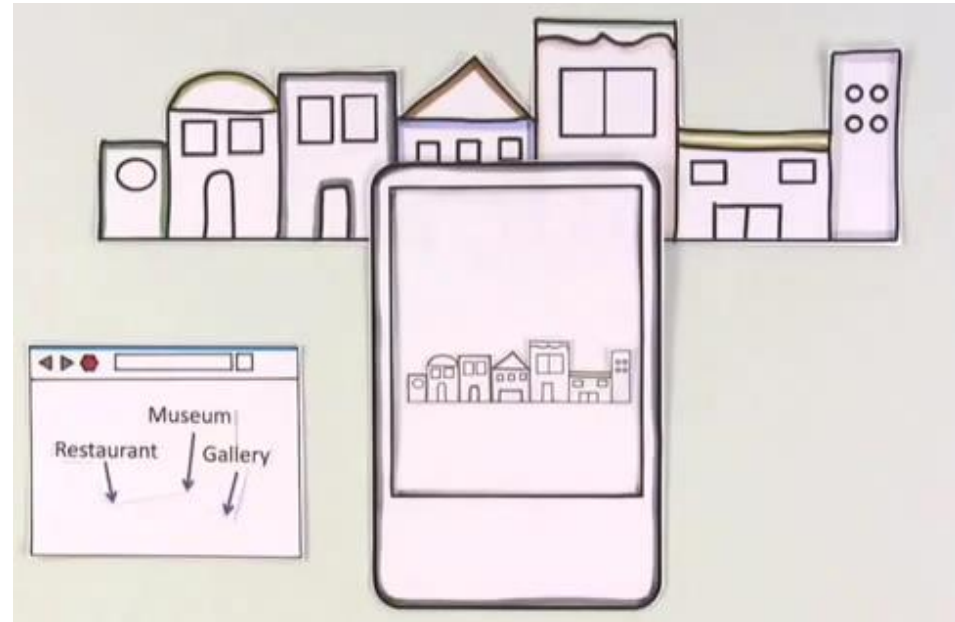Source: Gartner (July 2016)

# VR vs. AR

*What`s Diff.?*

- VR : <span style="color:red">Replaces</span> Reality
  – *Immersive Display*
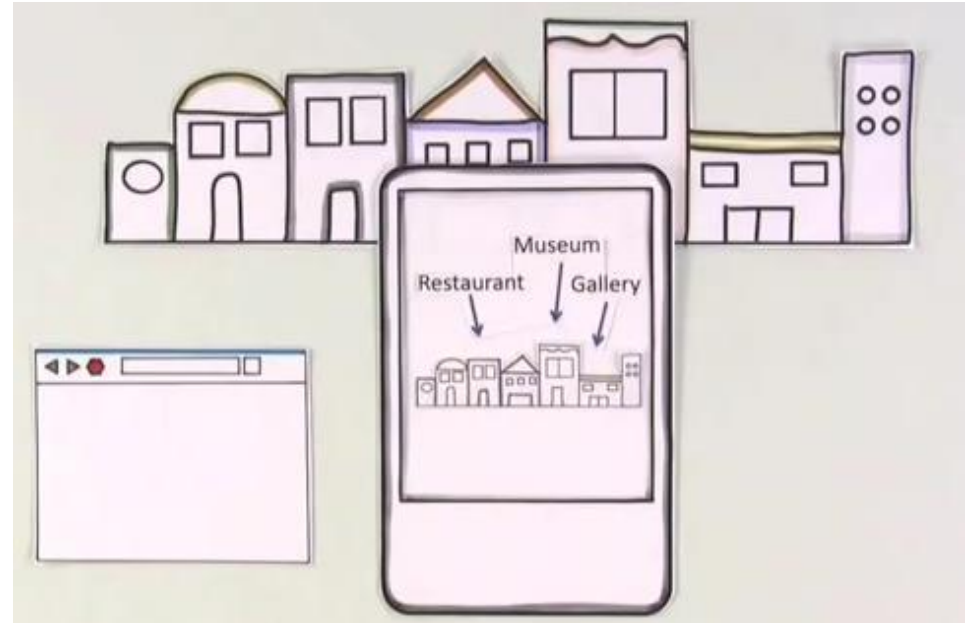
- AR : <span style="color:red">Enhances</span> Reality
  – *See-through Display*
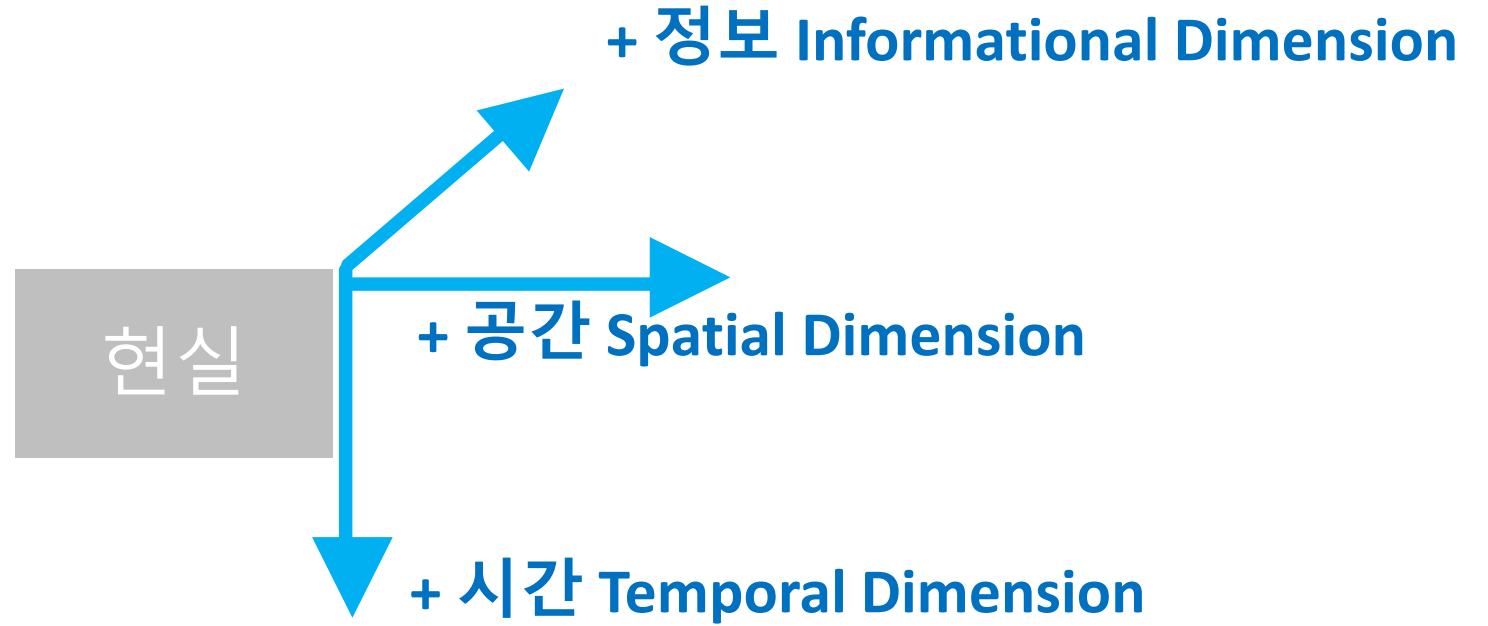
# Why AR?

- 왜 가상 공간의 정보가 필요한가?
- 현실에 없는 많은 유용한 정보가 있다

# Why AR?

- 왜 현실 공간에 붙여야 하는가?
  - 현실 공간과 연관되어야 쉽게 이해되고 가치가 증대되는 것이 많다

# VR & AR

*What for?*

현실

+ 정보 **Informational Dimension**

+ 공간 **Spatial Dimension**

+ 시간 **Temporal Dimension**

# VR & AR

정보
공간
시간


Guide/Navigation
Artworks of Mac Funamizu

Past/Current
Artworks of Mac Funamizu

Healthcare
Artworks of Mac Funamizu

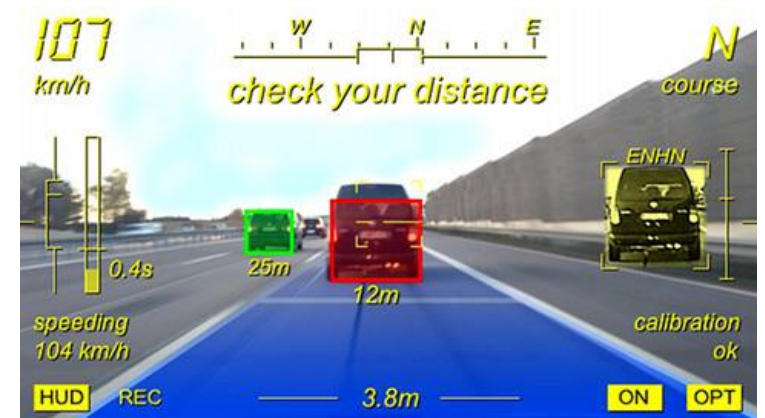Wikipedia and Dictionary
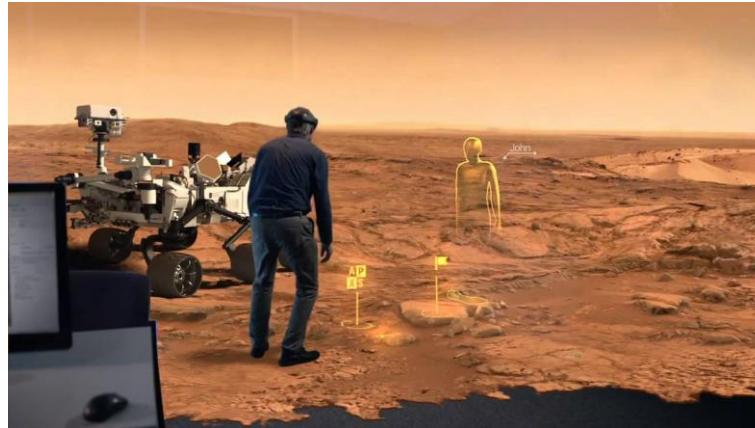Artworks of Mac Funamizu
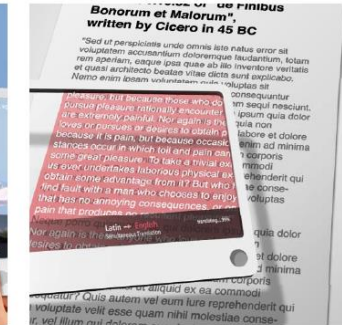
*AccuVein*

*Augmented Driving*

# VR & AR

정보
공간
시간


*Project Beyond, Samsung*


*NASA, Microsoft Collaboration Will Allow Scientists to 'Work on Mars'*


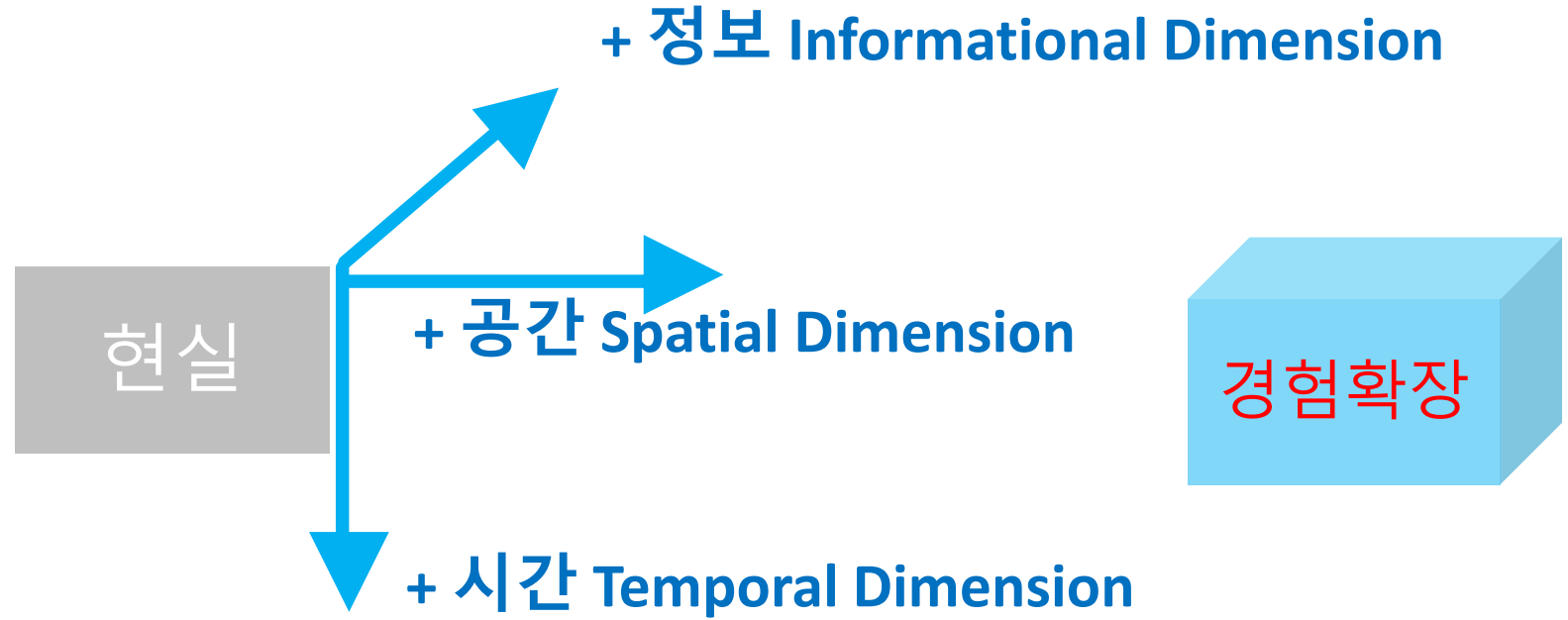*Microsoft's Illumiroom*

# VR & AR

정보
공간
**시간**


*Miralab, Univ. of Geneva*


*Expanded corning vision, Corning*

# VR & AR

*What for?*

+ 정보 **Informational Dimension**

현실

+ 공간 **Spatial Dimension**

경험확장

+ 시간 **Temporal Dimension**
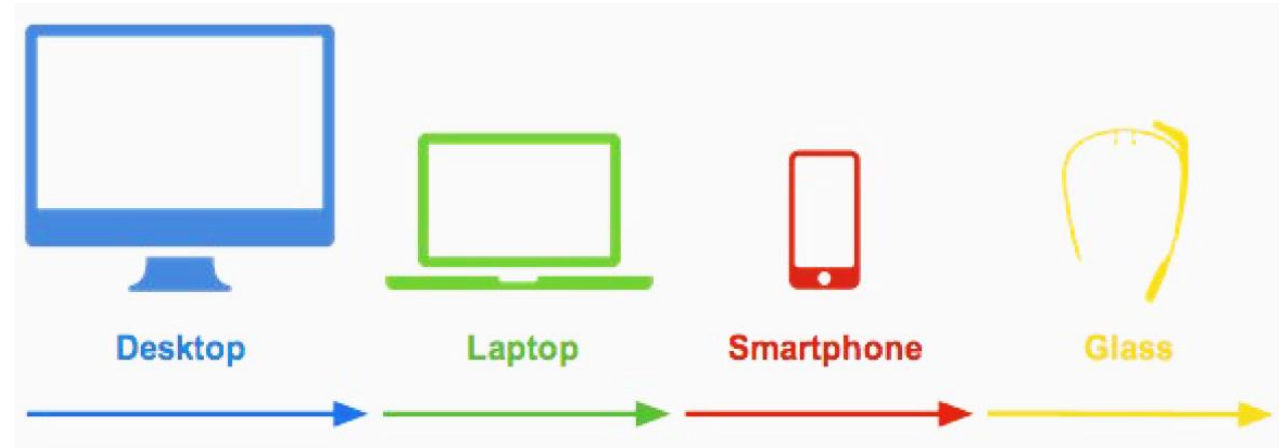
# VR & AR

## *Technologies*

- Display
- Contents
- Interaction
- Visually Aware

# VR & AR

## Technologies
### - Display

• Display



Nokia Future Technology

## Samsung's AR Vision Includes Smart Contact Lenses

*By Richard Adhikari*
*Apr 12, 2016 10:57 AM PT*

Print
Email

**S**amsung has been granted a patent for a smart contact lens, according to news reports published last week.

The lens is equipped with a tiny display, a camera, an antenna, and several sensors that detect movement and eye blinks. Eye blinks would provide the input, and a smartphone would be needed to process the images.

A user blinks to take pictures or interact with data displayed on the smart contact lens. Sensors pick up the blinks and relay the commands they indicate to the user's smartphone for processing. The results are sent back to the lens almost immediately.
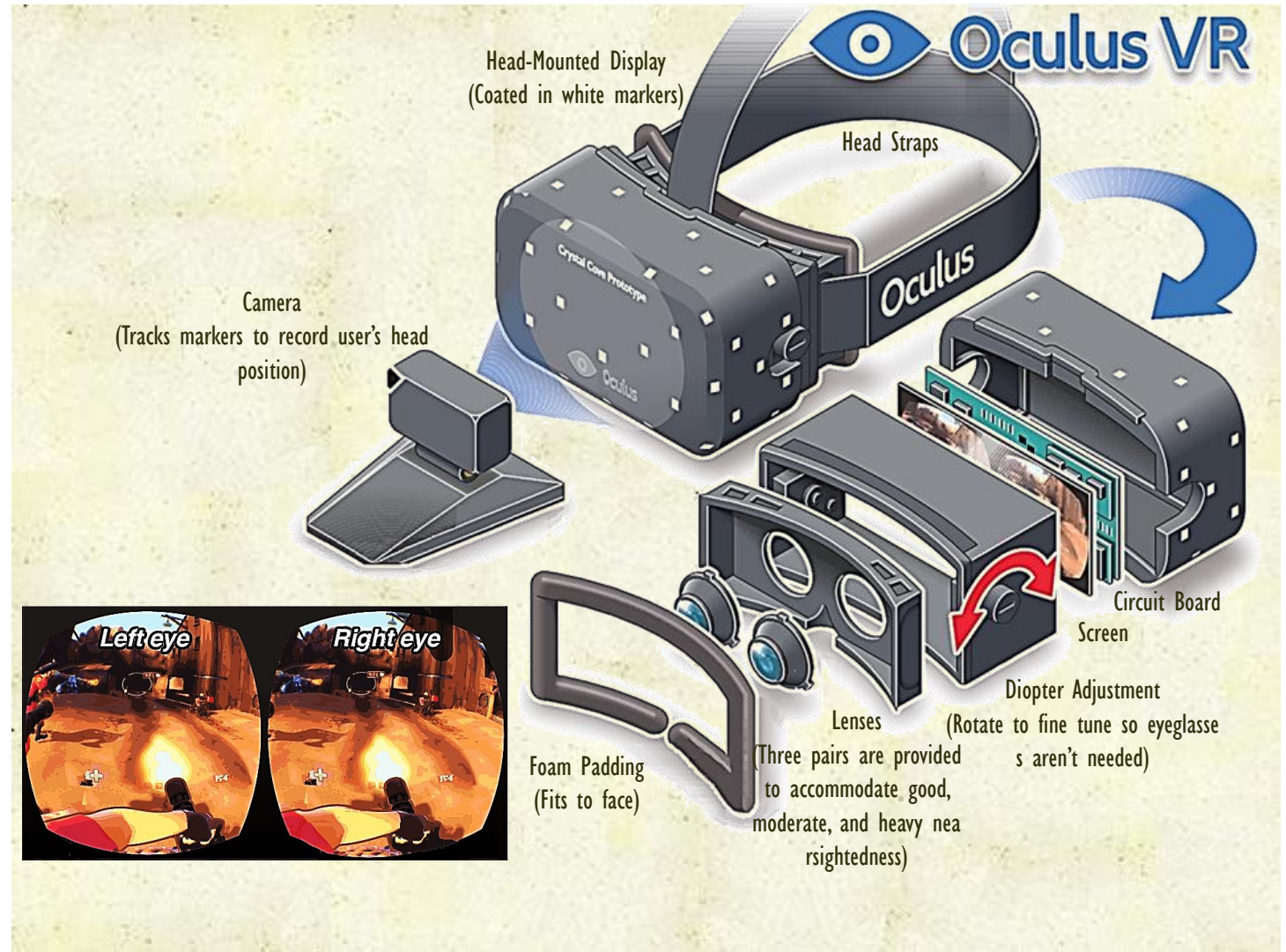
Some circuits apparently will be visible in the lens, but they are at its edge.

The patent was filed September 2014 and was approved last week by the South Korean Intellectual Property Office.

# VR & AR

## Technologies
### - Display

- Display

# VR & AR

## Technologies
## - Display

• Display



| Oculus Rift | Carl Zeiss Cinemizer | Silicon Micro Display ST1080 | Sony HMZ-T2 |
|---|---|---|---|
| 640x800 Resolution | 870x500 Resolution | 1920x1080 Resolution | 1280x720 Resolution |
| 90° Horizontal FOV | 30° Horizontal FOV | 39° Horizontal FOV | 45° Horizontal FOV |
| 13.4 Ounces | 4.2 Ounces | 6.3 Ounces | 11.6 Ounces |
| 7″ Diagonal Display | 0.39″ Diagonal Display | 0.74″ Diagonal Display | 0.7″ Diagonal Display |
| Liquid Crystal Display | Organic Light-Emitting Diode | Liquid Crystal on Silicon | Organic Light-Emitting Diode |
| $300 | $749 | $799 | $894 |

2016 Oculus Rift : 2160x1200, 90Hz,  FOV 110 °
2016 HTC Vive    : 2160x1200, 90Hz,  FOV 110 °

# VR & AR

**Technologies**
**-Contents**

- Contents
- – Image based modeling



2007, Hengel & Torr et al,
VideoTrace,
Univ. of Adelaide,
Oxford Univ
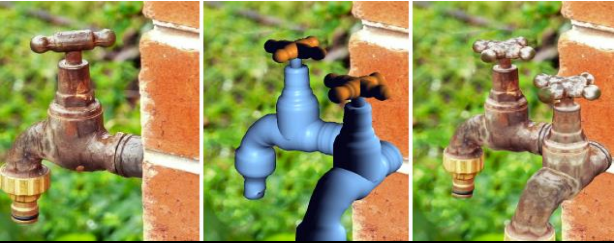


2013, Chen et al.,
3-sweep,
Tsinghua Univ.
Tel Aviv Univ.



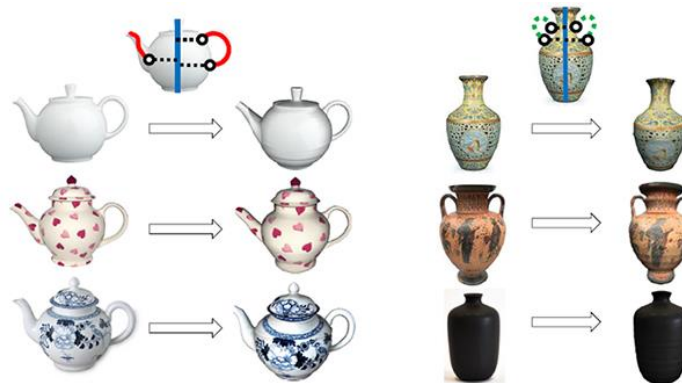## 3-Sweep: Extracting Editable Objects from a Single Photo

Submit to SIGGRAPH ASIA 2013

paperID: 0088

(This video contains voice)
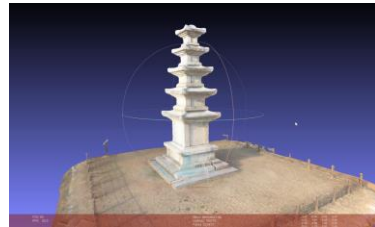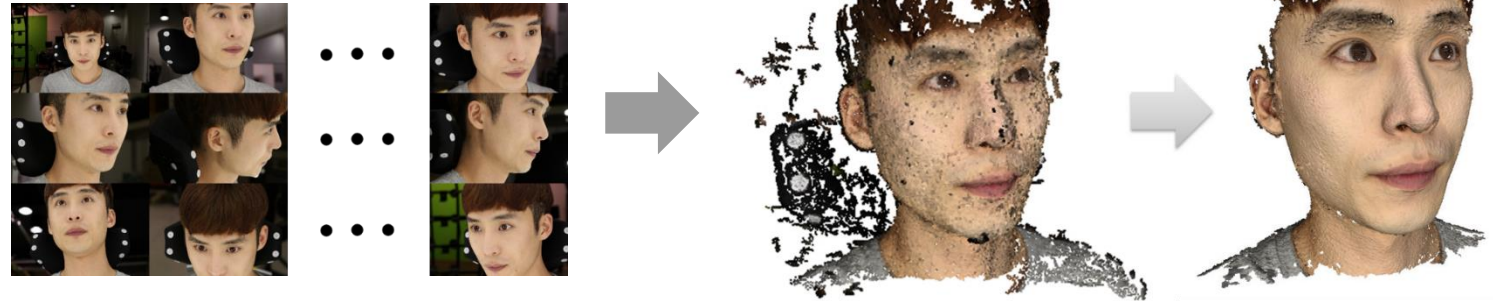


Video Trace, SIGGRAPH 2008



2015, Kim et al.,
3D Modeling from Photos
Given Topological Information,
KIST

# VR & AR

**Technologies**
**-Contents**

- Contents

  – *Image based modeling*

  - Bundler, SfM, PMVS, …





2015, Kim et al.,
KIST

# VR & AR

- Contents
  – *Depth Camera based modeling*

**Technologies**
**-Contents**



(a) Frame to frame tracking  (b) Partial loop  (c) Full loop  (d) M times duplicated loop
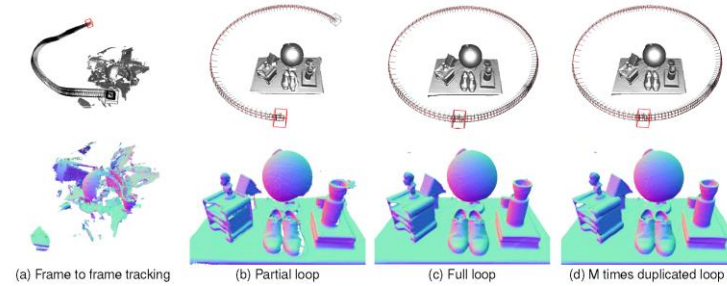


*KinectFusion (Microsoft 2012)*



Shahram Izadi
Partner Research Manager

*Holoportation (Microsoft 2016)*

# VR & AR

**Technologies**
**-Contents**

- Contents
  – *Depth Camera based modeling*

# VR & AR

## Technologies
### -Contents

- Contents
  - *Depth camera*

*Clo virtual fashion*

Live Input Depth Map    Live Model Output    Live RGB Image (unused)

Canonical Model Reconstruction    Warped Model

*Univ. of Washington*

*Softkinetic*

  - *Lightfield camera*

**Lens**
The Lytro Light Field Camera starts with an 8X optical zoom, f/2 aperture lens. The aperture is constant across the zoom range allowing for unheard of light capture.

**Light Field Engine 1.0**
The Light Field Engine replaces the supercomputer from the lab and processes the light ray data captured by the sensor.

The Light Field Engine travels with every living picture as it is shared, letting you refocus pictures right on the camera, on your desktop and online.

**Light Field Sensor**
From a roomful of cameras to a micro-lens array specially adhered to a standard sensor, the Lytro's Light Field Sensor captures 11 million light rays.

Source: http://www.lytro.com

Figure 3.2: Overview of processing the recorded light field.

Source: https://www.lytro.com/renng-thesis.pdf

https://pictures.lytro.com/

# VR & AR

- Contents
  – *Realistic rendering*

*Technologies*
*-Contents*



Liu et al. IEEE VR 2012
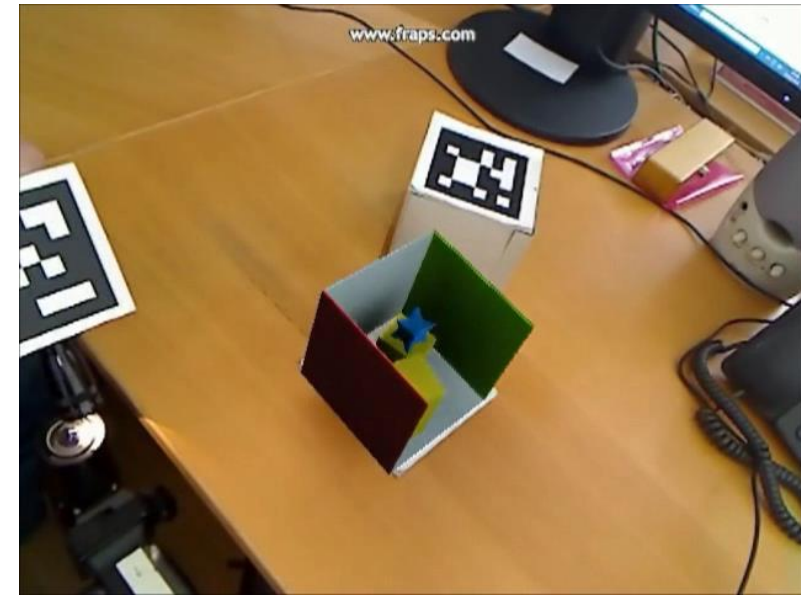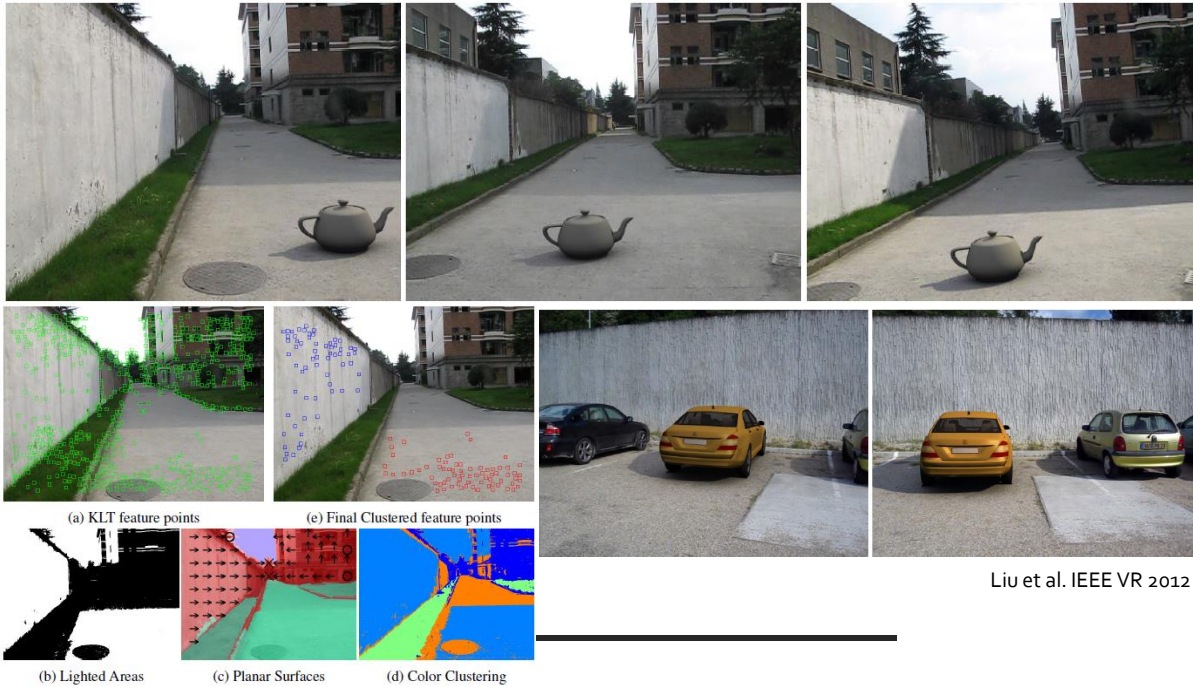
# VR & AR

## Technologies
### -Interaction

- Gesture


Film, Minority Report


Film, Ironman2

Real-time 3D Devices
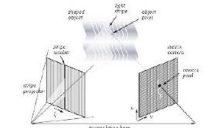
Stereo Cameras

Leap Motion (2013)

Structured Light Cameras

Kinect 360 (2009)

Time of Flight Cameras

Kinect One (2013)
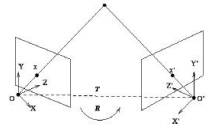
Parallax and Correspondence Matching: Sensitive to object texture, occlusions, translucency.

Correspondence Matching but projects active pattern, so texture not an issue.
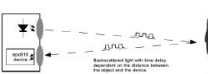
Relies on Optoelectronic delays and does not require parallax.
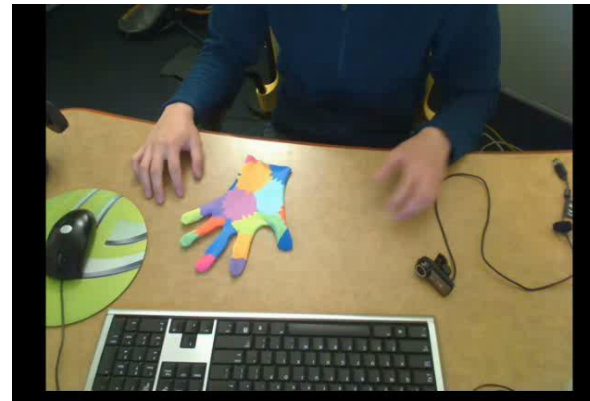

MIT Color Glove (SIGGRAPH 2009)


Can you see me?

Leap motion 2016

# VR & AR

- Device

## Technologies
### -Interaction



*Nintendo Wii, 2005*



*Sony Playstation Move, 2009*



*Microsoft Kinect, 2010*



Cyber Glove II    Cyber Touch    Cyber Grasp



*Oculus Touch, 2015*



sliding contactor bars on four sides of handle

input and motion tracking via integrated Razer Hydra

*Reactive Grip*

# VR & AR

## Technologies
### -Interaction

- Other Device


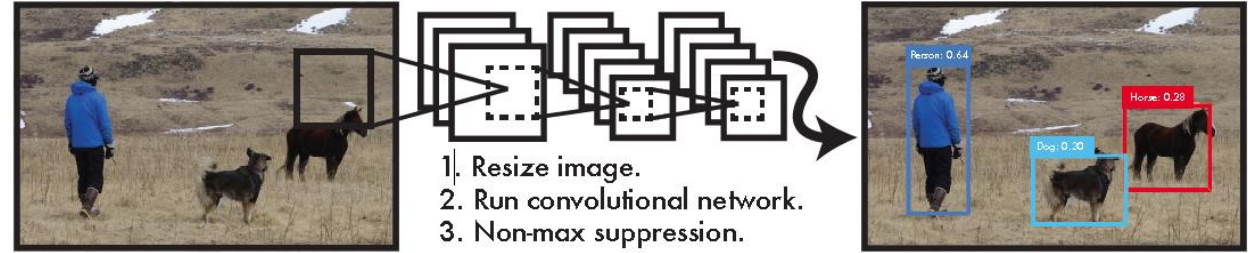Virtuix Omni


Cyberith Virtualizer


FEELREAL, Odor Generator


Metaio Thermal Touch, 2014

# VR & AR

## Technologies
### -Visually Aware

- Deep Learning 기반 객체 인식



1. Resize image.
2. Run convolutional network.
3. Non-max suppression.
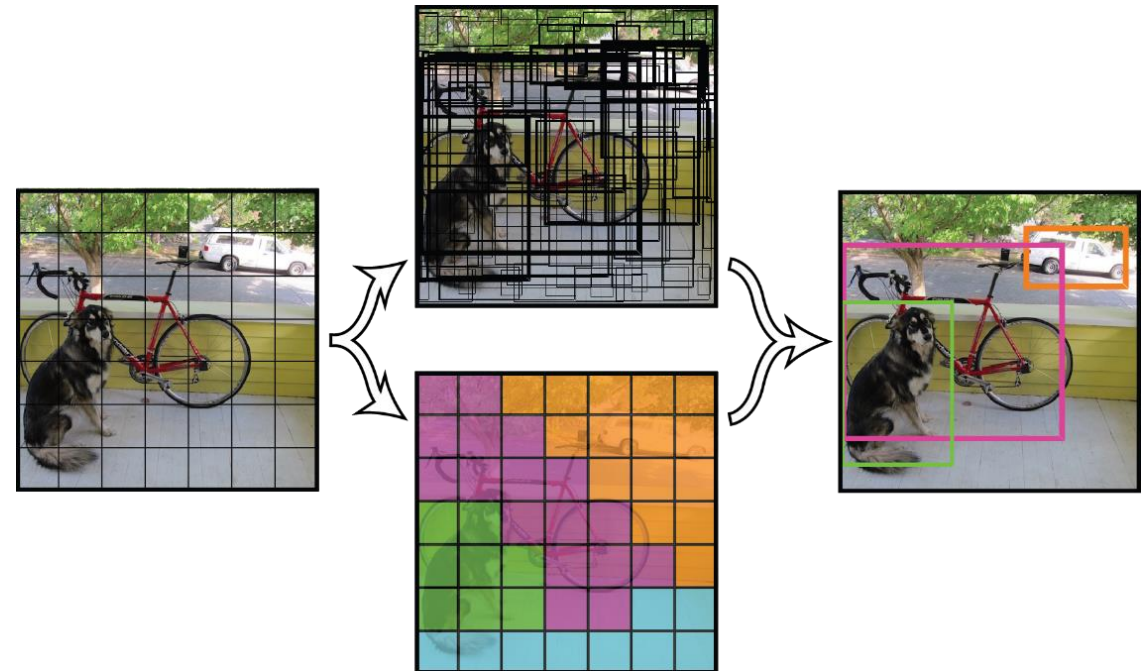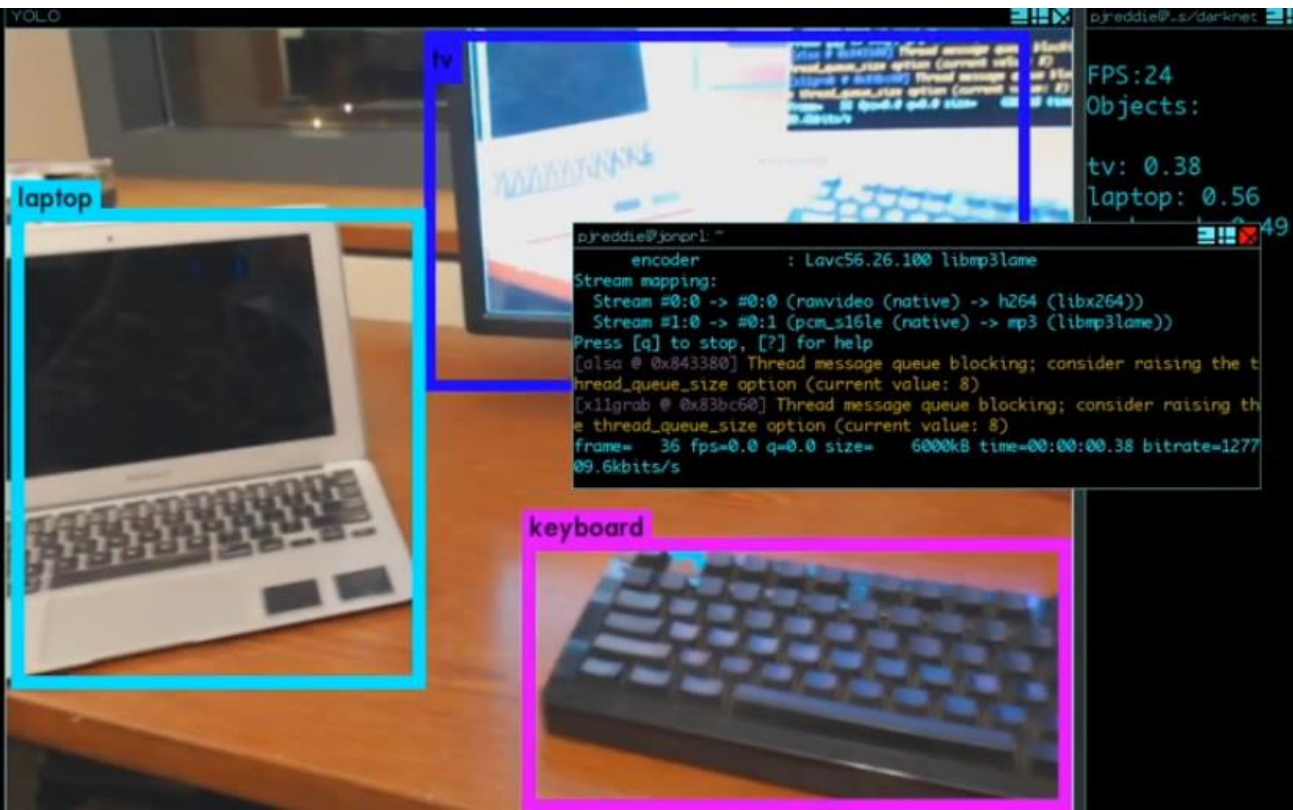
# VR & AR

## Technologies
### -Visually Aware


*Intel*

- Tracking

- *Single camera, Stereo Camera, Depth Camera, Hybrid …*
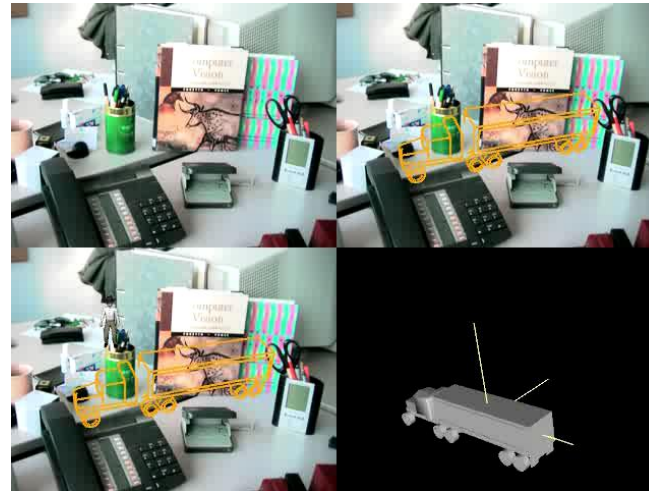

*Fraunhofer*
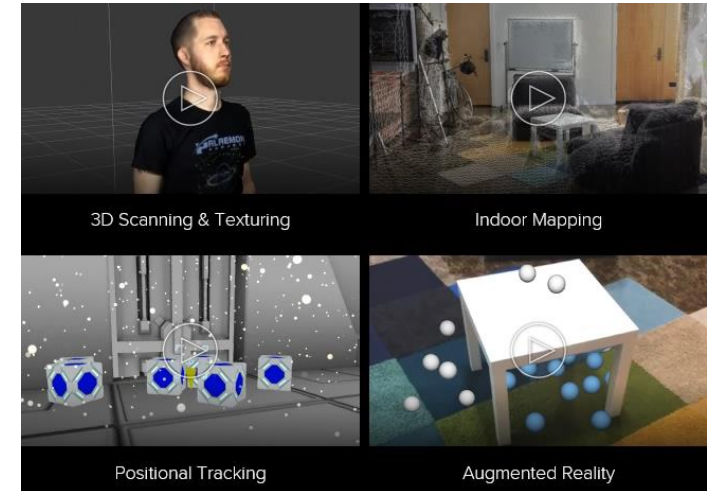

*Structure IO*
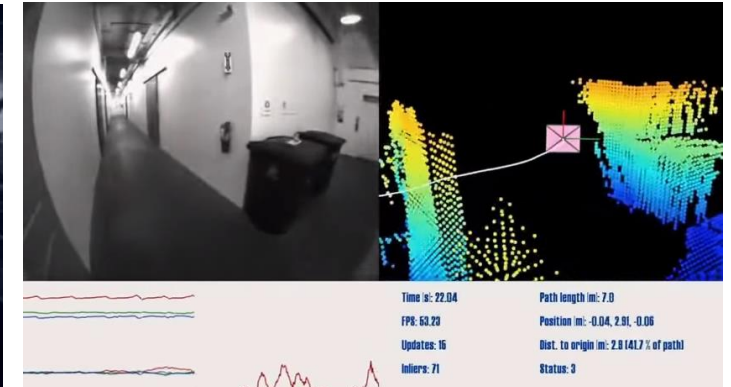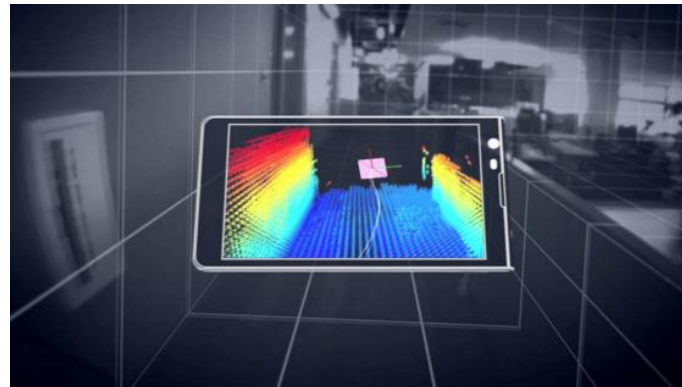



*Google*

# VR & AR

## Technologies
### -Visually Aware

- Tracking@VR

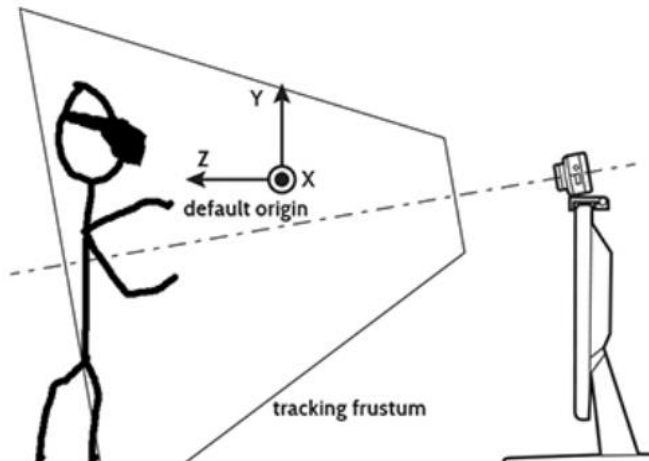① Positional Tracking



HTC's Lighthouse Station
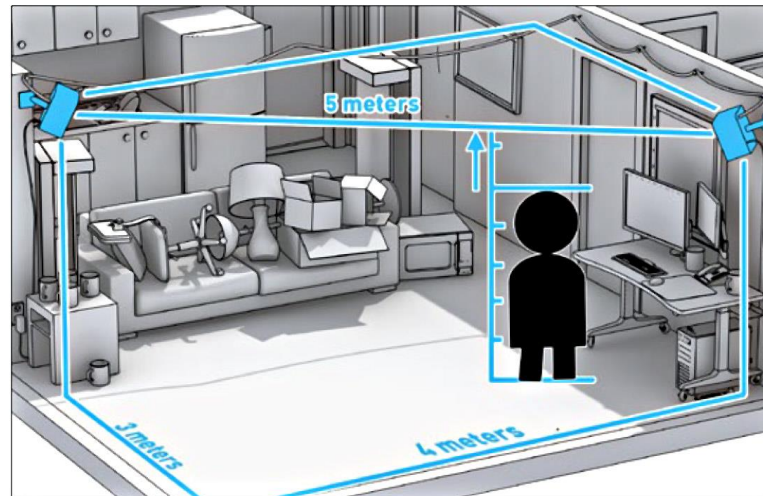
# VR & AR

## Technologies
### -Visually Aware
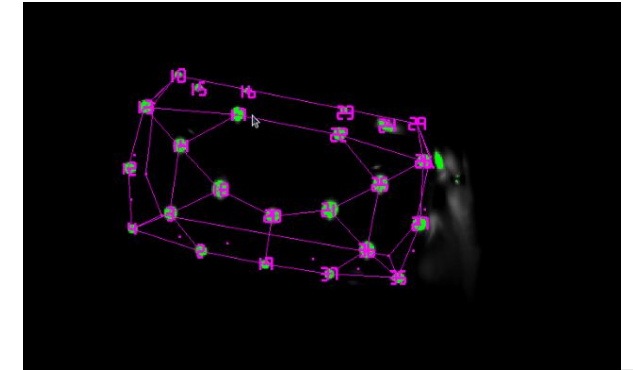
## Positional Tracking

- External camera, pointed at user

- 80° x 64° FOV

- ~2.5m range
- ~0.05mm @ 1.5m

- ~19ms latency
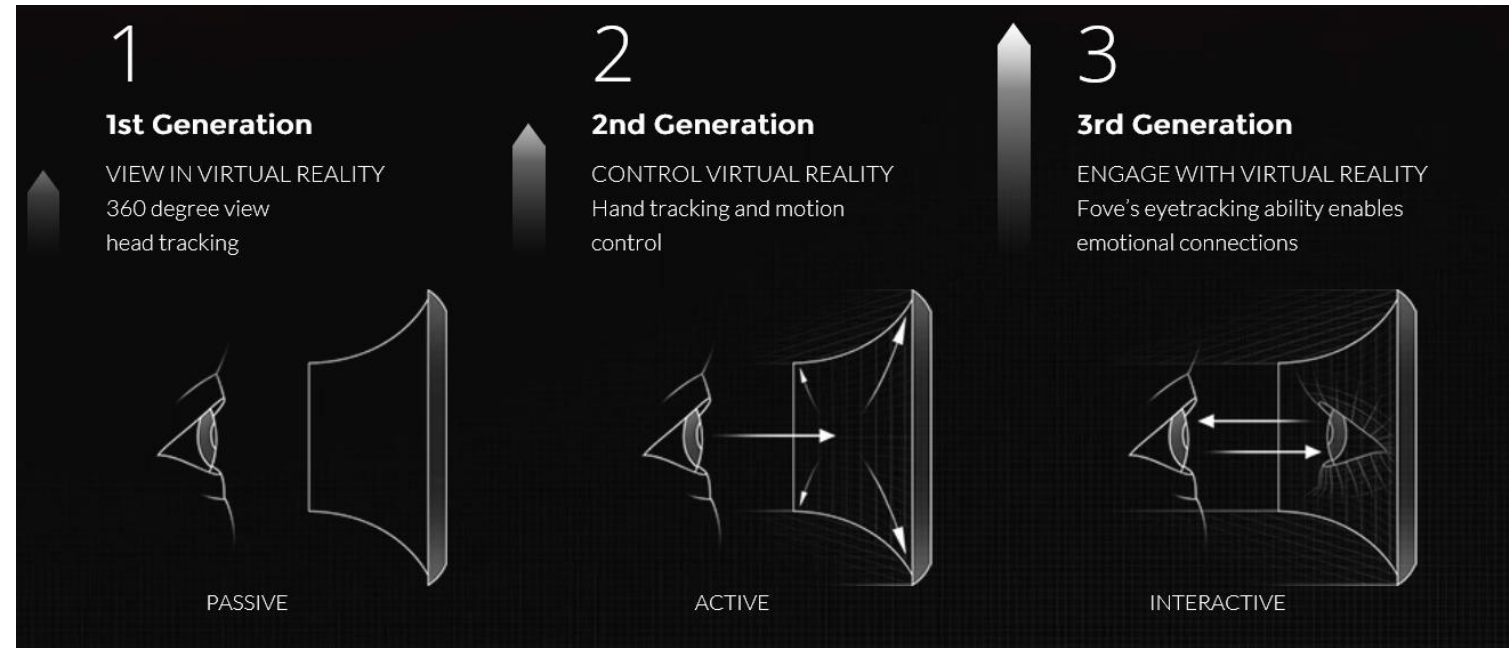  - Only 2ms of that is vision processing

# VR & AR

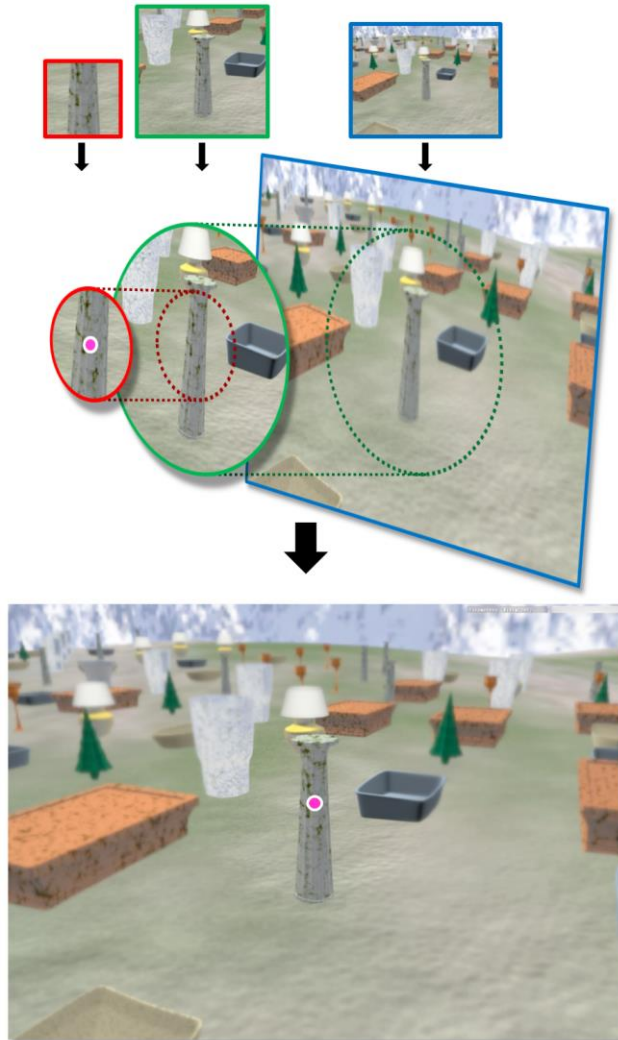## Technologies
### -Visually Aware
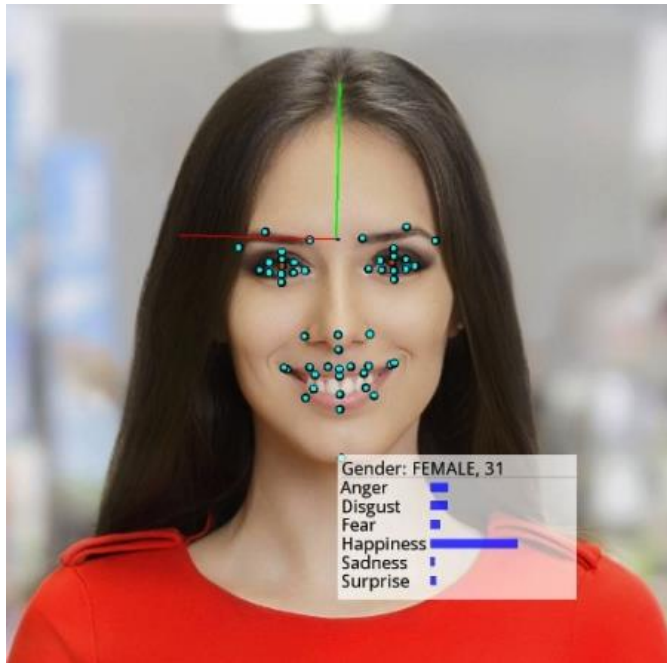
- Tracking@VR
① Eye Tracking

# VR & AR

## Technologies
### -Visually Aware

- Tracking@VR

① Eye Tracking

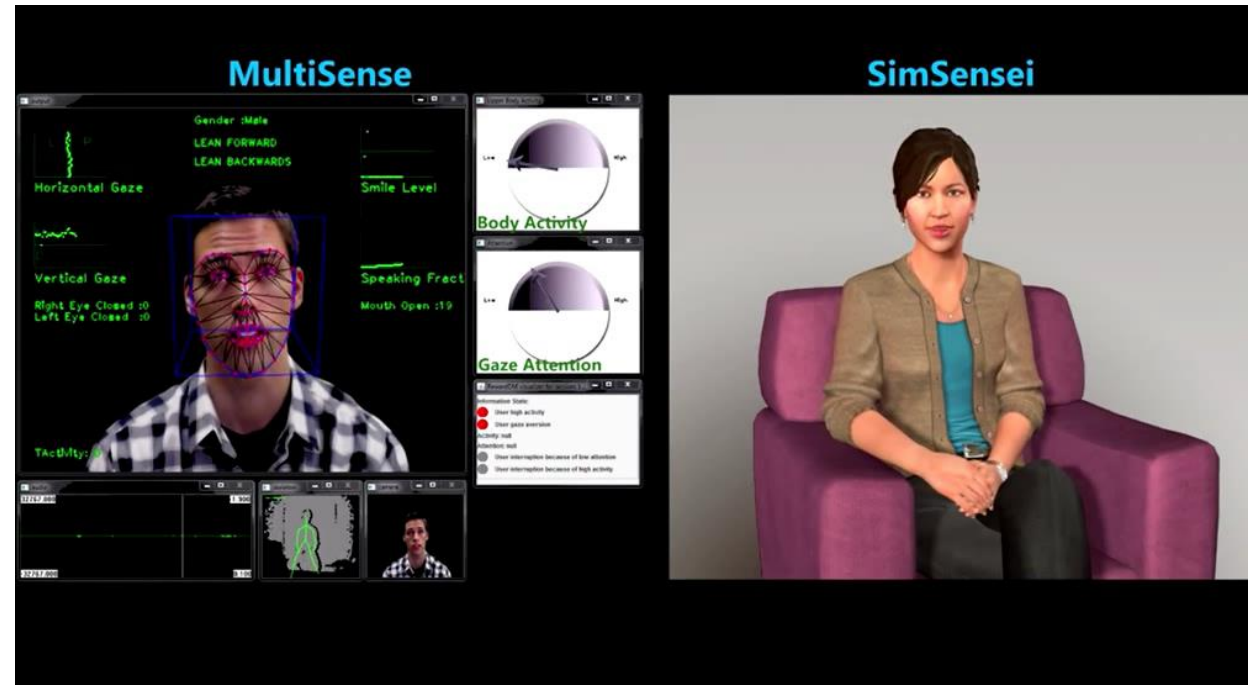② Rendering speed improvement by Foveated Rendering



Song: Going Home - Trevor Lentz

# VR & AR

## Technologies
### -Visually Aware



Gender: FEMALE, 31
Anger
Disgust
Fear
Happiness
Sadness
Surprise

- Emotional & Behavior Analysis

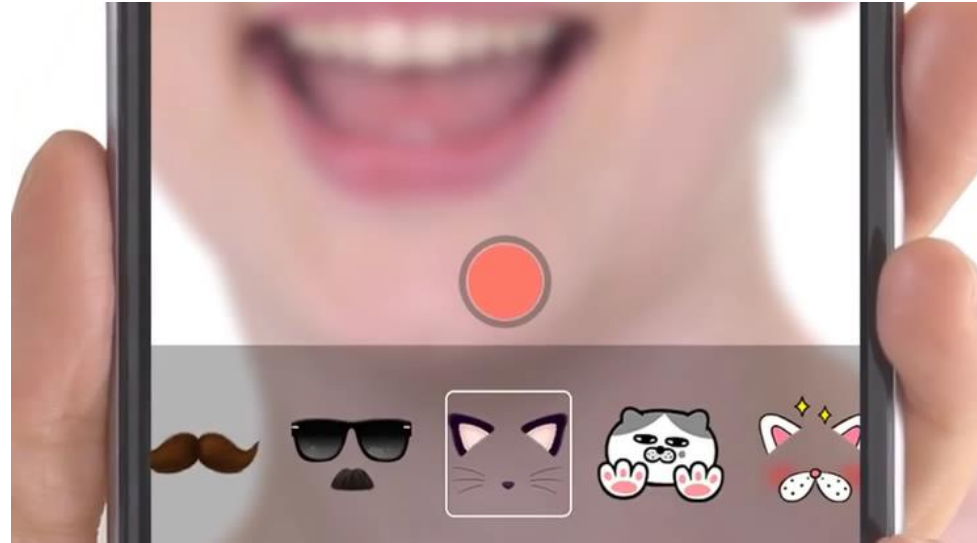Virtual human and multimodal perception for healthcare support



*SimSensei, USC ICT 2011~*

# VR & AR

## Technologies
### -Visually Aware
### -Applications

- Visually Aware



Line Camera

# VR & AR

## *Technologies*
*-Visually Aware*
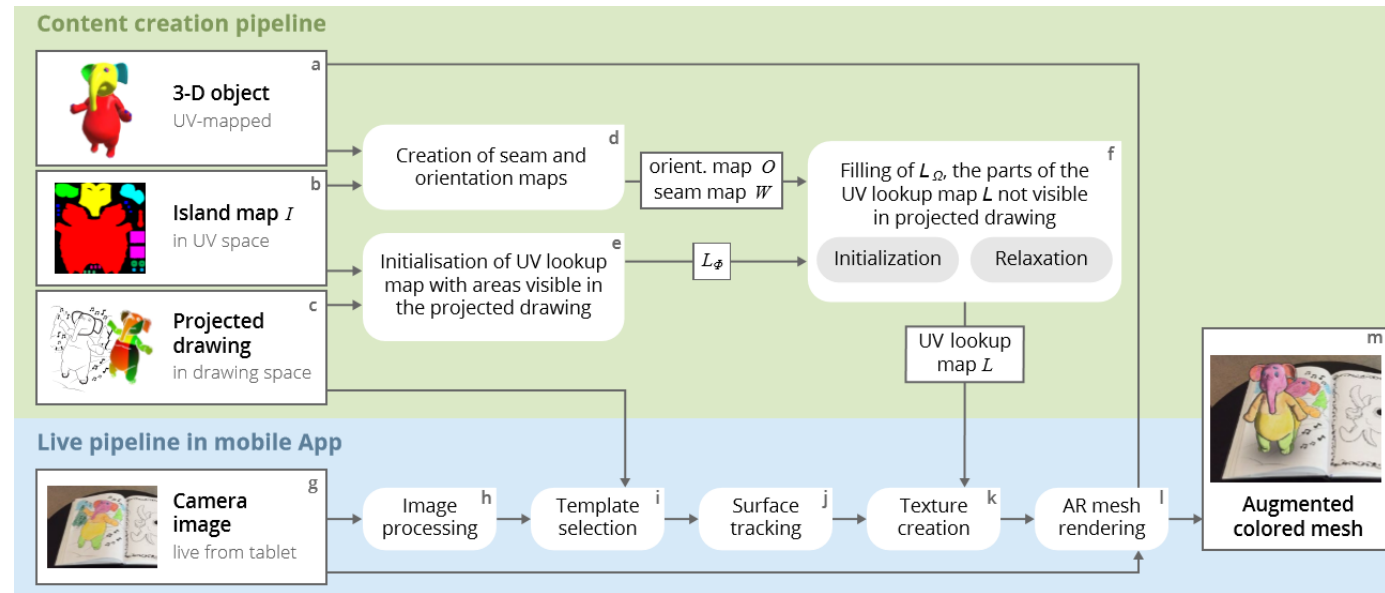*-Applications*

- Visually Aware



*Colar, HITlab NZ*



*Disney Research*

# VR & AR

## Technologies
### -Visually Aware
### -Applications

• Visually Aware
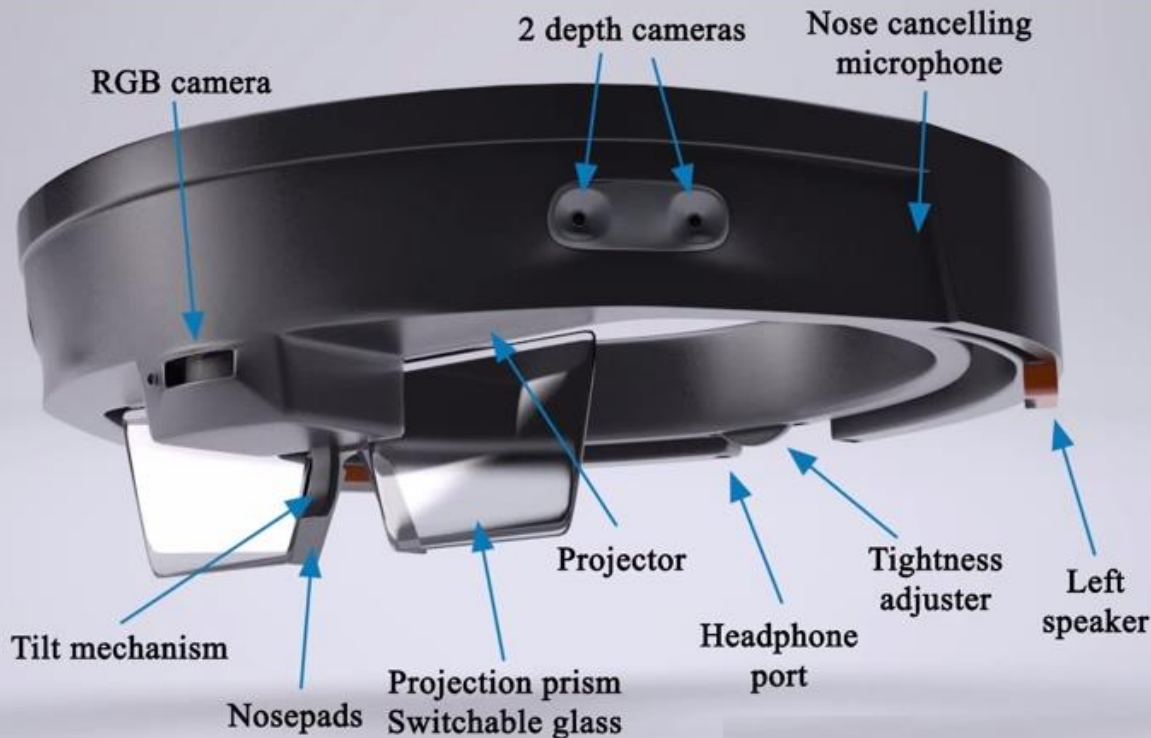




*Disney Research*

# VR & AR

**Technologies**
*-Applications*

- Microsoft Hololens

# VR & AR

- Microsoft Hololens

**Technologies**
**-Applications**



## HoloLens Hardware Specifications

| | |
|---|---|
| OS | Windows 10.0.11802.1033 32-bit |
| CPU | Intel Atom x5-Z8100 1.04 GHz Intel Airmont (14nm) 4 Logical Processors 64-bit capable |
| GPU/HPU | HoloLens Graphics |
| GPU Vendor ID | 8086h (Intel) |
| Dedicated Video Memory | 114 MB |
| Shared System Memory | 980 MB |
| RAM | 2GB |
| Storage | 64GB (54.09 GB available) |
| App Memory Usage Limit | 900 MB |
| Battery | 16,500 mWh |
| Camera Photos | 2.4 MP (2048x1152) |
| Camera Video | 1.1 MP (1408x792) |
| Video Speed | 30 FPS |

# VR & AR

## Technologies
### -Applications

- Microsoft Hololens
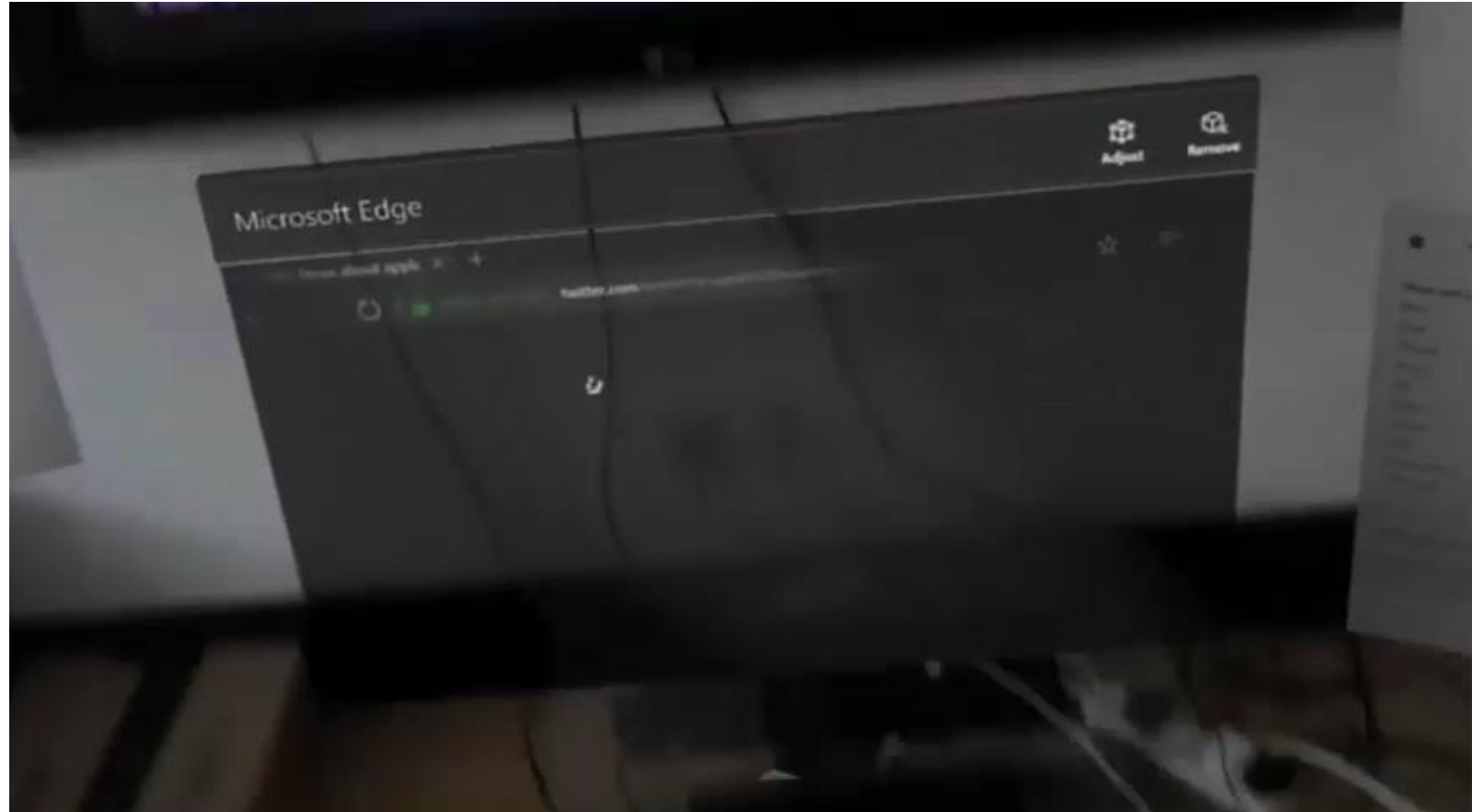
# VR & AR

## *Market*
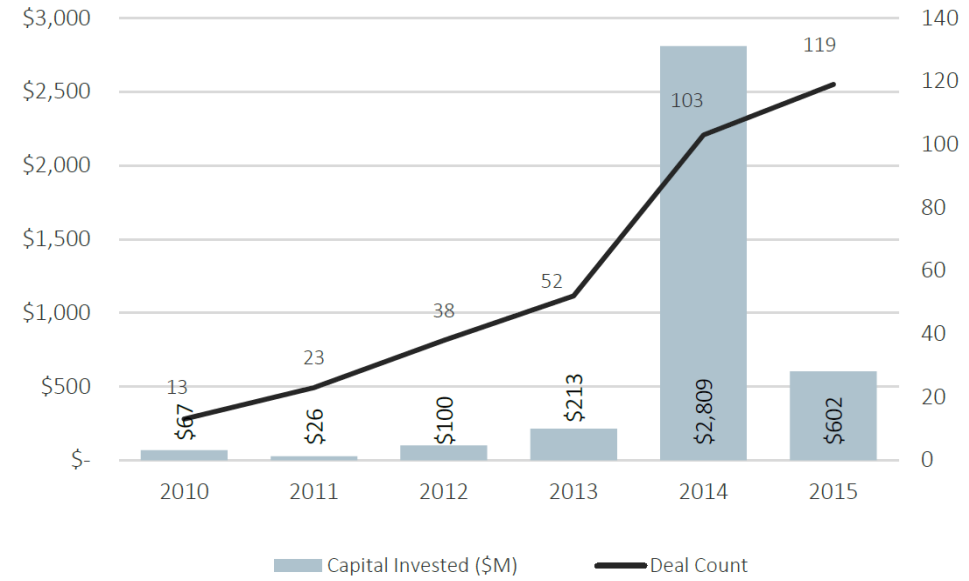


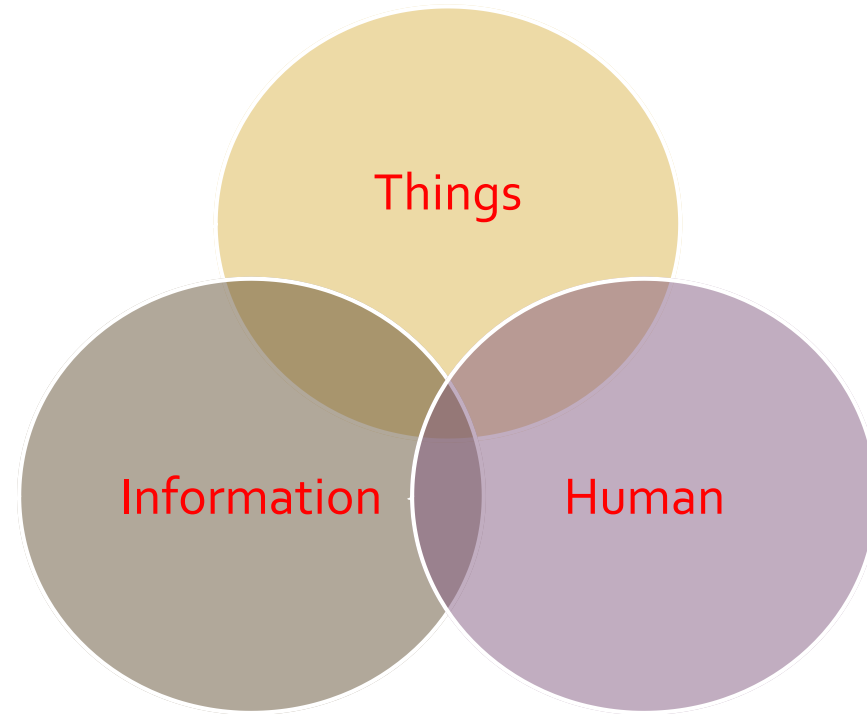연도별 VR/AR Deal Flow and 투자금액
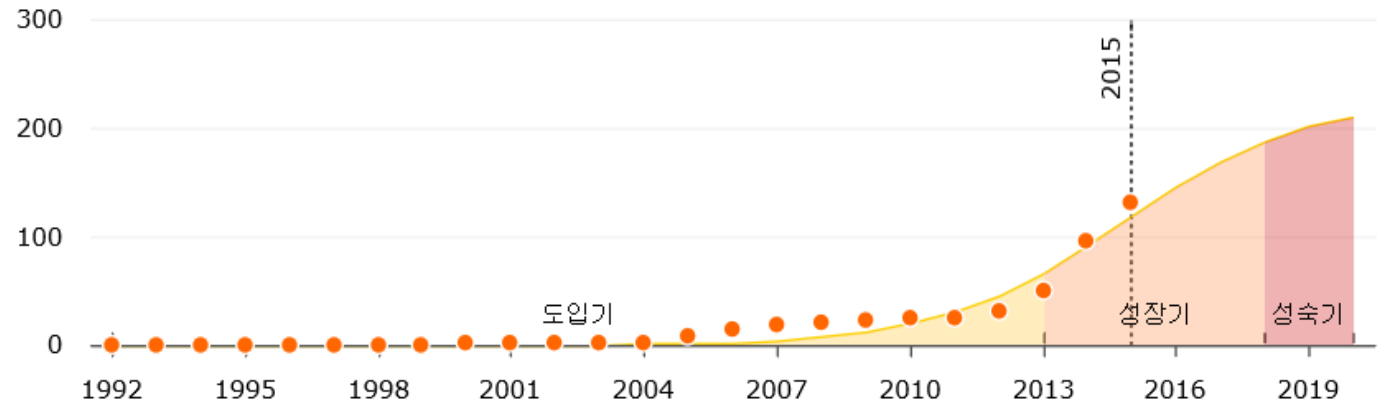


VR, AR 기술의 성장성 예측

*TOD 2016, http://tod.kisti.re.kr*

# AR+VR

2<sup>nd</sup> Eye, 6<sup>th</sup> Sense

# Q&A

Email : drjay@kist.re.kr
http://www.imrc.kist.re.kr/~kij

Things

Information

Human

THE BEST WAY TO PREDICT THE FUTURE... IS TO CREATE IT