# The Challenges and Advances in Mixed Reality Video Technology


Photo: https://thevrbase.com

Richard A. Kramer, Aashutosh Y. Taikar, Surabhi Tushar Godambe,
Haya Alorayj, Warit Paweenbampen

Oregon State University

# The Challenges and Advances in Mixed Reality Video Technology

What would be *the ultimate display?*

"*The ultimate display would, of course, be a room within which the computer can control the existence of matter*" *Ivan Sutherland, 1965 [4]*

**Thus the concept of Mixed Reality was born!**

# The Challenges and Advances in Mixed Reality Video Technology


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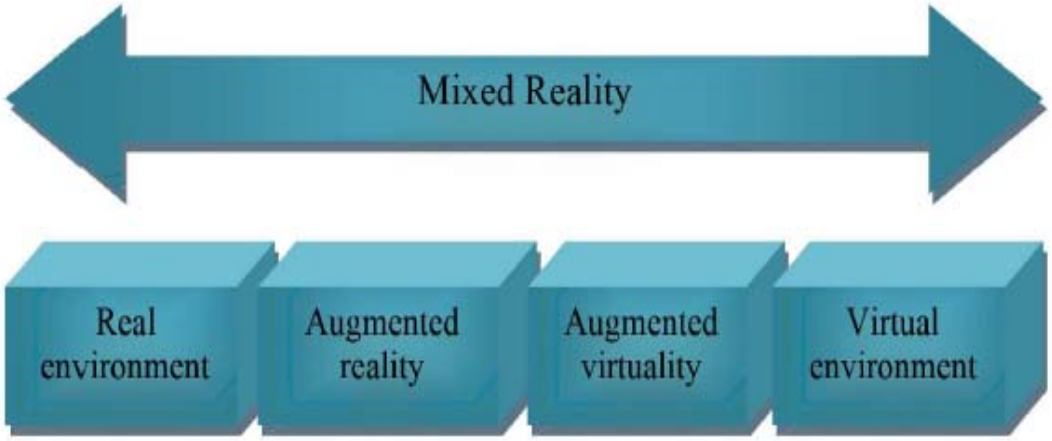
# What is Mixed Reality?

There is a continuum of virtual experiences that starts with our "Real environment"




- **"Augmented reality"** augments our reality with, for example, a holographic image of a real device
- **"Augmented virtuality"** combines both real world and virtual elements to create a hybrid real-world/virtual experience
- **A full "Virtual environment",** is often generally referred to **as "Virtual Reality" (VR).**

***We collectively refer this continuum of virtual experiences, which often intermix, as "Mixed Reality" (MR) overall.*** [4]

# So today, we would like to take you a journey

From here…

*Ruins of the Temple of Hera in Greece*

To here…


And finally – here.

*It is not an easy journey, or otherwise it would not have taken 52 years*

[42,43]

# Taking you to the forefront of the challenges and advances in Mixed Reality video technology

**Agenda and Motivation:**

**Mixed Reality image capture technology**

***Because accurately linking the objects to video is most critical!***

**Mixed Reality encoding technology**

***Expanding HEVC (High Efficiency Video Coding) technology for MR***

**Mixed Reality display technology**

***Ranging from $5.95 to thousands of dollars!***

**Other Advanced Mixed Reality Applications and Breakthroughs**

[28,39,41]

# Agenda

**Mixed Reality image capture technology**

Mixed Reality encoding technology

Mixed Reality display technology

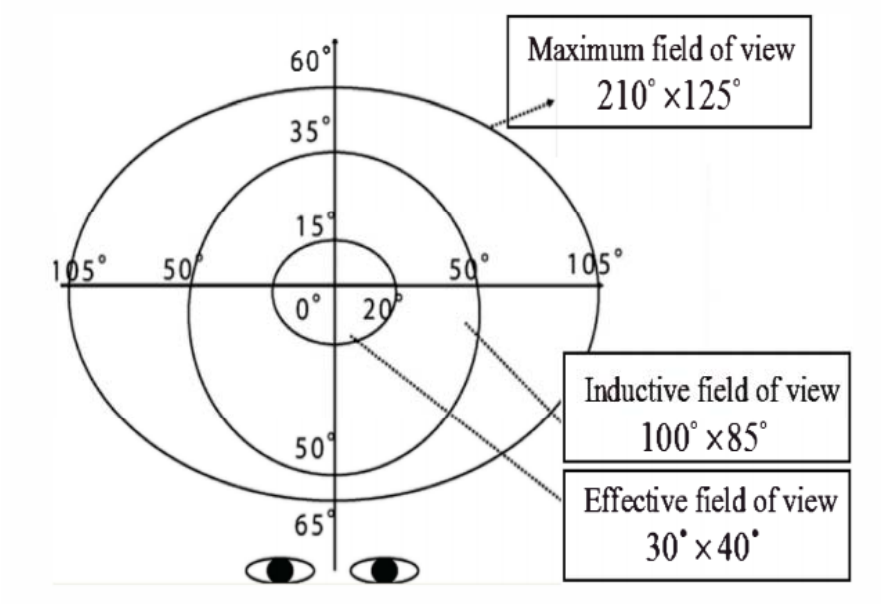
Other Advanced Mixed Reality Applications and Breakthroughs

Conclusion

# Mixed Reality Image Capture Technology

## Vision Mapping

- Effective field of view
- Inductive field of view

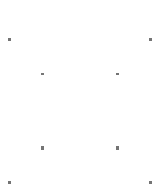



[10]

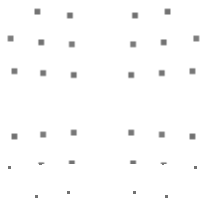
# Mixed Reality Image Capture Technology

Image processing

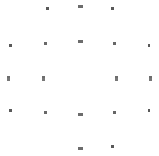
- Radial Distortion



Barrel



Pincushion



Mustache

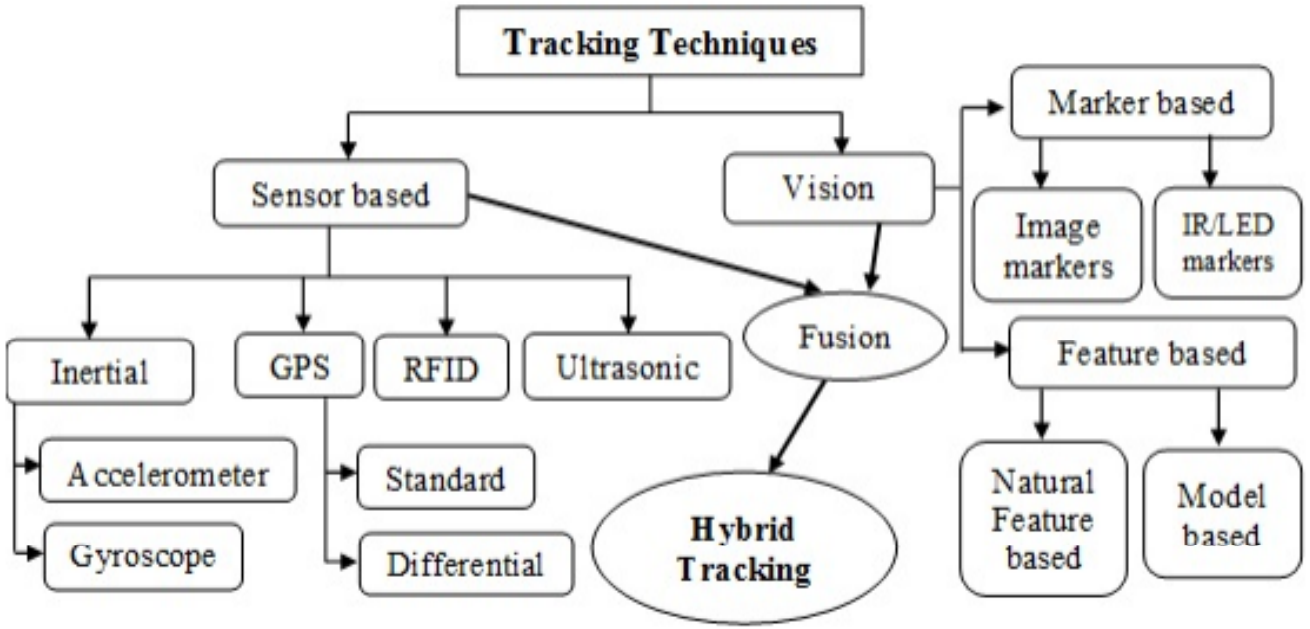
- Peripheral Distortion
- Blur caused by object oriented in a different angle

[11]

# Mixed Reality Image Capture Technology

Tracking and positioning in video for Mixed Reality

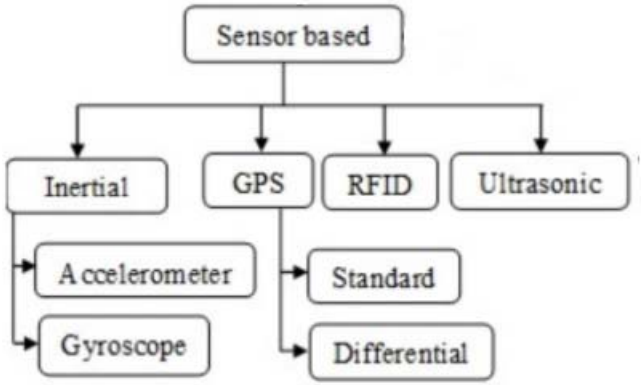
1. Sensor Based
2. Vision based
3. Hybrid tracking

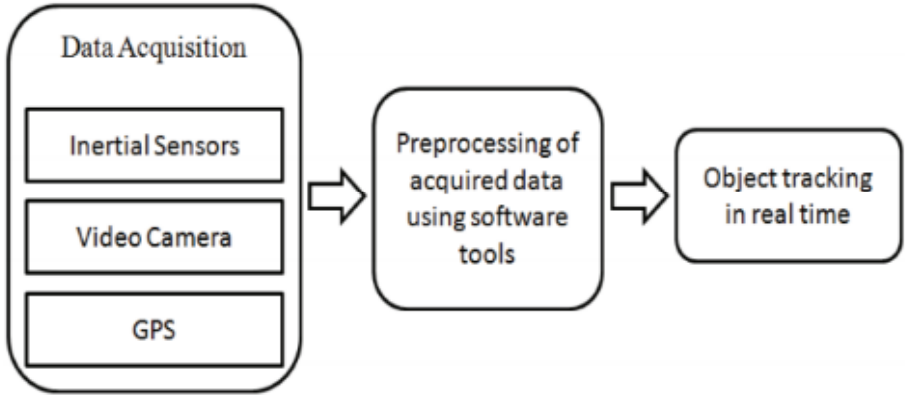



[11]

# Mixed Reality Image Capture Technology

- Sensor Based Tracking
- Sensors coupled with camera are used to track various parameters related to the orientation of camera.



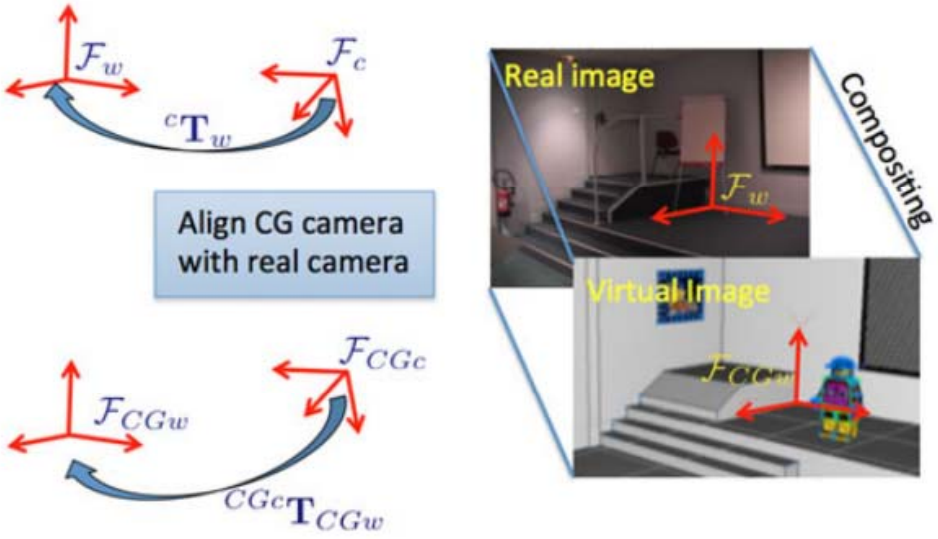

[3]

# Mixed Reality Image Capture Technology

- Vision Based Tracking

- Marker-based

- Marker-less




[3]

# Mixed Reality Image Capture Technology

- Hybrid Tracking
- Sensor based + Vision based
- Better accuracy
- Higher latency

[12]

# Agenda

Mixed Reality image capture technology

**Mixed Reality encoding technology**

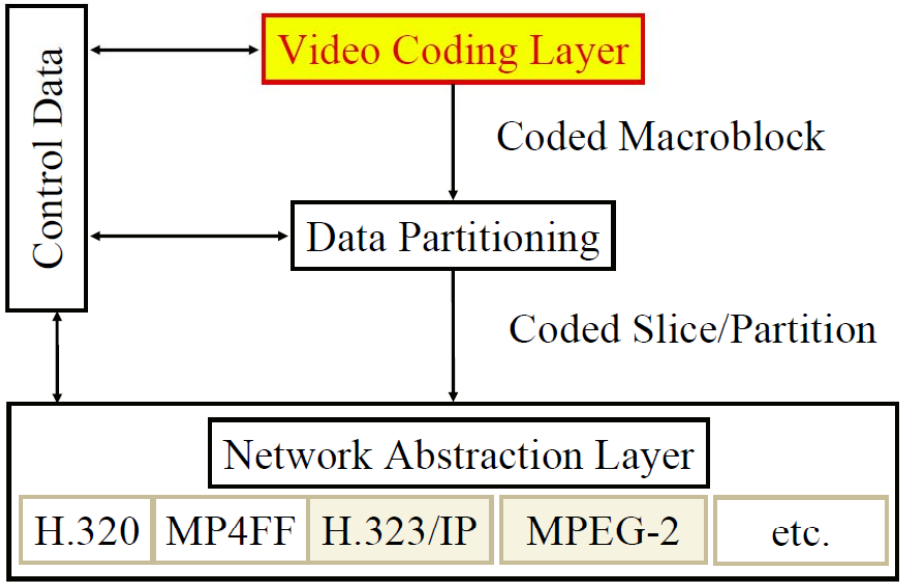
Mixed Reality display technology

Other Advanced Mixed Reality Applications and Breakthroughs

Conclusion

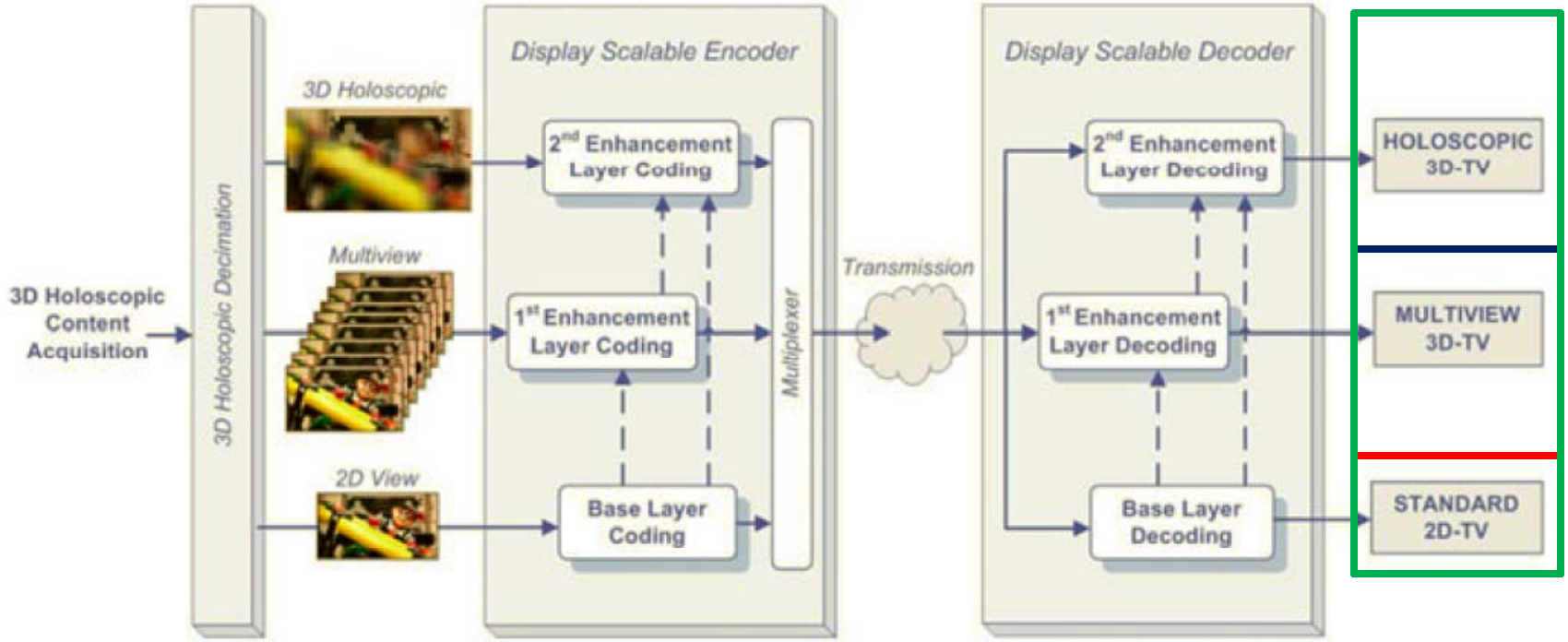
# Video Coding Layering

- Modern day video CODEC encode video into layers
- The base layer is always used
- Layering is based on  NAL (Network Abstraction Layers)NAL
- Based on the capabilities of the decoder, the layers can be used or discarded




[44, 45, 46]

# Proposed enhancement layers for MV




[5]

# Mixed Reality Encoding Technology

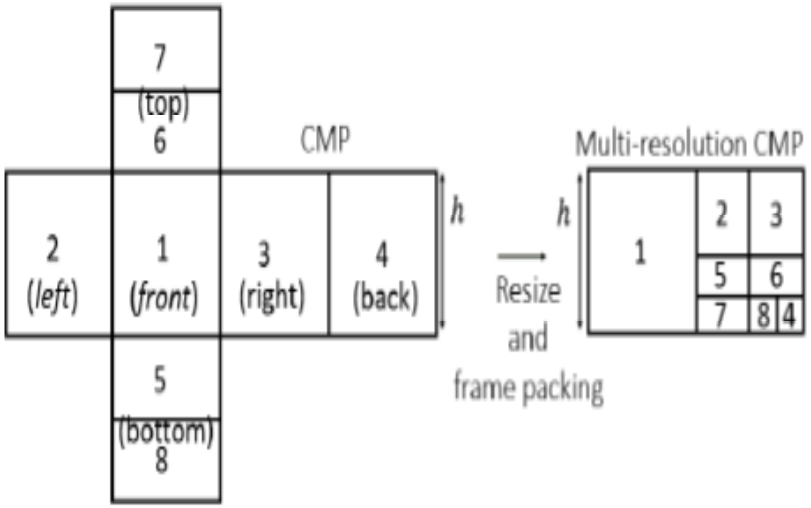
Encoding the MR video streams using standard encoders require the videos to be in a planar 2-D format and not in a 3-D immersive environment

Mapping Techniques

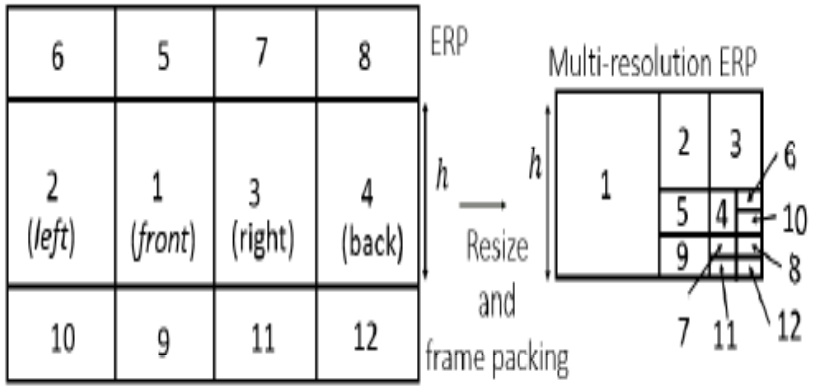
- Uniform Quality Mappings
- Non Uniform Quality Mappings

[14]

# Viewport Adaptive Encoding



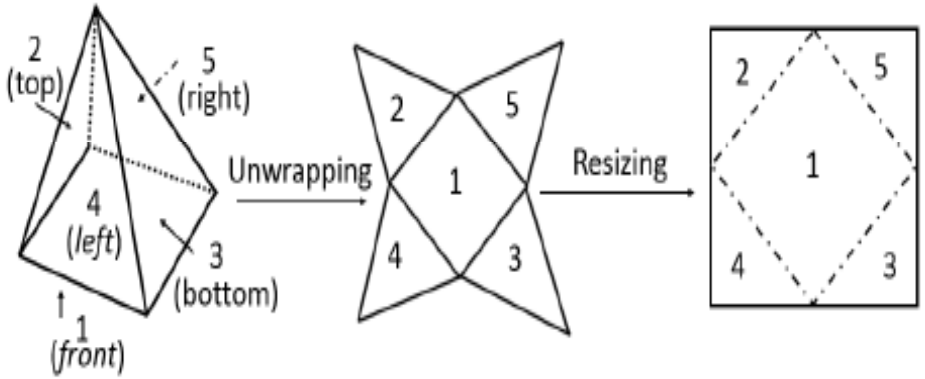

Multi-resolution Cubemap Projection



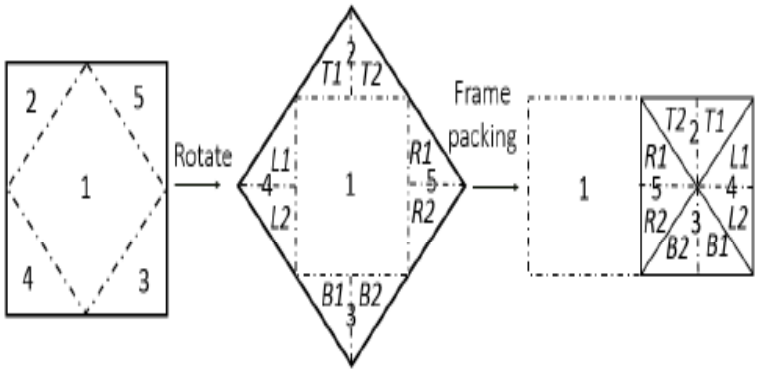

Equirectangular Projection

[15]

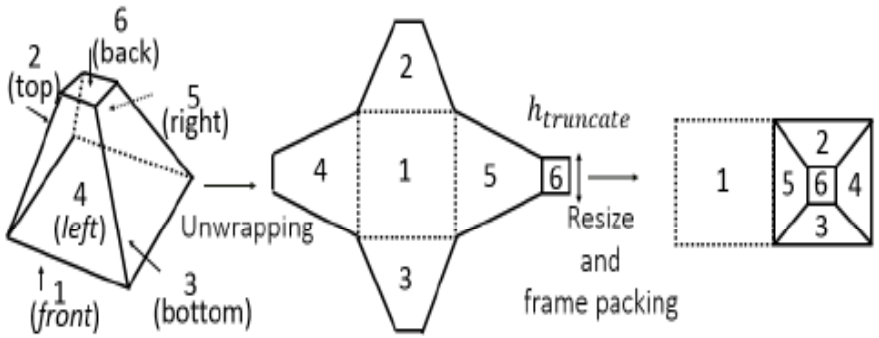
# Viewport Adaptive Encoding




Pyramidal Mapping and Projection



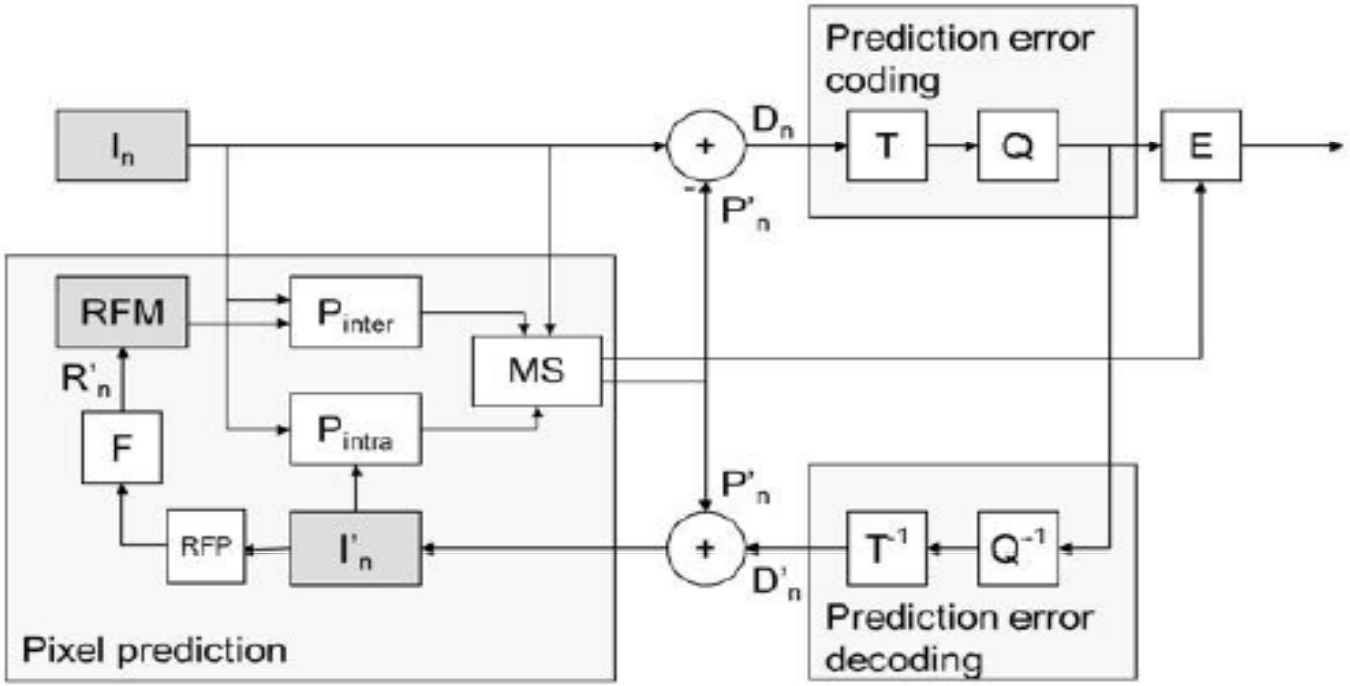

Truncated Pyramidal Mapping and Projection




Square Pyramidal Mapping and Projection

[15]

# Object Based Encoding




Proposed Encoder Block Diagram

RFM: Reference Frame Memory
F: Information Filter
RFP: Reference Frame Padding

[16]

# Object Based Encoding

Pseudo-cylindrically projected original bear attack sequence

Boundary block padded

Manipulated reference frame

[16]

# Agenda

Mixed Reality image capture technology

Mixed Reality encoding technology

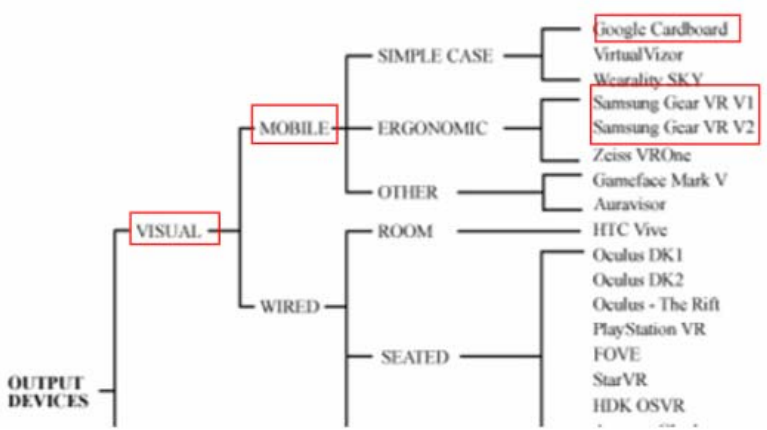
**Mixed Reality display technology**

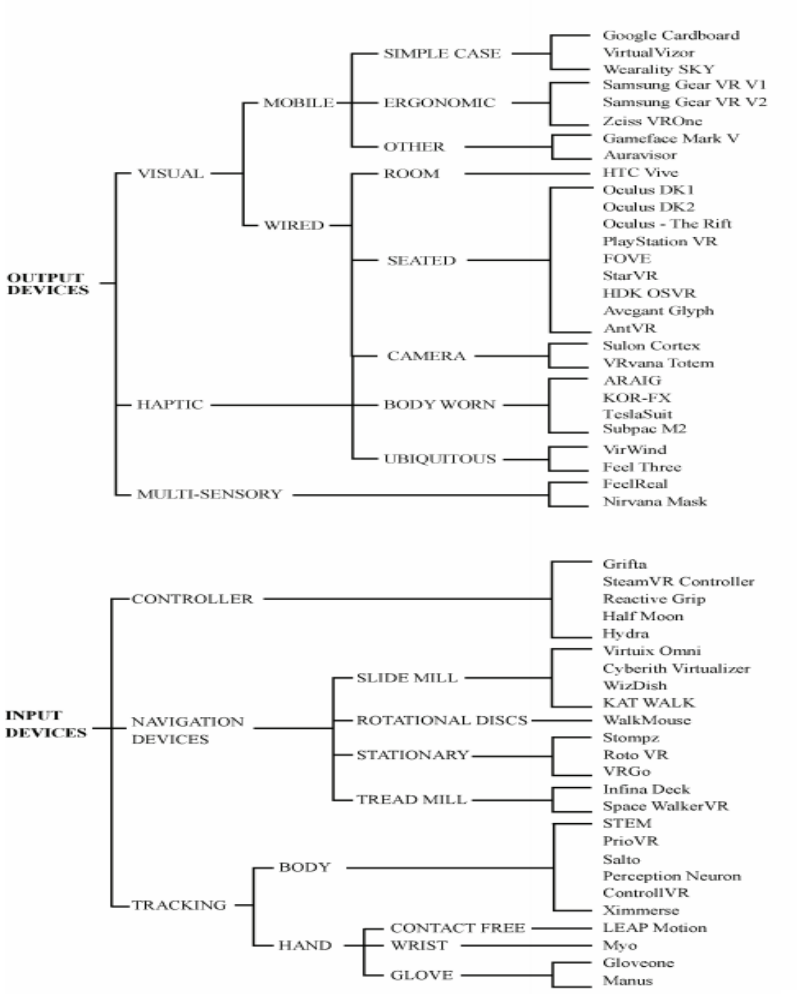
Other Advanced Mixed Reality Applications and Breakthroughs

Conclusion

# Mixed Reality Display Technology

## Mixed reality technology categories




[18]

# Mixed Reality Display Technology

Google Cardboard:

1. Portable
2. Affordable price
3. Compatible with most smart phones

- Display: two frames become one scene

| Condition | Level of control (travel is in the direction of gaze) |
|---|---|
| Continuous motion | No control of travel |
| Magnetic switch | Travel can be stopped and started using toggle switch |
| Bluetooth controller | Direct control of forward and backward travel |

[20, 21, 22]

# Mixed Reality Display Technology

Samsung Gear VR:

1. Portable.
2. Affordable price.
3. Touchpad
4. Inertial Measurement Unit
5. USB port to charge it.


*Figure 20: Gear VR[25]*

*Garbage classification[26]*

[25, 26]

# Mixed Reality Display Technology

## Evaluation between Google Cardboard and Gear VR

| | Google Cardboard | Samsung Gear VR |
|---|---|---|
| **Size** | Both of them have portable. | |
| **Cost** | Both of them have affordable price | |
| **Included tools** | Headset | Headset + touchpad |
| **Smart phone** | Works on most of smart phone platform. | Works only on Samsung Galaxy phones |
| **Control** | Limited control ability. | Higher level of control because of the touchpad. |
| **Sensor** | Depends mainly on the smart phone sensors | Has embedded IMU. More accurate movement tracking system. |

# Mixed Reality Display Technology

***Microsoft's HoloLens MR See-Through Technology***

- ✓ Multiple cameras
- ✓ Accelerometer
- ✓ Gyroscope sensors to track head location and movement
- ✓ Engine to locate objects
- ✓ Audio system
- ✓ Display system
- ✓ Transparent lenses
- ✓ **$$$$$**

[39]

# Agenda

Mixed Reality image capture technology

Mixed Reality encoding technology

Mixed Reality display technology

**Other Advanced Mixed Reality Applications and Breakthroughs**

Conclusion

# Other Advanced Mixed Reality Applications and Breakthroughs

Mixed Reality application fields:

- Entertainment
- Training
- Tourism

# Entertainment

- The most popular application for entertainment, is gaming


From: https://www.wired.com/video/2016/02/this-room-size-vr-game-makes-you-into-an-actual-action-hero/

# Training Military Personal

- Augmented Reality for Close Quarters Combat from Sandia National Laboratories

Source: Augmented Reality for Close Quarters Combat (CQB) - Umbra Simulation Framework, from: https://www.youtube.com/watch?v=ja6oy311rdw

# Other Advanced Mixed Reality Applications and Breakthroughs

## Tourism

- Archeoguide


(a) Actual ruins of the temple of Hera

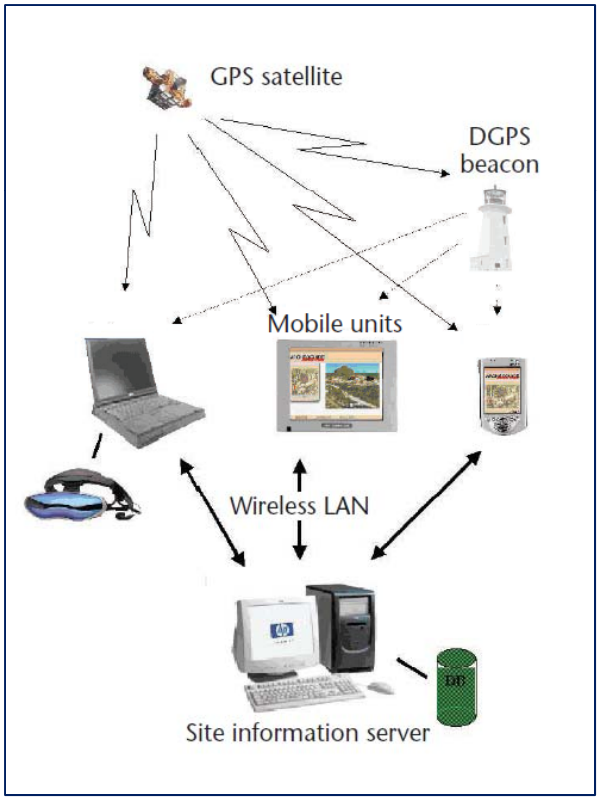

(b) Augmented reality of ruins of temple of Hera

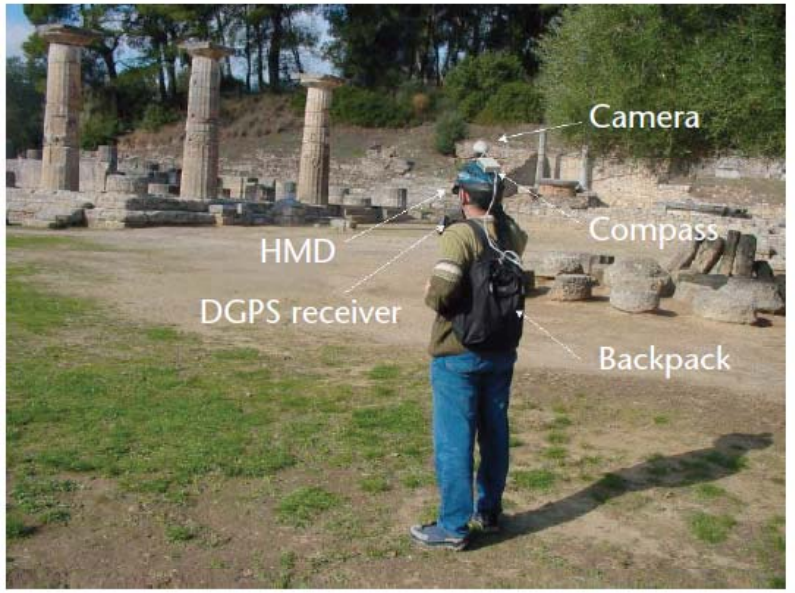
[30]

# Other Advanced Mixed Reality Applications and Breakthroughs

## Tourism

- Archeoguide




[30]

# See-through technology

Hololens

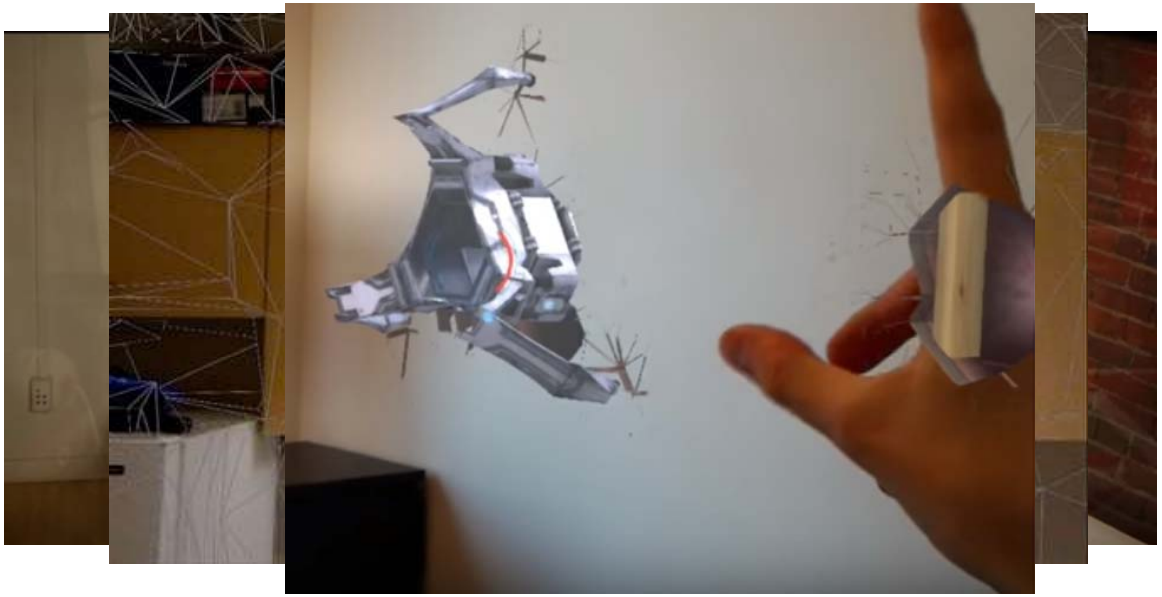
Why?

- More advance technology
- Walk Safe

# Microsoft Hololens

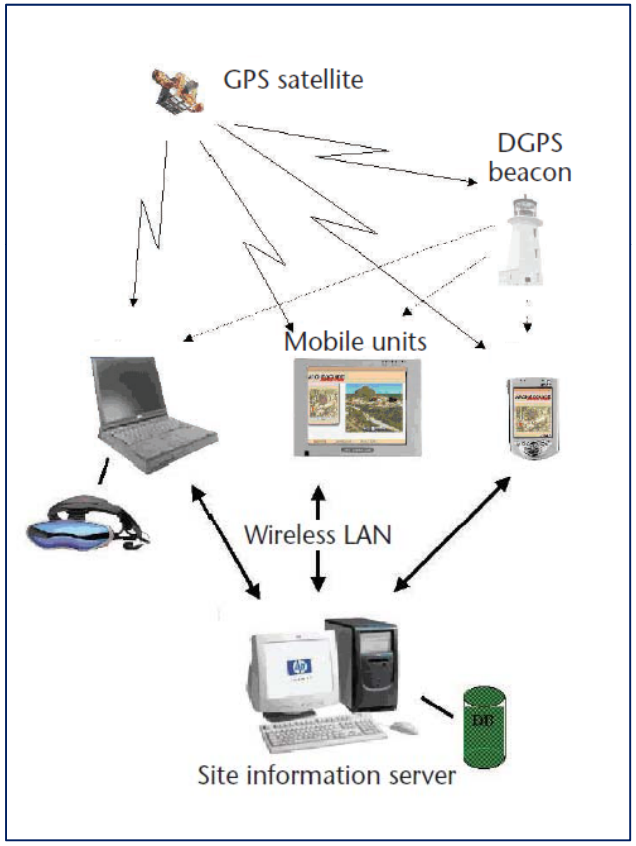
What can it do?

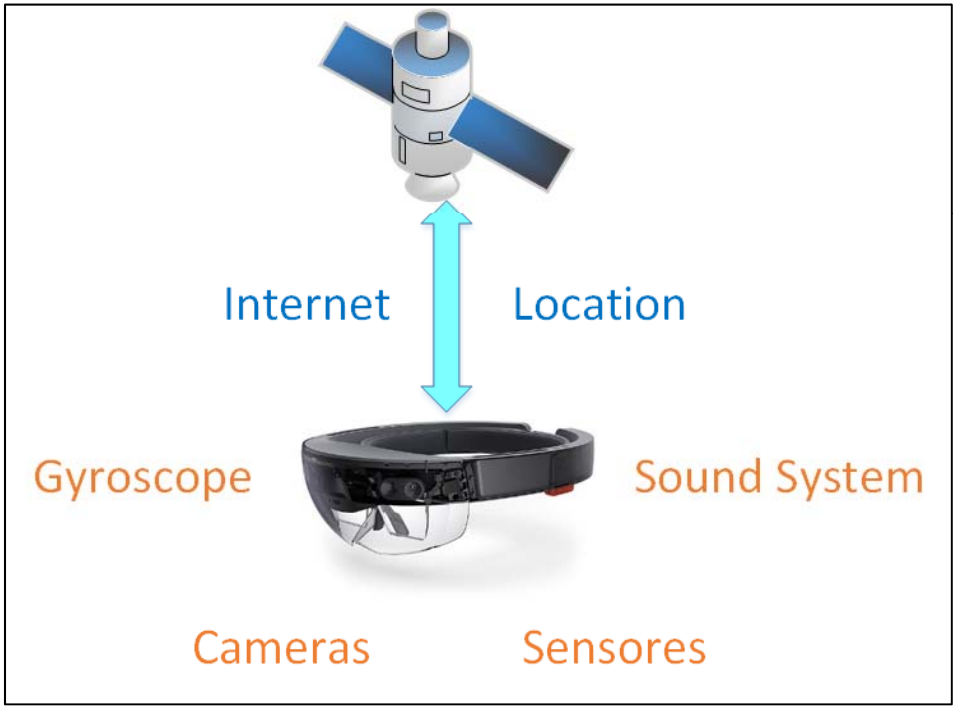
- 3D picture, animated
- Use well-Known applications: YouTube, Skype, MS Office, etc.
- Holotour
- Holomeasure
- Games



# From Archeoguide to Hololens

## What it can do?



# Other Advanced Mixed Reality Applications and Breakthroughs

Is this THE FUTURE?

Answer: YES And NO


Source: http://www.business-opportunities.biz/2012/02/starbucks-augmented-reality-cup/

From: http://spectrum.ieee.org/biomedical/bionics/augmented-reality-in-a-contact-lens/eyesb1

# Conclusion – the best of both worlds…

**Mixed Reality image capture technology**

We are excited about new advances to ***identify the most effective field of view based on both vision technology and motion sensing*** to apply precious image processing resources only where such resources would be most useful – **thus accurate tracking of image coordinates *with* the image are critical**

**Mixed Reality encoding technology**

We are encouraged based on the merits of various encoding technologies via **layering and various 360-degree mapping schemes to provide the absolute best use of precious video bandwidth.**

**Mixed Reality display technology**

While very affordable solutions have been offered, we find that you ***"get what you pay for".*** **We are excited about "see through" technology** yet it is not yet affordable.

**Other Advanced Mixed Reality Applications and Breakthroughs**

We are impressed by see through technology and how the combination of real-world and MR is the ***"the best of both worlds"!***

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# Questions?