글로벌 ICT 표준 컨퍼런스 2023

Global ICT Standards Conference 2023

Metaverse와 디바이스

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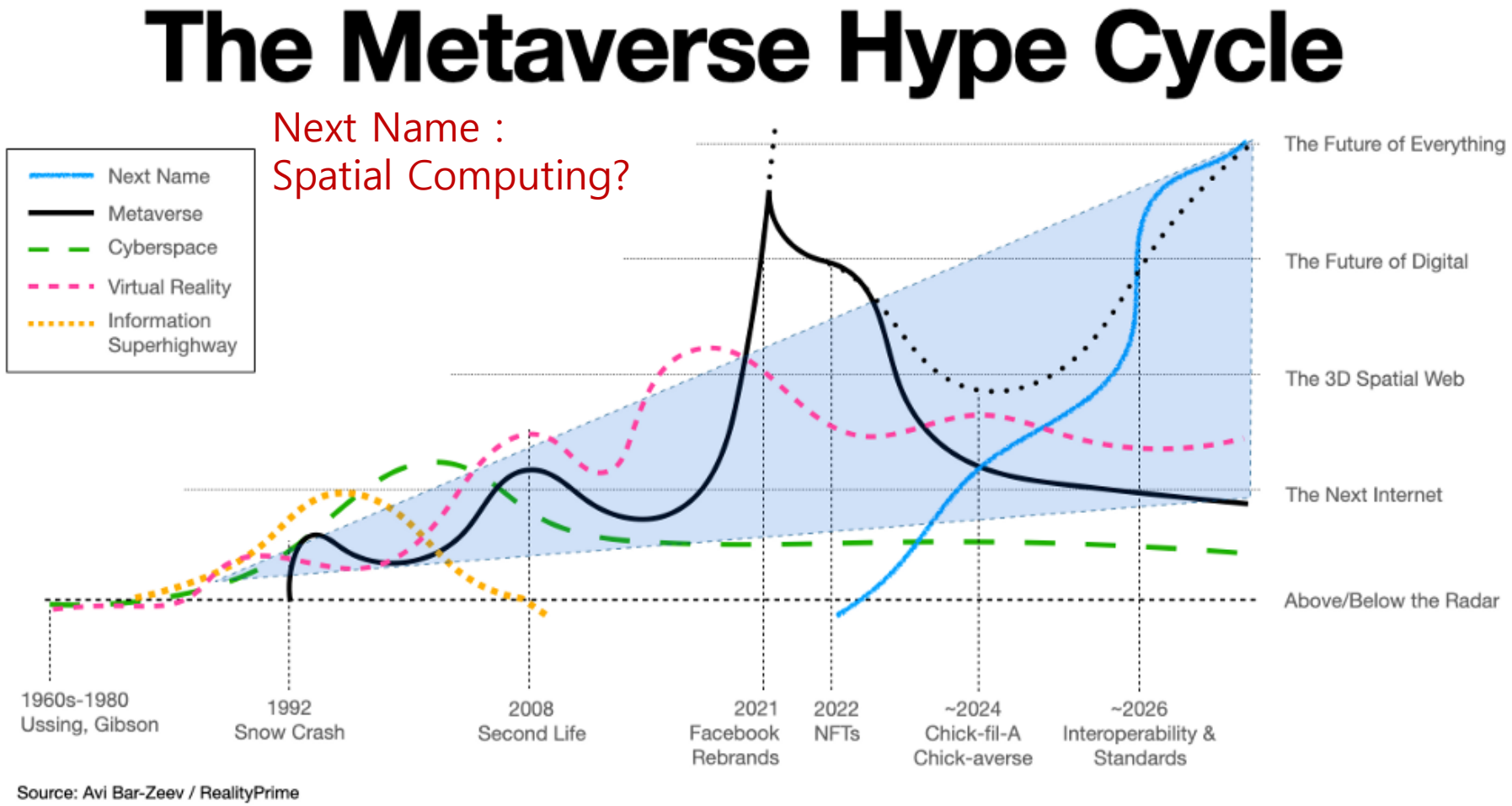
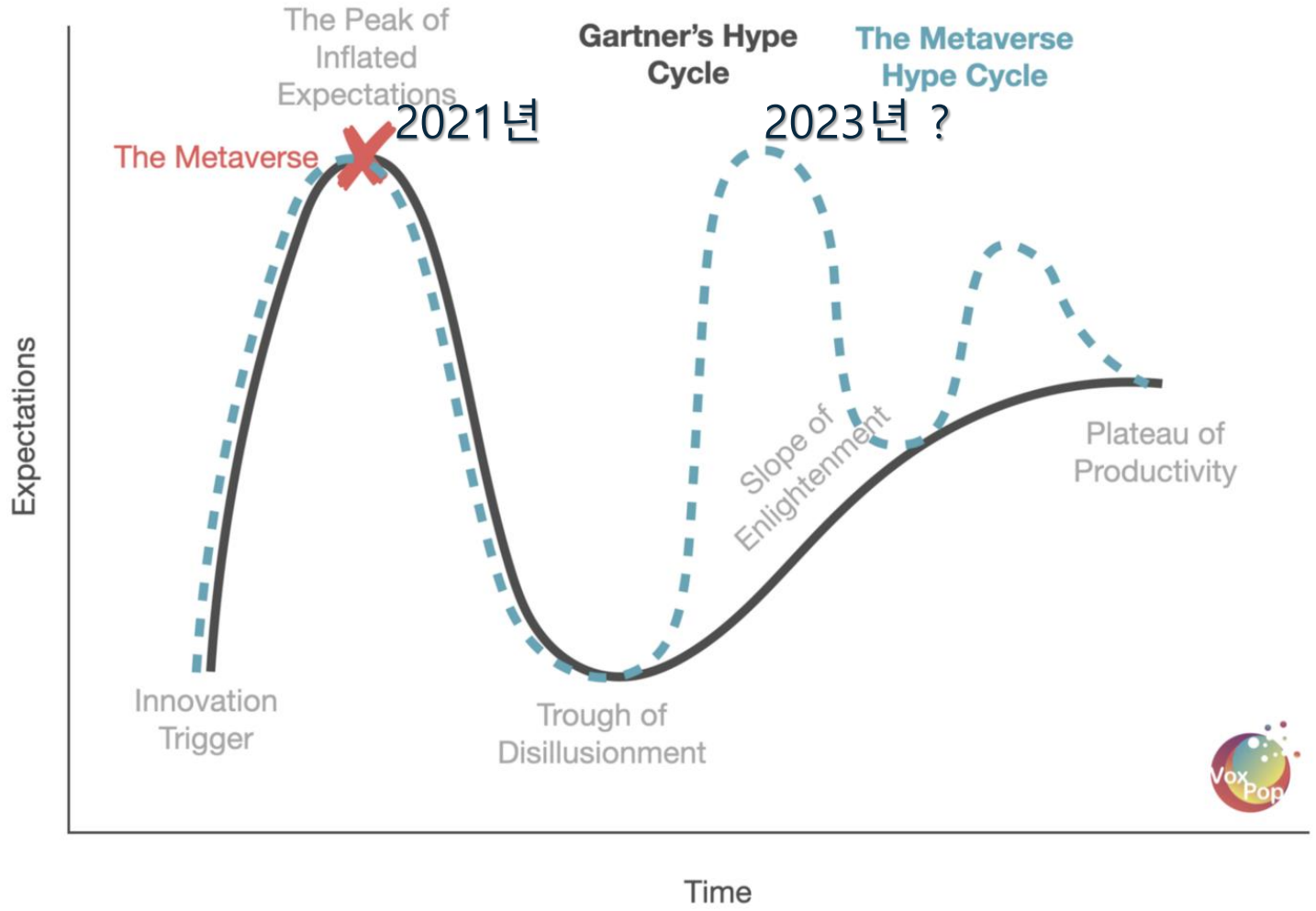
주최 과학기술정보통신부 Ministry of Science and ICT
특허청 Korean Intellectual Property Office
주관 국립전파연구원 National Radio Research Agency
TTA IITP KEA kista ETRI

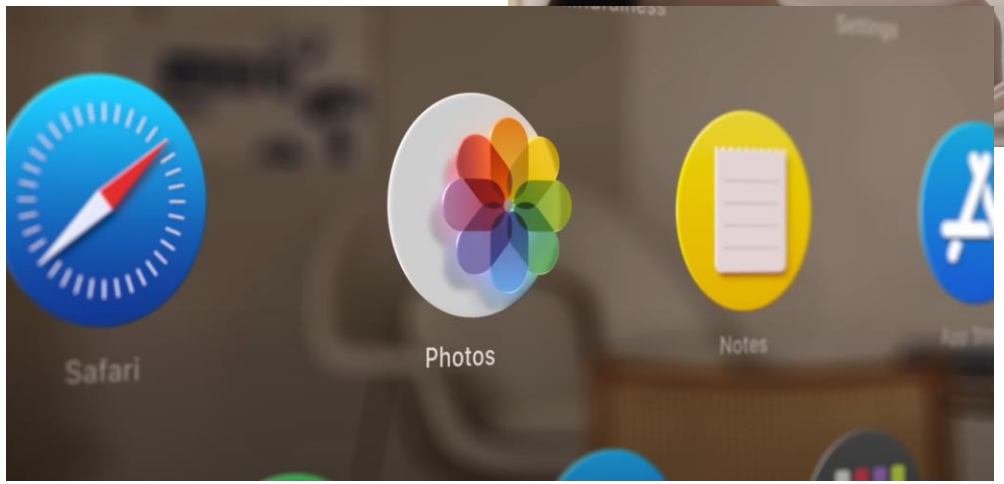
01. 메타버스 하이프 사이클

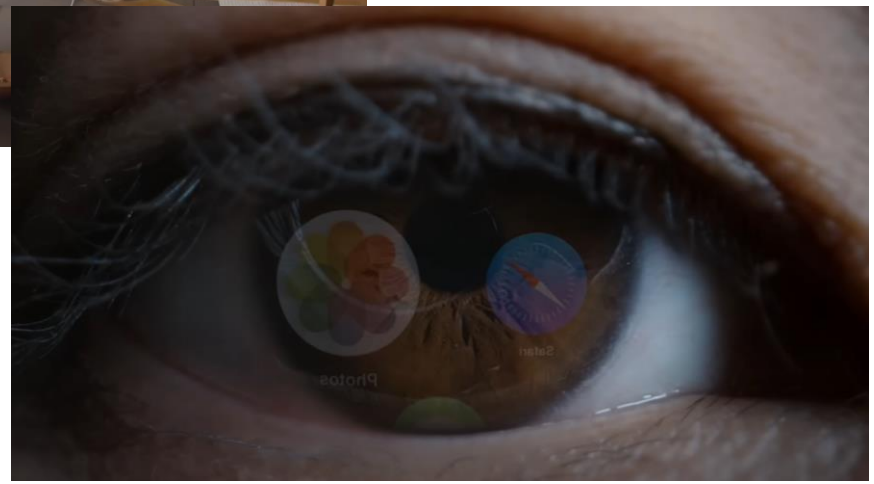


01. 메타버스 하이프 사이클



02. Apple Vision Pro – Vision OS





[s o u r c e] : https://www.youtube.com/watch?v=TX9qSaGXFyg i n t e r o d u c t i n g A p p l e v i s i o n P r o

02. Apple Vision Pro – 100 feet panorama

[s o u r c e] : https://www.youtube.com/watch?v=TX9qSaGXFyg i n t e r o d u c t i n g A p p l e v i s i o n P r o

02. Apple Vision Pro – 360

[source] : https://www.youtube.com/watch?v=TX9qSaGXFyg introducting Apple vision Pro

02. Apple Vision Pro – Work space

[s o u r c e] : https://www.youtube.com/watch?v=TX9qSaGXFyg i n t e r o d u c t i n g A p p l e v i s i o n P r o

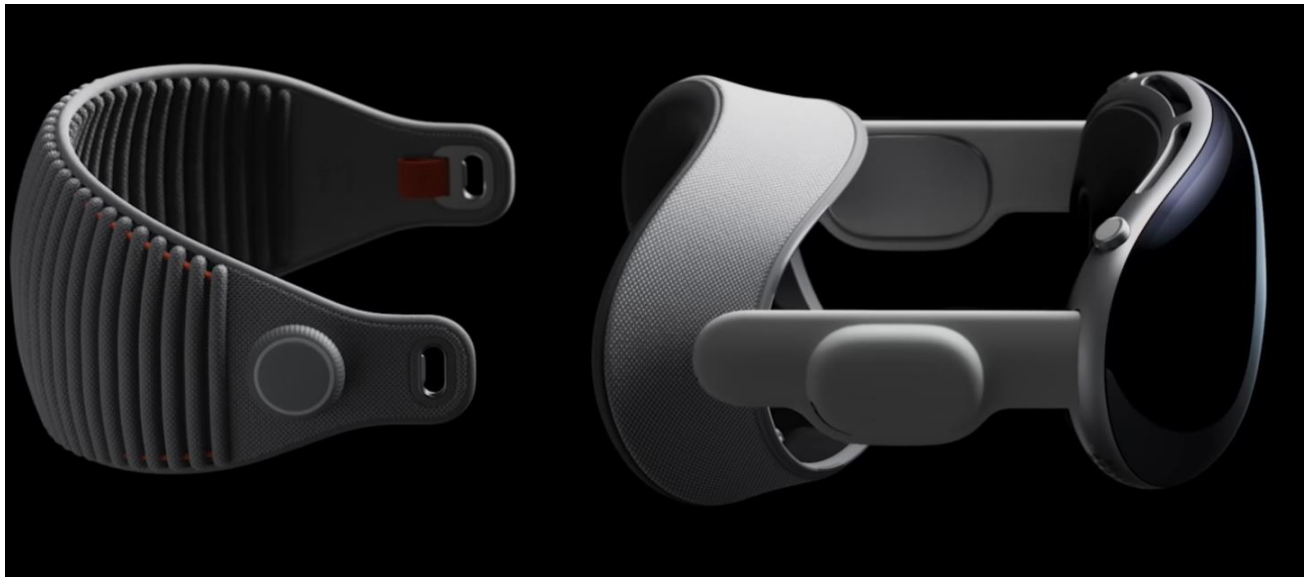
02. Apple Vision Pro – Work space

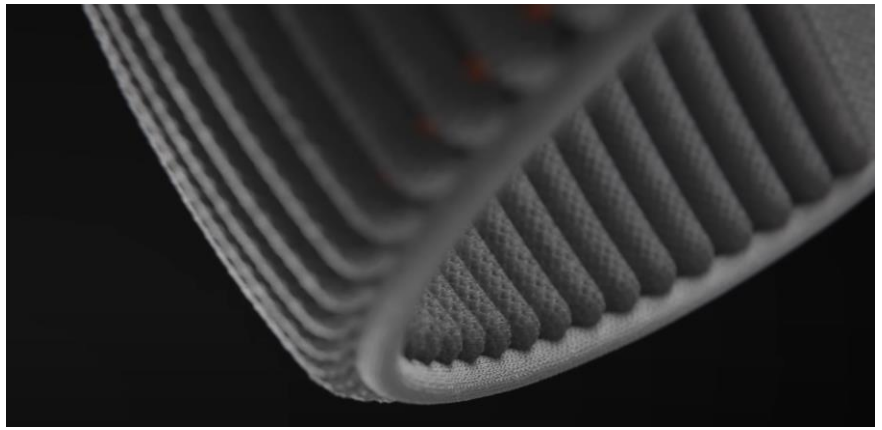
[s o u r c e] : https://www.youtube.com/watch?v=TX9qSaGXFyg i n t e r o d u c t i n g A p p l e v i s i o n P r o

02. Apple Vision Pro – Work space

[source] : https://www.youtube.com/watch?v=TX9qSaGXFyg introducing Apple vision Pro

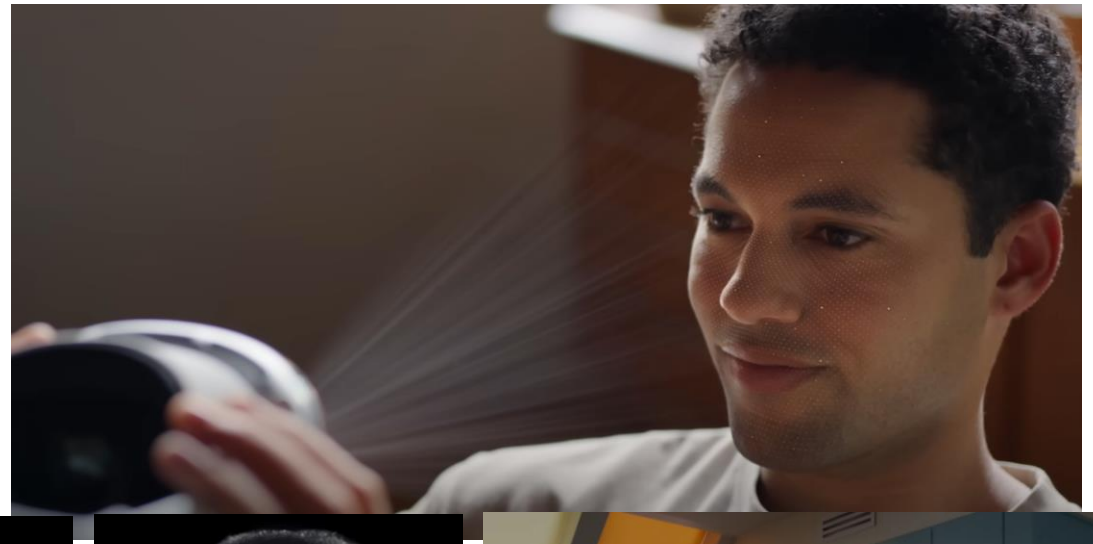
02. Apple Vision Pro – Design

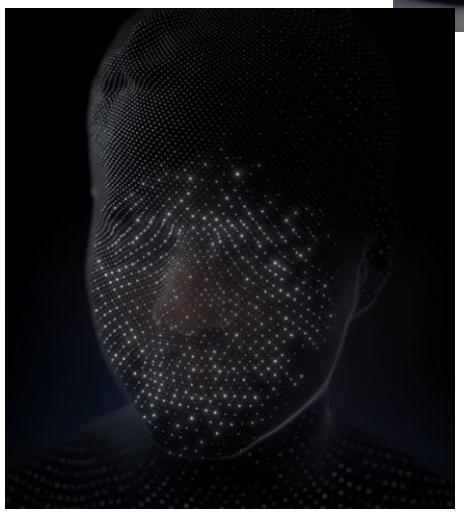


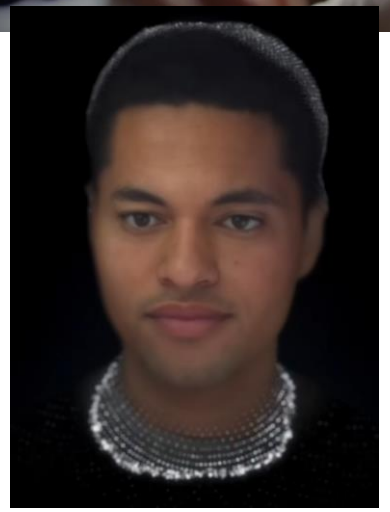


[s o u r c e] : https://www.youtube.com/watch?v=TX9qSaGXFyg i n t e r o d u c t i n g A p p l e v i s i o n P r o

02. Apple Vision Pro – Digital human

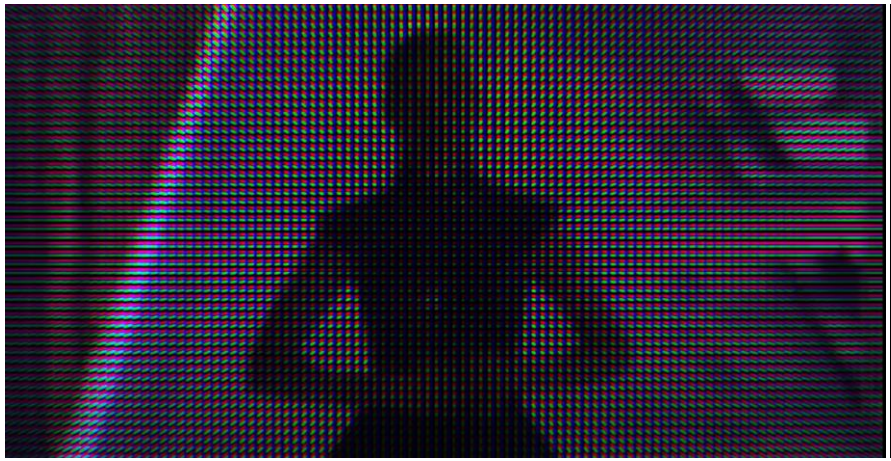


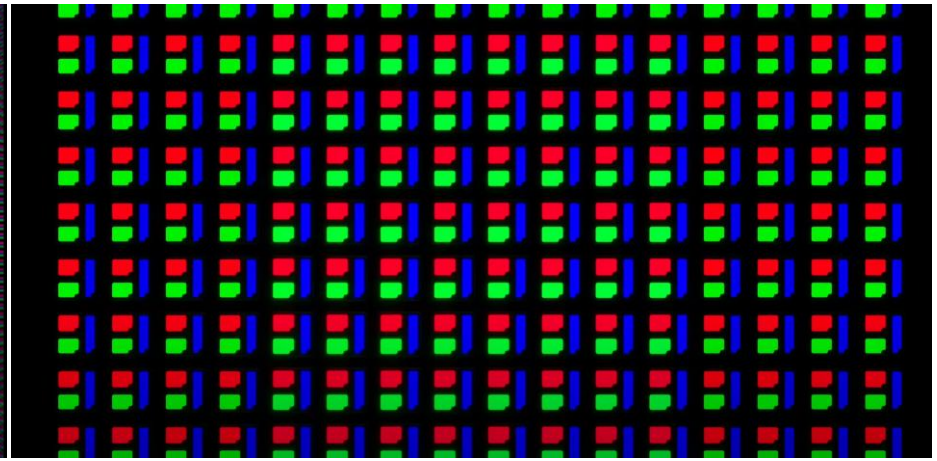




[s o u r c e] : https://www.youtube.com/watch?v=TX9qSaGXFyg i n t e r o d u c t i n g A p p l e v i s i o n P r o

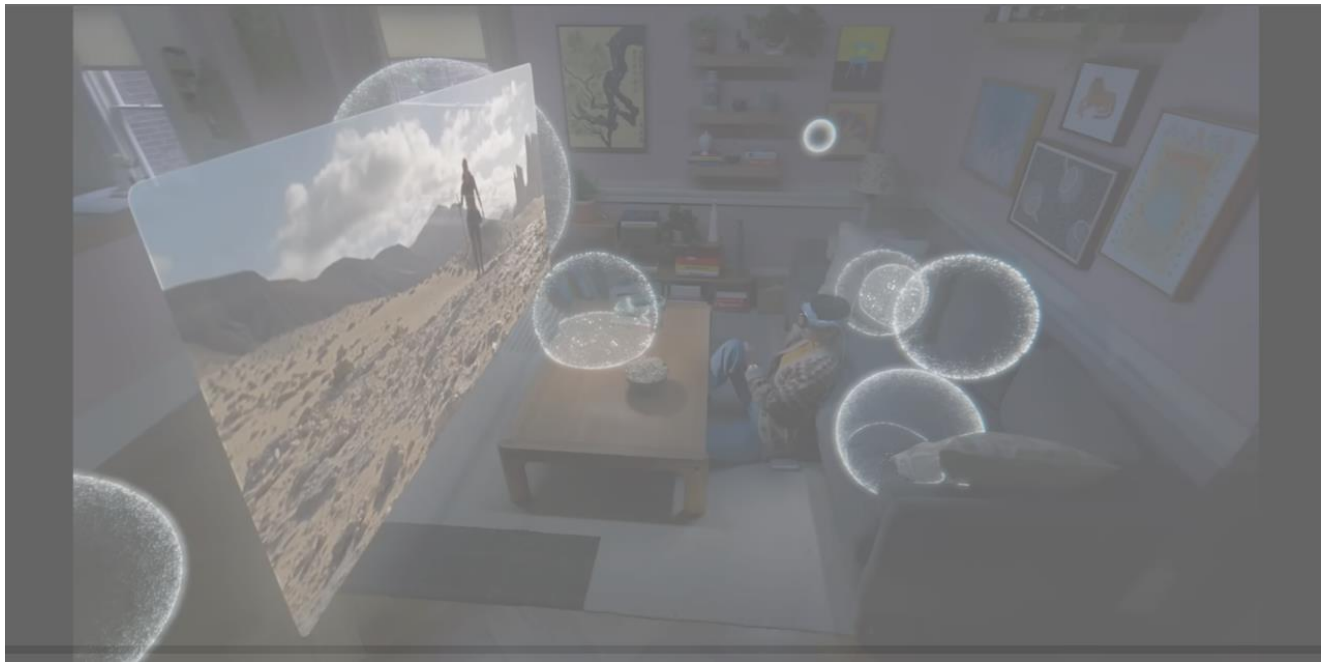
02. Apple Vision Pro – Tech : 2x4k Micro OLED





[s o u r c e] : https://www.youtube.com/watch?v=TX9qSaGXFyg inte r o d u c t i n g A p p l e v i s i o n P r o

02. Apple Vision Pro – Tech : Audio Raytracing



[s o u r c e] : https://www.youtube.com/watch?v=TX9qSaGXFyg i n t e r o d u c t i n g A p p l e v i s i o n P r o

02. Apple Vision Pro – Tech : 12(C)+5(S)+6(M)

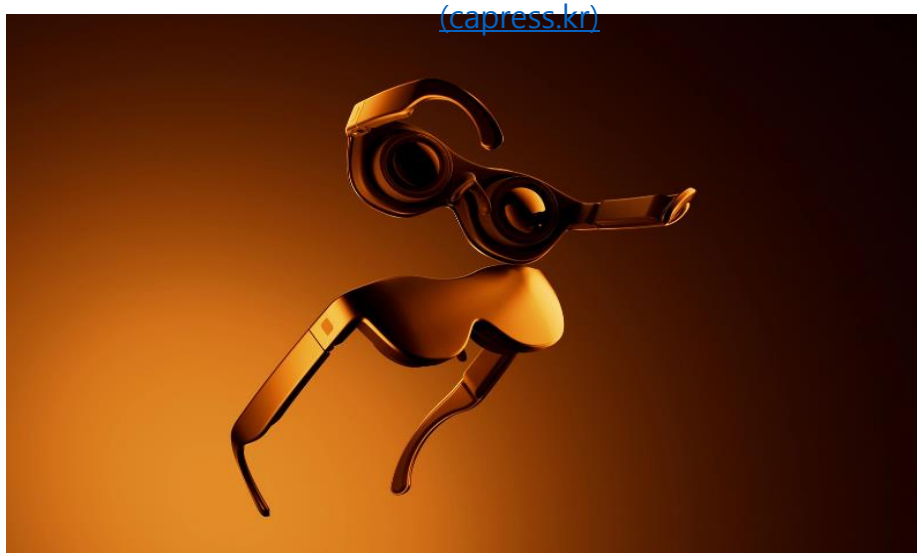
[source] : https://www.youtube.com/watch?v=TX9qSaGXFyg introducing Apple vision Pro

02. Apple Vision Pro – Tech : 12mmsec

[source] : https://www.youtube.com/watch?v=TX9qSaGXFyg introducing Apple vision Pro

03. Others

"비싸도 무조건 산다" BMW, 혹 할 만한 첨단 옵션 공개 (capress.kr)



독서 전용 VR 안경 등장...가격은 애플의 10분의 1 < 메타버스 < 산업 < 기사본문 - AI타임스 (aitimes.com)

Composition

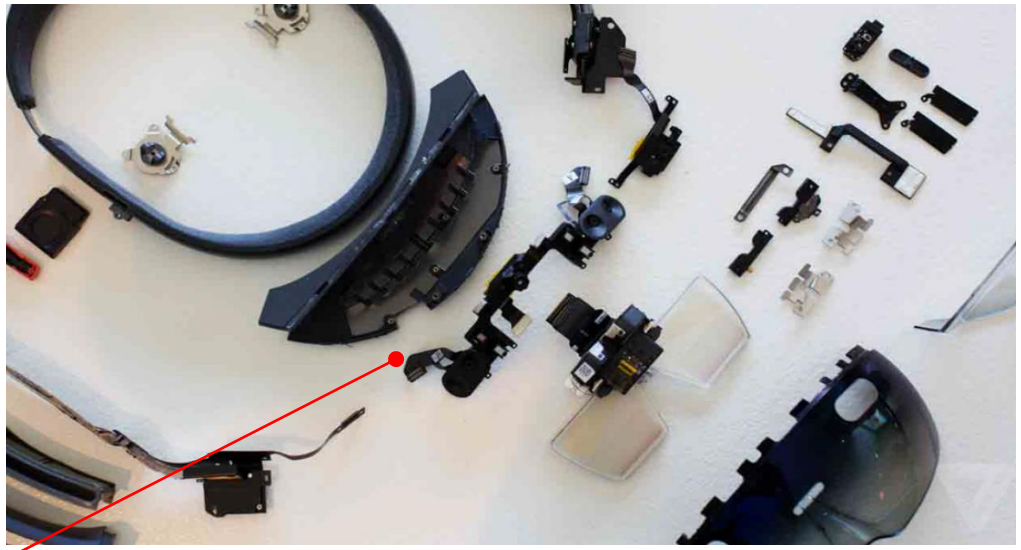
Displays
. 3.5 inch. – 5 inch.
. LCD, OLED

Magnifying Optics
. Providing FoV over 100 deg.
. Conventional, Fresnel, Pancake

Sensor/Processor/Interface
. IMU, (Fisheye) vision sensors, IR/depth sensor, etc.

https://ko.ifixit.com/

Device



https://www.theverge.com

Sensor/Processor/Interface

. IMU, (Fisheye) vision sensors, IR/depth sensor, etc.

Displays

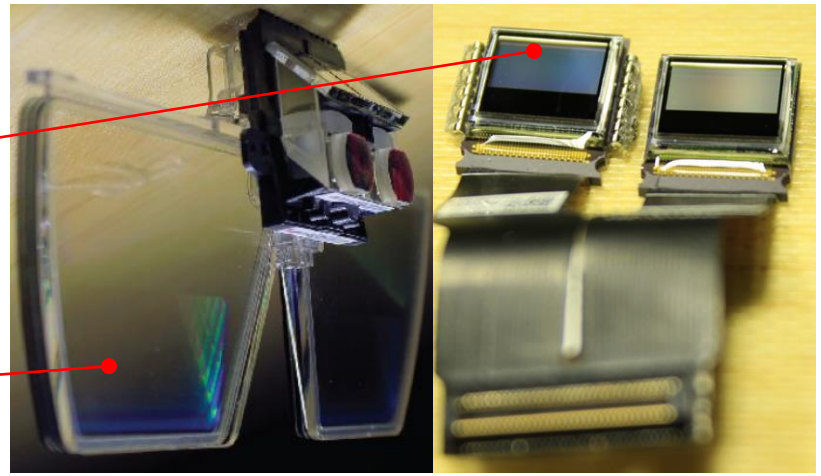
. Under 1 inch

. LCoS[1], OLEDoS[2], DMD[3](DLP[4])

Image Combiner Optics

. Providing FoV ~40 deg.

. Birdbath, Waveguide



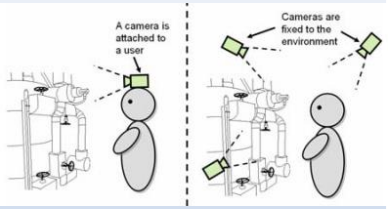
[1] Liquid crystal on silicon, [2] OLED on silicon
[3] Digital micro-mirror device, [4] Digital light processing

Device Types VR

Category	Types	Features	Examples
Processing Power	Tethered VR	▪ More immersive than other types (due to powerful processing resource outside) ▪ Need to connect to an external processing resource and power	▪ Oculus Rift ▪ HTC VIVE Pro
	Standalone VR (Untethered/ Wireless)	▪ To provide more mobility ▪ Heavier than tethered VR ▪ No need for connection to an external processing resource	▪ Pico Neo ▪ VIVE Focus ▪ Oculus Go
	Smartphone VR	▪ Affordable price range ▪ Key factors : screen type, resolution, battery life	▪ Samsung Gear VR ▪ Google Daydream View 2
Position Tracking	Inside-out	▪ No external sensors, but complex algorithm (needs more processing power)	▪ HTC Vive ▪ Samsung Odyssey
	Outside-in	▪ Additional external sensors ▪ Limited mobility	▪ Oculus Rift ▪ PS VR
Hand Tracking	Controller-free	▪ Built-in hand tracking	▪ Oculus Quest (additional controller also available)
	Controller-based	▪ Base station + controller	▪ HTC VIVE


Tethered VR: Oculus Rift.


Smartphone VR: Samsung Gear.



Device Types AR

Category	Types	Features
Processing Power	**Tethered AR**	▪ Suitable for lighter devices (i.e., glasses) ▪ Limited support of sensors ▪ Need for connection to external processing resource (i.e., dedicated processing module, mini PC or smartphone) and power
	Standalone AR (Untethered AR)	▪ Heavier than tethered AR ▪ AP-based processing module inside (usually limited processing power)
	Smartphone AR	▪ Not so popular yet ▪ Affordable price range
Form Factor	**Glasses**	▪ Monocular or Binocular type ▪ Tethered AR or standalone AR  VS  VS  ▪ Lower resolution & FOV ▪ Needs customization (IPD adjust, prescription insert) ▪ Key factors : Light optical system with large FOV, Bright display ▪ Applications : Personal entertainment
	Goggles	▪ Monocular or Binocular type ▪ Standalone AR (normally) ▪ Key factors : relatively lower requirements than glasses ▪ Applications : Sports 
	Headsets (Head-mounted)	▪ Binocular ▪ Tethered AR or standalone AR ▪ Key factors : relatively higher requirements than glasses + specific sensors for industrial applications

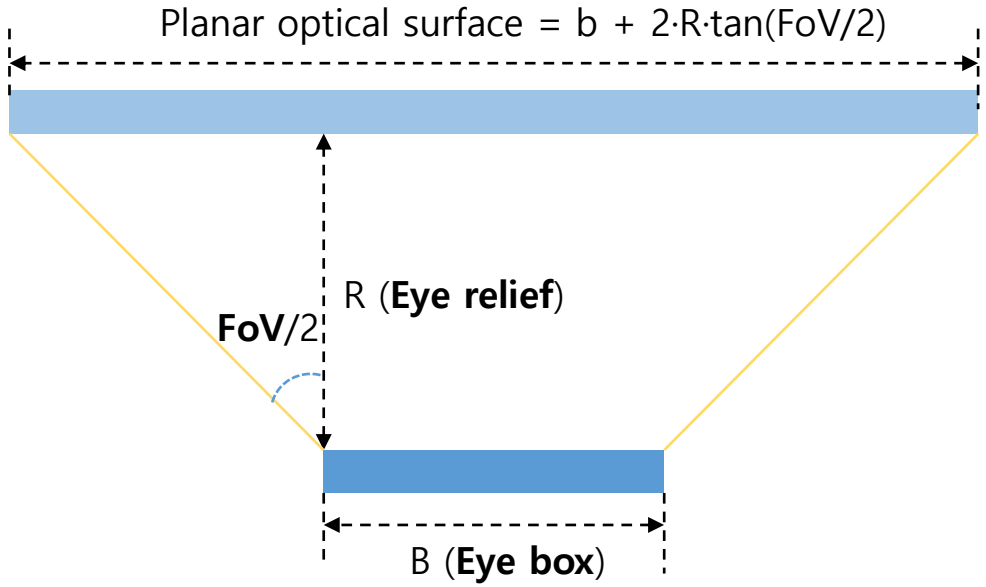
Development Issues on AR Devices

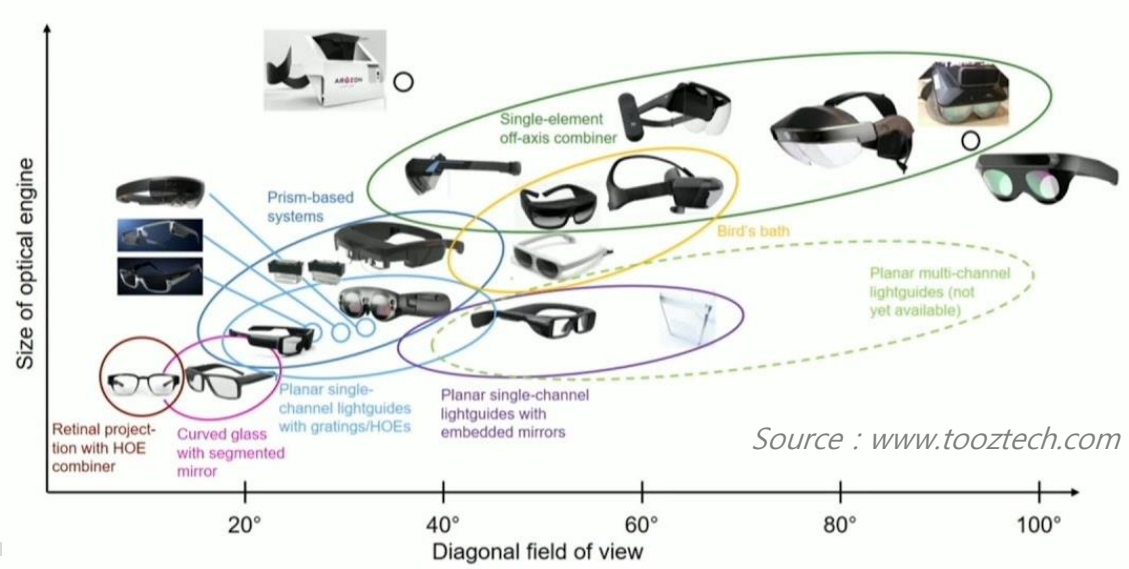
❖ Optical Issues

Optical efficiency ↑
Transparency ↑
Eye relief ↑
Eye box ↑
FoV ↑

❖ Display Issues

Brightness ↑
Resolution ↑
Volume ↓

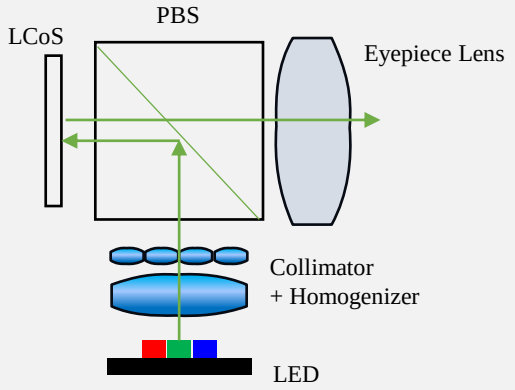




Development Issues – Micro Displays

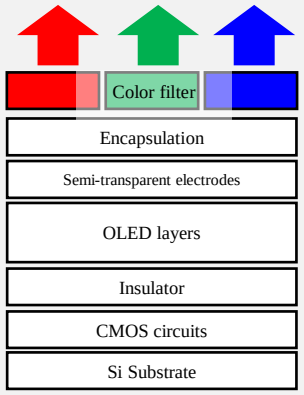
Key Elements	Selections	Considerations					
		Size (Volume)	Power Consumption	Brightness	Contrast	Technology Maturity	Ease of Manufacturing
Micro Display	µLCoS	* (**)	*	**	**	***	***
	µOLED	***	**	*	***	**	**
	µLED	***	***	***	***	*	*
	LBS	* (**)	*	***	***	*	*

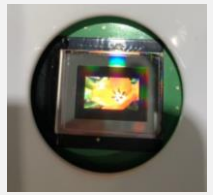
LCoS



Sony(SXRD), Himax, Kopin, Syndiant, Omnivision
[Raontech, May Display, Selcos]

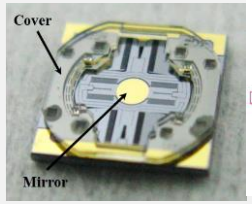
OLED

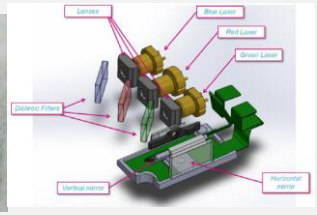


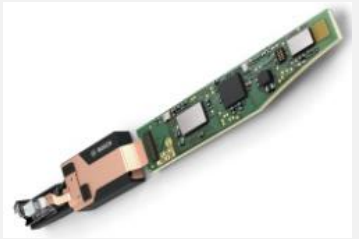


Sony, eMagin, Microoled, Kopin, Fraunhofer
[LG Display('19 IMID)]

LBS



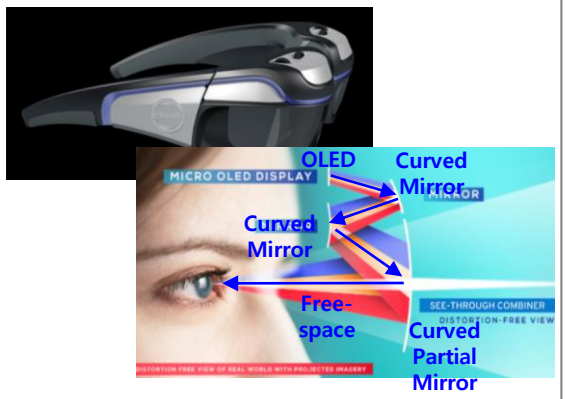




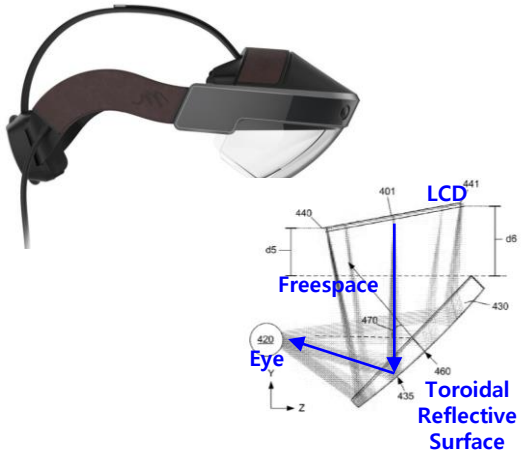
Microvision, STMicroelectronics, Bosch
[Panacea]

Development Issues – Optics (1)

Off-axis (spherical) combiner

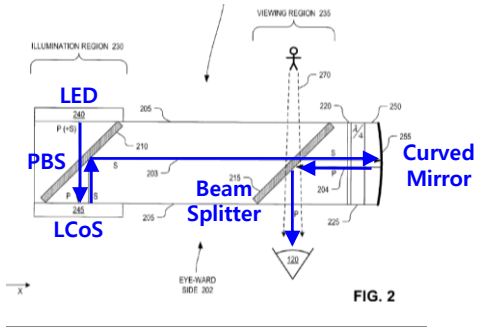


[Immy]

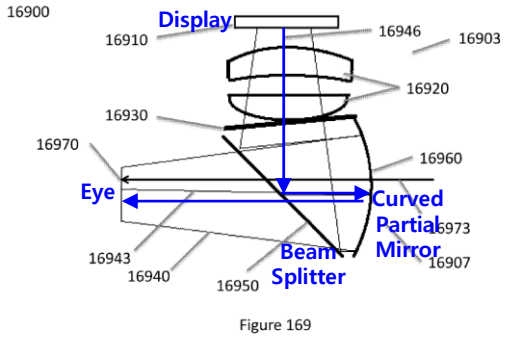


[Meta (US 2016/0139413)]

On-axis spherical mirror + beam splitter (or Birdbath)

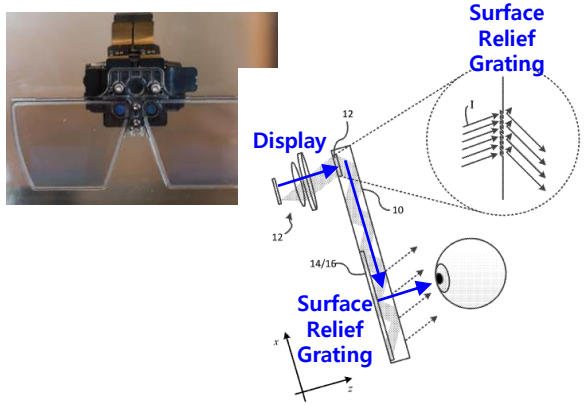


[Google (US 9013793)]

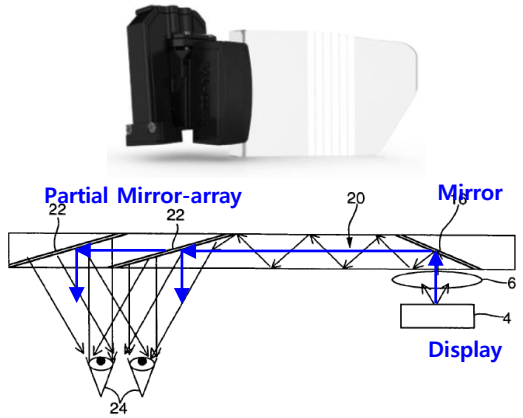


[ODG (US 9494800)]

Waveguide/Lightguide



[Microsoft (US 9513480)]



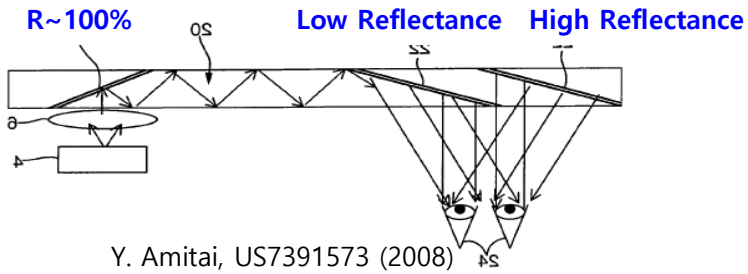
[Lumus (US 7391573)]

Big size combiner with **low cost**
Large field of view

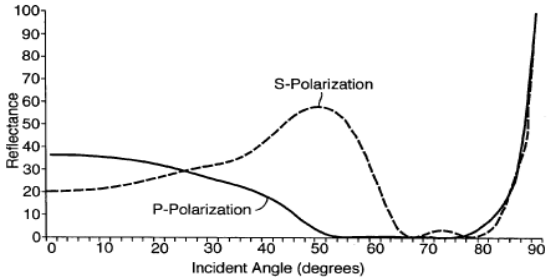
Thin combiner with **high cost**
Small field of view

Development Issues – Optics (2)

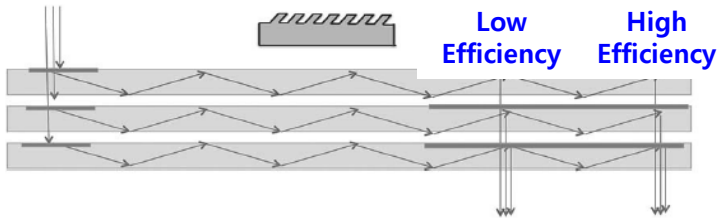
Reflective implementation : Array of partial mirrors

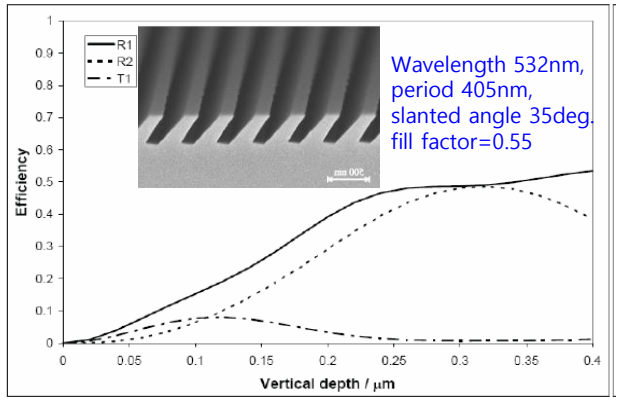


Y. Amitai, US7391573 (2008)



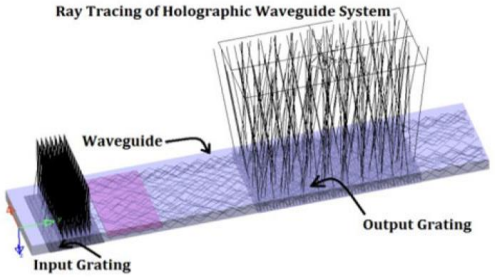
Diffractive implementation : Surface relief grating

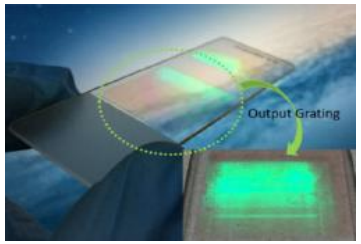


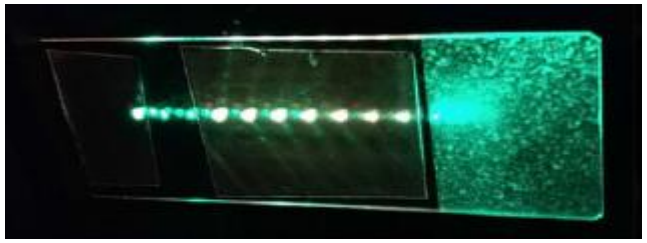


B. C. Kress, *et al.*, Proc. SPIE 10335, 103350K (2017)
T. Levola *et al.*, Opt. Express 15(5), 2067 (2007)

Diffractive implementation : Volume grating (photopolymer)



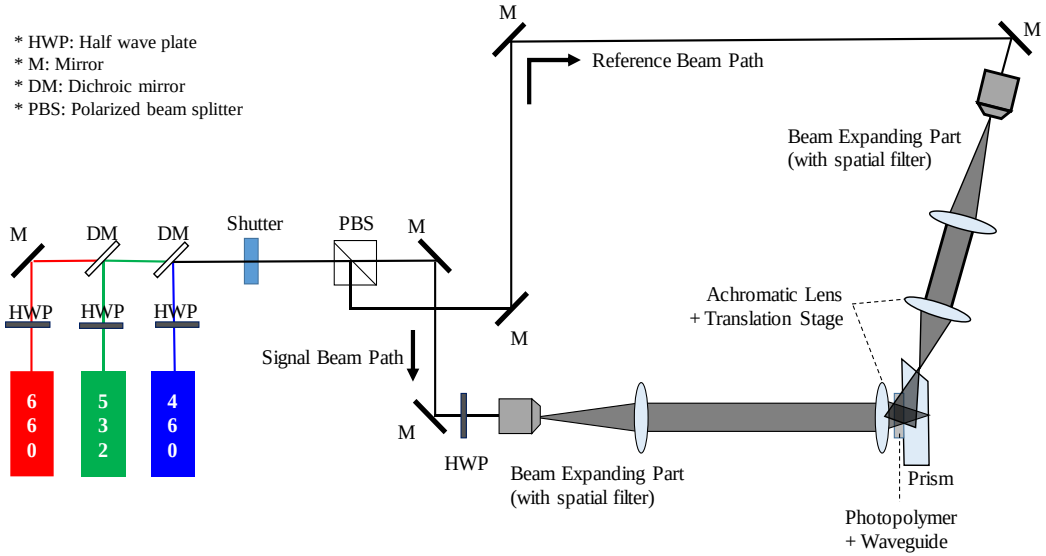


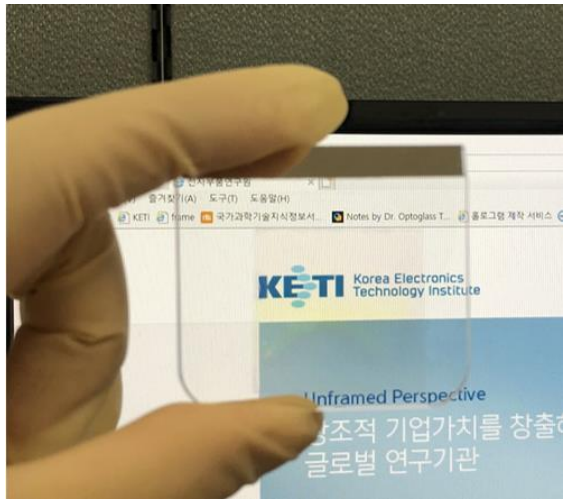


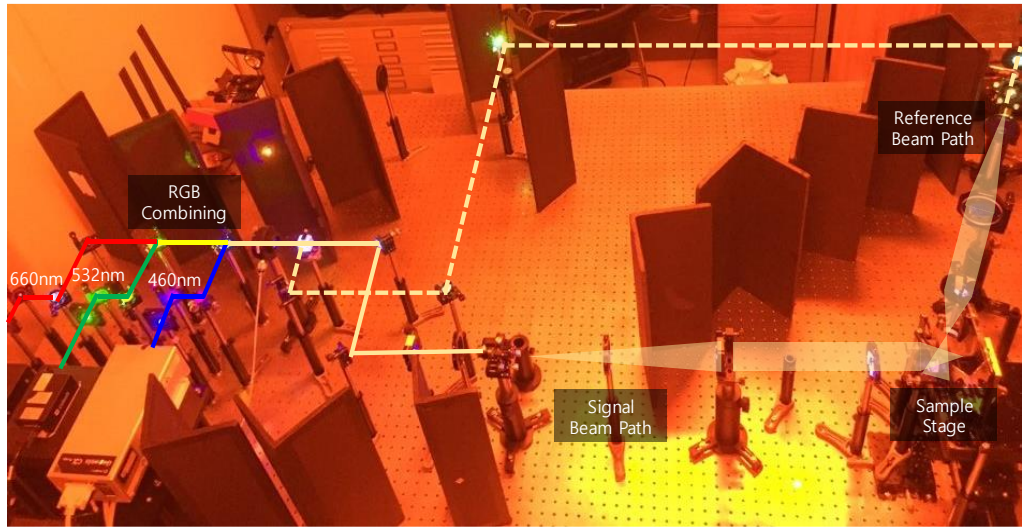
A. Liu, IEEE Photonics J. 10(4), 7000310 (2018)

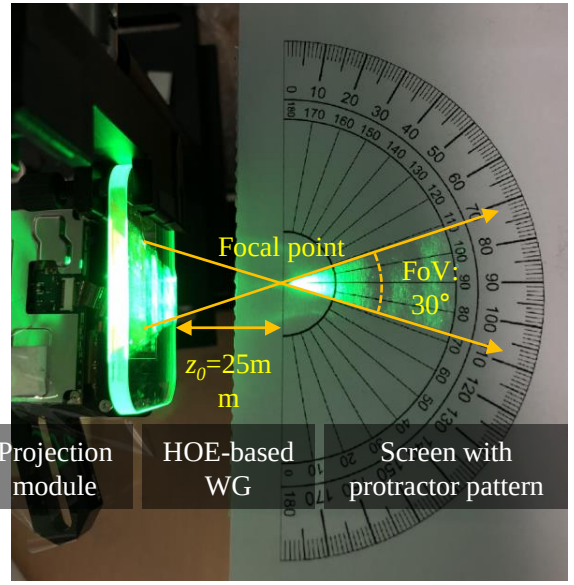
KETI's Solution #1 – HOE-based Waveguide

Diffractive Waveguide





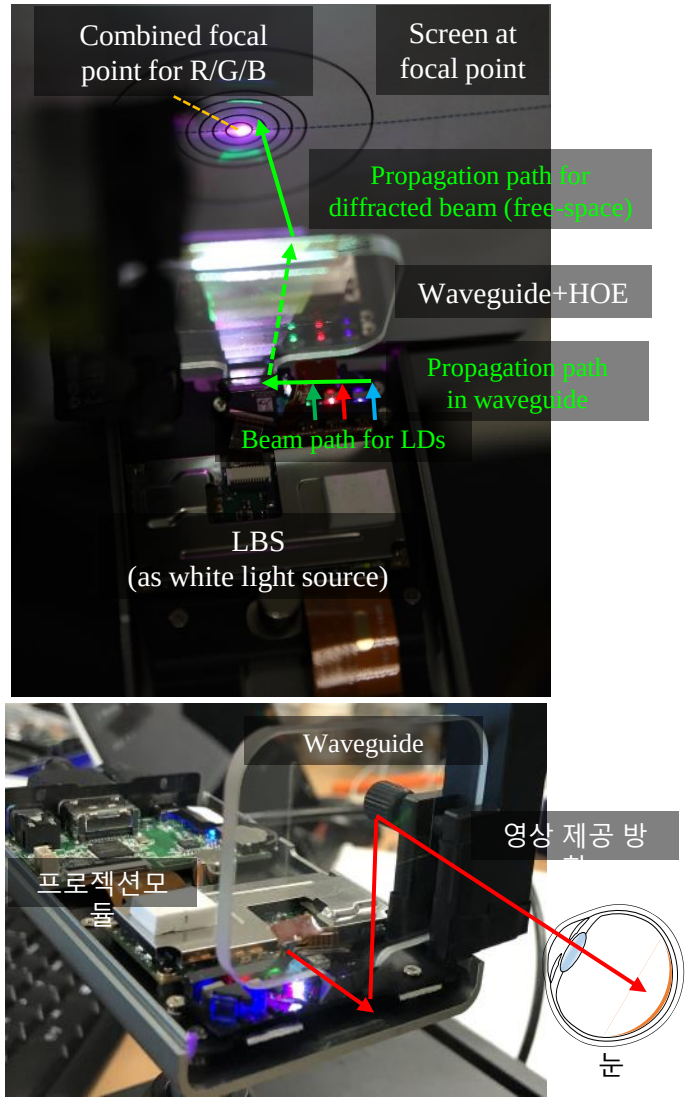




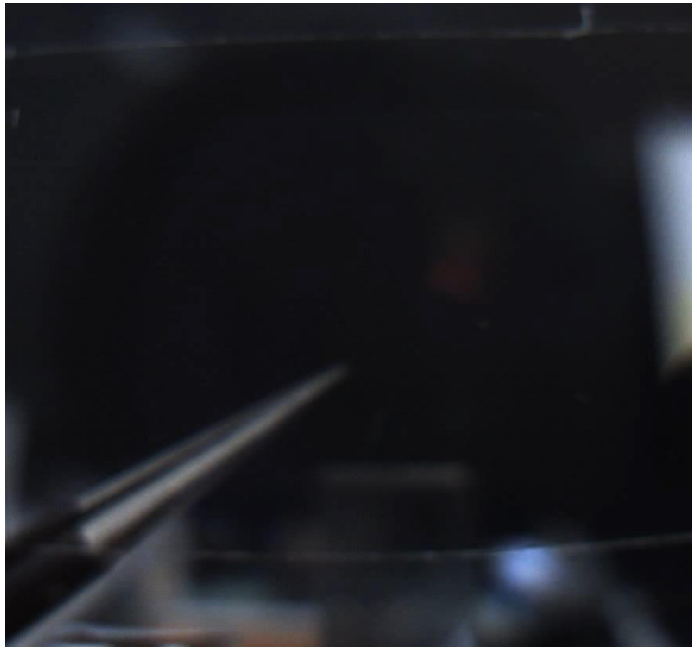
KETI's Solution #1 – HOE-based Waveguide

Diffractive Waveguide

[RGB Full color 초점 (파장 보상)]

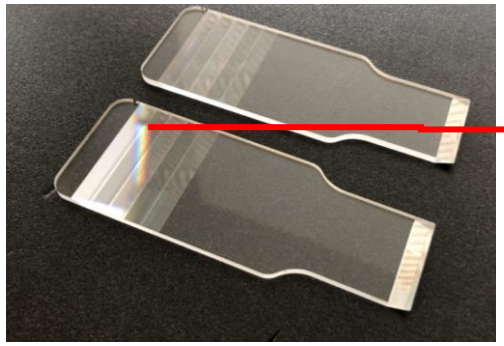


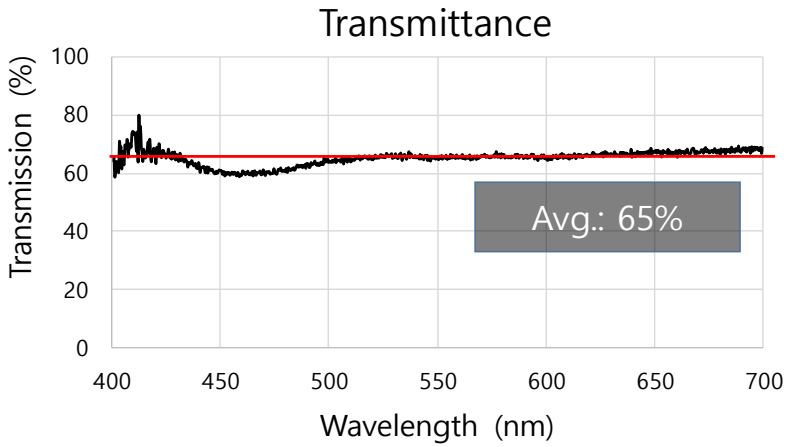
- **Specification**
  - Target μ-Display : LBS
  - FoV : 30
  - Eye-relief : 25mm
  - Transmittance : > 60%
  - Thickness : 3.5 mm

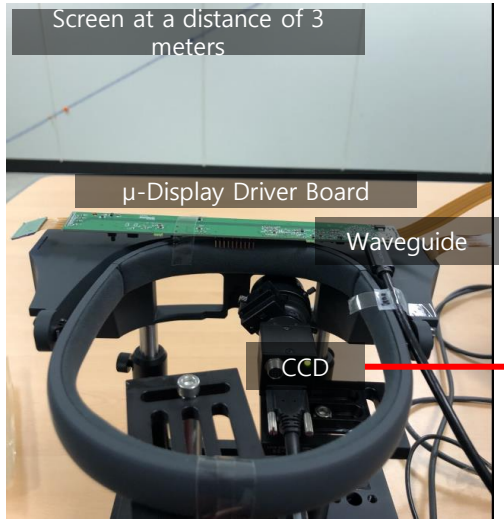


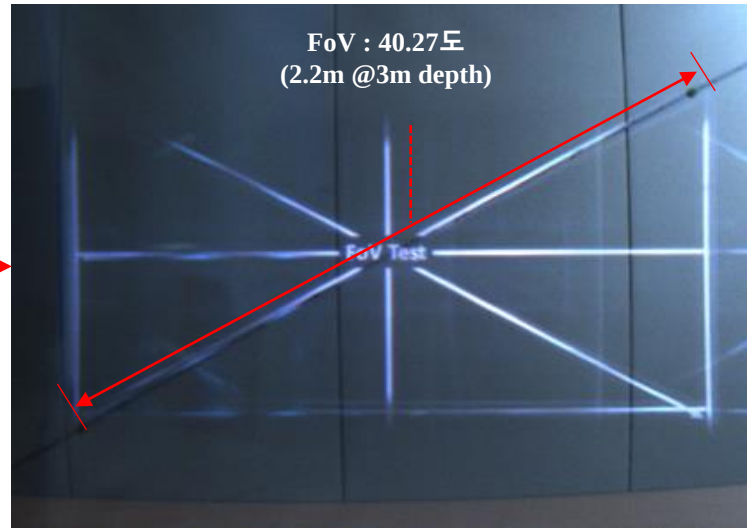
KETI's Solution #2 – Reflective Waveguide

Reflective Waveguide





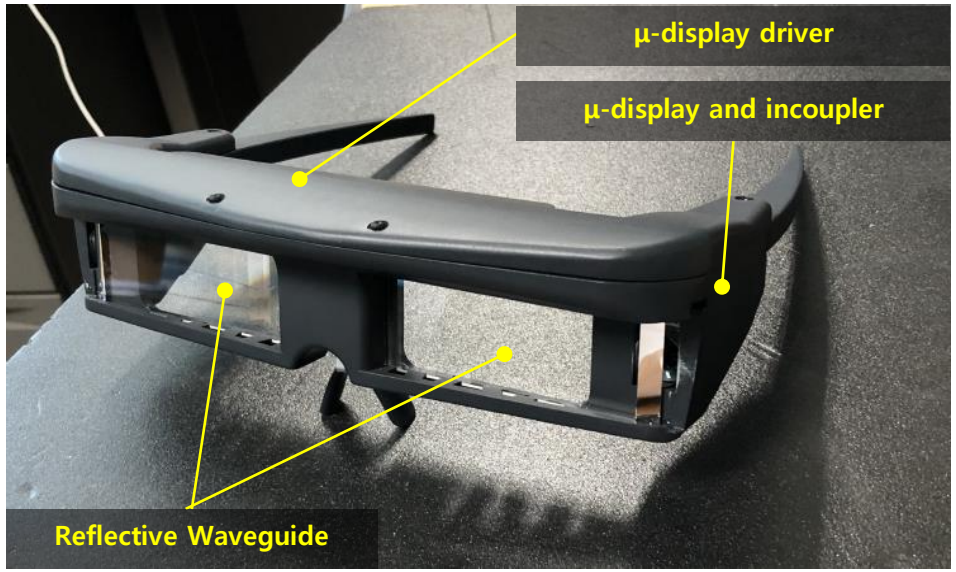


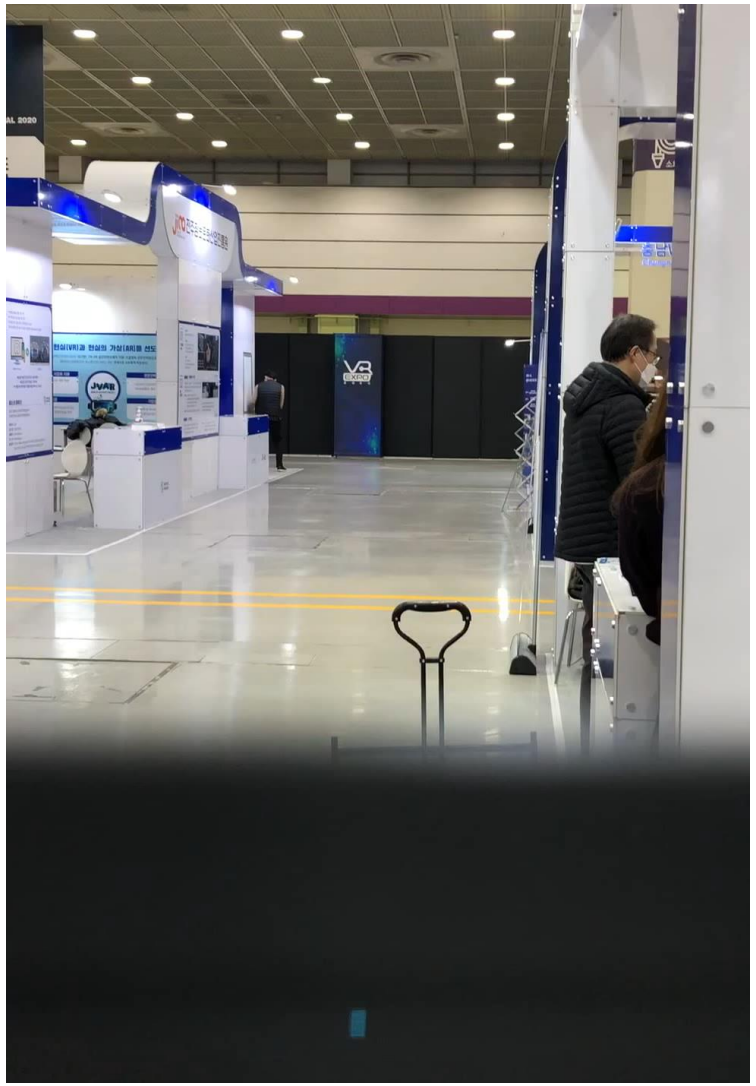


KETI's Solution #2 – Reflective Waveguide

Reflective Waveguide

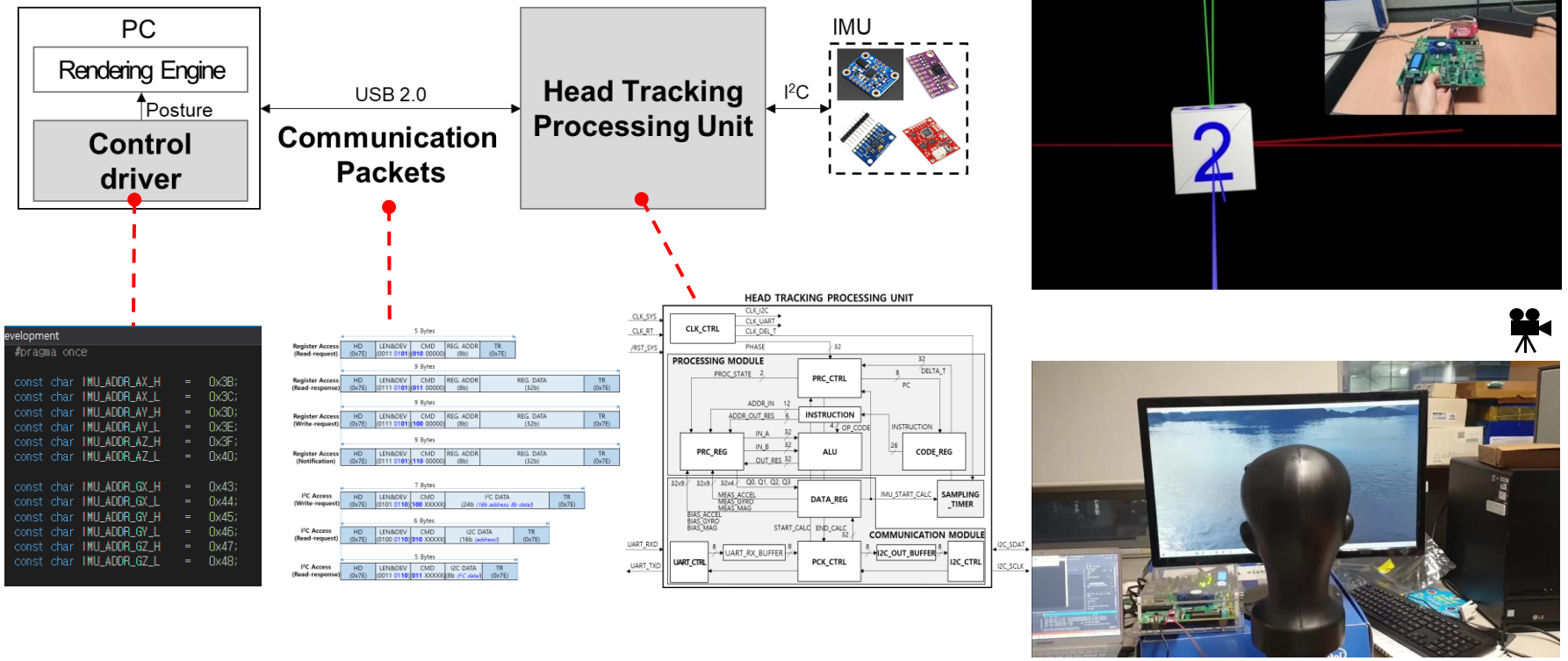
- **Specification**
  - µ-Display : 0.39", 1080p (BOE)
  - WG Thickness : 2.445 mm
  - FoV : 40.27
  - Eye-box : 15.5mm
  - Transmittance : 65.155%





KETI's Solution #3 – HW IP for XR functionality (1)

Head Tracking

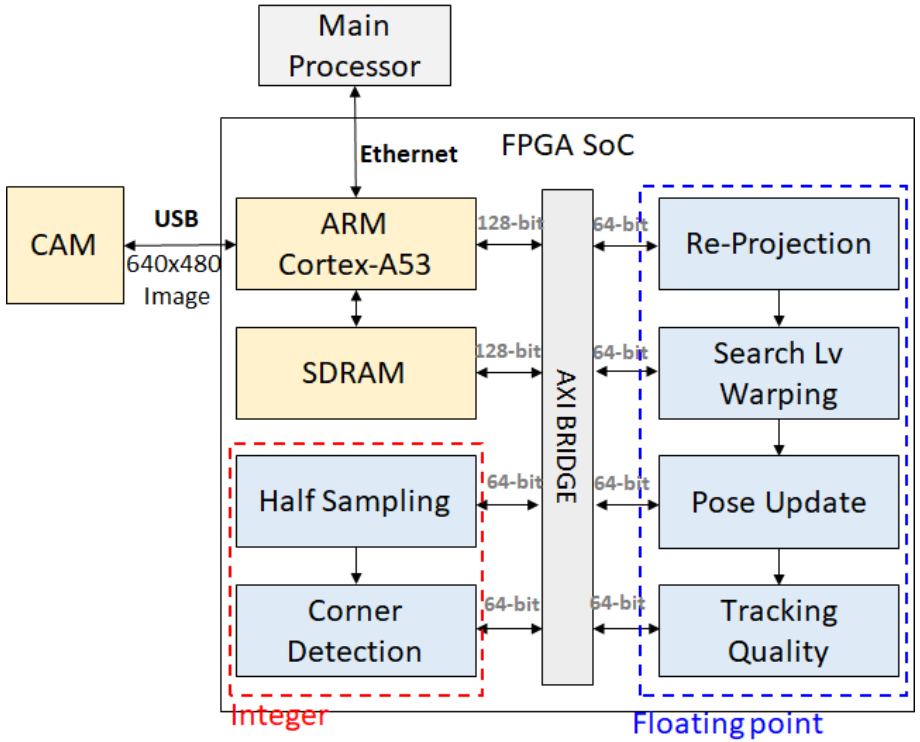


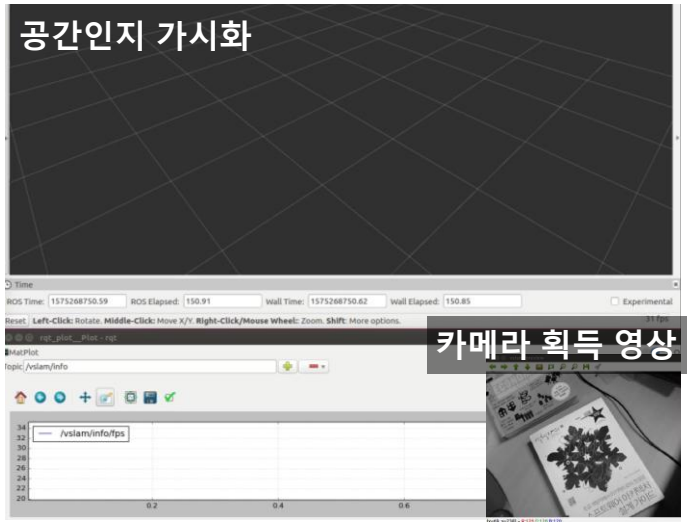

```
evelopment
 #pragma once

const char IMU_ADDR_AX_H    =   0x3B;
const char IMU_ADDR_AX_L    =   0x3C;
const char IMU_ADDR_AY_H    =   0x3D;
const char IMU_ADDR_AY_L    =   0x3E;
const char IMU_ADDR_AZ_H    =   0x3F;
const char IMU_ADDR_AZ_L    =   0x40;

const char IMU_ADDR_GX_H    =   0x43;
const char IMU_ADDR_GX_L    =   0x44;
const char IMU_ADDR_GY_H    =   0x45;
const char IMU_ADDR_GY_L    =   0x46;
const char IMU_ADDR_GZ_H    =   0x47;
const char IMU_ADDR_GZ_L    =   0x48;
```

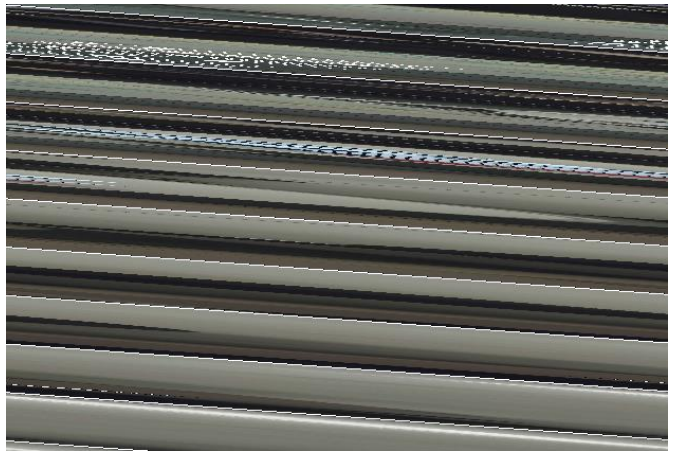

- ❖Composed of programmable controller and floating-point operation logic specialized in head tracking algorithms
- ❖Support of any type of IMU sensors (up to 9-DoF)
- ❖USB 2.0 and I2C interfaces for connecting external processing resource (i.e., PC) and IMU sensors

KETI's Solution #3 – HW IP for XR functionality (2)

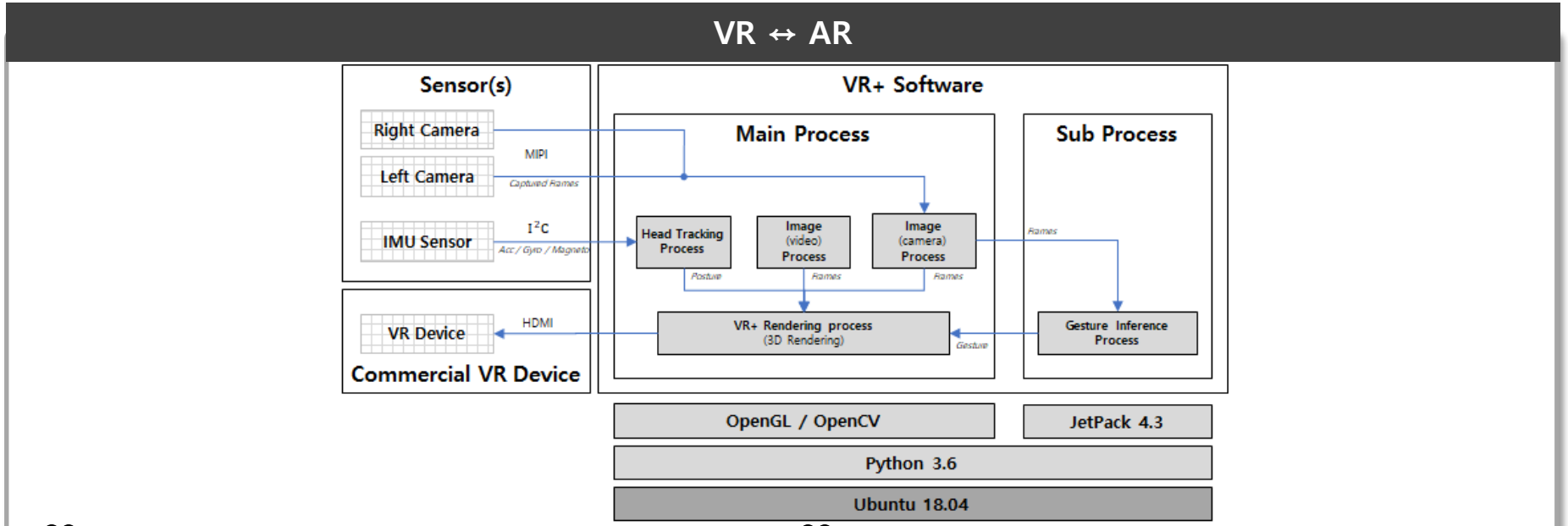
Localization & Mapping

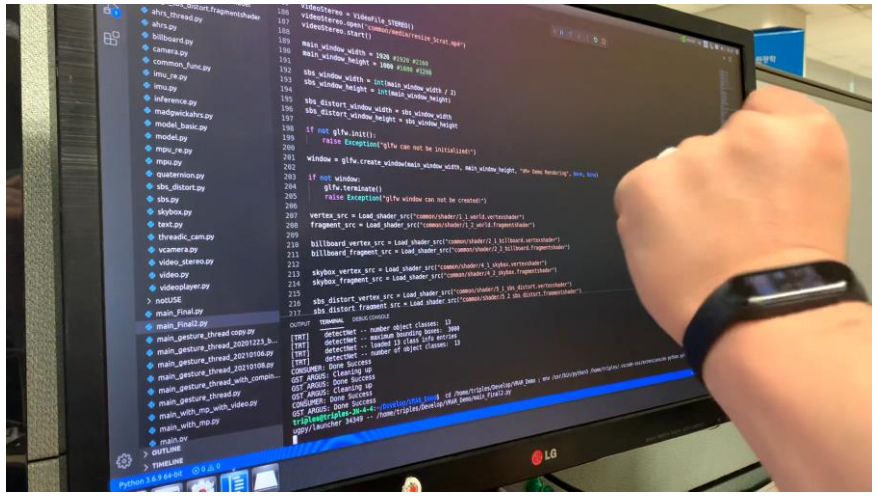






KETI's Solution #4 – VR extension to AR

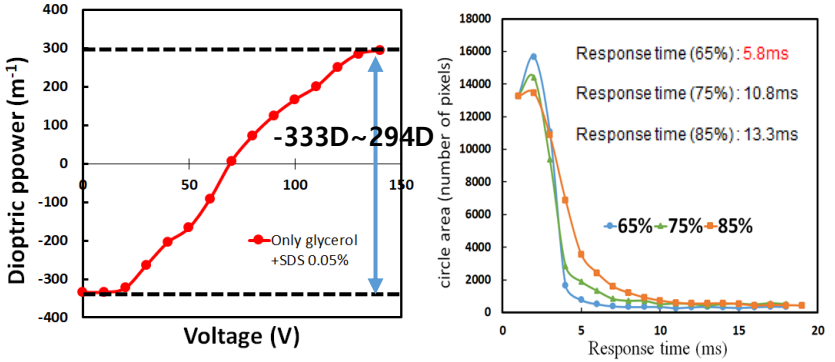




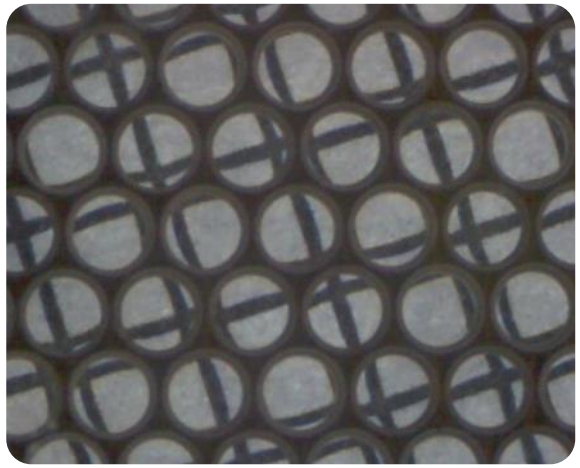
KETI's Solution #5 – Varifocal Integral Imaging Renderer

MLA for Varifocal Integral Imaging Display

- **Specification**
  - # of lens : 165 (15 × 11)
  - Lens Diameter : 1mm
  - Diopter Range : 627D (-333~294D)
  - Operation Speed : 5.8ms



(좌) 전압에 따른 Dioptric power 변화량
(우) 점도에 따른 렌즈 동작속도]



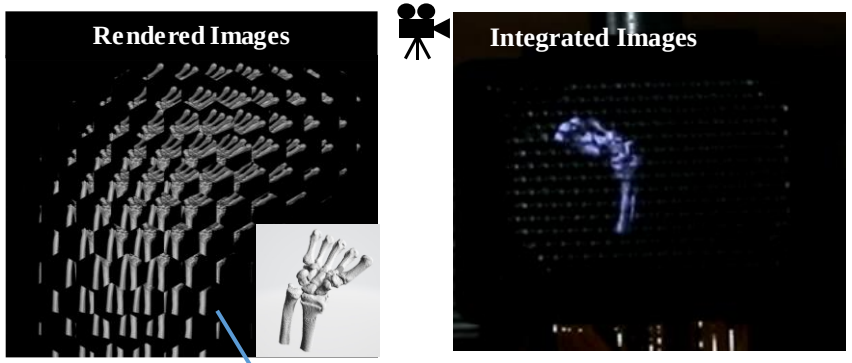
[Electro-wetting Micro Lens Array (MLA)]

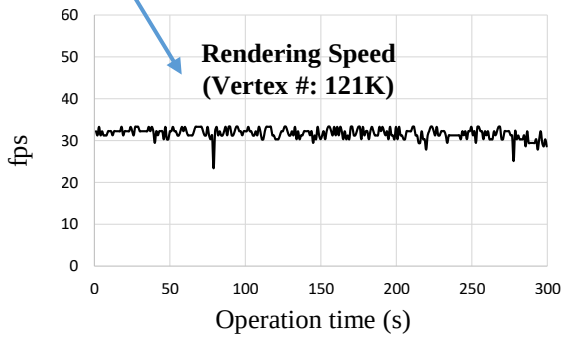
[letter 'A' @ 40V_30cm] [letter 'B' @ 50V_50cm] [letter 'C' @ 60V_100cm]

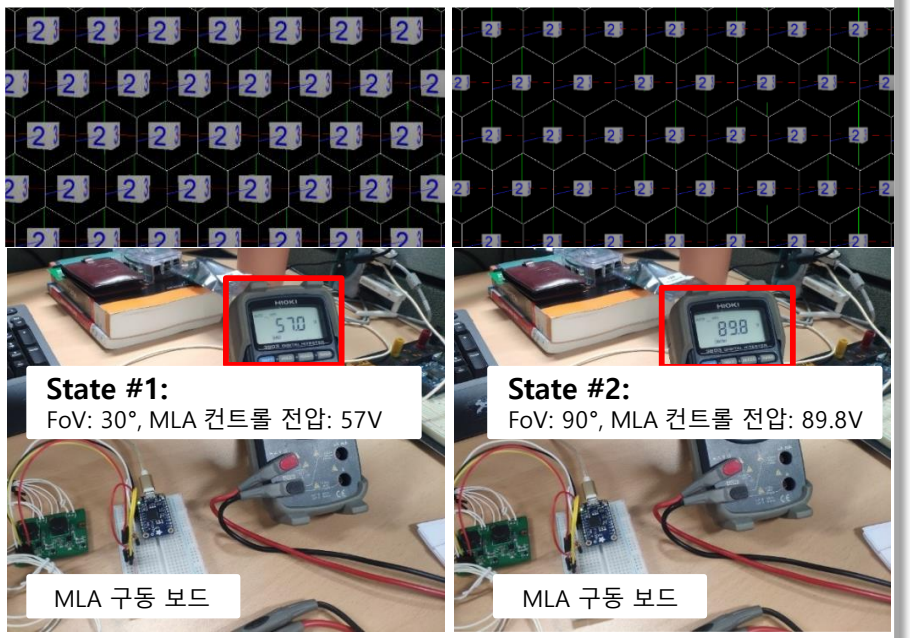
[전압에 따른 깊이 표현 범위 관측]

KETI's Solution #5 – Varifocal Integral Imaging Renderer

Varifocal Integral Imaging Renderer







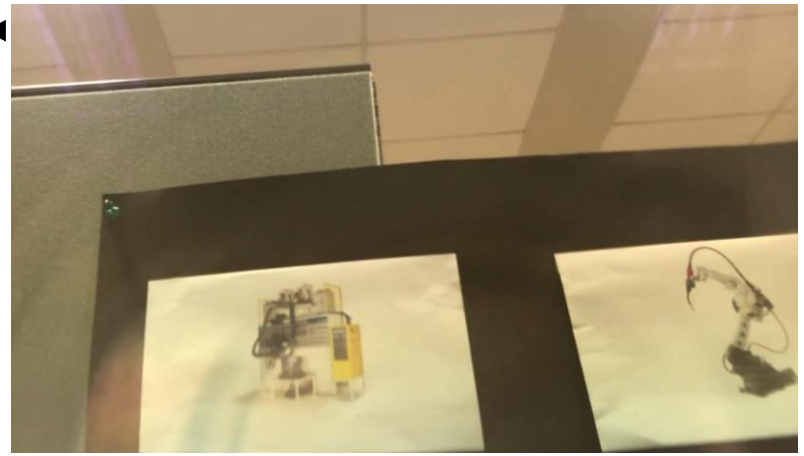
❖ 특징

- GLSL 및 GPU 기반 사용자 입력 실시간 반영이 가능한 집적영상 렌더러
- 초점 가변에 따른 렌더링 조건(개별 렌즈 화각, 심도 등) 변경 기능 제공
- 렌더러와 동기화된 MLA 구동 신호 출력 (USB/I2C)
- 30 fps 이상 동작 (Vertex # 121K 기준)

KETI's Solution #5 – AP-based Processing Boaed for AR Device

AP-based Processing Board for AR Device

- **Features**
  - AP : RK3399
  - Network : 4G/LTE, WiFi, Bluetooth
  - Support of IoT connection (oneM2M-compatible)
  - OpenMobius-based visualization engine inside



감사합니다.

정보통신미디어연구본부 임승옥본부장
solim@keti.re.kr