
Color Holographic
Wave-Front Printer
Korea Electronics Technology Institute [KETI]
Digital Holography Research Team
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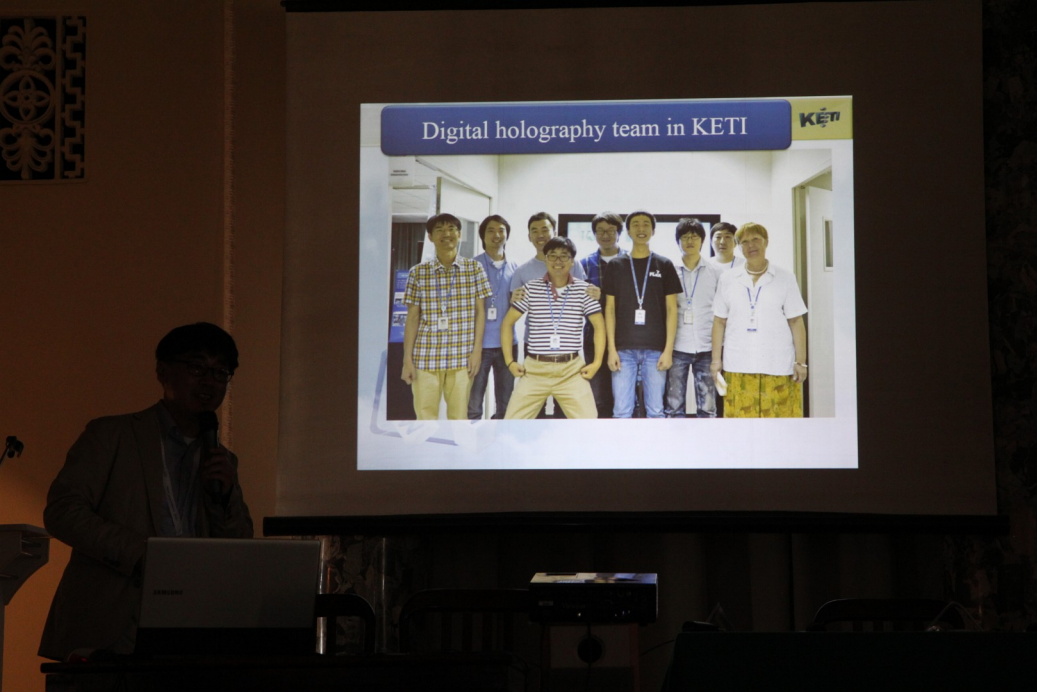
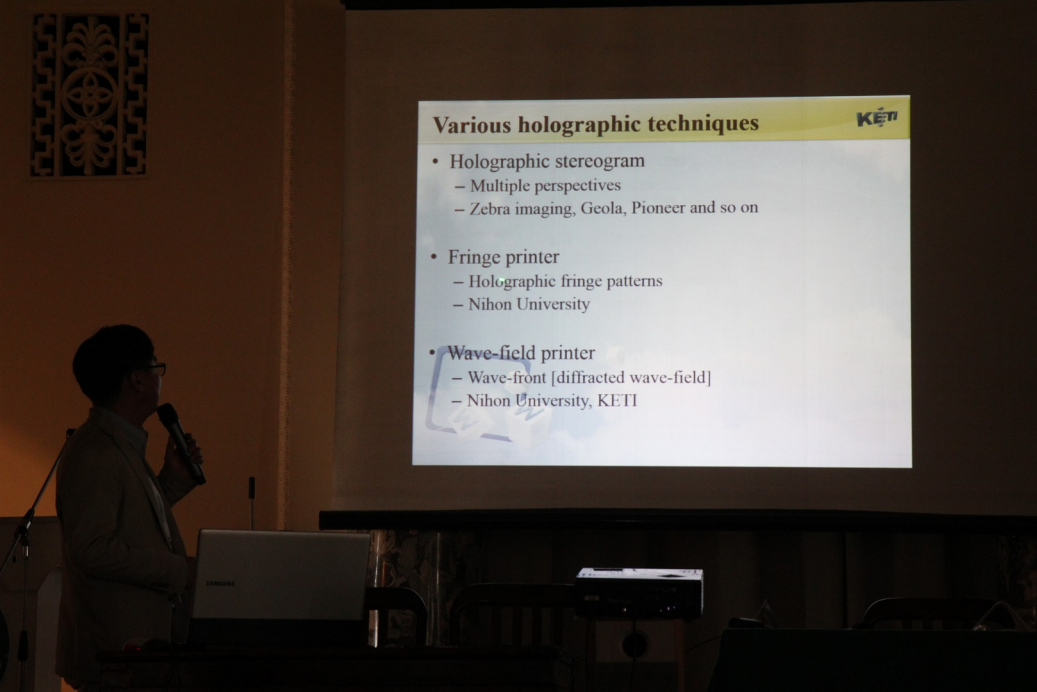
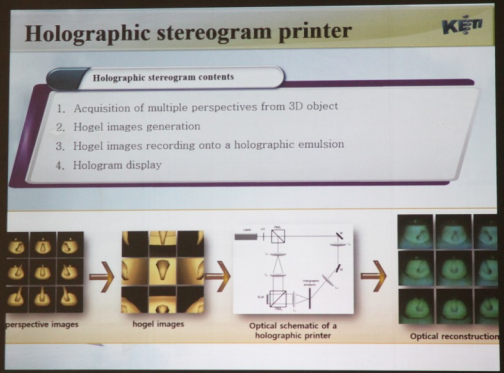
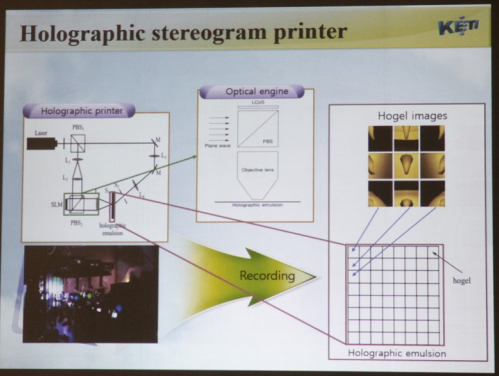
Sunghee Hong, Joosup Park (Ray Park), Jisoo Hong
KETI

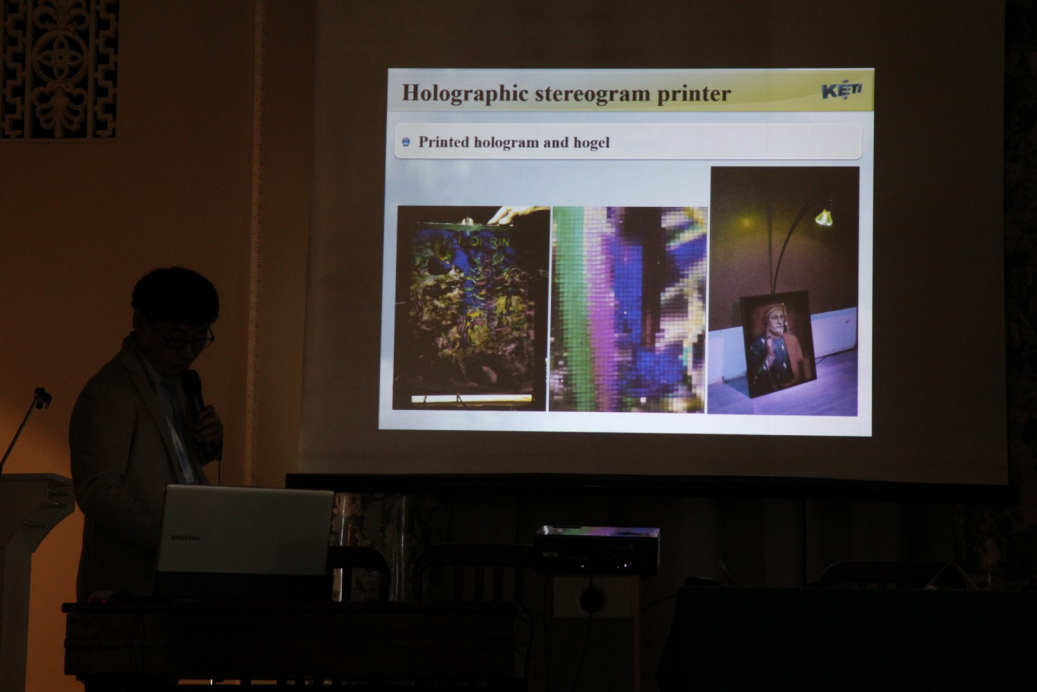

Digital holography team in KETI
KETI

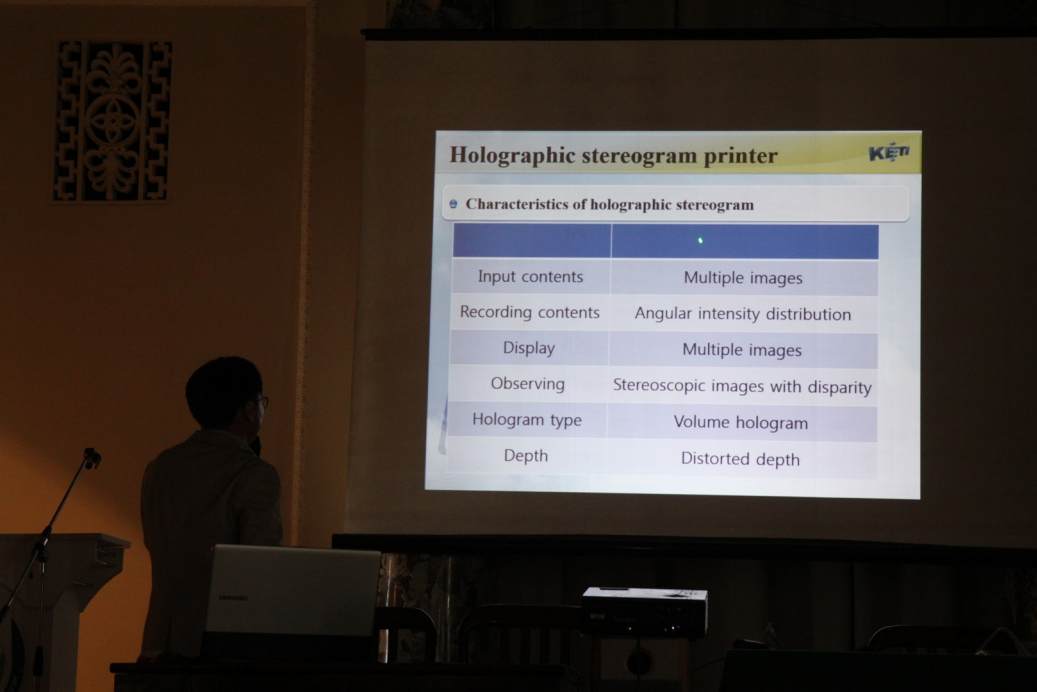

Analog hologram

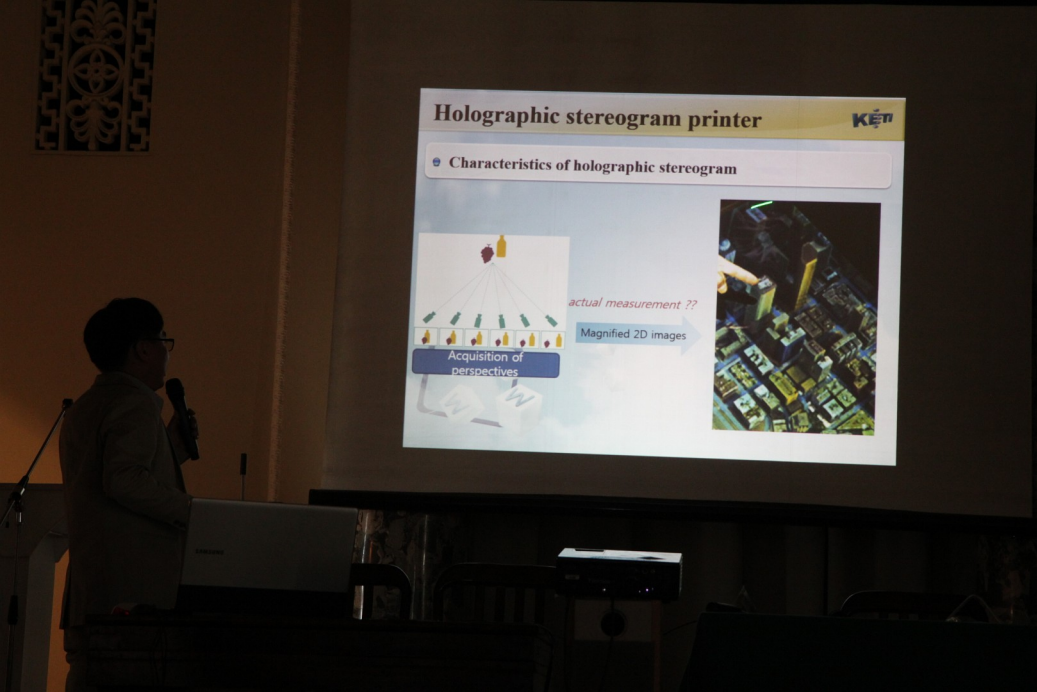

Various holographic techniques
KETI
• Holographic stereogram
– Multiple perspectives
– Zebra imaging, Geola, Pioneer and so on
• Fringe printer
– Holographic fringe patterns
– Nihon University
• Wave-field printer
– Wave-front [diffracted wave-field]
– Nihon University, KETI


Holographic stereogram printer
KETI
Holographic stereogram contents
1. Acquisition of multiple perspectives from 3D object
2. Hogel images generation
3. Hogel images recording onto a holographic emulsion
4. Hologram display
perspective images
hogel images
Optical schematic of a holographic printer
Optical reconstruction


Holographic stereogram printer
KETI
Holographic printer
Laser
PBS1
SLM
PBS2
holographic emulsion
Optical engine
LCoS
Plane wave
PBS
Objective lens
Holographic emulsion
Hogel images
Recording
hogel
Holographic emulsion


Holographic stereogram printer
KÉTI
Printed hologram and hogel


Holographic stereogram printer
KETI
Characteristics of holographic stereogram
Input contents
Multiple images
Recording contents
Angular intensity distribution
Display
Multiple images
Observing
Stereoscopic images with disparity
Hologram type
Volume hologram
Depth
Distorted depth


Holographic stereogram printer
KETI
Characteristics of holographic stereogram
actual measurement ??
Magnified 2D images
Acquisition of perspectives

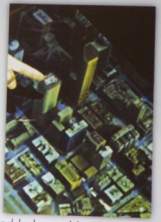
Wave-front holographic printer

KETI

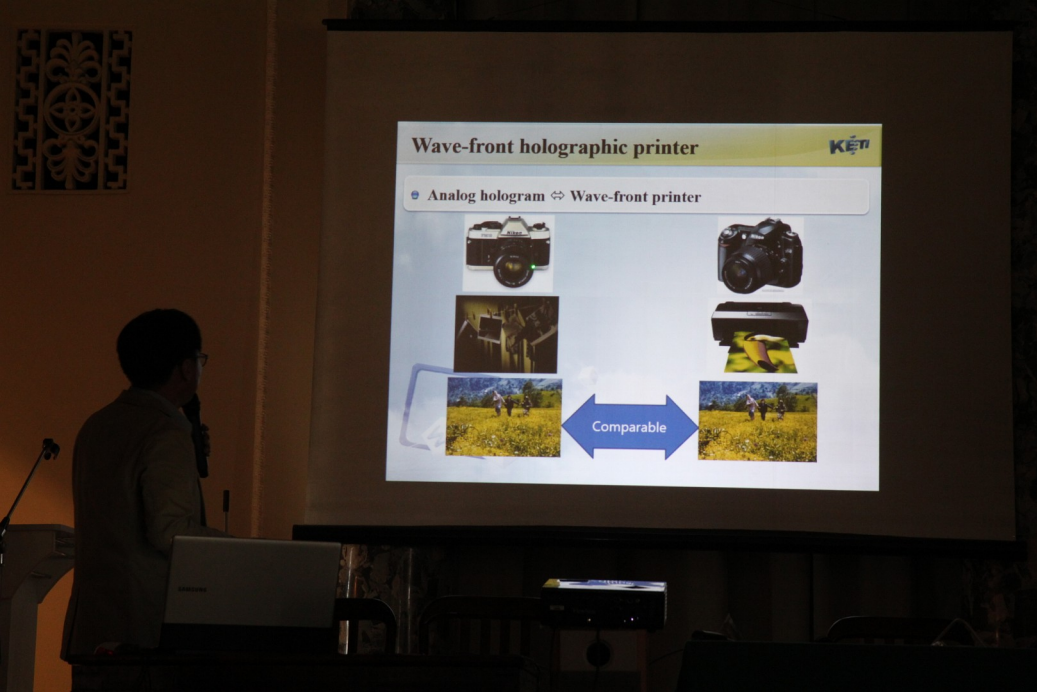
- Analog hologram ⇔ Holographic stereogram

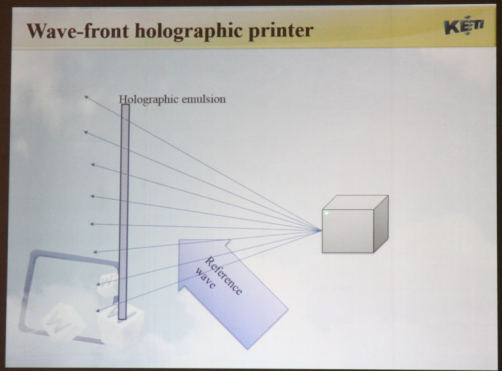
Analog hologram

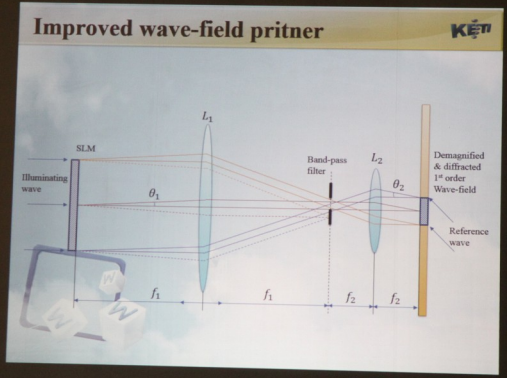
Comparable??

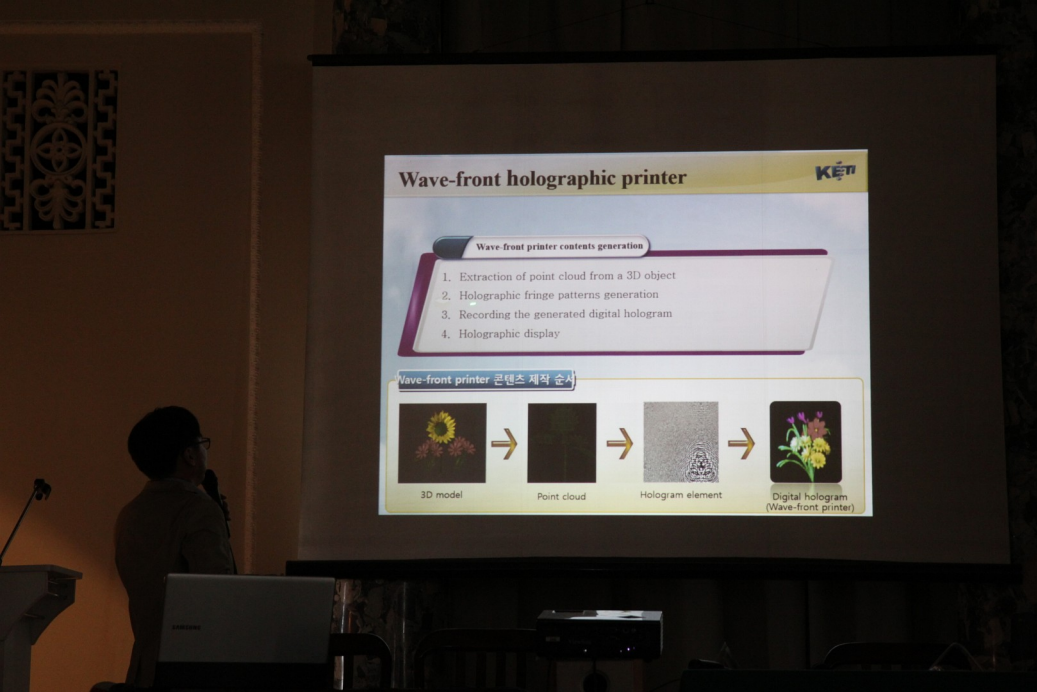


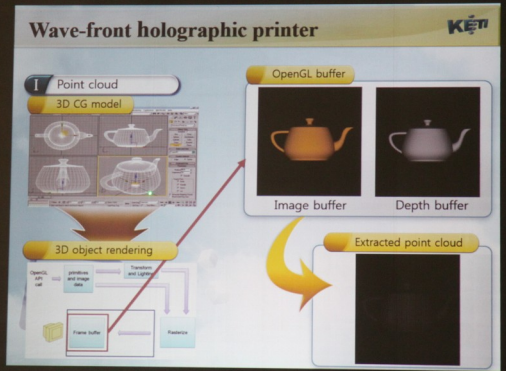
Printed holographic stereogram

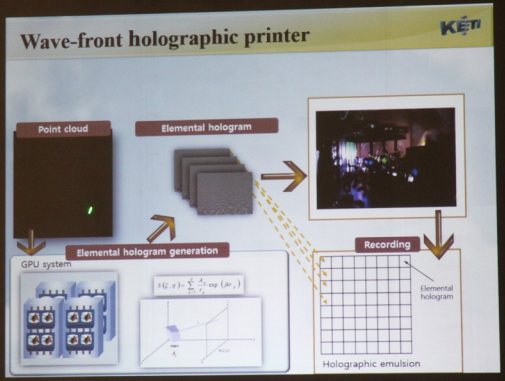

Wave-front holographic printer
KEN
Analog hologram ⇔ Wave-front printer
Comparable


Wave-front holographic printer
KETI
Holographic emulsion
Reference wave


Improved wave-field pritner
KEN
SLM
Illuminating wave
θ_1
L_1
Band-pass filter
L_2
θ_2
Demagnified & diffracted 1st order Wave-field
Reference wave
f_1
f_1
f_2
f_2


Wave-front holographic printer
KETI
Wave-front printer contents generation
1. Extraction of point cloud from a 3D object
2. Holographic fringe patterns generation
3. Recording the generated digital hologram
4. Holographic display
Wave-front printer 콘텐츠 제작 순서
3D model
Point cloud
Hologram element
Digital hologram
(Wave-front printer)


Wave-front holographic printer
KETI
Point cloud
3D CG model
3D object rendering
OpenGL buffer
Image buffer
Depth buffer
Extracted point cloud


Wave-front holographic printer
KETI
Point cloud
Elemental hologram
Elemental hologram generation
GPU system
Recording
Elemental hologram
Holographic emulsion

Wave-front holographic printer

- Improved phase-added stereogram
  - Spatial frequencies on ξ and η axis: u and v

$$u_p = \frac{\sin\theta_{\xi p} - \sin\theta_{\xi \mathrm{ref}}}{\lambda}, \quad v_p = \frac{\sin\theta_{\eta p} - \sin\theta_{\eta \mathrm{ref}}}{\lambda}$$

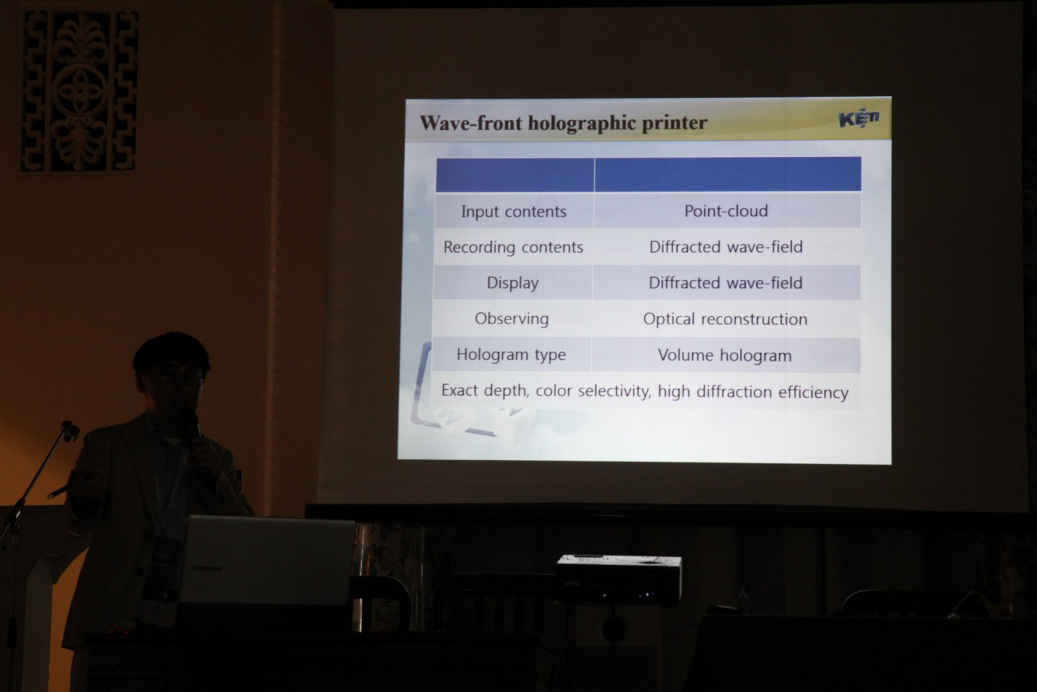
  - Approximation

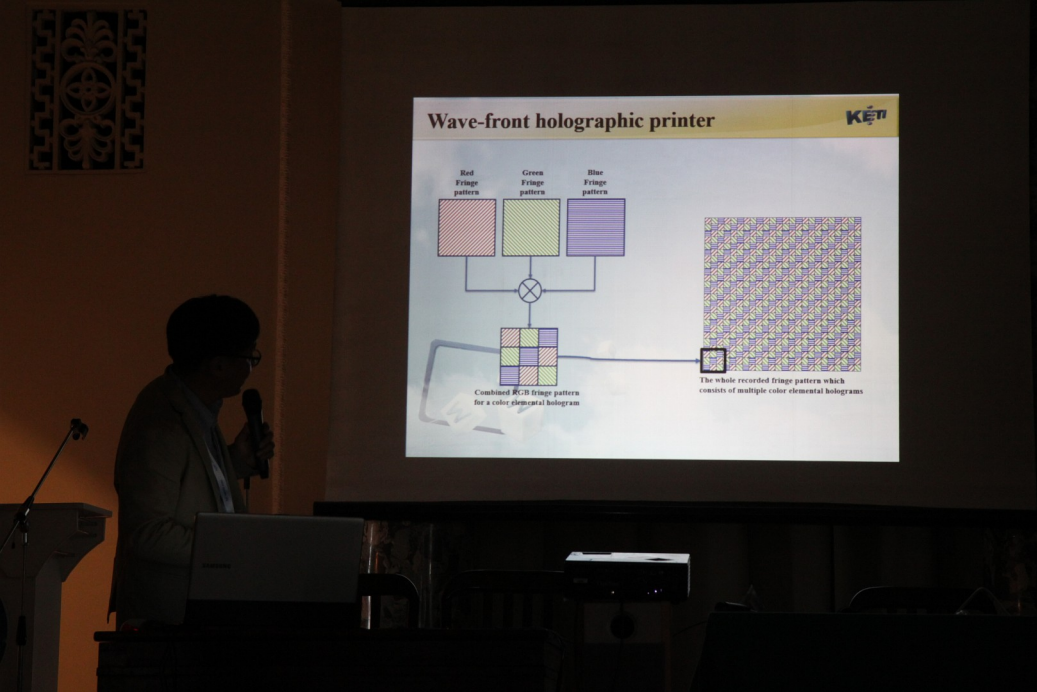
$$H(\xi,\eta) = \sum_{p=1}^{N} \frac{A_p}{r_p} \exp(jkr_p) \exp\left\{j2\pi\left[u_p(\xi - x_p) + v_p(\eta - y_p)\right]\right\}$$

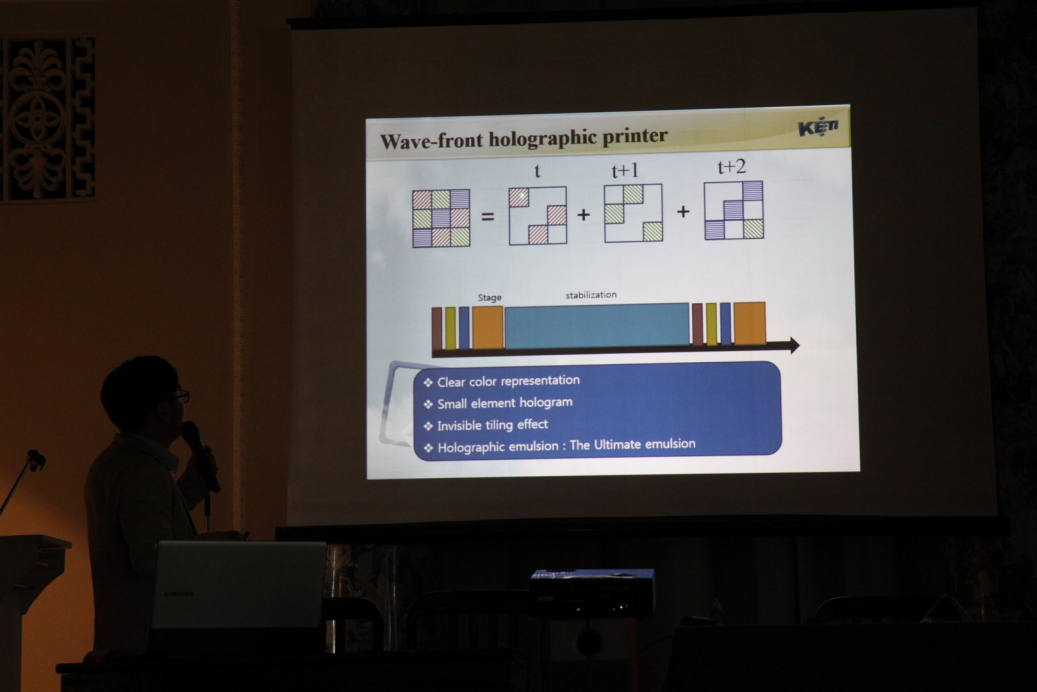
Phase

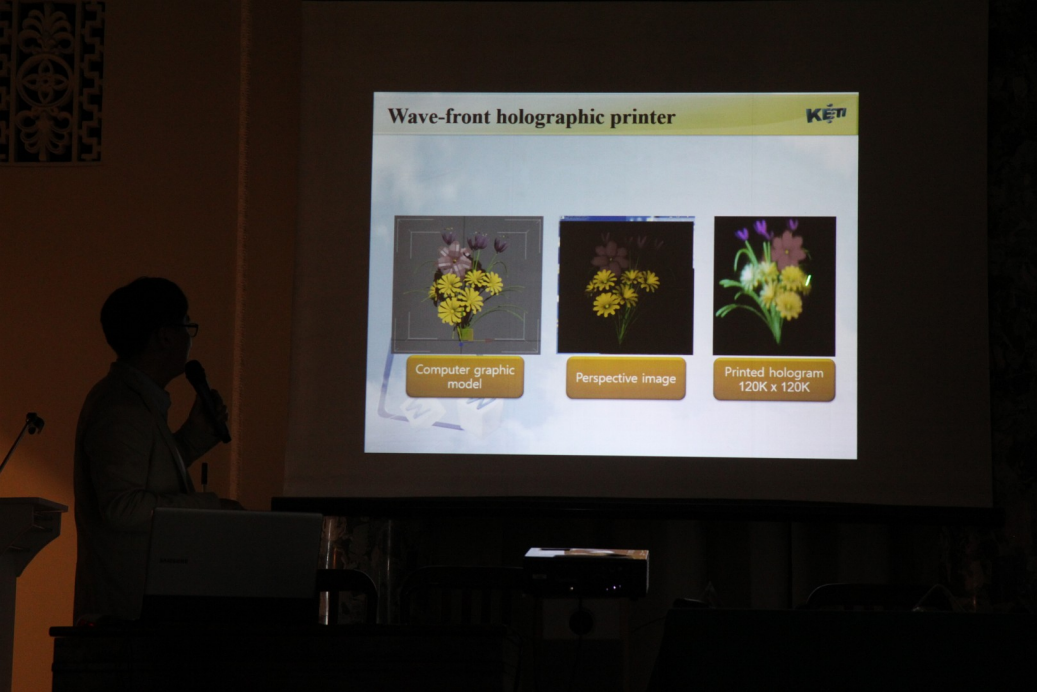
Complex sinusoid

Sum of the harmonic functions of different spatial frequencies and complex amplitudes

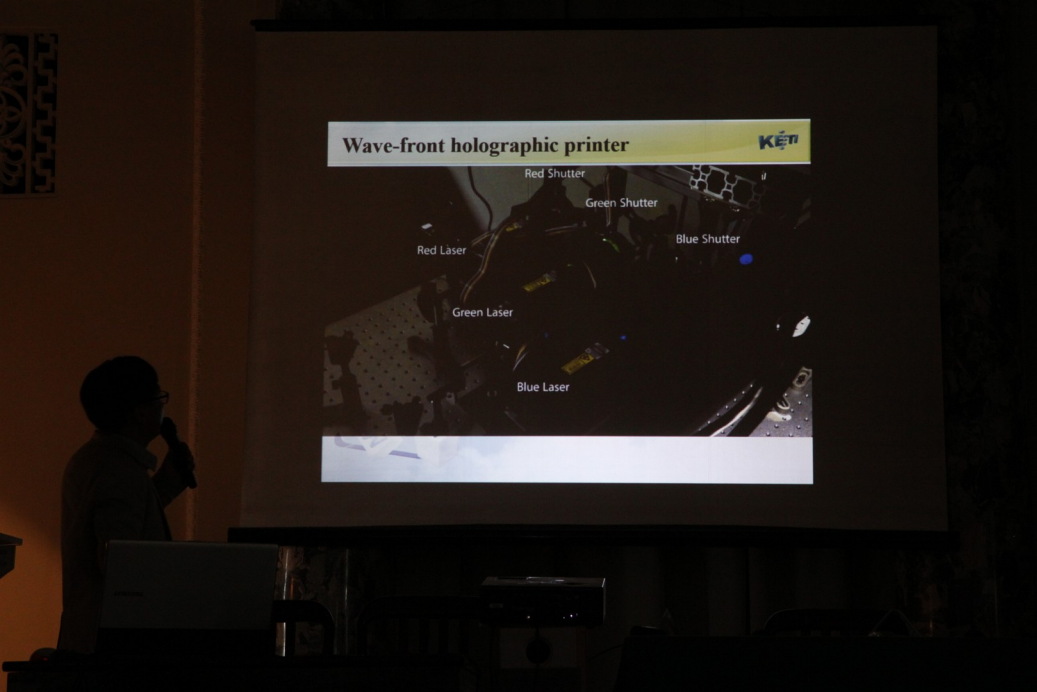

Wave-front holographic printer
KETI
Input contents
Point-cloud
Recording contents
Diffracted wave-field
Display
Diffracted wave-field
Observing
Optical reconstruction
Hologram type
Volume hologram
Exact depth, color selectivity, high diffraction efficiency

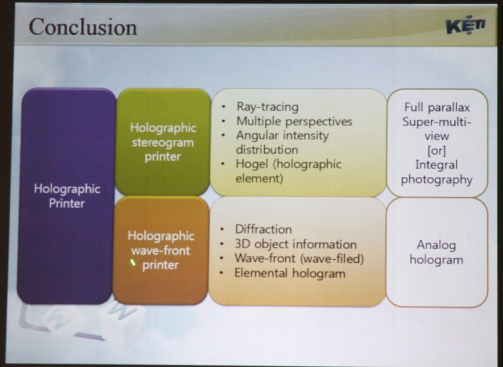

Wave-front holographic printer
KETI
Red Fringe pattern
Green Fringe pattern
Blue Fringe pattern
Combined RGB fringe pattern for a color elemental hologram
The whole recorded fringe pattern which consists of multiple color elemental holograms

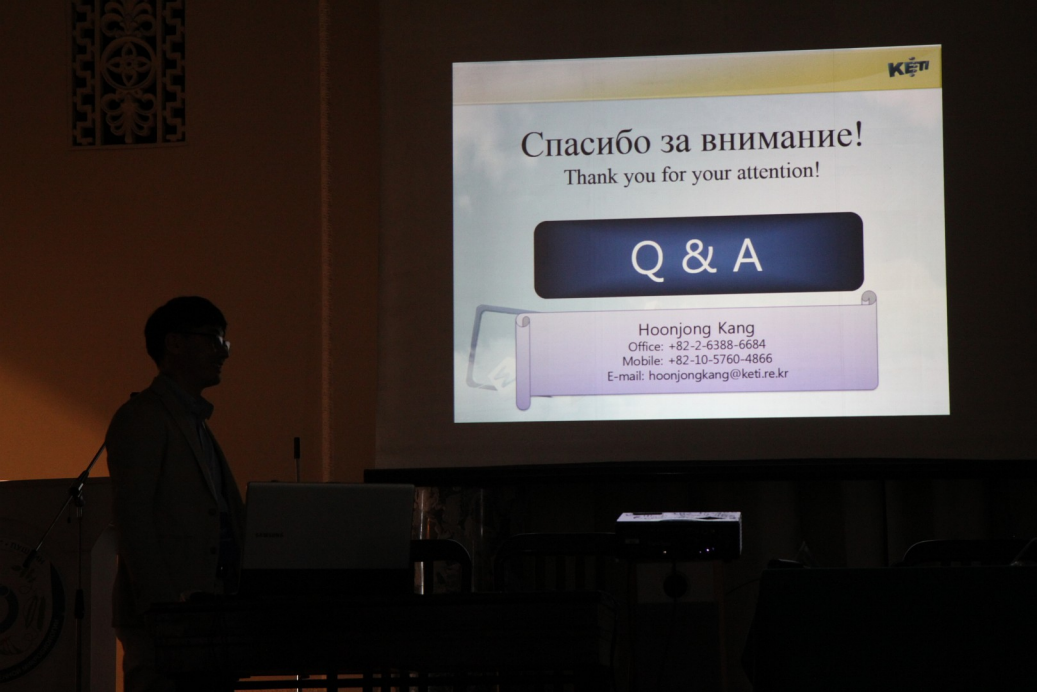

Wave-front holographic printer
KETI
t
t+1
t+2
=
+
+
Stage
stabilization
❖ Clear color representation
❖ Small element hologram
❖ Invisible tiling effect
❖ Holographic emulsion : The Ultimate emulsion


Wave-front holographic printer
KETI
Computer graphic model
Perspective image
Printed hologram 120K x 120K


KETI
• Size of hologram plate : 89.3mm x 89.3mm
• Pixel interval : 462nm x 462nm
• Interval of elemental hologram : 390um x 390um
• Number of element holograms : 235 x 235
• Total number of pixels : 199,750 x 199,750 ~ 39 Gpixels


Wave-front holographic printer
KETI
Red Shutter
Green Shutter
Blue Shutter
Red Laser
Green Laser
Blue Laser


Conclusion
KETI
Holographic Printer
Holographic stereogram printer
Ray-tracing
Multiple perspectives
Angular intensity distribution
Hogel (holographic element)
Full parallax Super-multi-view [or] Integral photography
Holographic wave-front printer
Diffraction
3D object information
Wave-front (wave-filed)
Elemental hologram
Analog hologram


KETI
Спасибо за внимание!
Thank you for your attention!
Q & A
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