Optical design of Hologram Optical Element-based See-through glasses

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1. Similar feature of Hologram and Augmented reality

Hologram and augmented reality device have same purpose: 3D image creation
2. Display Ergonomics contradictions

Notebook, Volume is DECREASING

K = S_{display} / S_{device}

K = 0.25
K = 0.3
K = 0.45
K = 0.75

Mobile phone, Display ratio is INCREASING

Virtual Displays
• Portable
• Compact
• Dynamic
2. display size $\neq$ visual size

(example of PBS)

If $\alpha=40^\circ$, $L=3\, m$ $\Rightarrow$ visual size $= 86\, inch$

Visual size $= 2L \cdot \tan\left(\frac{\alpha}{2}\right)$
4. Potential application area of Augmented reality

- Display Enhancement
- Real/IoT and virtual object control by gesture
- 3D AR modeling (and then 3D-Printer)

- Biofeedback
- Instruction
- Navigation

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5. Why HOE compared with other constructions

- **PBS**
  - EMB - PBS size
  - Small EMB
  - Bulky system

- **TIR free-form prism**
  - Bulky system

- **Mirror array**
  - Mirror array
  - Lumus
  - Low productivity
  - Visible pattern

**Simple layout of HOE-based glass**

- Nonvisible pattern from inside and outside
- Small size of system in front of eyes

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6. Theoretical base

In-coupling

Out-coupling

Multiplication

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7. Simulation result

- Display
- Eyepiece
- Lightguide
- HOE1
- Pupil position
- HOE2

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8. Experimental procedure

Holograms on phoresist waveguide

Silicon deposition on hologram samples

Photopolymer

waveguide

Exposure. Photopolymerization

Photoresist hologram samples

waveguide

Photopolymer

photoresist holograms unsticking from waveguide. Silver removal. Washing

Replica of Out-coupling hologram

Replica of In-coupling hologram

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9. Prototype Result

**illumination part**

- Laser
- F = 30 μm
- Divergence is regulated by beam expander (distance d)
- Beam Splitter
- Waveguide

**Eyepiece module**

- LCdK Mount
- Screw
- Beamsplitter
- Barrel of eyepiece

**Prototype result**

- Illumination part
- Waveguide
- Eyepiece
- LCdK
- LCdK driver

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Thank you!

Спасибо!