OLED based binocular interactive see-through HMD

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Outline

• Introduction
• System Overview
• Applications
Introduction

OLED-Microdisplay

- Excellent contrast ratio
- Large dynamic range
- Low power consumption

State of the art: Uni-directional output

Additional image sensor

Beyond state of the art: Bi-directional input+output

Diversity of new applications

Uni-directional display: VGA, 6x8mm²

(www.hypoled.org)
Introduction

Bidirectional OLED-Microdisplay

- Top-emitting OLED
- Direct evaporation of OLED stack through a shadow mask
- Unpatterned OLED
  - Pixel shape defined by bottom electrode (CMOS top metal-anode)
  - Common cathode
- Colour filter (optional)
Introduction

Chip-architecture

- Nested display and image sensor pixel matrix
- Separated controls
- Configuration via IIC
- Common bias block
- External ADC
- Mobile host system for data processing and applications
Introduction

Bidirectional OLED-Microdisplay feedback mode demonstrator

- Acquired image directly fed back into display

See this demo at booth #1371!
System Overview

System architecture

- Computer / Netbook
- AR-Platform
  - Camera data via LVDS
  - Display data via LVDS
- HMD electronics
  - Display data parallel
  - Camera data parallel
- Bidirectional OLED microdisplay
- Bidirectional optics left eye
- Bidirectional optics right eye
System Overview

Netbook

AR-Platform

Binocular HMD with interface electronic

Bidirectional optics
System Overview

Specifications:

- Display: 640 x 480 pixels
- Viewing-area (µD): 10.2 mm x 7.7 mm
- Eyetracking camera: 128 x 96 pixels
- FOV (see-through): 26.5° x 17.2°
- FOV (info channel): 20° x 21.6°
- Accommodation distance: 750 mm
- See-through Transparency: 50 %
- Eye-motion box: 5.6 mm x 11.2 mm
- Weight: 198g
Applications

Eyetracker

1. Input Image
2. Adaptive Filtering
3. Histogram Equalization
4. Detecting Corneal Reflections
5. Detecting Pupil
6. Ellipse fitting
7. Gaze-track

Detection of pupil (red) and reflections (green)
Applications

- **Bidirectional display**
  - Displays an image and detects another image on the same device
- **HMD application**
  - Tracking eye-movement for users sight and awareness
- **Gaze-based human-display-interaction**
  - Interactive augmented-reality

![Diagram of bidirectional display and HMD application](image.png)
Applications

Worldmap
- Fullsize earth map
- ROI is displayed on HMD
- Moving ROI by gaze

Try this demo at booth #1371!
Summary

- Bidirectional OLED-Microdisplay
- Demonstrator OLED based binocular interactive see-through HMD is available
- Work was in parts sponsored by Federal Ministry for Education and Research of the German government

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Thank you for attention
Optical System
HMD-Application

- See-through optics (beam-splitter, VIS transmissive mirror)
- Different imaging planes for display and camera
- Near-infrared illumination of eye scene

captured eye scene with 160x120 pixel
bidirectional OLED microdisplay
virtual image
Introduction to organic LEDs - OLEDs

- **Lighting**
- **Medium and large display** ⇒ TFT

**bottom-emitting**
- Transparent conductor
- Organic layers
- Metal cathode
- Substrate

**top-emitting**
- OLED-on-CMOS

(silicon wafer)