

12. Head-Mounted Display-Systeme (HMD)

12.1 Grundprinzipien

12.2 System-Design

Head-Worn Displays



1999



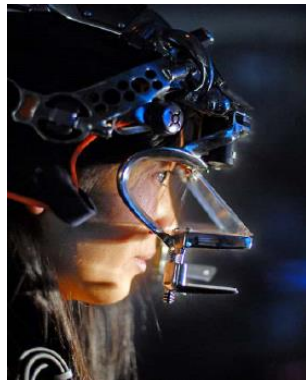
1999



2009



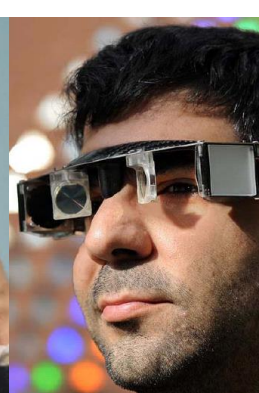
2005



2007



2009

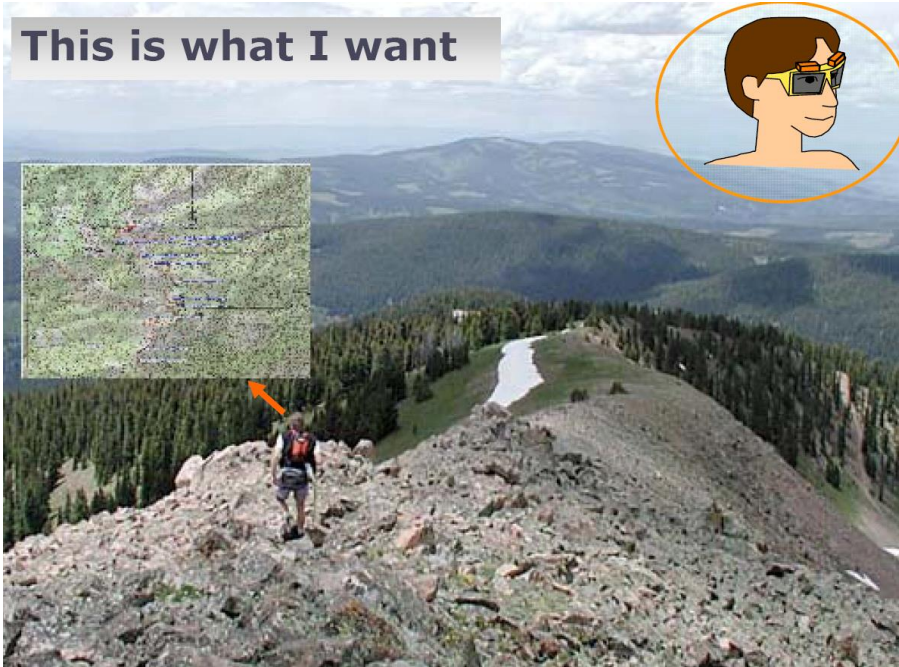
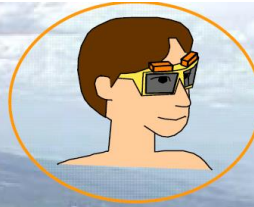


K. Thompson et al.,
The Coming Generation of Head-worn Displays (HWDs), OSA Annual Meeting 2009

Anwendung Head-Worn Displays



This is what I want



This would be nice too

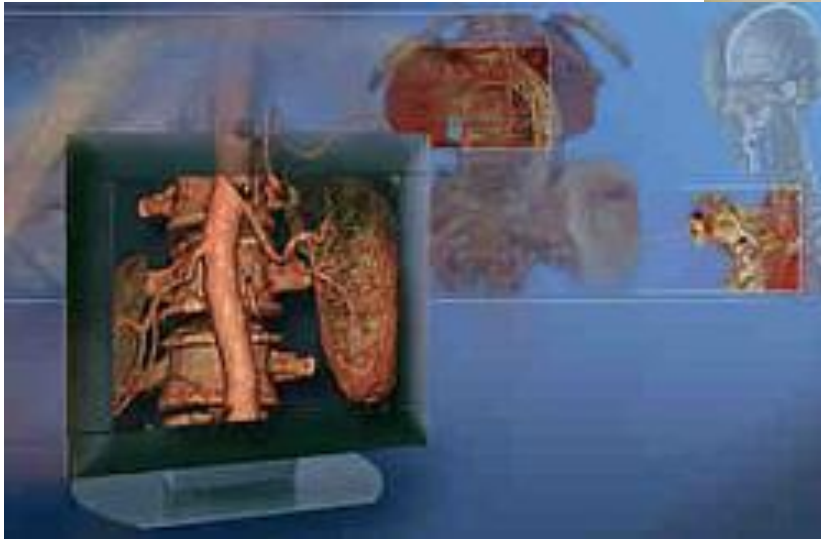
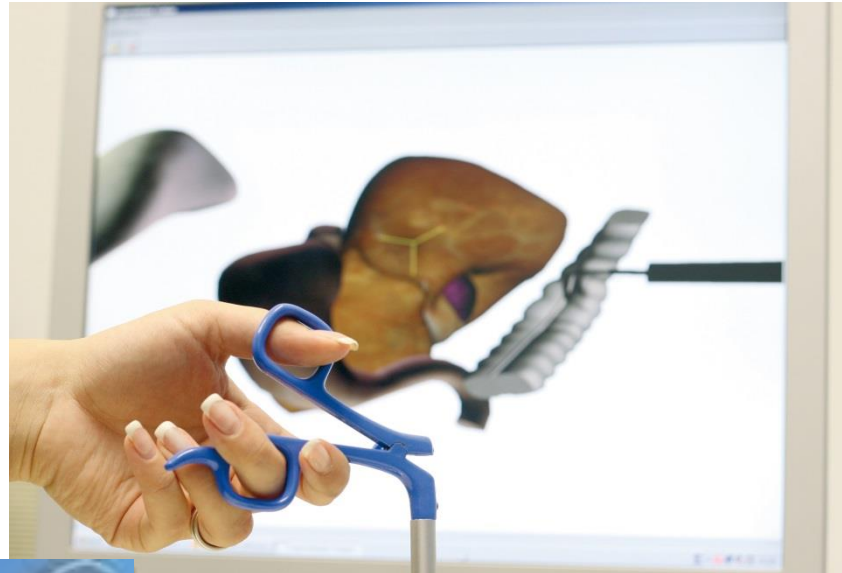


Anwendung Head-Worn Displays



Medizintechnik:

3D-Visualisierung / Endoskopie
Mixed - Reality



Typen von Head-Worn Displays



Rein Digital (Virtual Reality)



<http://www.cyberneum.de/de/technische-ausstattung/head-mounted-displays-hmds.html>

See-Through Digital & real (augmented reality)



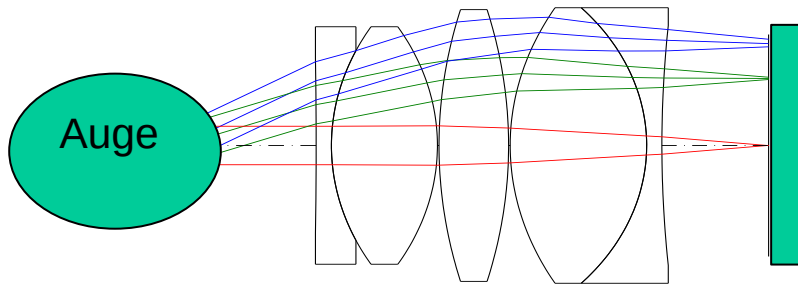
Datenbrille Teil-Bildfeld



Zwei grundsätzliche Varianten:

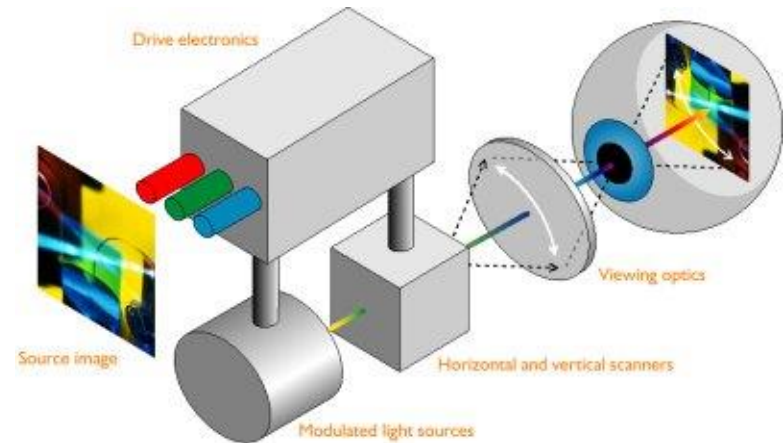
A. Abbildung von LCD/Mikrodisplays

Prinzip: Abbildung eines Displays mit Hilfe von Optik in das Auge

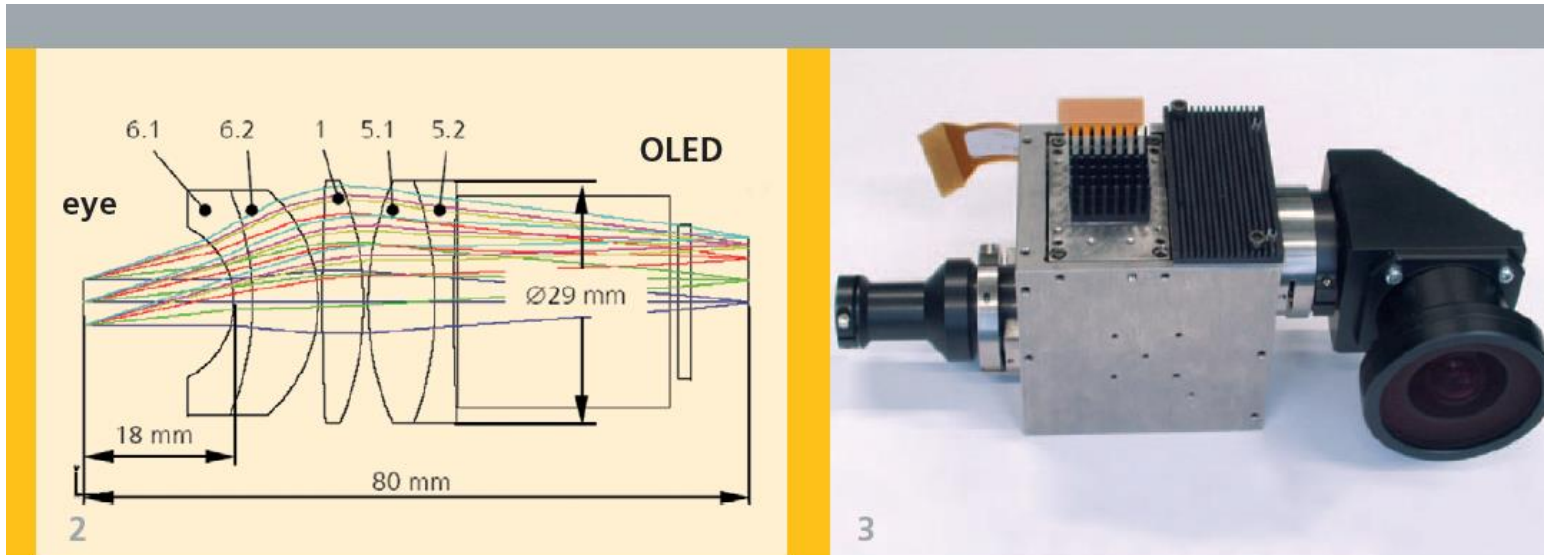
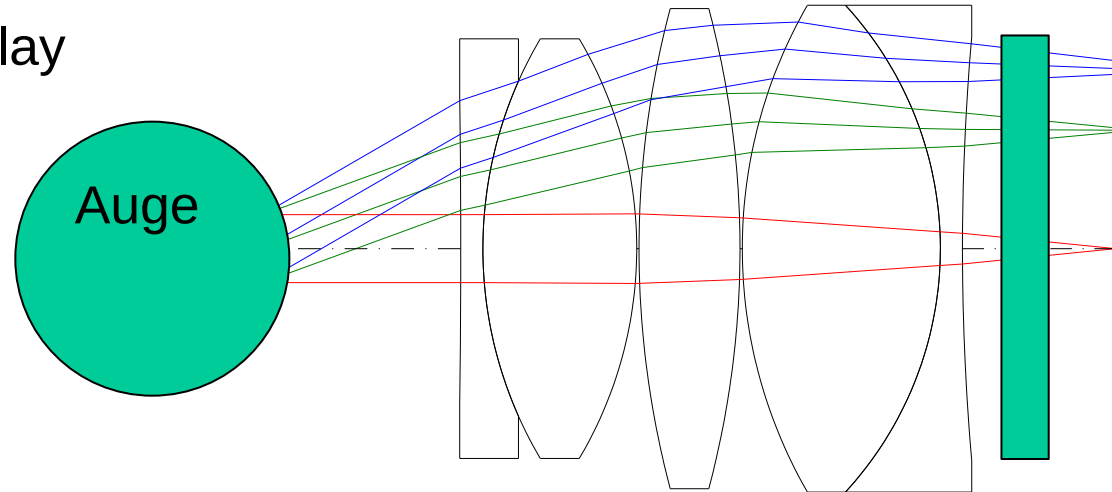


B. Retina Projektion

Prinzip: Direkte Erzeugung des Bildes auf der Netzhaut



Im Prinzip:
Okular & Mikrodisplay



XVGA-Display:

Format: 1280×1024

Pixel Aspect Ratio: Square

Pixel Pitch: $9.3\mu\text{m}$

Viewing Area: $11.941 \times 9.560\text{mm}$



http://www.olightek.com/products_detail/&productId=35.html

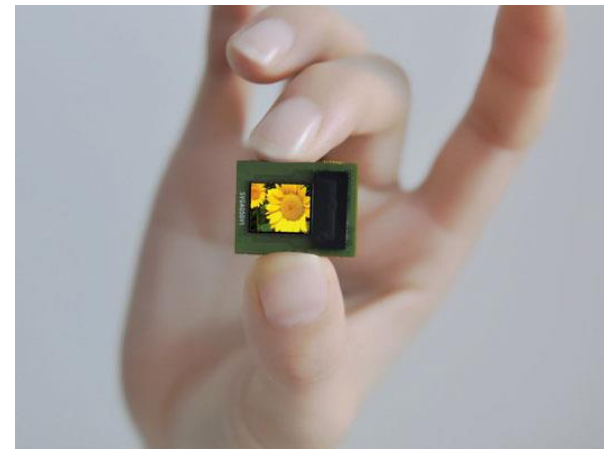
SVGA

Format: $800 (\times 3) \times 600$

Pixel Aspect Ratio: Square

Pixel Pitch: $12.6\mu\text{m}$

Viewing Area: $10.13\text{mm} \times 7.61\text{mm}$



Optisches System (Beispiel)

- Field of view (FOV): 33.9° , 28.5°
- Exit Relief: 52mm
- Exit Pupil: 7mm
- Magnification: 10X
- Lens Material: Glass



→ Brennweite: 10X = $f' = 25\text{mm}$

http://www.olympus.com/products_detail/&productId=35.html

→ Zusammenhang Bildgröße / Winkel : $y = f' \cdot \tan(w)$

z.B. Display-Breite: 12mm → $w = 28.5^\circ$

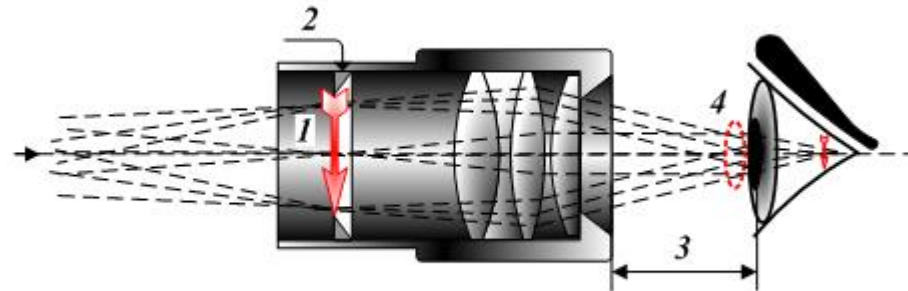
→ Pixelgröße vs. Auflösung : $dy = f' \cdot dw$

→ 0.01mm-pixel → 0.4mrad ($1.5'$)

(Auge = $1'$, d.h. Pixel sind evtl. noch sichtbar)

Eye –Relief (evtl. auch Exit – Relief)

= Abstand zwischen Auge und erster optischen Fläche



Eye –Relief

Exit Pupil Diameter

= Durchmesser der Austrittspupille

➔ kritisch, da Augenbewegung, Justage mit berücksichtigt werden muss

Field of View (FOV)

= Durchmesser des sichtbaren Bildfeldes

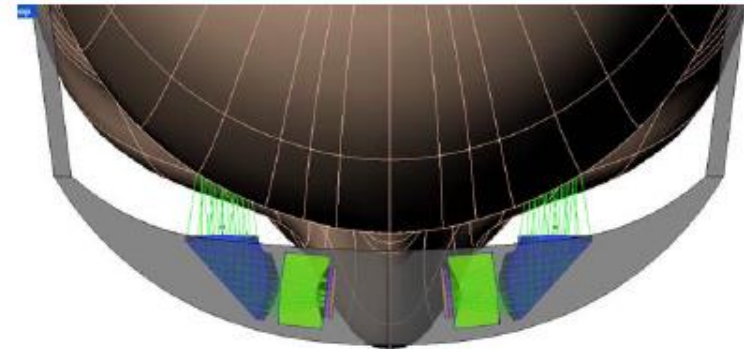
➔ Problem: Display-System liefern eher begrenztes FOV, da Kompromiss zwischen Auflösung und Bildfeld notwendig ist

Stereo – Display System



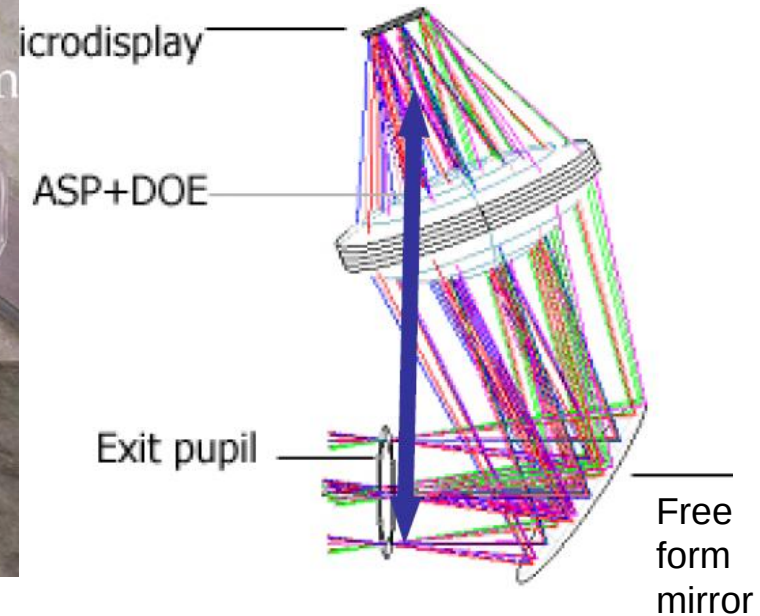
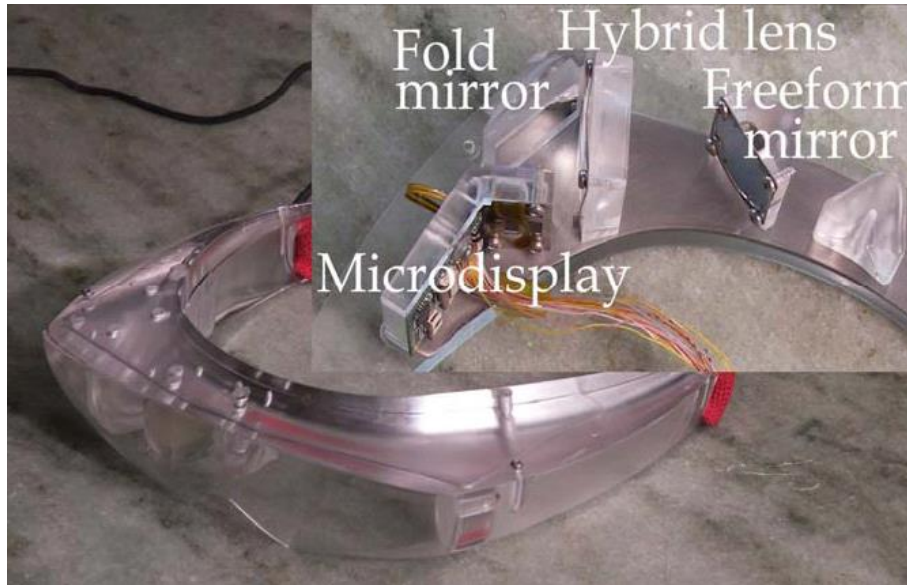
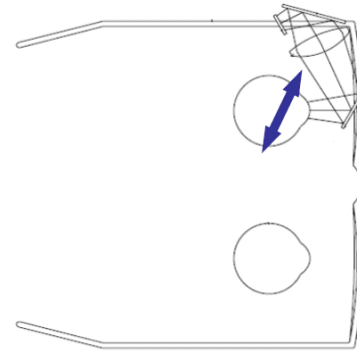
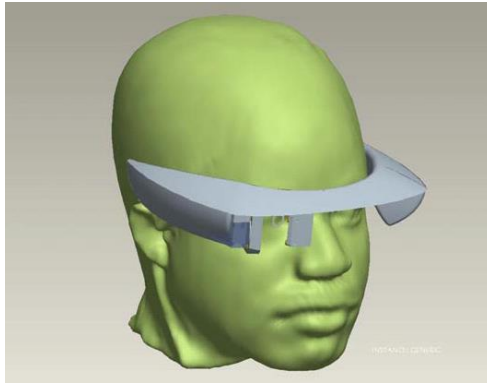
■ achieved VGA resolution for HMD optics

	VGA resolution	WVGA Resolution
Resolution	(640x480)	(854x480)
Format	4:3	16:9
Weight:	87g excl. HDMI Cable 119g incl. HDMI Cable	87g excl. HDMI Cable 119g incl. HDMI Cable
Compact size (LxWxH) [cm]	4.4 x 14.5 x 3	4.4 x 14.5 x 3
Field of View	26° diagonal	23° diagonal
Virtual Image Size (viewed from virtual 2m)	39"	34"
Eye Relief	20mm	20mm
Exit Pupil Diameter	10mm	10mm
Focus Distance	2.13m	2.13m
Interpupillary Distance (IPD)	63.5mm	63.5mm



Quelle: Fraunhofer IPMS

Design Head-Worn Displays

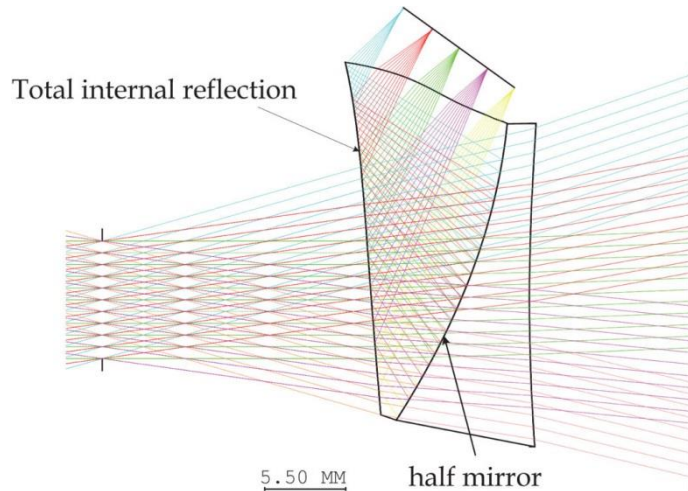


O. Cakmakci, J. Rolland,
Design and fabrication of a dual-element off-axis near-eye optical magnifier, Opt. Lett. 32 (2007), 1363-1365

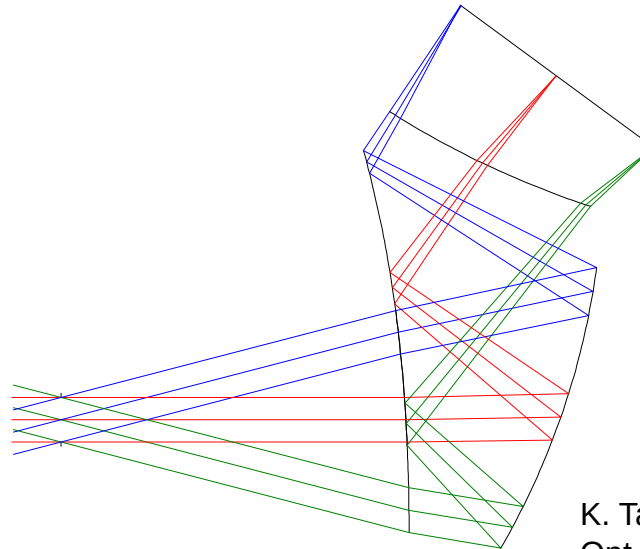
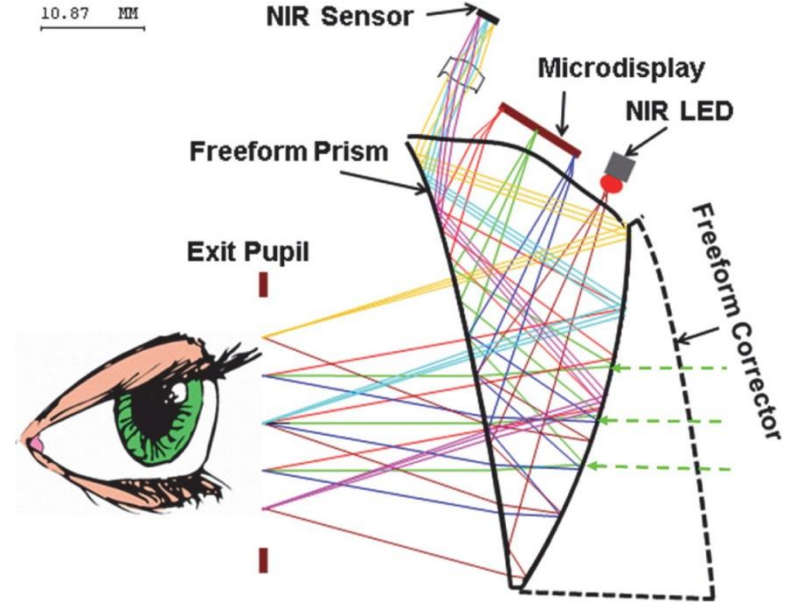
Design Head-Worn Displays



Komplexe Optik wegen Geometrie



(b)



K. Takahashi,
Opt. Rev. 18 (1), 55-59 (2011)

Google Glass

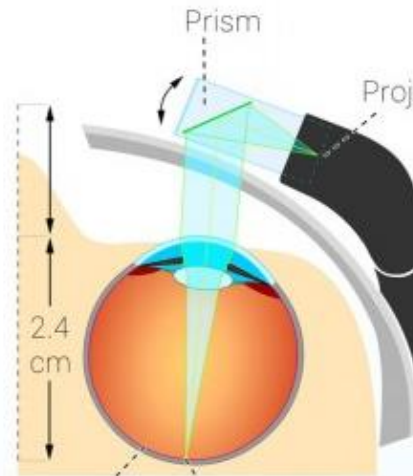
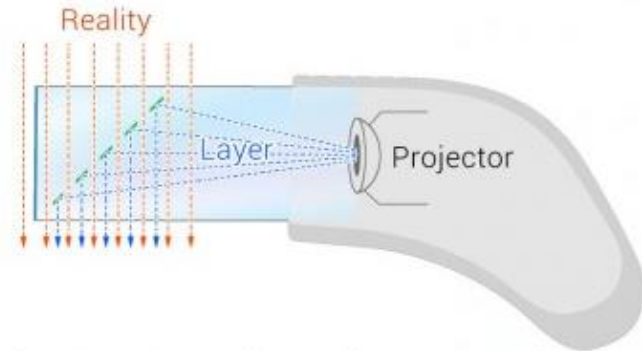


➔ Retina Display Technik



Reality Layer

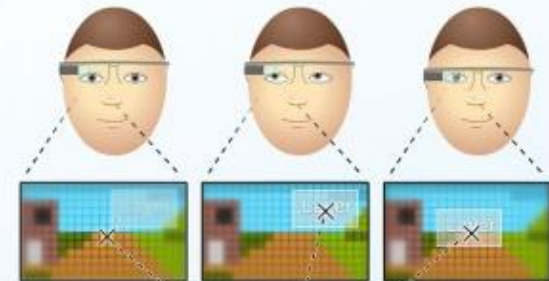
A clever prism projects a layer over reality light.



Retina Fovea (sharpest image)

The prism focuses the image directly on the retina.

Position of layer depends on position of Google Glass:



Visual focus

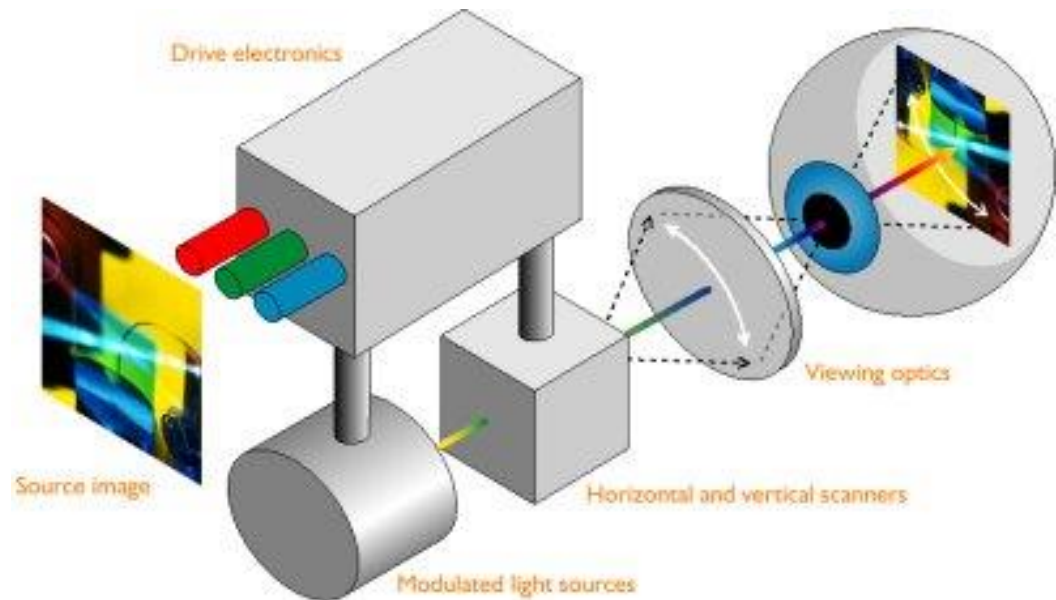
Virtual Retina Displays



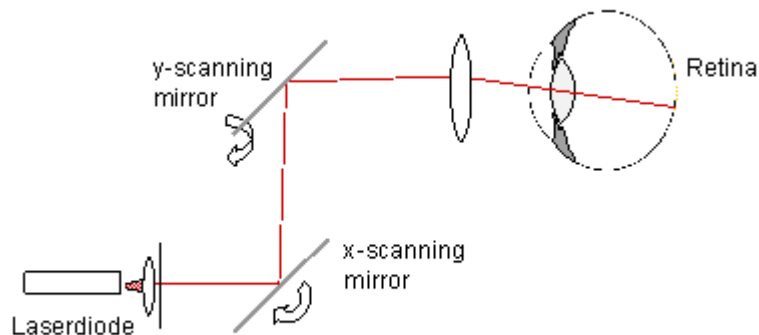
Bild wird erst im
Auge erzeugt !

Laser / Lichtstrahl
Erzeugt Bildpunkt im
Auge

➔ Mikro-Scan-Spiegel
notwendig (MEMS)



<http://www.iraiment.com/images/glasses/vrd/smallsystem.jpg>

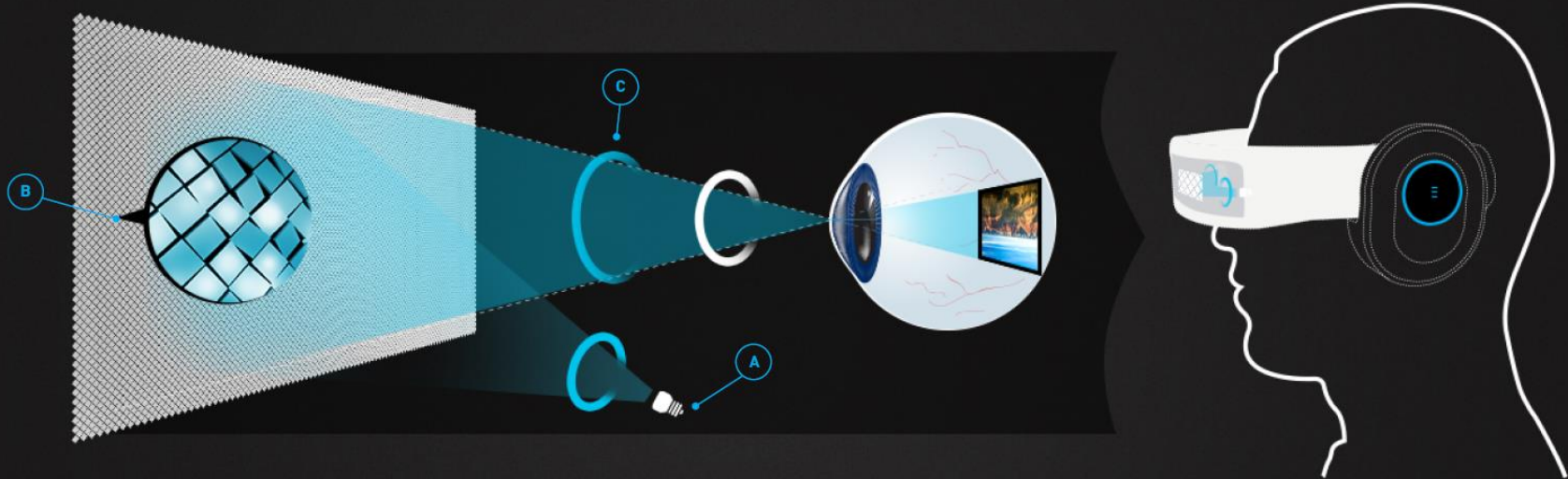


Virtual Retina Displays



GLYPH

VIRTUAL RETINAL DISPLAY (VRD)



(A) LOW-POWER LED

Light from a low-powered LED mimics natural light, eliminating fatigue so long-term usage is comfortable.

(B) MICROMIRROR ARRAY

Two million mirrors reflect the conditioned light and shape it into an image fit for the eye with vivid clarity.

(C) OPTICS

Patented optics focus and project the light stream directly onto the retina, resulting in extraordinary visuals, all without a screen.

Head-Mounted Display Varianten

- ➔ Rein Digital
- ➔ See Through
- ➔ Datenprojektion

Prinzipien:

Abbildung von Mikrodisplays

- ➔ Optik ähnlich wie Okular
- ➔ Teilweise exotische Geometrien (Freiformoptik)

Retina Projektoren

- ➔ Bild entsteht erst auf der Netzhaut
- ➔ Scan-Verfahren mit beweglichen Spiegeln