

Einführung: Was ist AR?

Vorlesung „Augmented Reality“

Prof. Dr. Andreas Butz

WS 2006/2007

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Organisatorisches

- Vorlesung: Fr. 12-14 Uhr, Amalienstr. 17, Raum 105
- Übungen (Sebastian Boring, Arnd Vitzthum): Mo, 16-18, Implementierung ausgewählter Konzepte der Vorlesung
- Webseite: <http://mimuc.de/ar>
- Kontakt: butz@ifi.lmu.de, Sebastian.boring@ifi.lmu.de, arnd.vitzthum@ifi.lmu.de
- Sprechstunde:
 - Andreas Butz: Mi, 16-17 Uhr, Amalienstr. 17, Raum 502

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Überblick

- Von der Realität zur Virtualität
- Was ist Augmented Reality (AR)?
- Einordnung der Erweiterten Realität
- Funktionsweise eines generischen AR-Systems
- Vorlesungsinhalte

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Von der Realität zur Virtualität



Realität



Erweiterte
Realität
(Augmented
Reality – AR)



Erweiterte
Virtualität
(Augmented
Virtuality)

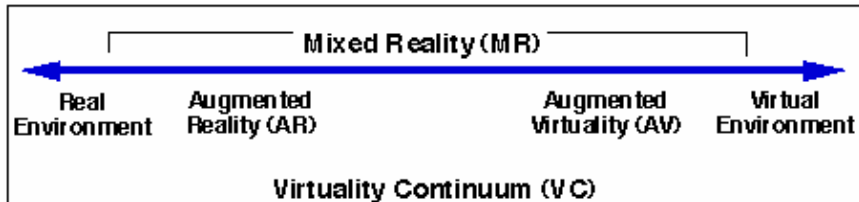


Virtualität
(Virtual
Reality – VR)

[Regenbrecht et al. 2003, Billinghurst 2002]

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Milgrams Virtuality Continuum



- Milgram & Kishino: *A taxonomy of mixed reality visual displays*, IEICE Transactions on Information Systems, Vol E77-D, No.12 December 1994.
- Mixed Reality (MR) ist Oberbegriff über
 - Erweiterte Realität (Augmented Reality – AR)
 - Virtuelle Realität (Virtual Reality – VR)

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Definition von AR nach Azuma

Drei Kriterien eines AR-Systems:

1. Kombination von realen und virtuellen Inhalten
2. Interaktiv in Echtzeit
3. Im 3D-Raum registriert

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Kombination realer/virtueller Inhalte

- Kombination kann auch Dinge aus realer Welt entfernen („Diminished Reality“)
- Verschiedene Wahrnehmungskanäle
 - Visuell
 - Auditorisch
 - Haptisch
 - Olfaktorisch



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Interaktiv in Echtzeit

- „Herr der Ringe“ kombiniert reale und virtuelle Inhalte, ist aber nicht interaktiv
- Echtzeit macht AR schwierig:
 - Latenz i. A. < 100 ms
 - Bei visueller AR hohe Bildwiederholraten (> 30 fps) nötig



ARQuake [Piekarski, 2002]

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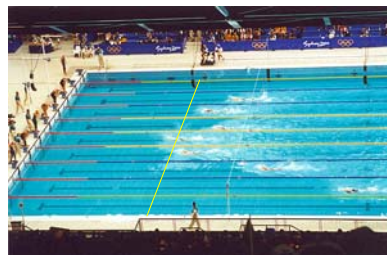
Registrierung im 3D-Raum



Beleuchtung der virtuellen Szene reagiert auf die Position der „Sonne“

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Kommerzielle AR Beispiele



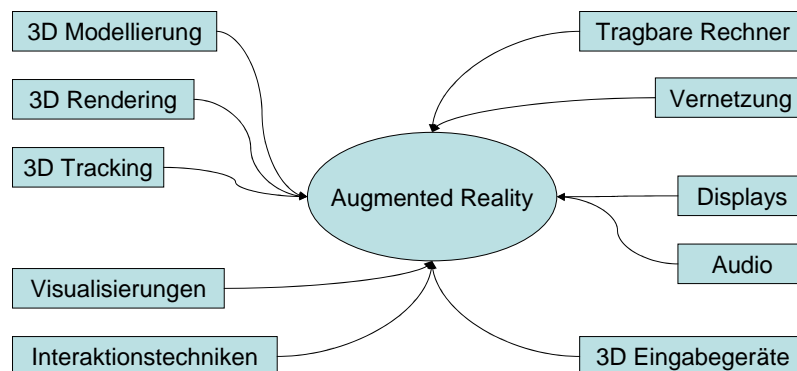
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AR innerhalb der Informatik

- AR ist ein **Paradigma** (siehe MMI1)
 - Andere Paradigmen (nicht immer klar getrennt):
 - Mobile computing
 - Wearable computing
 - Personal Computer
 - Virtual reality
 - ...
- Innerhalb der (vis.) AR verschiedene Ansätze:
 - Head Mounted Displays (HMDs)
 - Handheld AR
 - 2D Projektion in der phys. Umgebung
 - ...

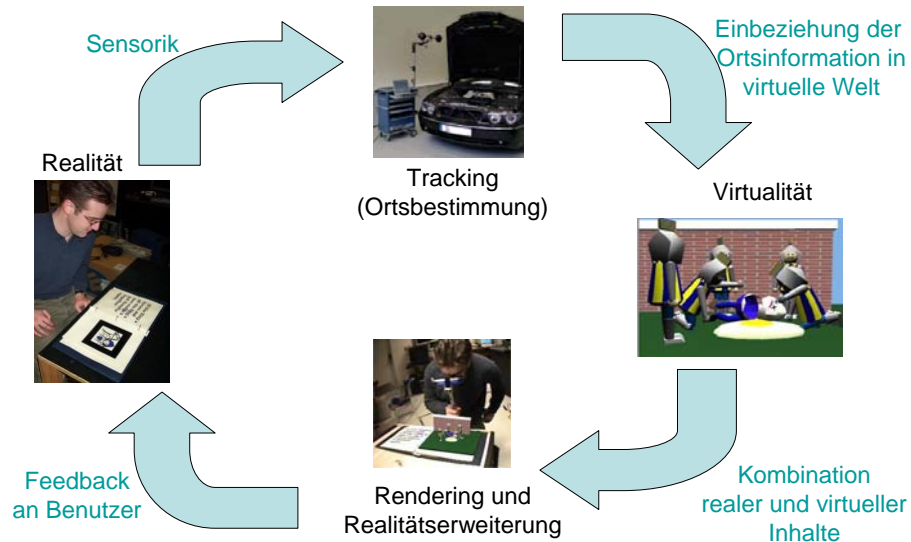
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Was benötigt man für AR?



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Ein Generisches AR-System



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Vorlesungsinhalte

- Anwendungen der AR (Beginn heute)
- Tracking
- Displaytechnologien
- Programmierung von 3D Szenen
- Interaktionstechniken für AR
- Nichtvisuelle AR
- Softwaresysteme für AR
- Authoring von AR-Anwendungen
- Ausblick: Ubiquitous Computing
- Demos der AR
Übungsgruppen

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Anwendungen der AR

- Industrie
 - Konstruktion, Reparatur
- Medizin
 - Operationsunterstützung
- Transport
 - KFZ, Flugzeuge
- Unterhaltung, Bildung
 - Museen
 - Fernsehen

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Tracking (Ortsbestimmung)

- Grundlagen der 3D Geometrie
- Vorstellung verschiedener Trackingverfahren
- Sensorfusion
- Kamerabasiertes Tracking:
 - Kameramodelle
 - 3D-Rekonstruktion aus 2D Daten

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Displaytechnologien

- Head Mounted Displays (HMDs)
 - See-through vs. Video-based
- Handheld displays
- Stationäre displays
- 2D Projektion in der phys. Umgebung
- 3D-Displays

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Programmierung von 3D Szenen

- Szenengraphen
- Beschreibungsformate
- Modellierung realer Objekte zur korrekten Verdeckungsdarstellung
- Performanceaspekte

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Interaktionstechniken für AR

- Techniken aus der VR
 - 3D-Eingabegeräte
 - Selektion
 - Manipulation
 - Navigation
- Techniken aus der PC-Welt
 - Menüs, Annotationen
- Techniken aus der phys. Umwelt
 - Spezialisierte Werkzeuge
 - Tangible UIs

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Nichtvisuelle AR

- Räumliches Audio
 - Kopfhörer
 - Lautsprecher
- Haptik
- Force Feedback
- Gravitationssimulation
- Geruch

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Softwaresysteme für AR

- Kurze Einführung in das Software Engineering
- Systemaspekte für AR
 - Verteilung
 - Echtzeitfähigkeit
 - Designalternativen
- Überblick über existierende AR-Systeme

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Authoring von AR-Anwendungen

- Problembereiche des Authoring
- Vorstellung von Authoringsystemen
 - SILK
 - Alice
 - DART
 - AMIRE
 - Authoring of Tangible AR Applications

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Ausblick: Ubiquitous Computing

- Kernideen UbiComp
- AR zur Simulation von UbiComp
- AR als echter Teil von UbiComp

Anwendungsbeispiele für AR

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Anwendungen der AR

- Industrie
 - Konstruktion, Reparatur
- Medizin
 - Diagnose, Operationsunterstützung
- Transport
 - KFZ, Flugzeuge
- Unterhaltung, Bildung
 - Museen
 - Fernsehen

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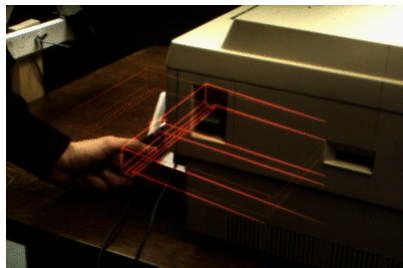
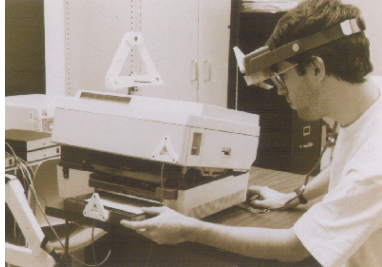
Medizin: UNC Chapel Hill, 1992



- Ultraschall-Scan vom Bauch einer Schwangeren
- 3D-Rekonstruktion
- Überlagerung des Bildes mittels HMD
- → 3D-Stethoskop

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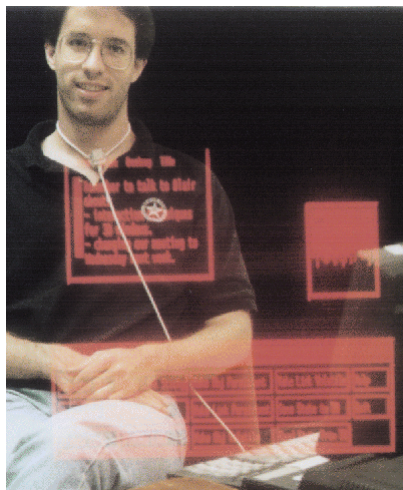
KARMA: Columbia University, 1993



- Use AR for technical maintenance
- Have a 3D model of a laser printer
- Instruct via HMD:
 - How to open it
 - What part to change
 - How to remove it
- Ultrasonic tracking
- Reflection Technologies „P4 Private Eye“ HMD
 - Monochrome LED
 - One eye only

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Windows on the World: Columbia 1993



- Use HMD as an extension of regular screens
- Drag windows off the screen
- Arrange windows in the world
- Maked display screen substantially bigger

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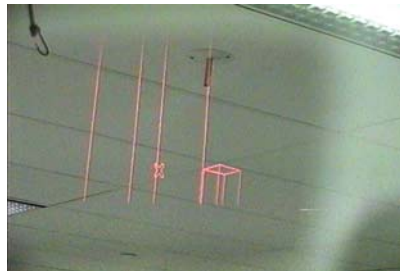
Construction: Boeing, 1994



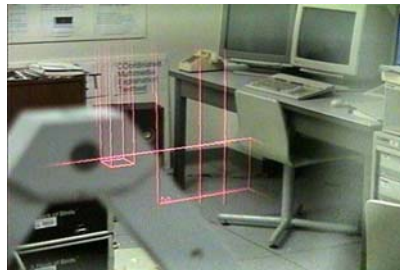
- Assembly of wire harness for airplanes
- Assembled on a large board
- Traditionally tedious task
- Equip board with markers
- Show in HMD where to mount next wire

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Architectural Anatomy: Columbia, 1994



- Reveal hidden structures in a building
- Get information about these structures



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AR for Construction, Columbia, 1996



- Assembly of a „Space-Frame“ construction from single parts
- Given sequence of steps
- Use a barcode scanner to identify mounted parts
- Check if correct part has been mounted
- AR system shows the next part's position

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AR for Construction, Columbia, 1996



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EMMIE: Columbia, 1998

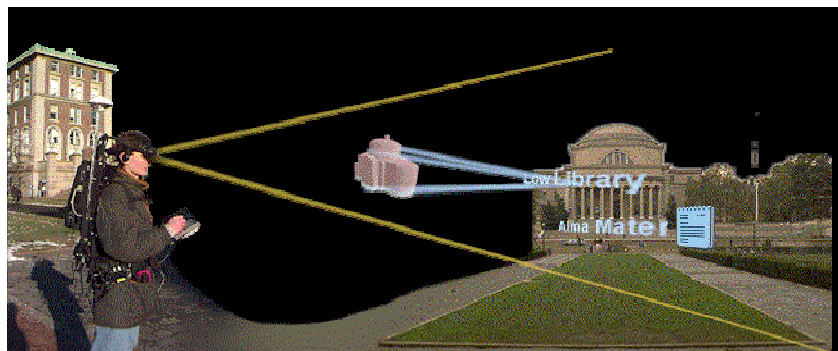


- Support a meeting
 - Several participants
 - Shared 3D world
 - With or w/o HMD
- 3D icons representing units of data
- 1:1 translation of desktop metaphor
- „Environment manager“ in analogy to window manager

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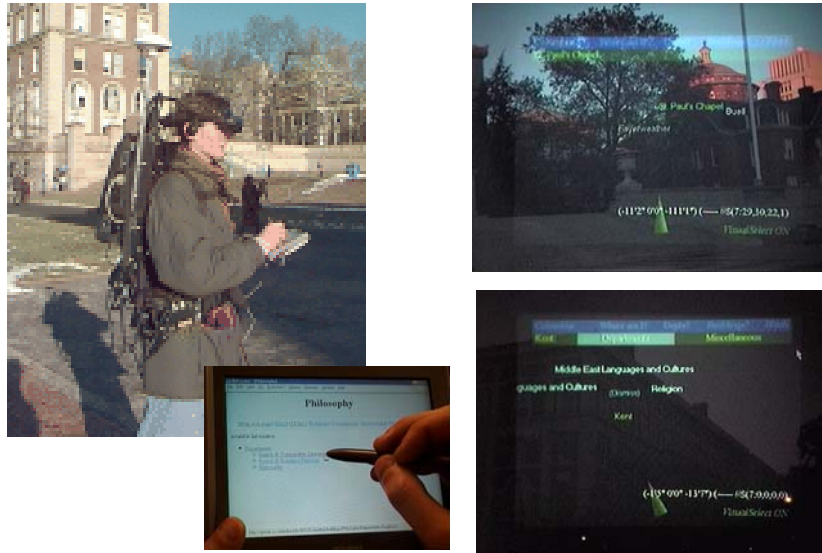
Mobile AR Systems: Columbia, 1997-now

- Augmented Reality system in a backpack
- Tracking by DGPS (centimeter level)
- Interaction via handheld devices
- Various applications



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MARS: A Touring Machine, 1997



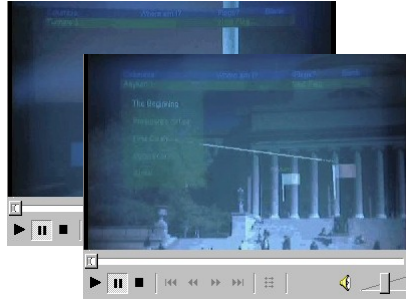
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MARS: Situated documentaries, 1999



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MARS: Situated documentaries, 1999



- Content produced in cooperation with journalists
- Stories „located“ on university campus
- Visible only through AR: flags
- Content playback in HMD
- Content playback o handheld
- Interaction in HMD and on Handheld

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MARS: Authoring Environment, 2003



- Authoring for situated documentaries
- Composition of clips from media snippets
- Assignment of clip positions on a 3D map
- Preview of clip playback
- Links between clips
 - Can be followed forward and backward
 - Turn campus into physical hypertext

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Archeology Visualization, Columbia 2003



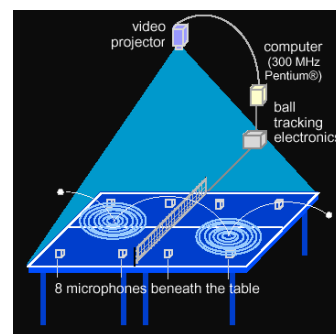
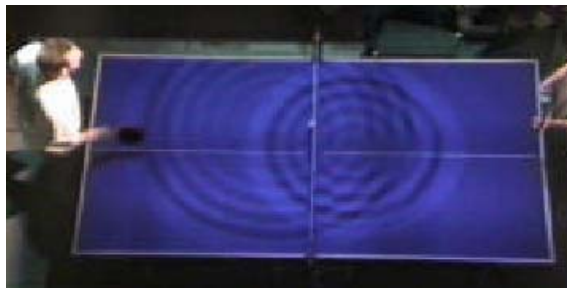
- Record dig site surroundings as QTVR panorama
- Record detailed 3D model of
 - The actual dig site
 - The objects found
- Later: review what was found where
- Virtual visit of the dig site possible

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PingPongPlus

(Ishii et al. SIGGRAPH 98)

- Physical PingPong
- Virtually augmented
- Additional game functionality



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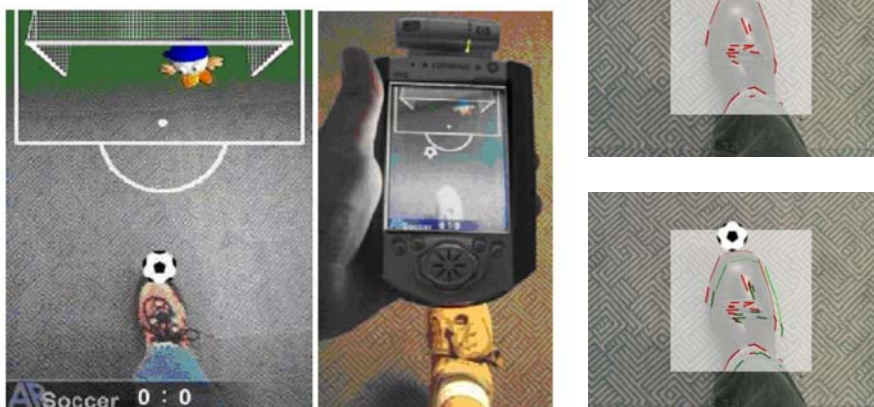
Invisible Train: Schmalstieg, 2004

- 2 players with handhelds with cameras
- Empty wooden toy train tracks with markers
- Trains only visible on the handheld
- Players can set the shunting switches
- Goal: avoid collisions as long as possible



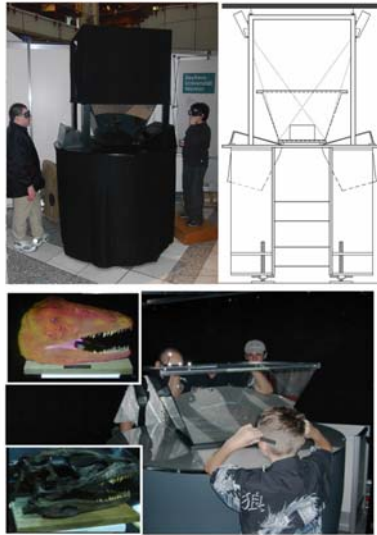
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AR-Soccer, Uni Paderborn, 2004



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AR in Museums: [Oliver Bimber](#), 2003-now

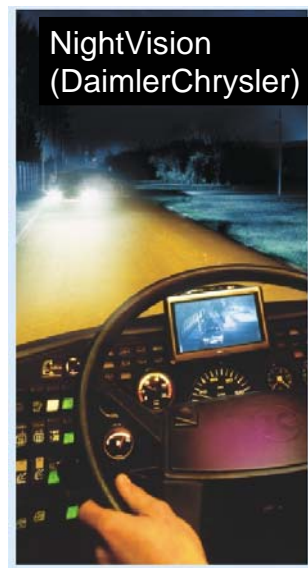


- Augmenting physical exhibits by
 - Additional information
 - 3D animation
- Camera-based tracking with markers
- Video-see-through
 - Laptops
 - Mobile phones

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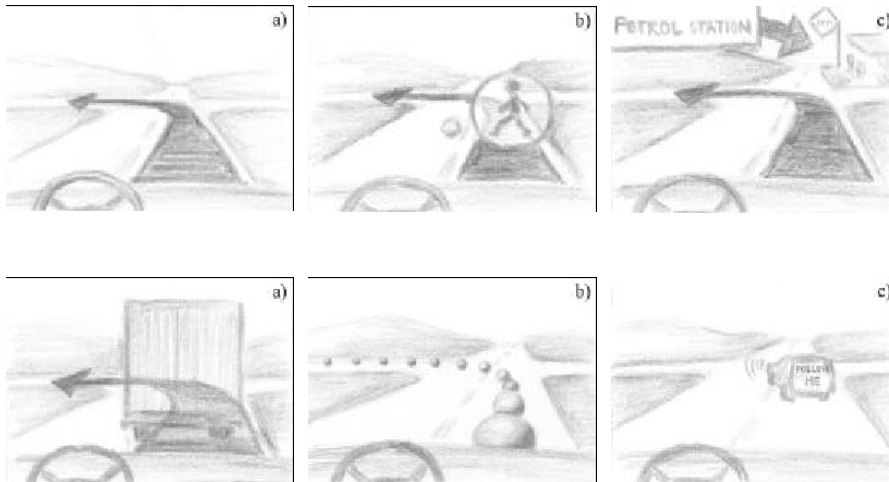
NightVison, Daimler-Chrysler 2000

- Uses infrared laser light and infrared cameras
 - Invisible to others
 - Narrow spectrum, can be filtered
- Doesn't blind other cars



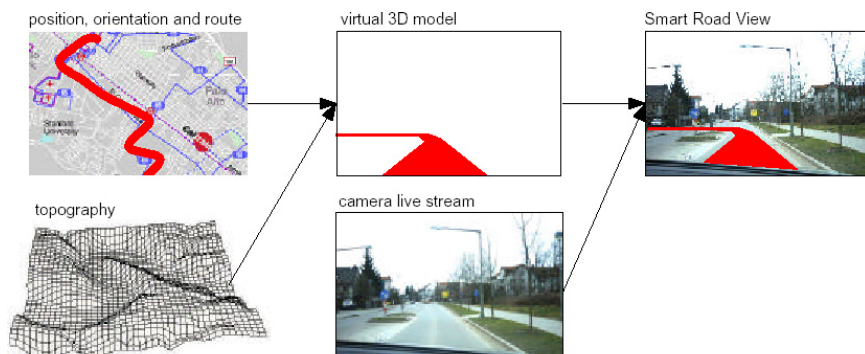
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AR in car navigation, Siemens VDO 2004



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AR in car navigation, Siemens VDO 2004



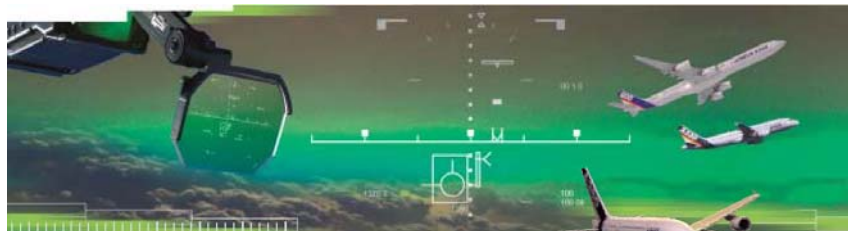
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AR in car navigation, Siemens VDO 2004



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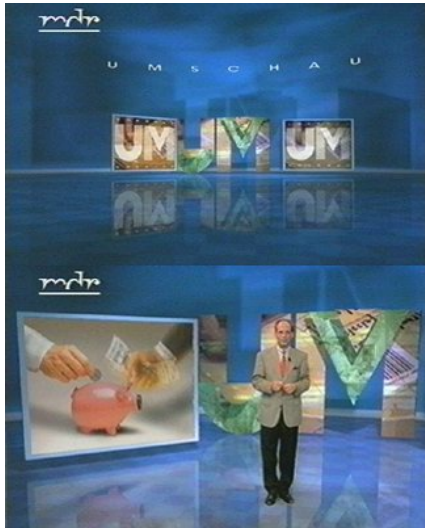
Head-up display in airplanes



- Manufactured by Thales Avionics
 - AMLCD (Active Matrix Liquid Crystal Display) glass
 - Can host innovative visualizations, such as
 - EVS (Enhanced Vision System)
 - SVS (Synthetic Vision System)
 - SGS (Surface Guidance System)
- Starting Dec. 2004, built into Airbus A318-380
- Not much technical info available yet...

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Virtual Studios for TV production



- Track the [camera](#)
- Use a blue box to film live [actor/reporter](#)
- Create an animated 3D environment
- [Mix the two](#) in real time
- Interact with [virtual objects](#)

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Links to original projects

- <http://hci.rockwellscientific.com/AR/>
- <http://www.cs.columbia.edu/graphics/>
- <http://www.uni-weimar.de/~bimber/>
- <http://www.virtuelles-studio.info/>

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