mixed reality

course notes

Alex Olwal
alx@csc.kth.se

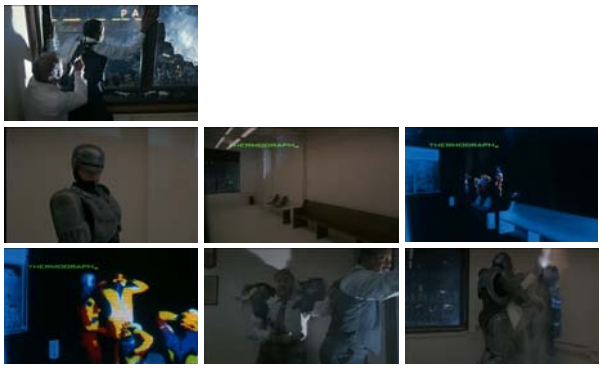
videos & material from lecture (+more):
www.csc.kth.se/~alx

for use in the course only, not to be distributed/duplicated/copied without permission

mixed reality

- blend real + virtual (digital/synthesized/...)
- seamlessly combine virtual data with real
- supplement real
- ease & improve understanding

robocop (1987)



terminator 3 (2003)

mixed reality

- blend real + virtual (digital/synthesized/...)
- seamlessly combine virtual data with real
- supplement real
- ease & improve understanding

head-up-displays

Boeing Next-Generation 737 (2003)
visibility$_{min}$ w/o HUD: 182 m
visibility$_{min}$ with HUD: 91 m

NASA's Gulfstream GV

C-130J Hercules

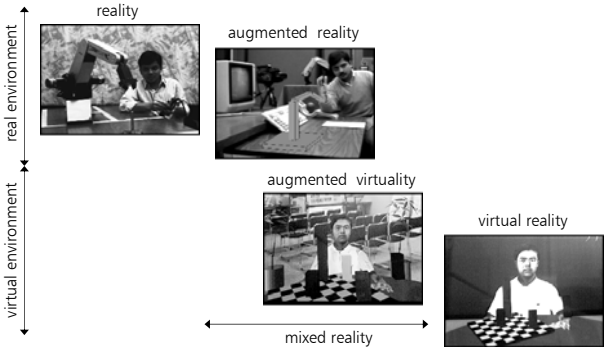
new mobile platforms

Layar

WIKITUDE

continuum

[Milgram & Kishino 1994]



augmented reality: definition

[Azuma 1997; Azuma, Baillot, Behringer, Feiner, Julier & MacIntyre 2001]

1) real + virtual objects in real environment
2) runs interactively and in realtime
3) registers real + virtual objects with each other

issues

display technology

- visually combine computer graphics with view of real world

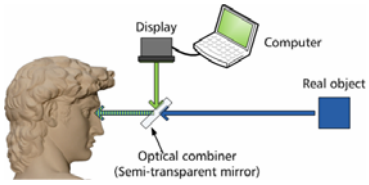
tracking/registration

- accurately combine computer graphics with real world objects in 3D

see-through displays

optical see-through

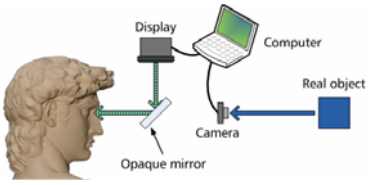
- semi-transparent displays
- optical combiners



see-through displays

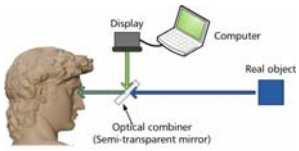
video see-through

- opaque displays
- video cameras

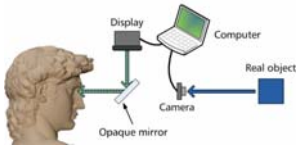


see-through displays

optical see-through
- lower cost
- no downsampling
- no delay of real
- no offset



video see-through
- flexible composition
- sync real/virtual
- simpler calibration



issues

display technology
- visually combine computer graphics with view of real world

tracking/registration
- accurately combine computer graphics with real world objects in 3D

tracking/registration

ultrasonic
- Intersense IS-600, IS-900

electromagnetic
- Ascension Flock of Birds
- Polhemus LIBERTY LATUS, FASTRAK

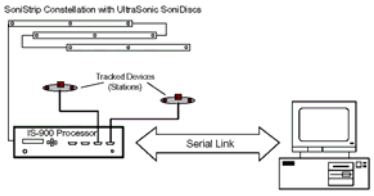
optical/camera-based
- marker-based (e.g., ARToolKit, ARToolKitPlus, ARTag)
- 3rdTech HiBall tracker
- A.R.T.
- WorldViz PPT

hybrid
- Intersense IS-1200 VisTracker

natural feature tracking
- Computer vision techniques

ultrasonic

- IS-900



electromagnetic

- Ascension Flock of Birds (DC)

- Polhemus LIBERTY LATUS/FASTRAK (AC)

optical/camera-based

- ARToolKit / ARToolKitPlus / ARTag

ARToolKit

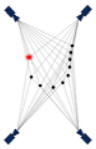
ARToolKitPlus

ARTag

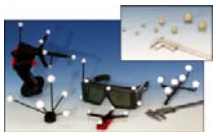
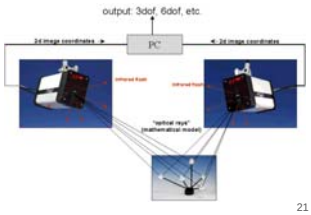
- 3rdTech HiBall tracker

optical/camera-based

- WorldViz PPT



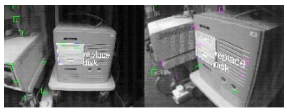
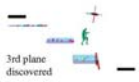
- A.R.T.

hybrid

- InterSense IS-1200

natural feature tracking

advanced sensing in consumer electronics

- Nintendo Wiimote + "sensor" bar + MotionPlus

advanced sensing in consumer electronics

- Project Natal

advanced sensing in consumer electronics

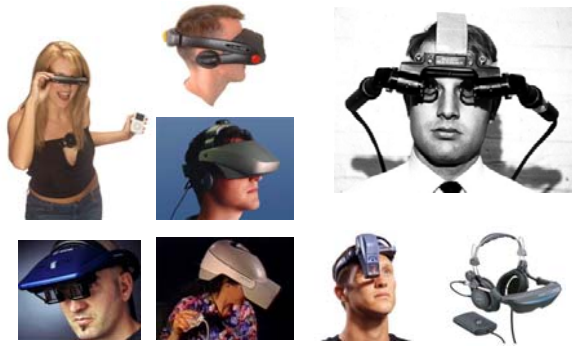
- PlayStation Move

display types

> head-mounted-displays (HMDs)
handheld
spatial

HMD

[Sutherland 1968]

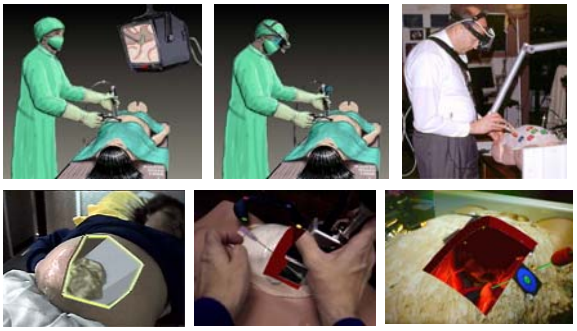


annotation

[Feiner, MacIntyre, Haupt & Solomon 1993], [Feiner, MacIntyre, and Seligmann 1993], [Bell, Feiner & Höllerer 2001], [Bell, Höllerer & Feiner 2002]

medical augmented reality

[State, Livingston, Garrett, Hirota, Whitton, Pisano & Fuchs 1996]
[Fuchs, Livingston, Raskar, Colucci, Keller, State, Crawford, Rademacher, Drake, & Meyer 1998]

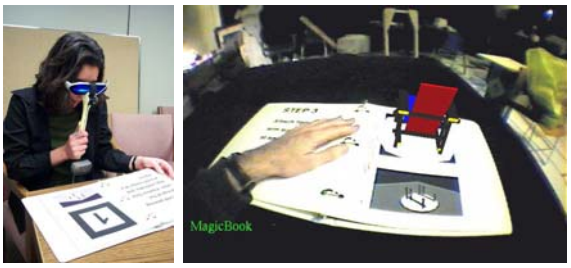


situated documentaries

[Höllerer, Feiner & Pavlik 1999]

MagicBook

[Billinghurst, Kato & Poupyrev 2001]



archeology

[Benko, Ishak & Feiner 2004]

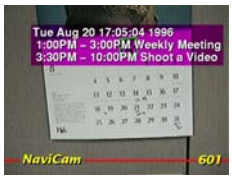
display types

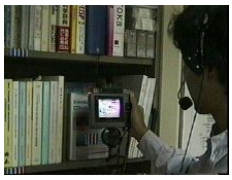
head-mounted-displays (HMDs)

> handheld

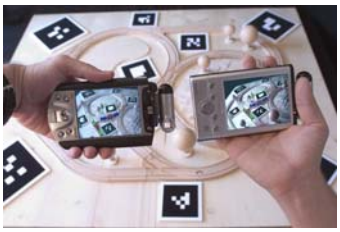
spatial

handheld: NaviCam [Rekimoto 1995]





handheld: PDA [Wagner, Pintaric & Schmalstieg 2003]



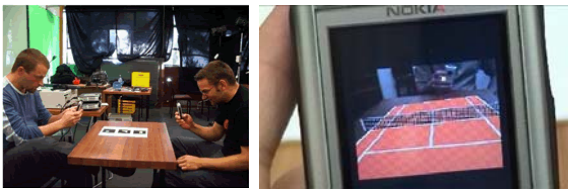
handheld: cell phone [Möhring, Lessig & Bimber 2004]

handheld: ARToolKitPlus & StudierStube ES

[StudierStube augmented reality project]

handheld: ARToolKit

[Henrysson 2006]

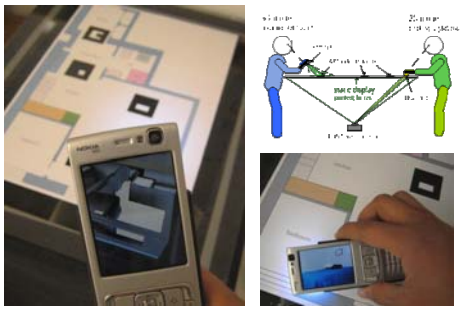


handheld: lightsense

[Olwal 2006]

handheld: LUMAR – Hybrid 2D & 3D

[Olwal & Henrysson 2007]



display types

head-mounted-displays (HMDs)

handheld

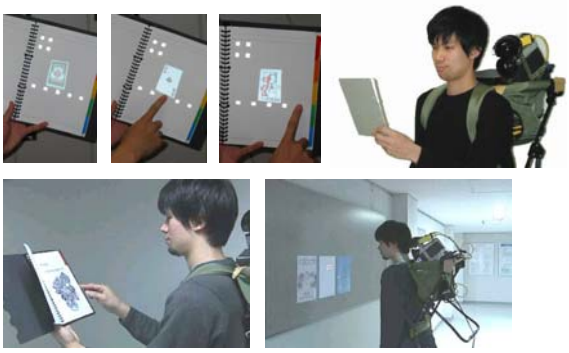
> spatial

spatial: everywhere displays

[Pinhanez 2001]

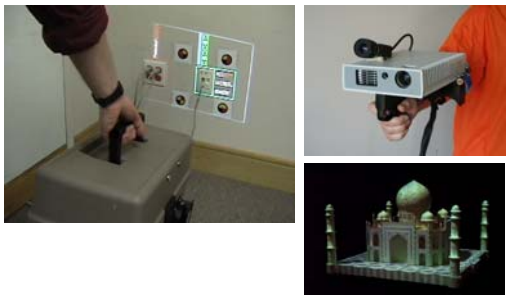
spatial: on-board MR projector

[Karitsuka & Sato 2003]



spatial: iLamps, Shader Lamps

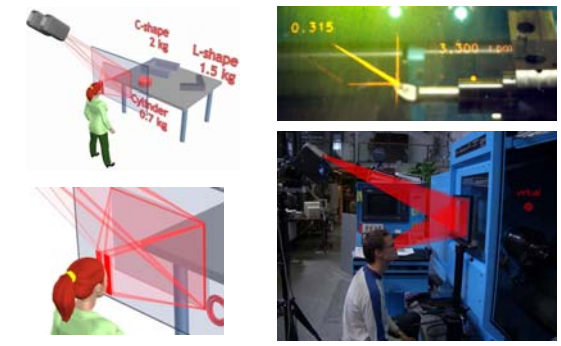
[Raskar, vanBaar, Beardsley, Willwacher & Rao 2003]
[Bandyopadhyay, Raskar & Fuchs 2001]



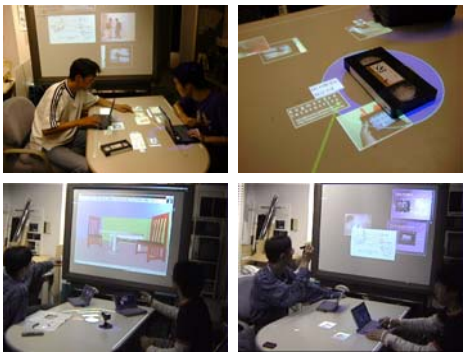
spatial: SurfaceFusion [Olwal & Wilson 2008]

spatial: ASTOR

[Olwal, Lindfors, Gustafsson, Kjellberg & Mattsson 2005]

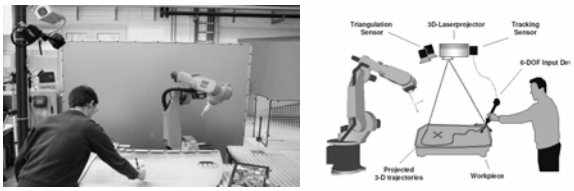


spatial: augmented surfaces [Rekimoto & Saitoh 1999]



spatial: interactive laser projection

[Zaeh & Vogl 2006]



spatial: immaterial, dual-sided

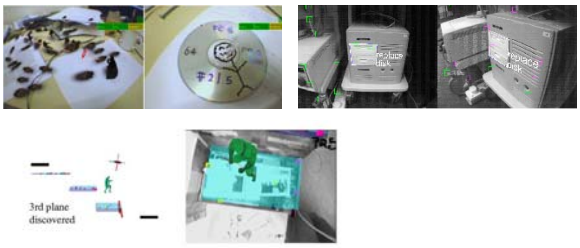
[Olwal, DiVerdi, Rakkolainen & Höllerer 2007]
[DiVerdi, Rakkolainen, Höllerer & Olwal 2006]

spatial: handheld projectors

[Cao, Forlines & Balakrishnan 2007]

SLAM: simultaneous location & mapping

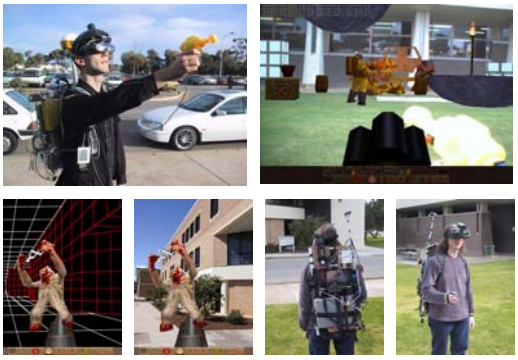
[Klein & Murray 2007]
[Reitmayr et al. 2007]
[Chekov et al. 2007]



augmented & mixed reality entertainment

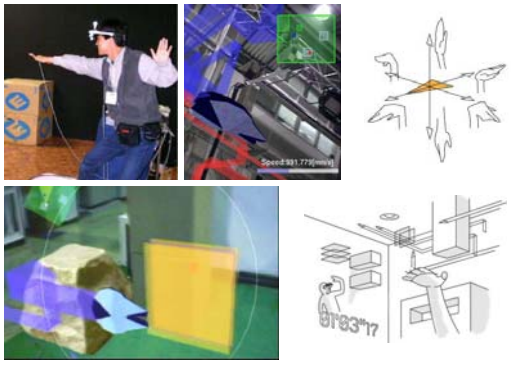
ARQuake

[Piekarski & Thomas 2002]



BLADESHIPS

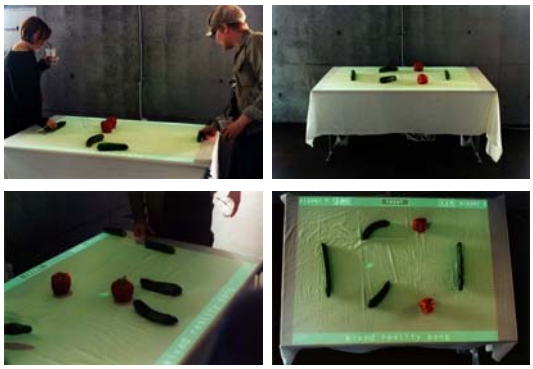
[Takemura, Haraguchi & Ohtarski 2004]



Human Pacman

[Cheok, Goh, Farbiz, Liu, Li, Fong, Yang & Teo 2004]

Mixed Reality Pong [Kallio 2001]



AquaGauntlet

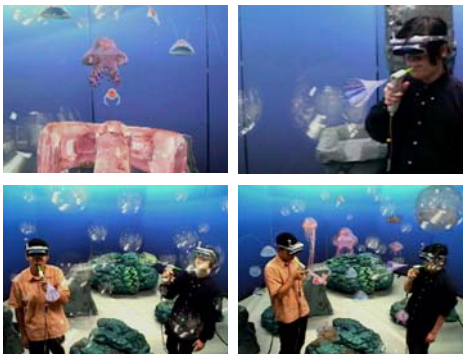
[Ohshima, Satoh, Yamamoto & Tamura 2000]

RV-Border Guards

[Ohshima, Satoh, Yamamoto & Tamura 1999]

Jellyfish Party

[Okuno, Kakuta, Takayama & Asai 2003]



augmented & mixed reality summary

definition

- real + virtual in real environment
- interactive & real-time
- register virtual w/ real

realities

- reality – augmented reality – augmented virtuality – virtual reality

issues

- display technology (HMD, handheld, projector)
- tracking/registration

augmented & mixed reality

videos & material from lecture (+more):
www.csc.kth.se/~alx

Individual projects in interactive computer graphics (can start anytime): 3D graphics, augmented/virtual reality, touch screens, or anything else you might be interested in...

> DD2465, advanced individual course in computer science, 6 hp
> DD2464, bigger advanced individual course in computer science, 9 hp
> DH2466, advanced individual course in human-computer interaction, 6 hp

> DM2904, individual course in media technology, 6 hp
> DM2905, individual course in media technology, 7.5 p

>Master's thesis project