# Virtual and Augmented Reality
# 2017-2018

Augmented Reality

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# Previous lectures

- Remembering ...
  - VR & AR definitions
    - What is the difference between VR & AR ?
  - VR & AR applications
  - VR & AR hardware
    - HW limitations

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# AR (Augmented Reality) Definition

- AR is a technology that <u>superimposes</u> a <u>user's real world view</u> with (computer-generated) <u>virtual text or image</u> on the user's viewing screen, monitor, helmet facemask, glasses, goggles, HMD (Head-Mounted Display), windshield, ..., <u>in real-time</u>.
  - AR concept was created in 1990, by Thomas P. Caudell
- AR definition (Azuma, 1997)
  - combines real & virtual worlds
  - interactively, in real-time
  - real & virtual objects are aligned in 3D

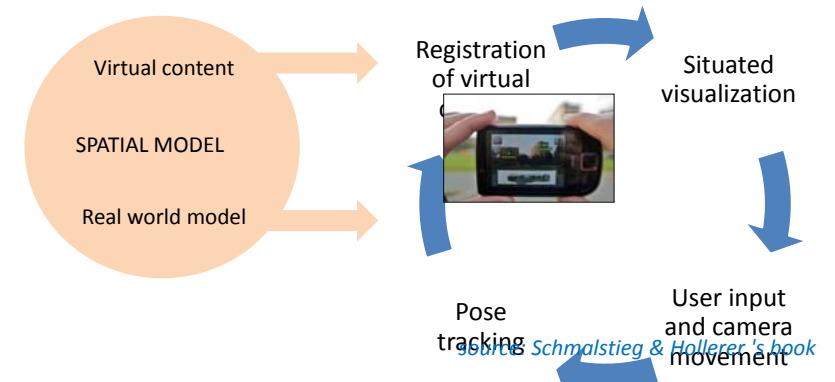- AR is not limited to the view sense ...
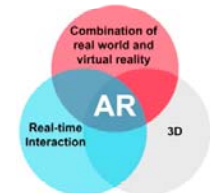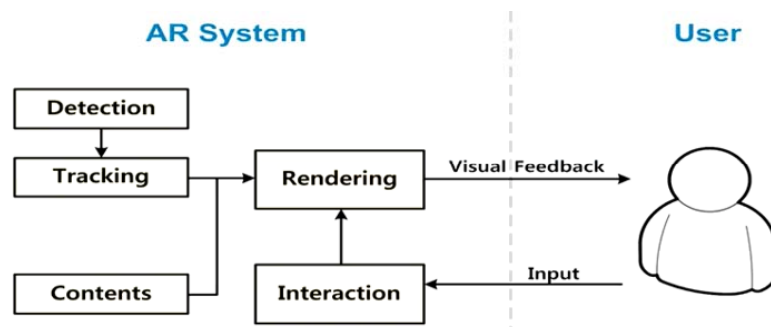
# Reality-Virtuality Continuum

**Mixed Reality**

**Real Environment**    **Augmented Reality**    **Augmented Virtuality**    **Virtual Environment**
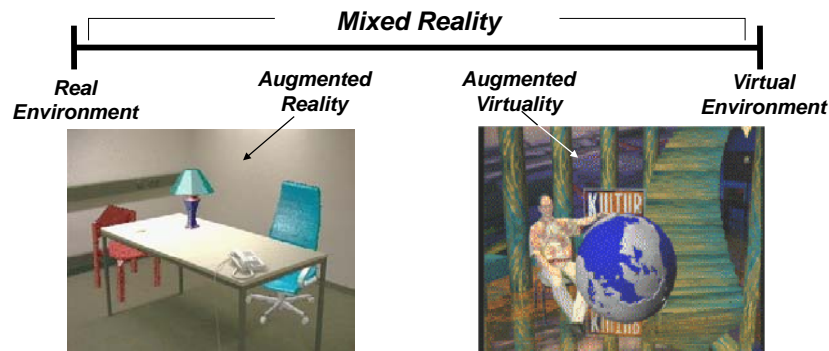
*P. Milgram, F. Kishino,*
*"A Taxonomy of Mixed Reality Visual Displays",*
*SPIE Vol. 2351, Telemanipulator and Telepresence Technologies, 1994.*

# AR Feedback Loop

- AR uses a feedback loop between human user and computer system. The user observes the AR display and controls the viewpoint. The system tracks the user's viewpoint, registers the pose in the real world with the virtual content, and presents situated visualization.
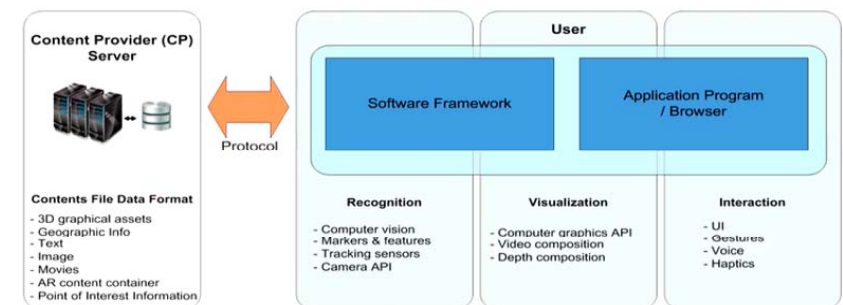
Virtual content

SPATIAL MODEL

Real world model

Registration of virtual

Situated visualization

Pose tracking

*source: Schmalstieg & Höllerer 's book*

User input and camera movement

# AR Workflow



**AR System**      **User**

Detection → Tracking → Rendering → Visual Feedback

Contents → Interaction ← Input

# AR Technologigal Components



**Content Provider (CP) Server**

Protocol

**User**

Software Framework

Application Program / Browser

**Contents File Data Format**
- 3D graphical assets
- Geographic Info
- Text
- Image
- Movies
- AR content container
- Point of Interest Information

**Recognition**
- Computer vision
- Markers & features
- Tracking sensors
- Camera API

**Visualization**
- Computer graphics API
- Video composition
- Depth composition

**Interaction**
- UI
- Gestures
- Voice
- Haptics

# AR hardware

- AR hardware
  - positioning:
    - vision / cameras
    - other sensors:
      GPS, wifi, compass, accelerometer, gyroscope
  - visualization:
    - monitor/display,
    - HMDs (optical-see-through / video-see-through)
    - projector
  - processing:
    - desktop/laptop
    - handheld

# Combining sensors and vision

- Sensors
  - Give us first information on where we are in the world, and what we are looking at
  - Are not sufficiently accurate
    (= wrongly placed augmentations)
  - Produce noisy output
    (= jittering augmentations)
- Vision
  - Is more accurate
    (= stable and correct augmentations)
  - Requires choosing the correct keypoint database to track from
  - Requires registering our local coordinate frame
    (online-generated model) to the global one (world coordinates)
- Hybrid (Vision + Sensors)

# AR software

- Libraries
  - ARToolkit, ..., OSGART, Studierstube, Vuforia,...
  - FLARToolKit (integration of ARToolkit into Adobe Flash)
  - to do: search for more
- AR browsers
  - superimpose points of interest on a live video feed
  - Layar, Metaio, Wikitude, ...
  - to do: search for more

    - http://www.perey.com/ARStandards/survey-of-mobile-ar-browsers/
    - https://ercim-news.ercim.eu/en103/special/an-introduction-to-ar-browsers
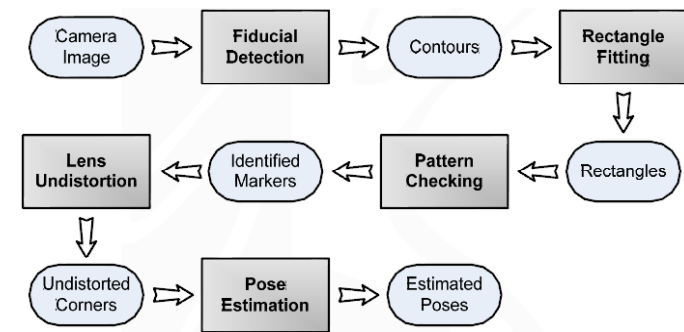
# Vision-based AR

- Marker-based
  - fiducial markers
  - barcodes
- Marker-less
  (natural feature tracking)
  - Tracking from features of the surrounding environment
- Pros & Cons
  - ...?

# Marker tracking pipeline
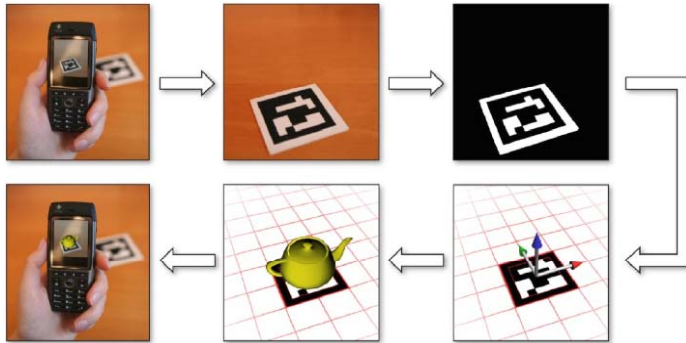


# Marker tracking overview



# Natural feature tracking