

Augmented reality

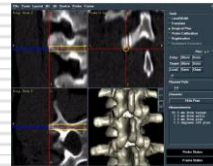
Principles and materials
Examples

Jocelyne TROCCAZ

Visualization in guiding systems

□ Passive systems (navigation)

- Classically: a screen with localization information (GPS type)
- Augmented reality systems: information merged to the reality



□ Expected advantage of AR

- Information easier to interpret
- Located where the surgeon has to focus his/her attention



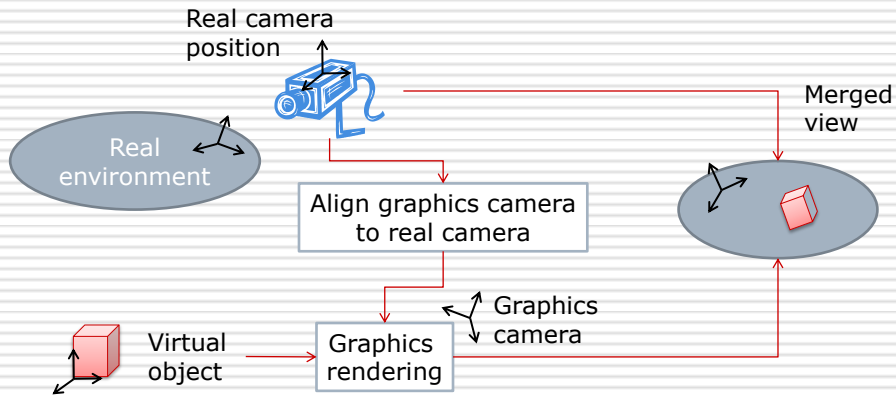
Technical possibilities

- Merging mode: optical / video (digital)
- Display: head-mounted display (HMD) / external screen / specific display (i.e. surgical microscope)
- Visualization: mono / stereo

Image superimposition

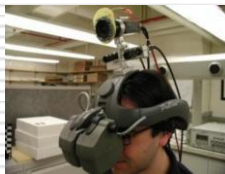
- Requires to register the patient (reality) to the data (augmentation)
- Video overlay:
 - Capture the real environment
 - Compute the data in the right location
 - Merge reality and data images
 - Display
- Optical overlay:
 - Compute the data in the right location
 - Display
- Involves calibration

Example: video overlay



Overlay Video/Optical

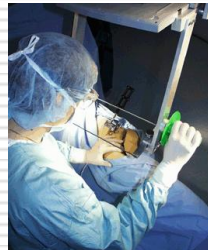
Display
Screen/HMD



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MIT - Harvard Med School



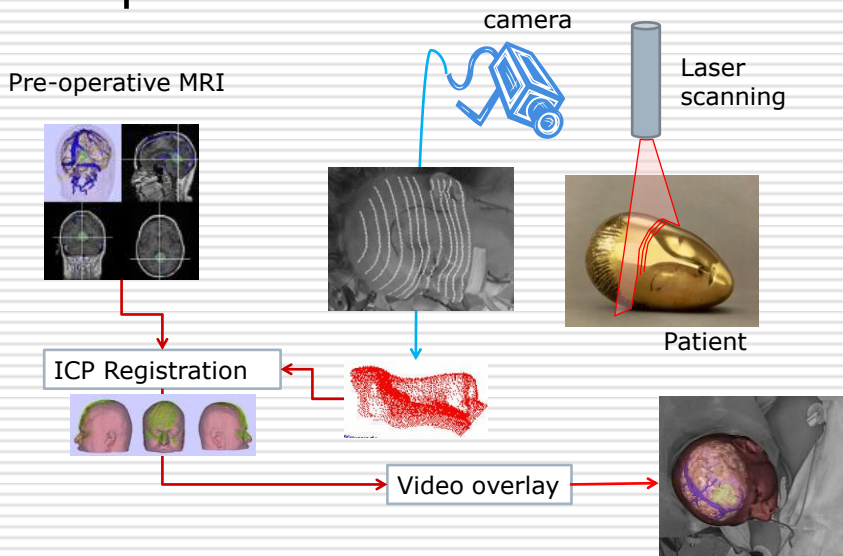
CMU - Shadyside Hospital

Example I (video/screen)

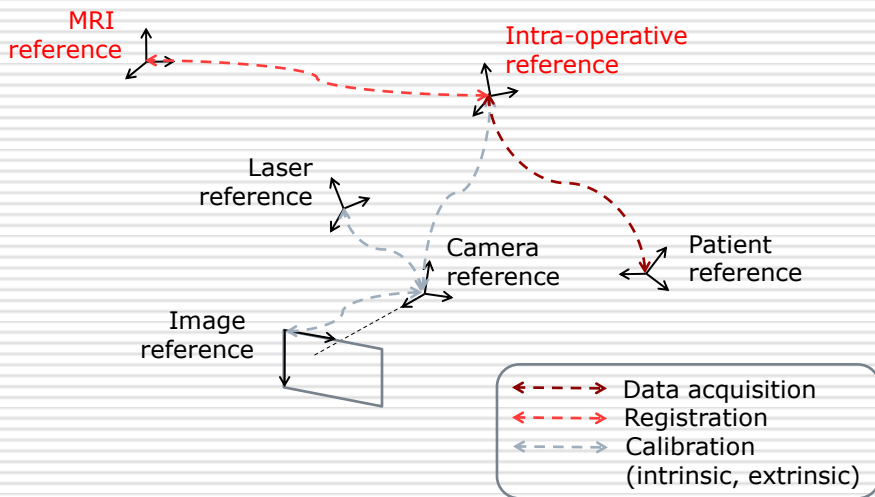
Harvard-MIT system [Grimson, Kikinis]

- Pre-operative MR imaging and 3D modeling
- Intra-operative surface acquisition and registration
- Video overlay on a screen

Example 2: Technical components



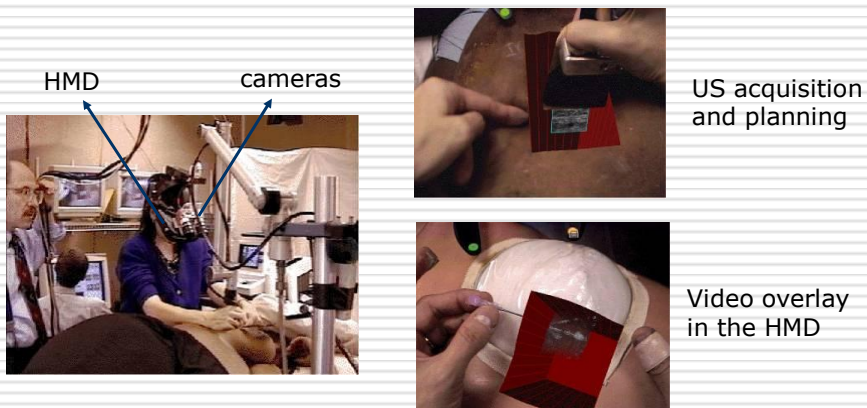
Reference frames to be linked



Example 2 (video/HMD)

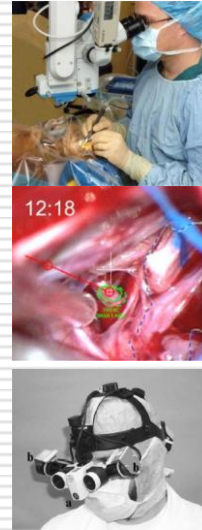
UNC – Fuchs and colleagues

□ For ultrasound guided procedures



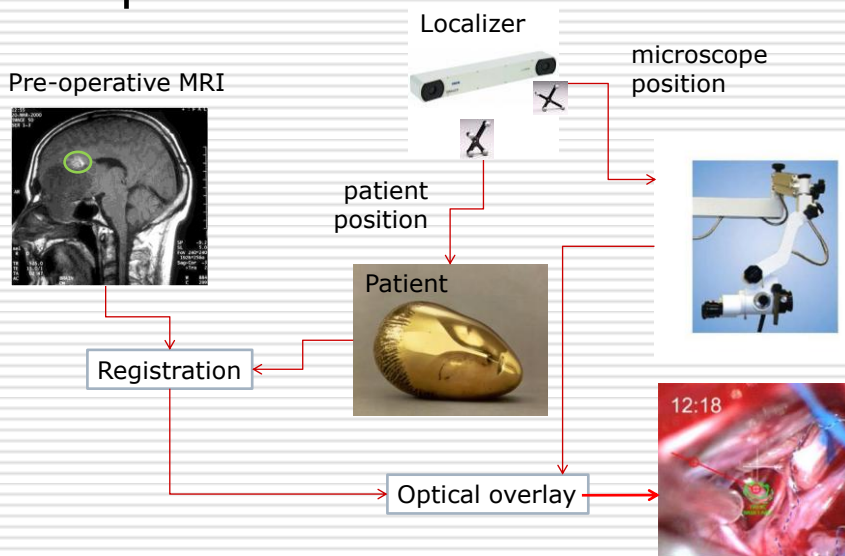
Example 3 (optical/surgical microscope)

- Application in neurosurgery/ENT
- Add planning information in the images coming from the binocular
- Integrated into products
- Easy to use in clinical practice (natural evolution of existing device)
- Simple visualization

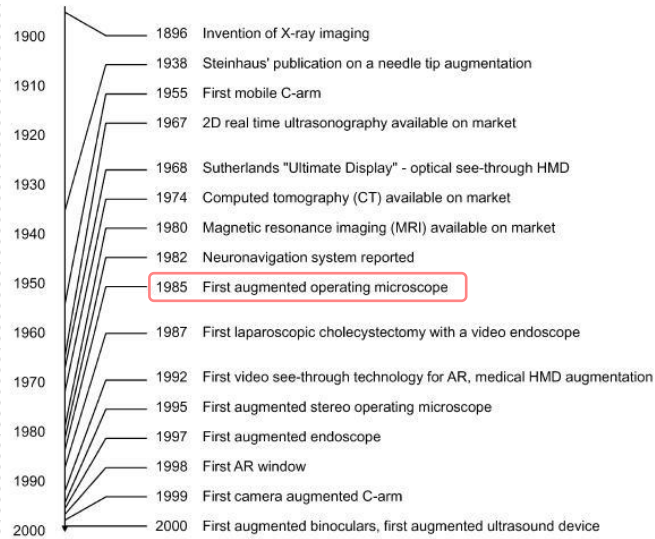


HMD version
[Birkelfelner et al.]

Example 3: Technical components

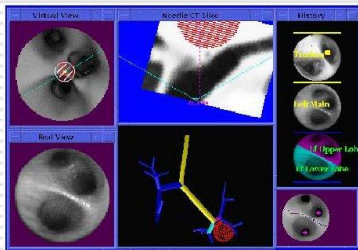


From Sielhorst et al. JOURNAL OF DISPLAY TECHNOLOGY, VOL. 4, NO. 4, DECEMBER 2008

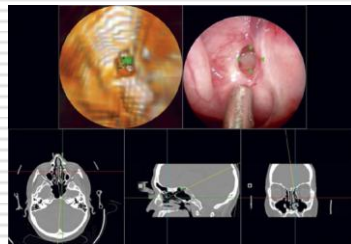


Other "natural" displays

Endoscopic images



Bricault et al. IEEE TMI1998

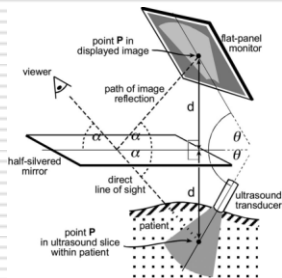


Shahidi et al. IEEE TMI2002

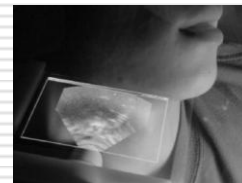
Fluoroscopic images

Other devices (1)

- Sonic flashlight (Stetten et al. CMU)
 - To visualize US data where they are acquired



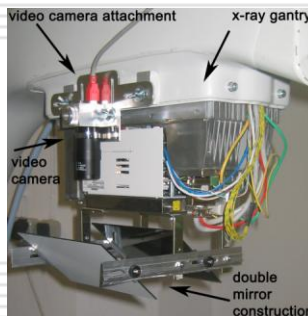
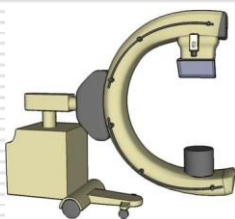
Principle



Applications

Other devices (2)

- CamC (Navab et al. & Siemens)
 - Combine X-ray views to video views of the patient
 - Modified X-ray system (camera+mirrors)



Technical issues

- Right place: calibration
 - Optical overlay less accurate (user-based subjective calibration)
- Right time: synchronization
 - Video overlay: ability to synchronize but possible delay
 - Optical overlay: time lag
 - May be an issue for instrument guidance

Technical issues (2)

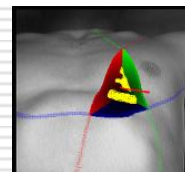
- Right way: visualization and perception
 - Brightness (low for see-through systems)
 - Virtual object always appears sharp whatever the distance
 - Spatial relationships of the objects
- Other constraints: sterility, clinical usability



IRCAD



Univ. of Rochester



Grenoble Univ. (TIMC)

Some conclusions

- Advantages of video overlay
 - Good quality
 - More precise
 - Data synchronized
 - Possible storage
- Advantage of “natural” live images (surgical microscopy, endoscopy, fluoroscopy, etc.)
 - Already in the OR
- Very few clinical evaluations