ETH
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Augmented Visualization with Natural Feature Tracking

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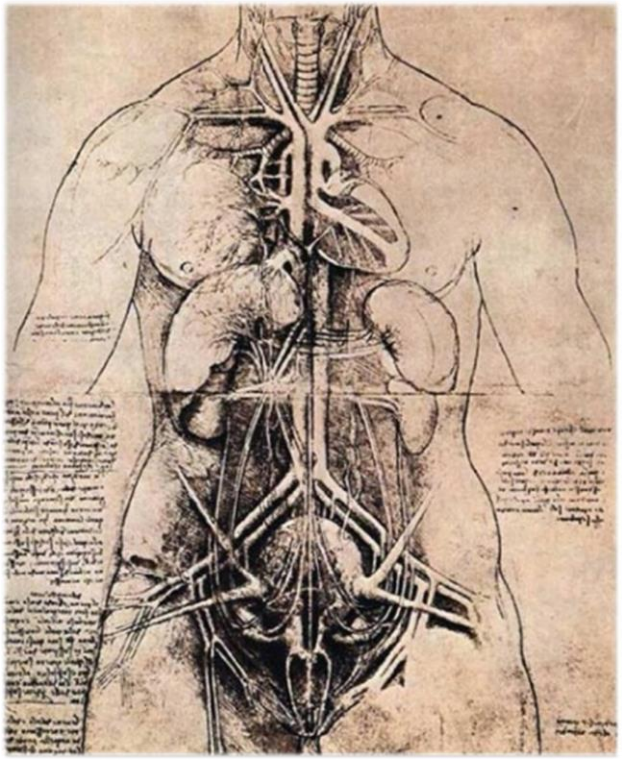
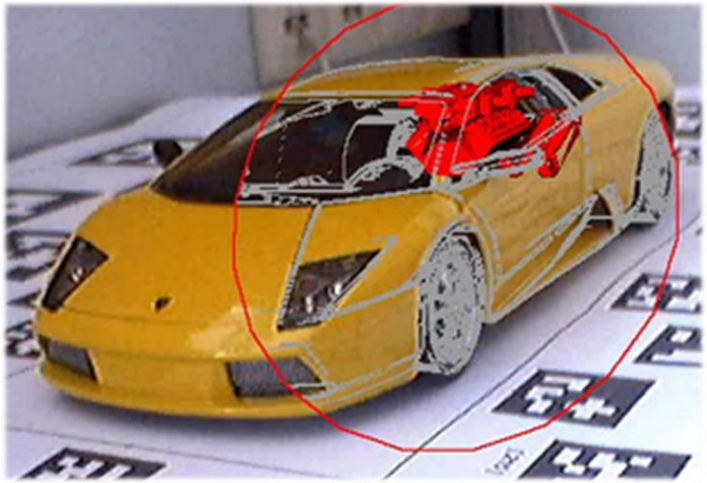
The Magic Lens Metaphor

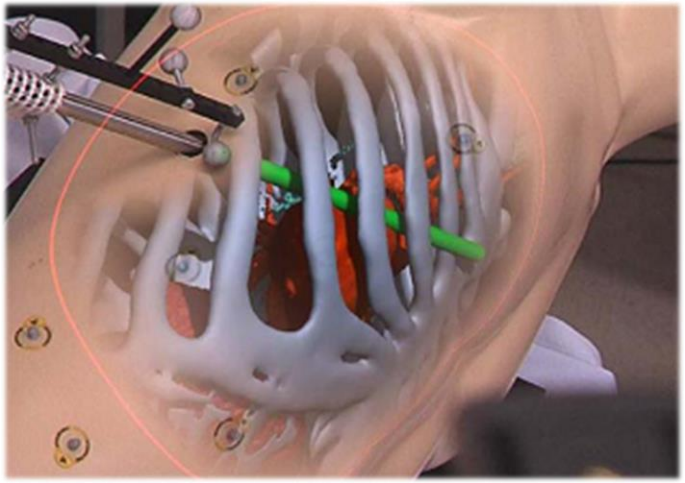


[Leonardo Da Vinci, 16th century]

The Magic Lens Metaphor (2)



[Kalkofen et al. (2007)]

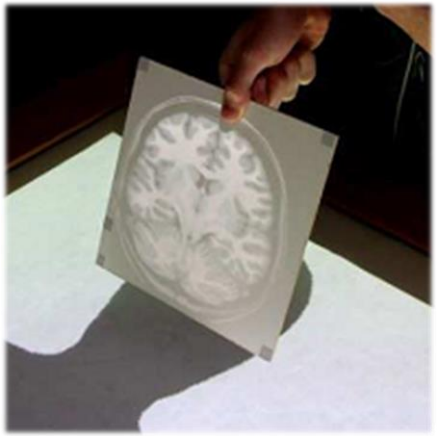


[Bichlmeier et al. (2007)]

The Magic Lens Metaphor (3)

[Sanneblad et al. - Ubiquitous Graphics (2005)]

[Reitmayr et al. - Augmented Maps (2005)]

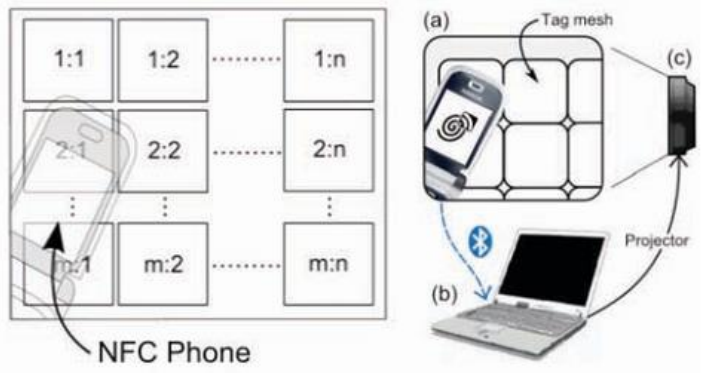


[Spindler et al. - PaperLens (2009)]

Interaction with Displays

[Ballagas et al. - Point & Shoot (2005)]

[Boring et al. - Shoot & Copy (2007)]



[Hardy et al. - Touch & Interact (2008)]

[Boring et al. - TouchProjector (2010)]

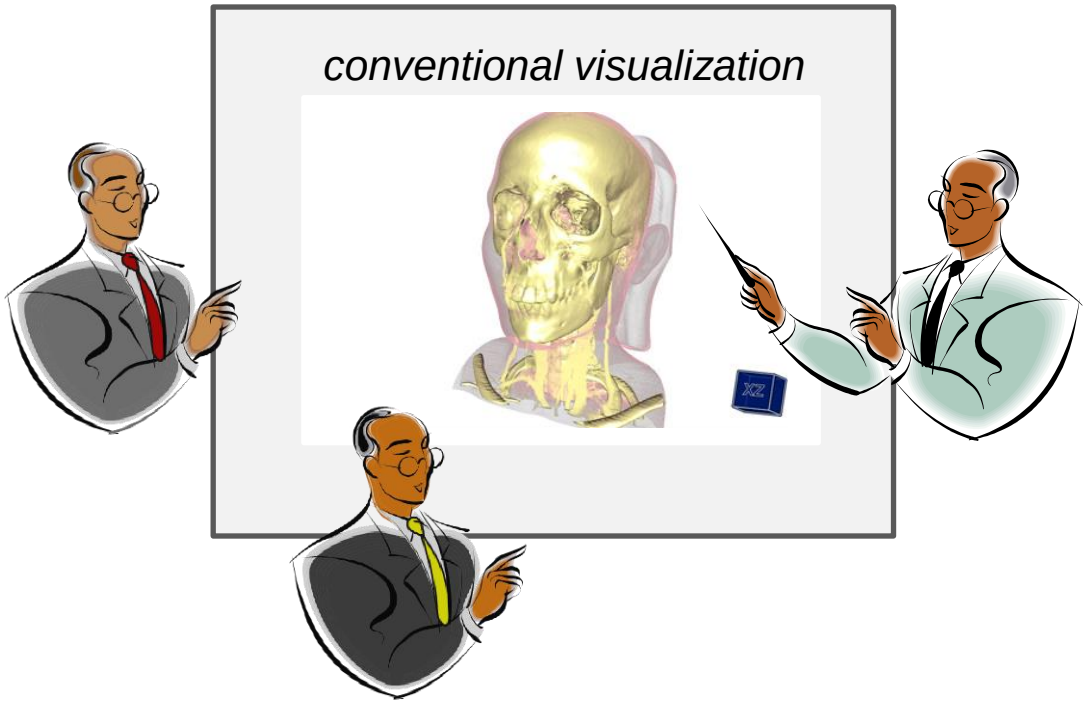
Can we do that ***without any markers?***

AUGMENTED VISUALIZATION

Idea

- **Assumptions**
  - Visualizations are shown on monitors or large projections
  - The visualized scene is rendered/virtual
  - Group of people with different interests

- **Goals**
  - 6DoF input
  - personal overlay information for each participant
  - widely available & cheap HW
  - avoid any special markers



augmented visualization

Idea

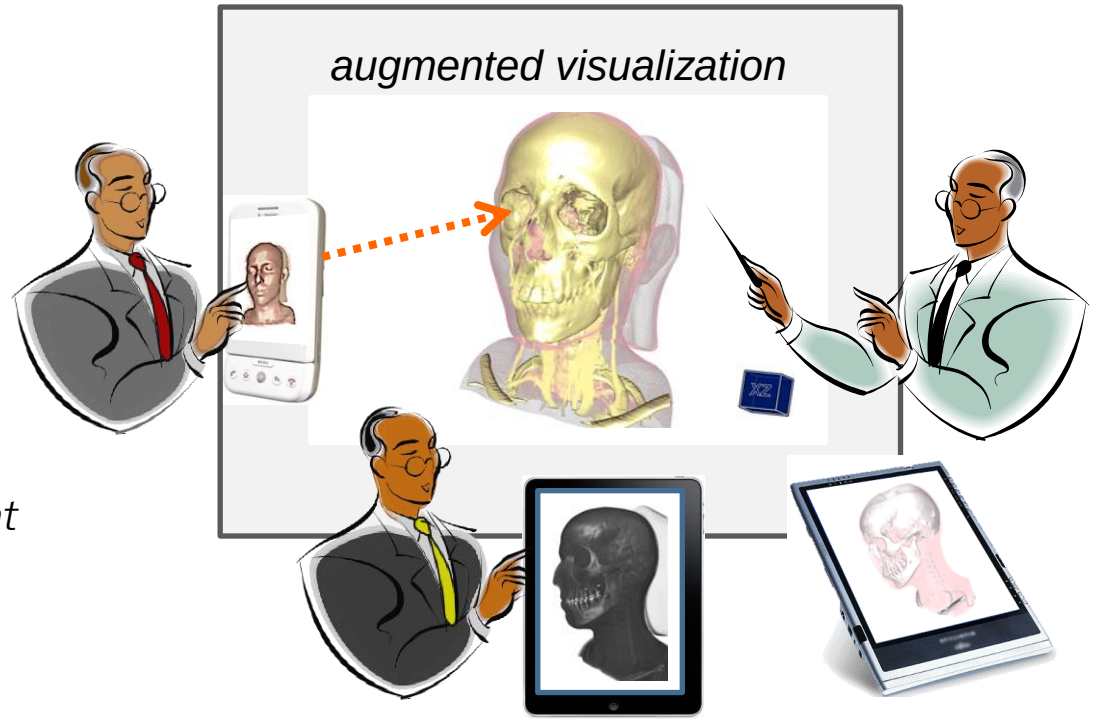
- **Input**
  - touch screen
  - buttons
  - accelerometer
  - camera tracking

Pose estimation of each participant

- **Output**
  - ”magic lens” display
  - vibration
  - etc.

Personal overlays for each participant

novel interaction device(s)



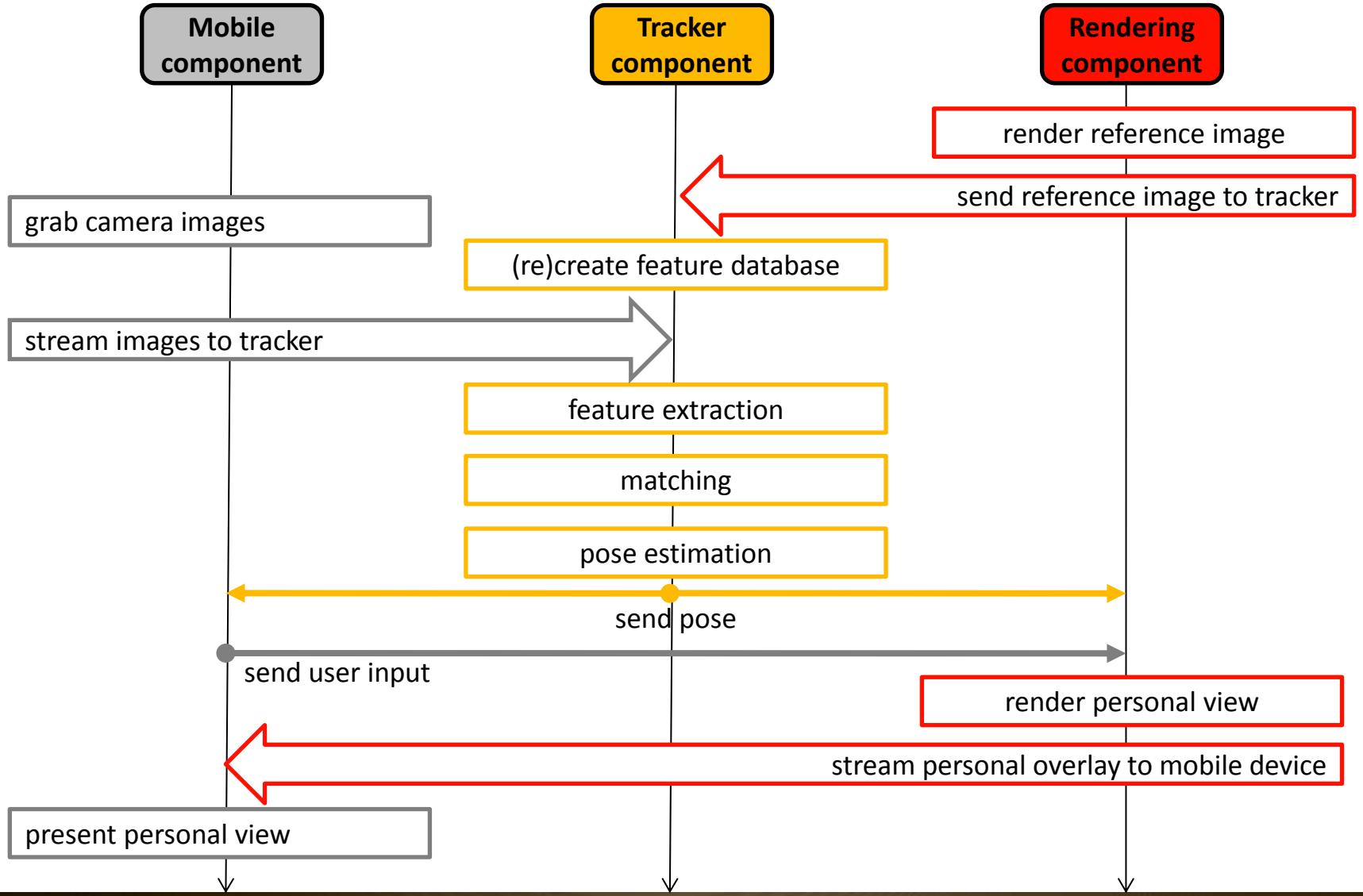
SYSTEM OVERVIEW

Rendering Component

Tracking Component

Mobile Component

System Overview



SYSTEM OVERVIEW

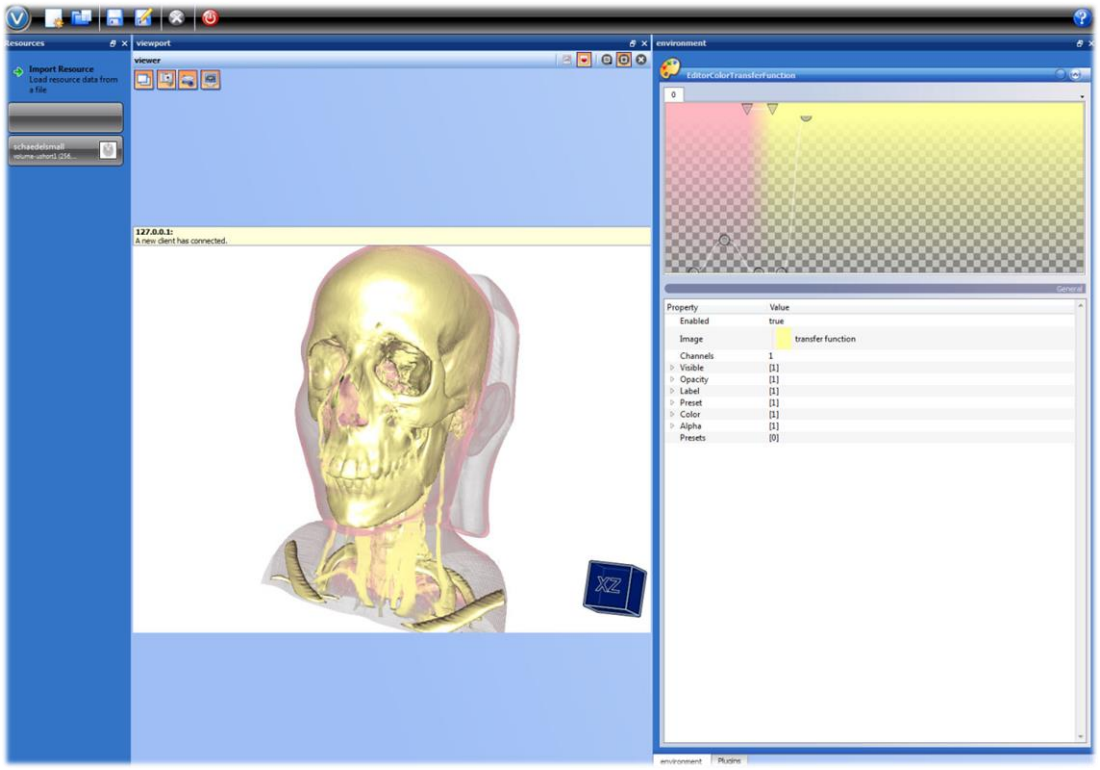
Rendering Component

Tracking Component

Mobile Component

Rendering Component

- VolumeShop volume rendering framework
- Multiple viewports
  (common view and personalized views)
- XML-based Plugins
- Simple remote
  control extension



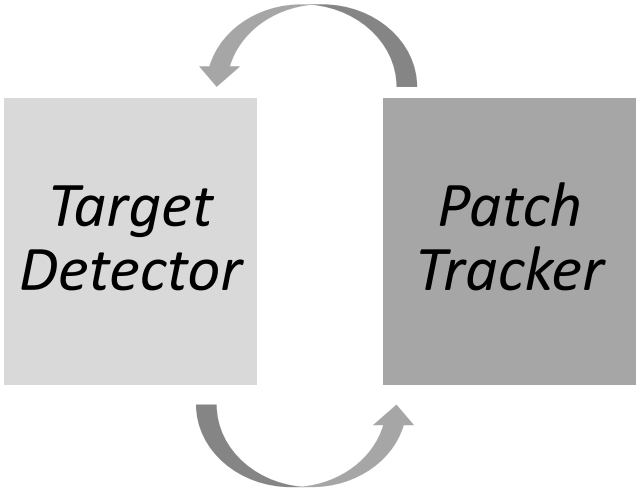
SYSTEM OVERVIEW

Rendering Component

Tracking Component

Mobile Component

Tracking Component



A) Detection & Initialization:

1. feature extraction
   - FAST [Rosten&Drummond2006]
2. feature description
   - modified SURF (at multiple scales) [Bay et al. 2008] [Wagner et al. 2009]
3. feature matching
   - brute force, Euclidean distance (database not too large)
4. outlier detection & pose estimation
   - geometric constraints & RANSAC

B) Patch Tracking:

- prediction of affinely warped patches in subsequent images
- up to extreme tilts and lighting changes

SYSTEM OVERVIEW

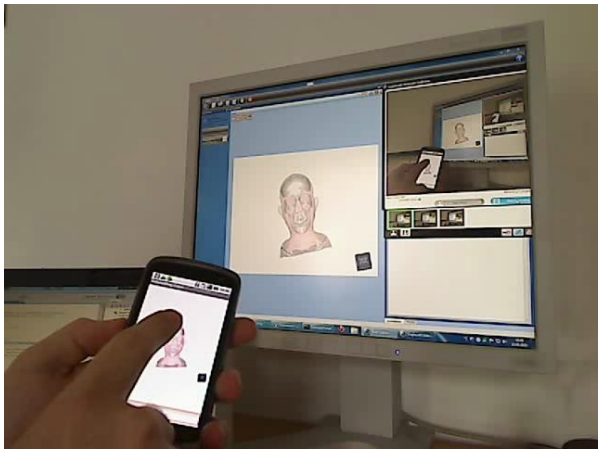
Rendering Component

Tracking Component

Mobile Component

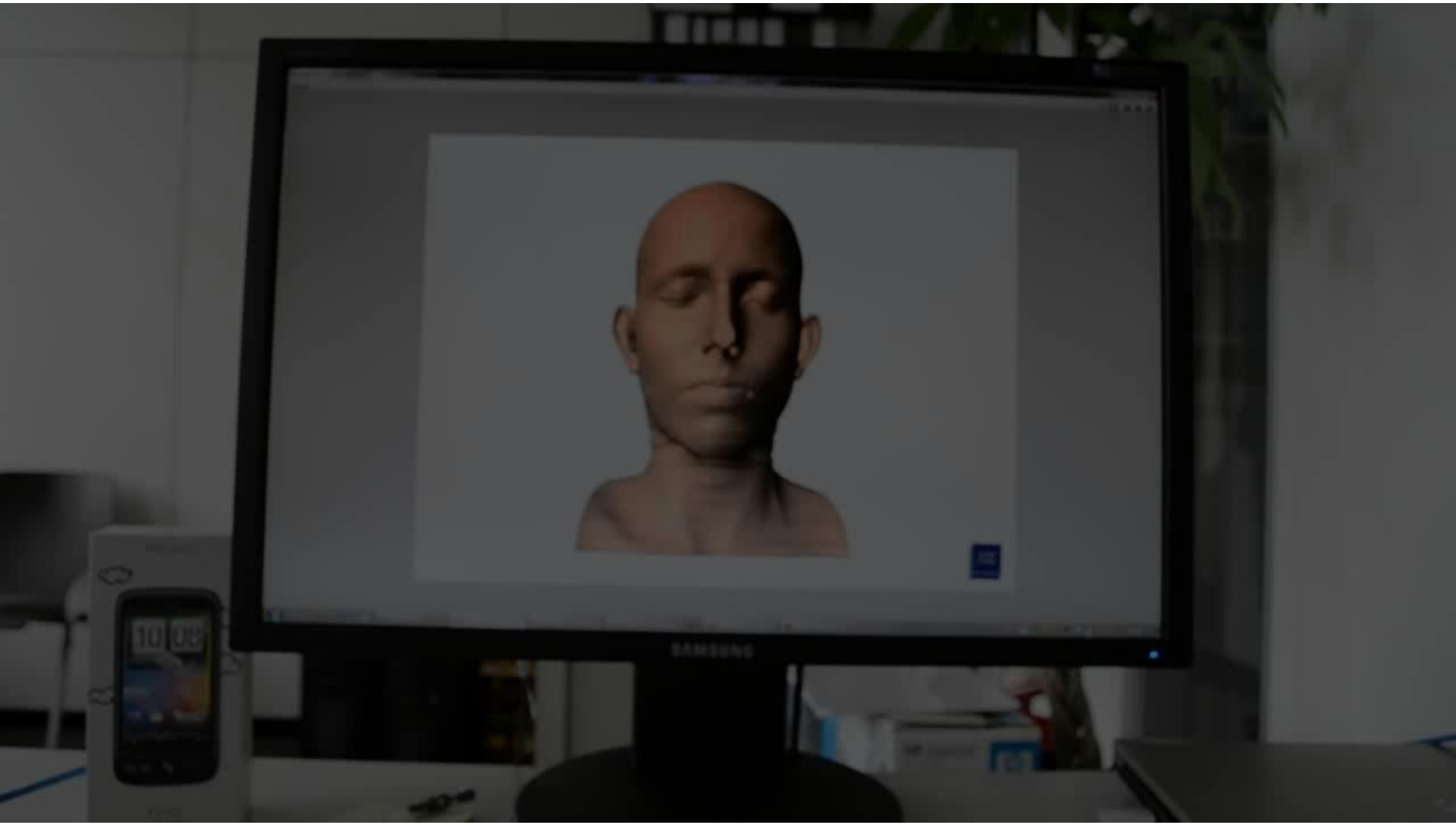
Mobile Component

- HTC Desire (Google Nexus One)
  - Hardware H.263 and JPEG encoder
  - WiFi connection
  - Camera
- H.263 video streaming
  - Android Media API + localhost loopback
  - RTP/RTSP
  - Too much delay
- JPEG frame streaming
  - Android Camera API
  - UDP
  - GStreamer node in the tracker
  - Low delay, good quality
- User Interface
  - Touch screen
  - Pointer
  - Overlay images



RESULTS

Results – Video

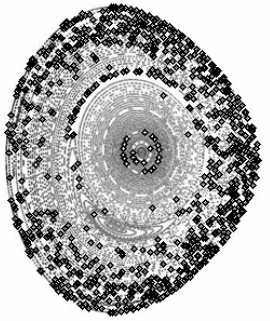


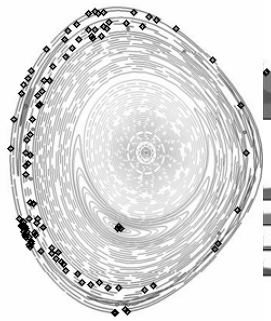
Results – Frame rates

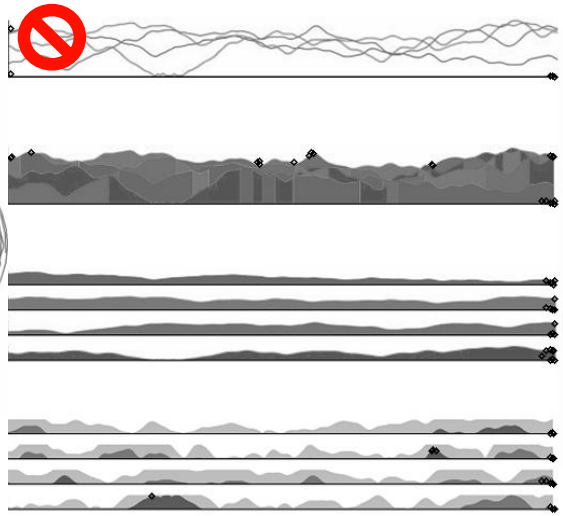
Camera resolution	JPEG quality	Overlay resolution	Average FPS
320x240	80%	128x128	19.2
320x240	80%	256x256	15.2
320x240	80%	320x240	14.7
320x240	80%	800x480	9.5
640x480	80%	256x256	8.8
640x480	30%	256x256	9.2
320x240	30%	256x256	16.8
176x144	80%	256x256	19.1 (degraded)
176x144	30%	256x256	failed
320x240	80%	128x128	14.2 (2 users)
320x240	80%	128x128	11.4 (3 users)

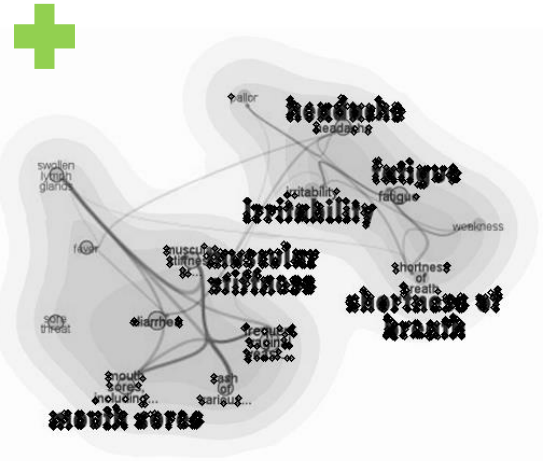
Results – Content

- Robust tracking when more than 100 keypoints
- This assumption usually holds in scientific visualization
- Distance range is limited









Conclusion

- So far...
  - Interactive frame rates
  - No special hardware required
  - Easy to implement and deploy
  - Simple GUI

- The next steps...
  - Porting the tracker onto the phones
  - Automatic camera calibration
  - Extension to multiple targets (multiple displays)
  - New applications

Thank you for your attention!

谢谢