Bremen


# Visual Computing in praktischen Anwendungen

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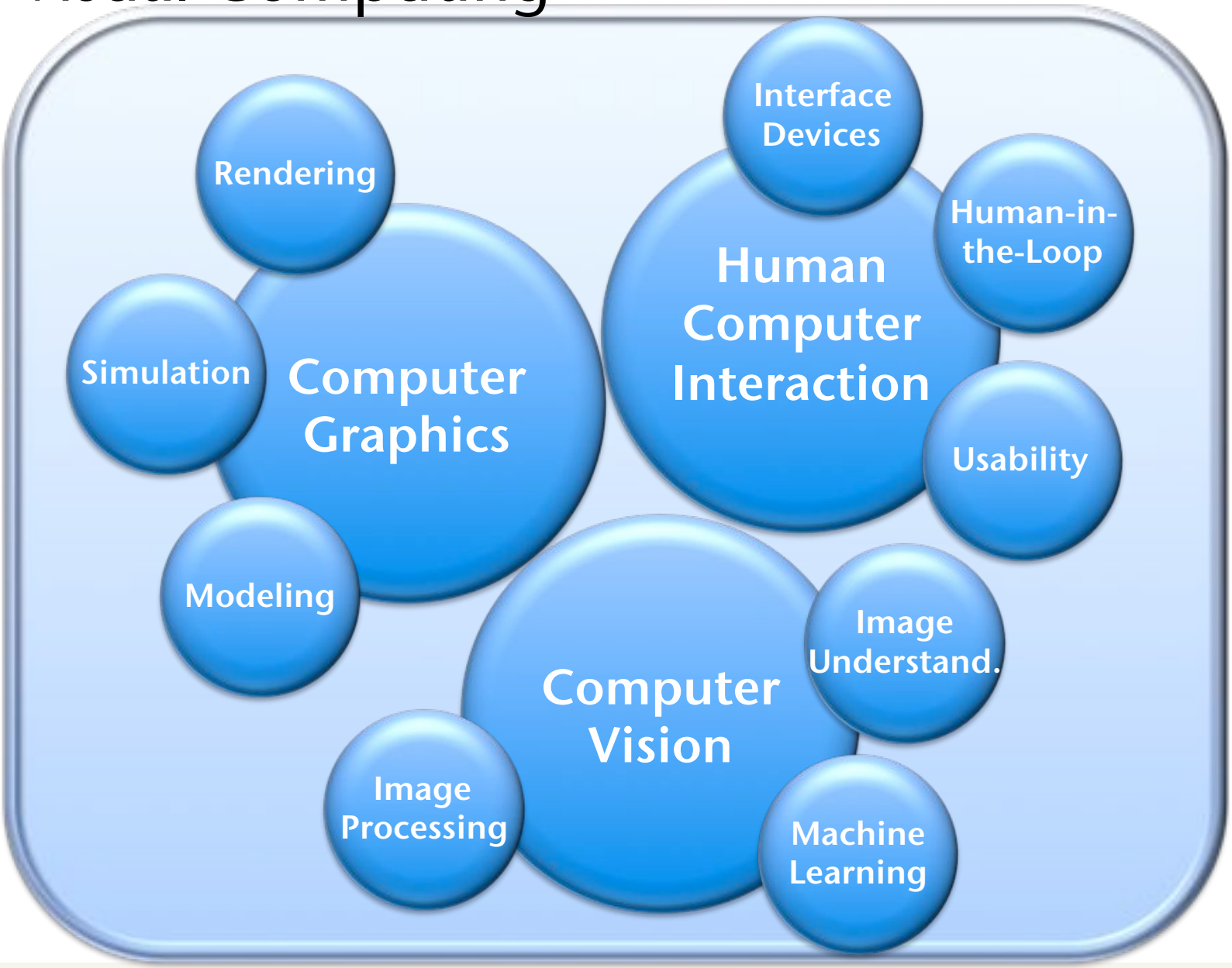
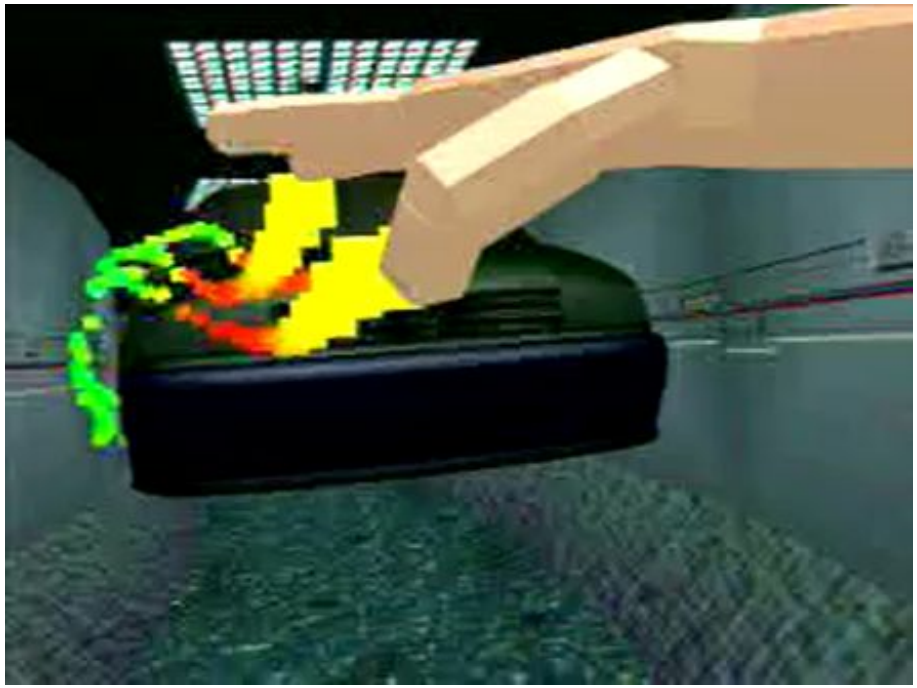
# Visual Computing



# Applications of Virtual Reality

## Virtual wind tunnel



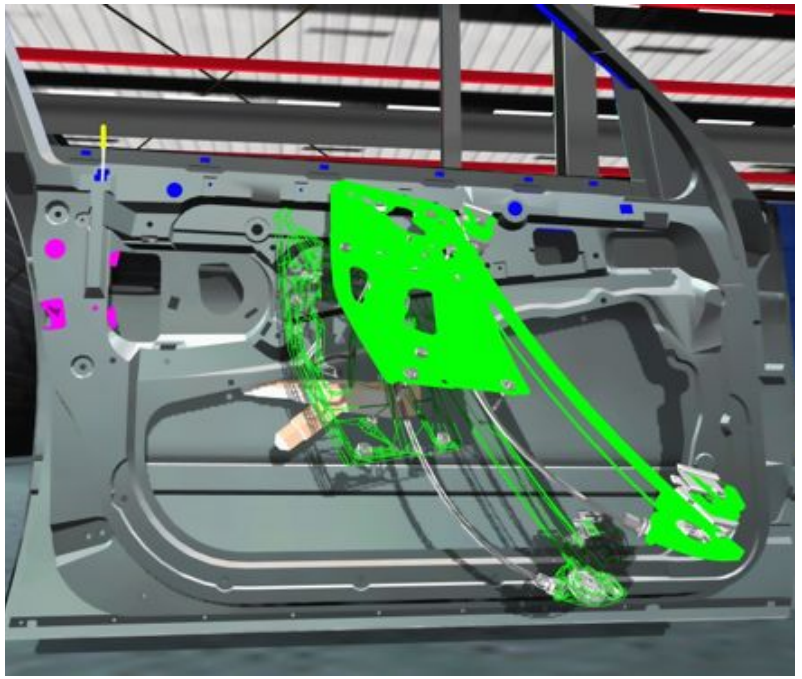
[with Volkswagen]

## Ergonomic studies

[with BMW]

# Assembly simulation


[with BMW]

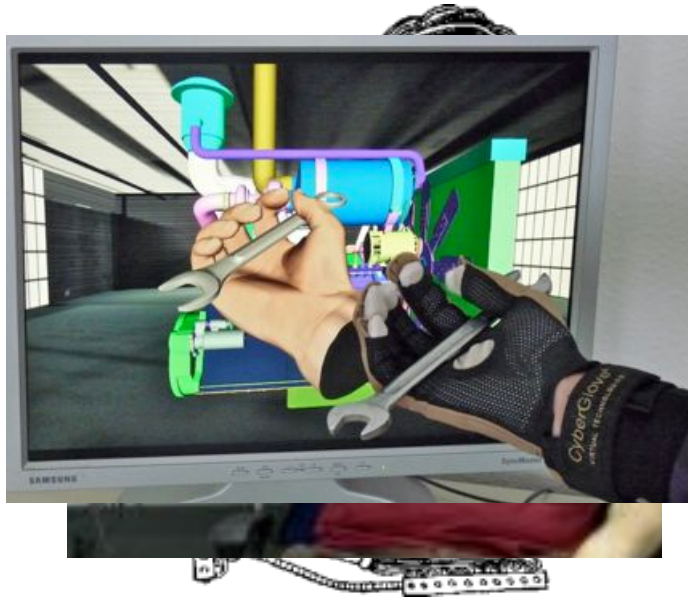


[with BMW]

# One of Our Research Themes

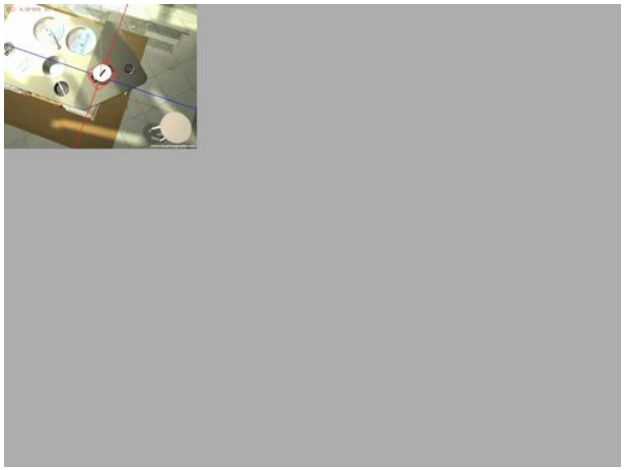
- Approaches for un-intrusive, natural, direct, and physically plausible interaction with virtual environments
  - In particular, direct manipulation of virtual objects using the virtual hand

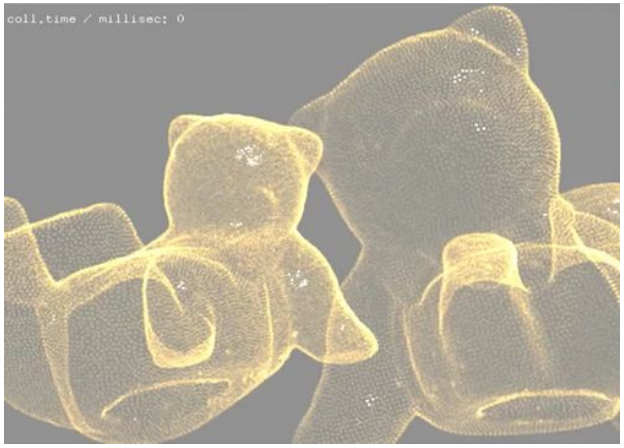
*"...the toughest part for us to achieve in practice seems to be the realistic interaction."*
[Jim Foley: Top Ten Problems in CG, IEEE CG&A]

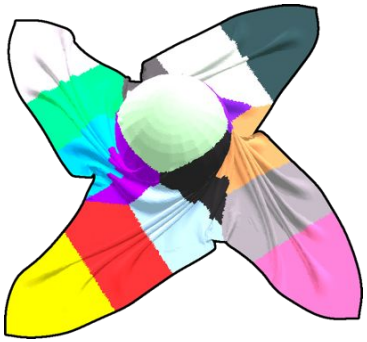


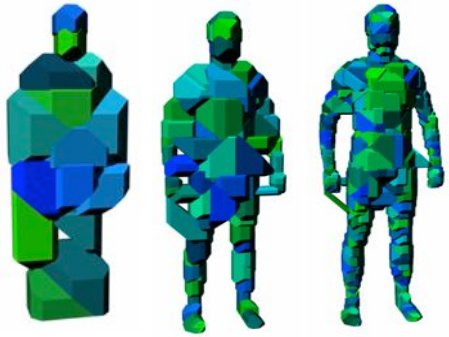
# Collision Detection & Response

- Rigid & deformable bodies
- Probabilistic coll.det. (time-critical)
- Kinetic bounding volume hierarchies
- Point cloud intersections
- Massively parallel sorting on the GPU (optimal depth & work complexity)



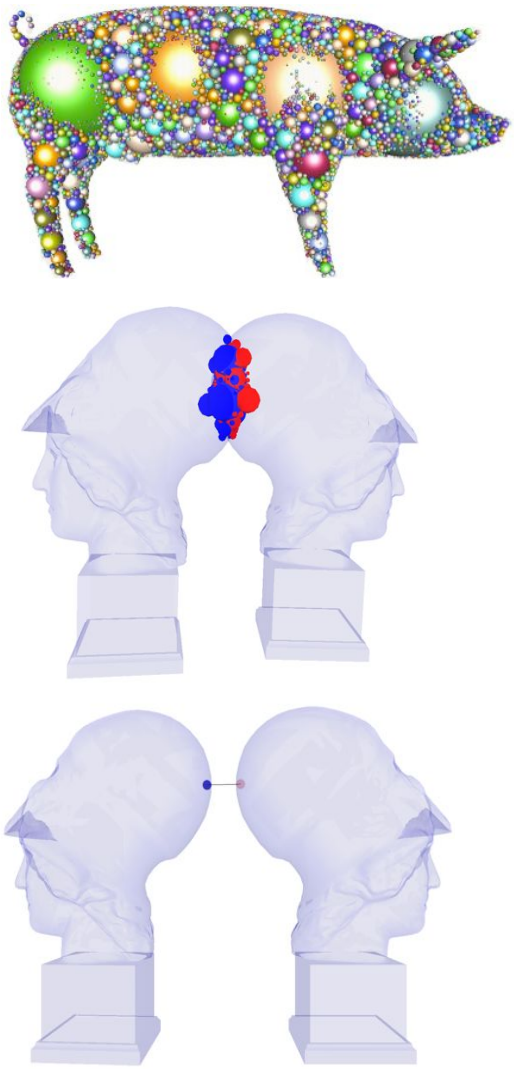


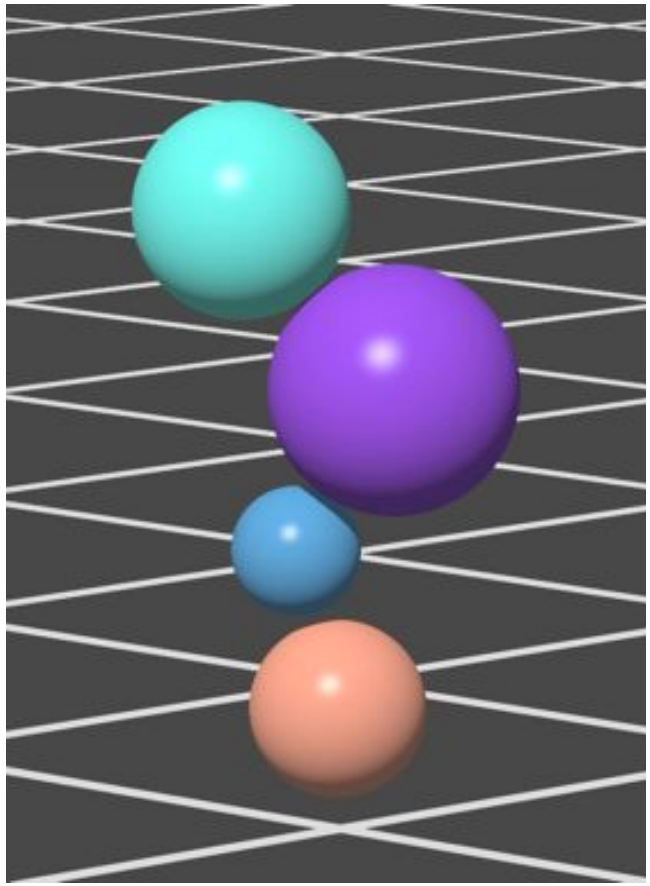


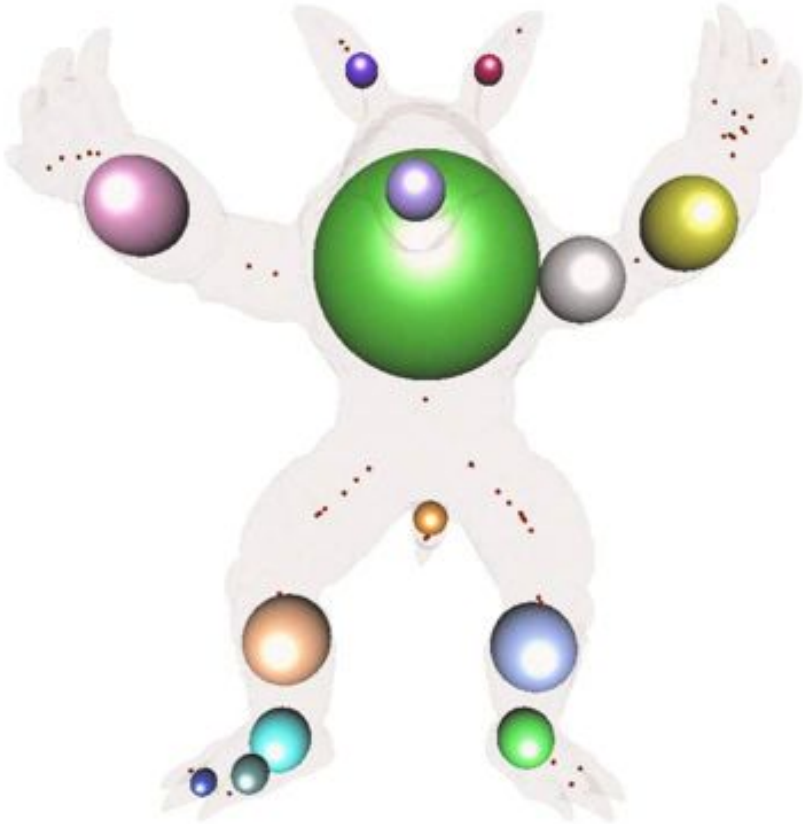
# Inner Sphere Trees (ISTs)

- Basic idea: fill object from inside with non-overlapping inner bounding volumes
- ➢ Sphere Packing (multimodal)
  - Could be other BVs, too
- Goal: dense packing & few spheres
- Advantages:
  - Computes separation distance *and* penetration volume in a few milliseconds
  - Can do so with the *same* algorithm
  - Penetration volume = water displacement → new approach to computing haptic forces



# Prototype-based massively-parallel algorithm on GPU





[Siggraph Asia sketches]

# Application: Collaborative Haptic Workspace

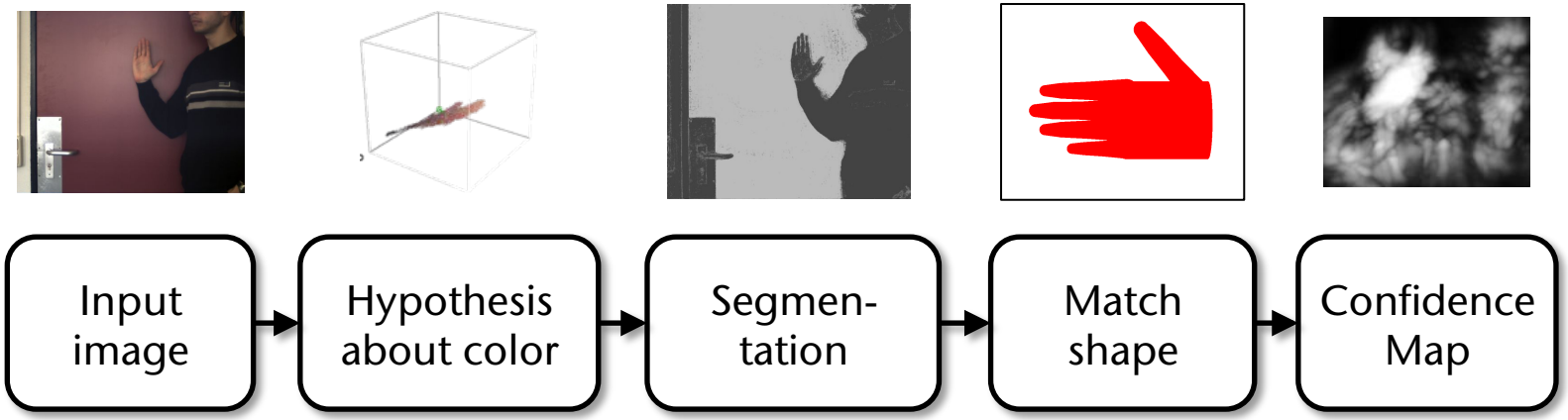
12 moving objects ; 3.5M triangles ; 1 kHz simulation rate ; intersection volume ≈ 1-3 msec

# Camera-Based Articulated Object Tracking

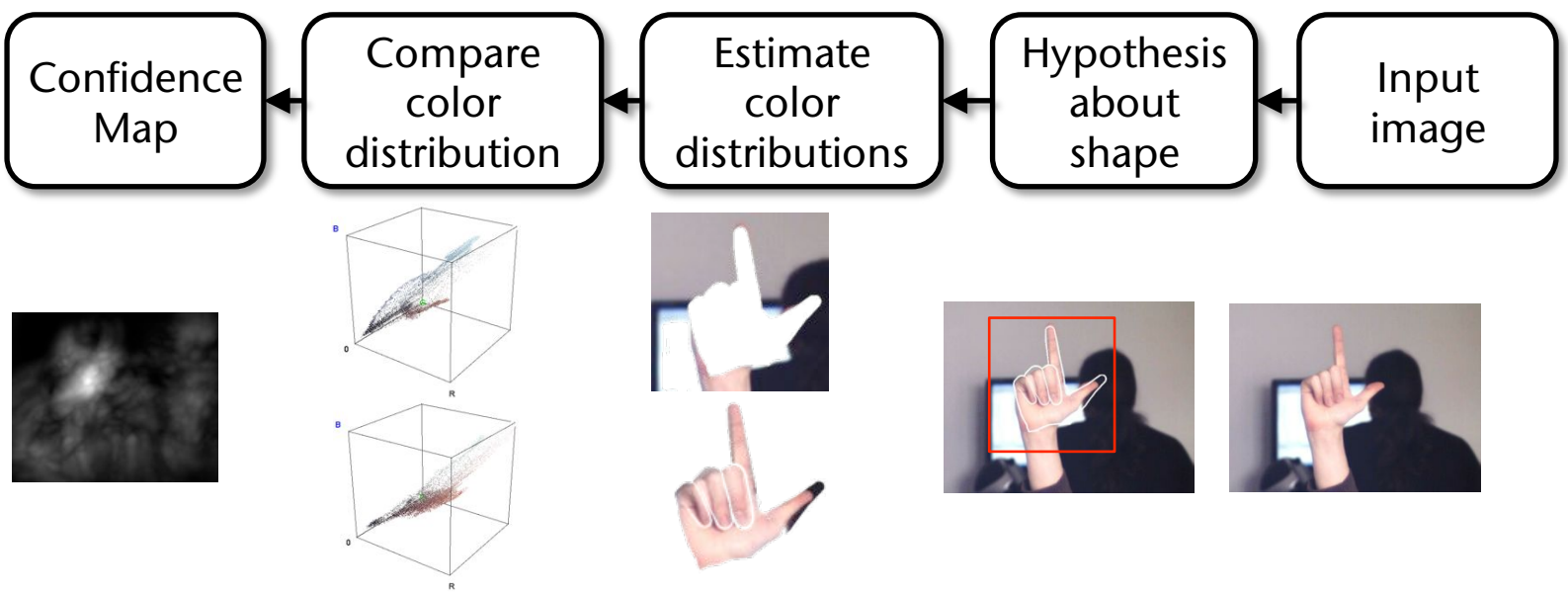
- Goal: markerless tracking of human hand with cameras in real-time
  - High-dimensional configuration space (26 DOFs)
  - Determine global hand position and orientation in 3D space (6 DOF's)
  - Determine hand pose, i.e., angles of finger joints (20 DOF's)

# A Segmentation-Free Approach

Standard segmentation-based approach

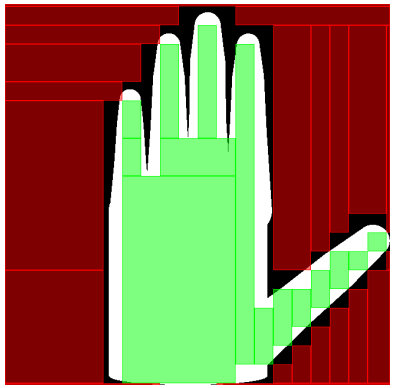


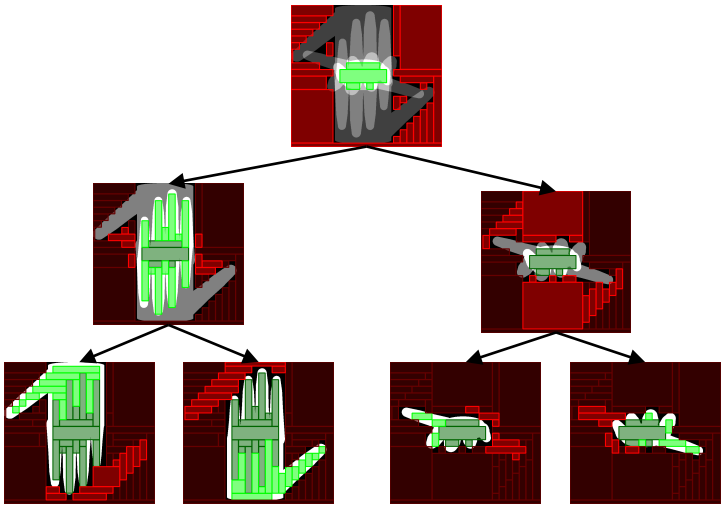

Our novel segmentation-free approach



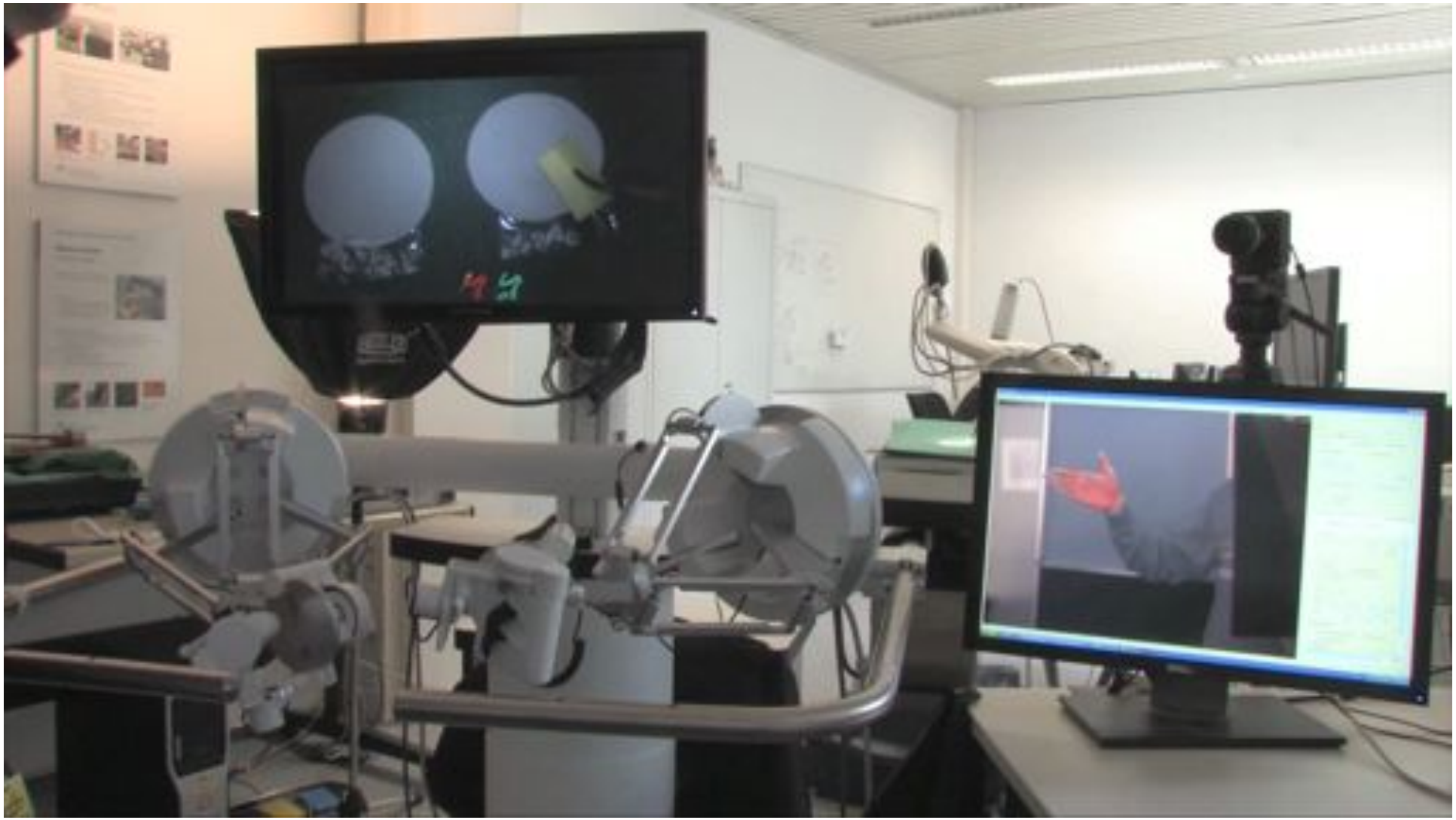
# Fast Area-Based Template Matching

- Novel representation for templates: rectangle coverings
- Benefits:
  - Matching time no longer depends on image or template resolution
  - Speedup = 10-25 x
  - Easy to turn into hierarchical matching algorithm → complexity = $O(\log n)$ for $n$ templates!



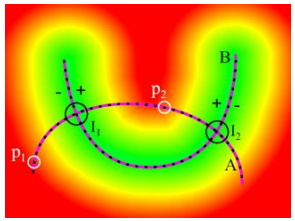


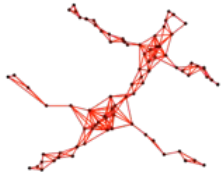
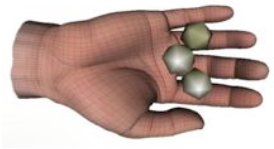
# One Possible Application: Touch-less Control of Robots

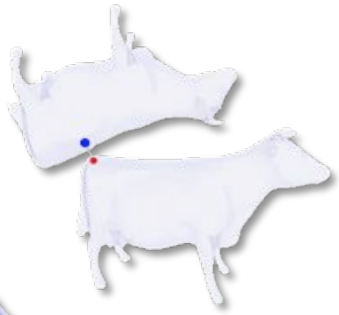


With DLR, Oberpfaffenhofen: touch-less hand-based control of the surgery robot MiroSurge

# Thank You!

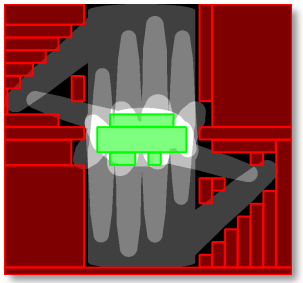






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