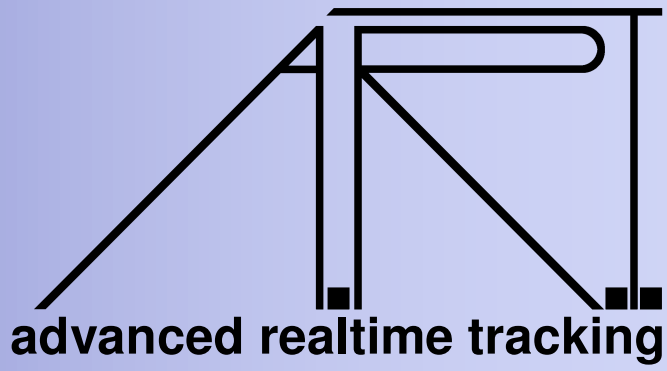

Optical Tracking of Finger Positions

A new method for interaction in virtual worlds

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Position of AR/VR in industry

advanced realtime tracking

- **VR: Fully established tool in**
  - Automotive (Europe only?)
    - All automotive producers
    - Most Tier-1 suppliers
  - Aerospace industry
- **AR/MR catching up**
- **Mainly used for**
  - Design review
  - Digital Mock-Up (DMU)
  - Ergonomics
  - Assembly
  - Customer presentations

Industrial AR/VR applications

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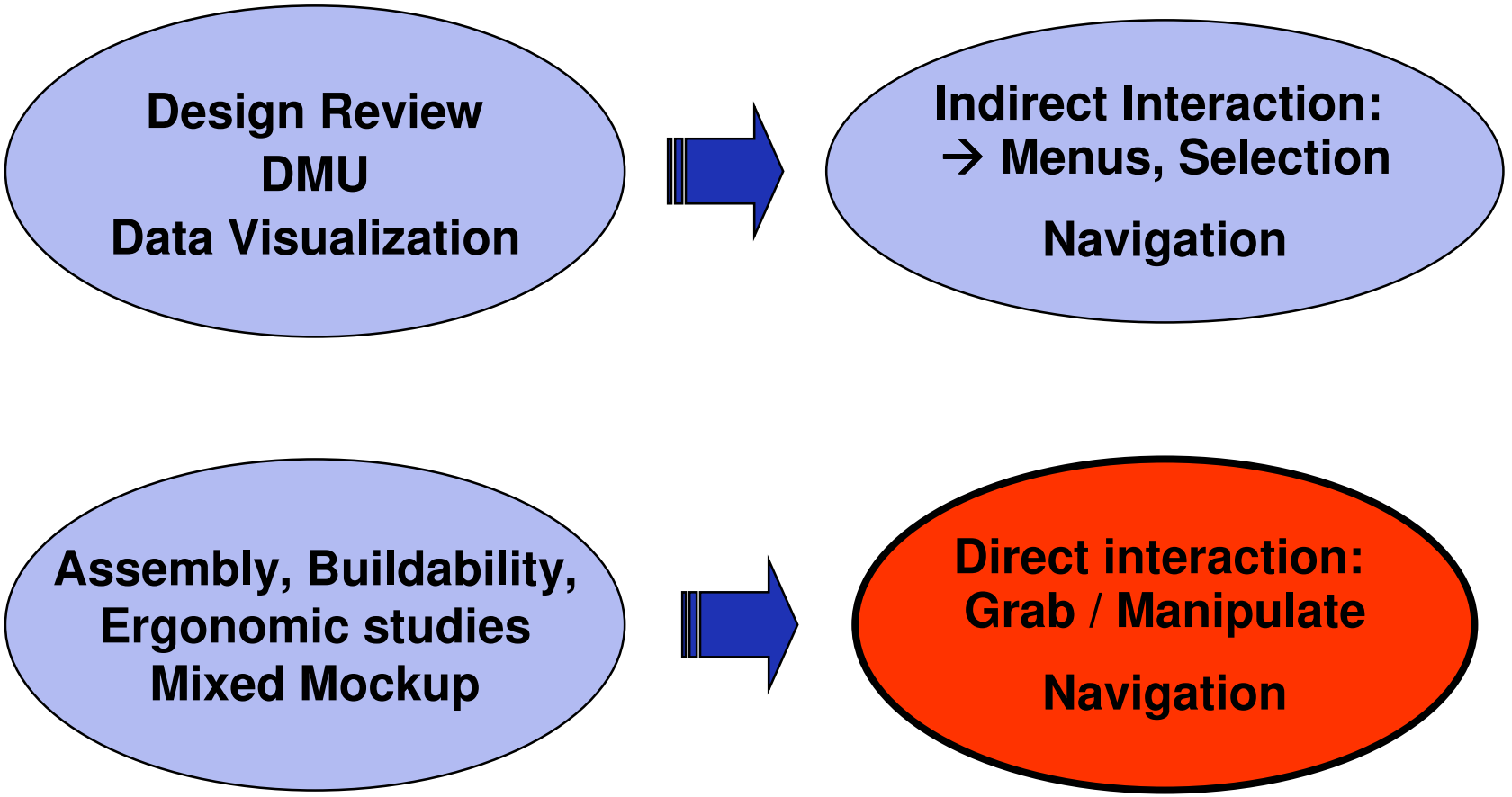

Why Fingertracking?

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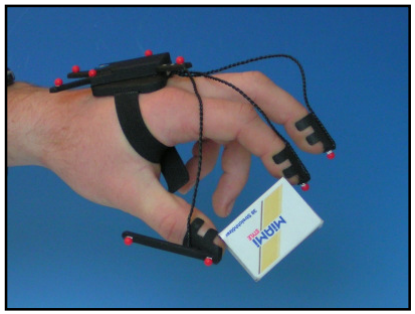
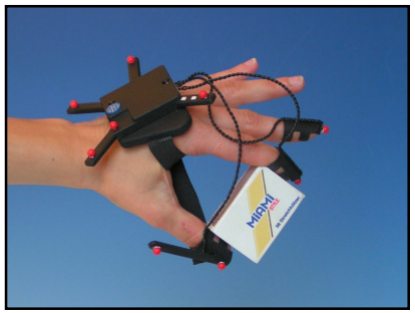
- **Normal data gloves**
  - 6DOF sensor at wrist
  - Strain gages for backward kinematical approach
  - Glove over full hand to guide strain gages
  - External cables required



- **Problems**
  - 6D Errors propagate over long lever
  - Different finger/hand sizes
  - Gloves used over longer period are not hygienic
  - Ergonomics: Weight & Cables



The new approach

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- **Initiated by VW**
  - An ergonomic device for ergonomic / assembly studies
- **Design goals**
  - Precise positions for finger tip
  - Reliable measurement
  - Light-weight
  - No external cables
- **Developed in cooperation of**
  - Volkswagen AG
  - Technische Universität München
  - A.R.T.

First tests: passive markers

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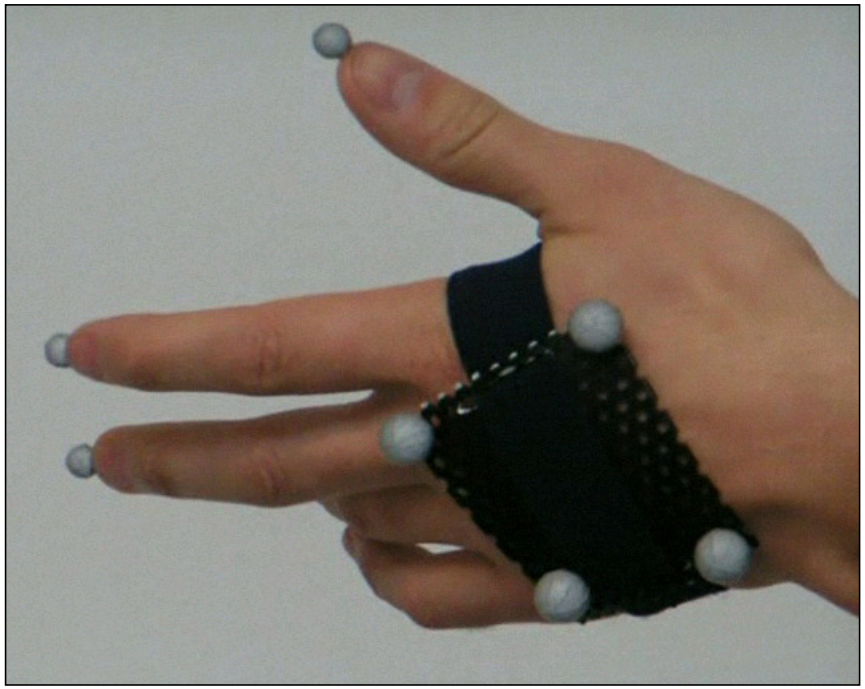
- **First prototype**
  - 3DOF marker at finger tip
  - 6DOF target at back of hand
- **Problems**
  - Marker identification
  - Marker size
  - Merging markers
  - Marker pollution



Active markers

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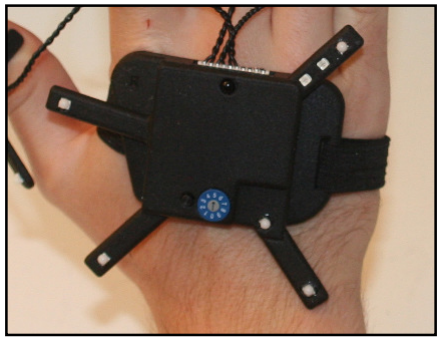
- **Infrared LEDs**
  - Pulsing for efficient power usage:
    → Only emit when camera CCD active
  - Synchronized by modulated flash
  - Multiple flash groups possible
- **Addressable**
  - Enable / disable LED per frame
  - Sequentially switch between LEDs
- **Robust**
  - No performance degrading when soiled with fat
  - Mechanically robust
- **Small**
  - LED with diffusor sphere is <2mm



Active markers in finger tracking

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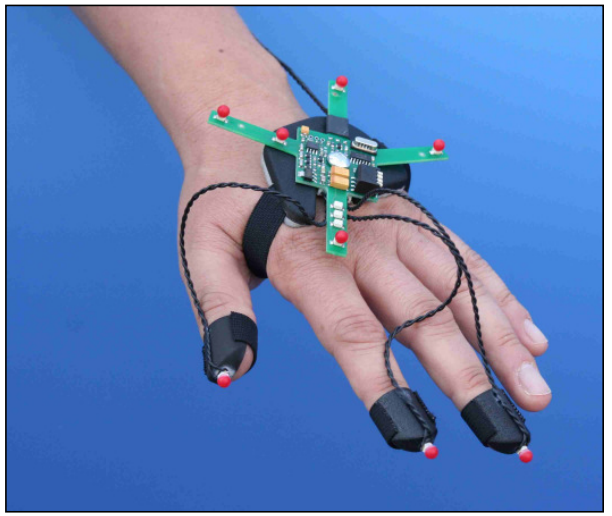
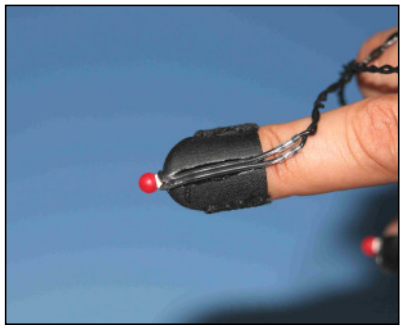
- **Principle**
  - Thimbles with LEDs on finger tips
  - 6DOF target on back of hand
  - Finger tip LEDs flash sequentially
  - Target LEDs flash in every frame



- **Advantages**
  - Finger markers small
  - All markers robust against soiling
  - No merging markers for fingers



- **Disadvantage**
  - Fingers tracked with 1/3 tracking frequency

Calculating finger positions

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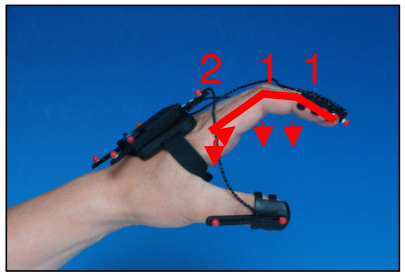
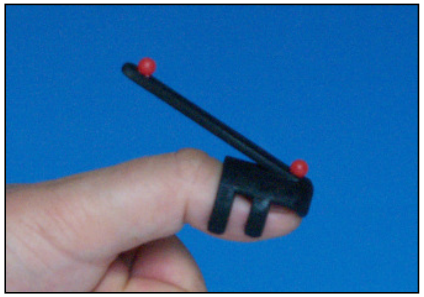
- **Normal fingers (index/middle)**
  - 3 joints: 2 hinge joints and 1 ball joint
  - 4 degrees of freedom
  - Unique solution possible when last joint and tip given (no external forces)
  - Measure back of hand (6DOF) + tip (3DOF)



- **Special: the thumb**
  - Saddle joint instead of ball joint
  - Higher flexibility in movement
  - Requires additional information:
    → measure line instead of tip position



Finger marker positions

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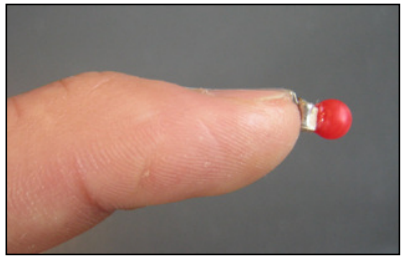
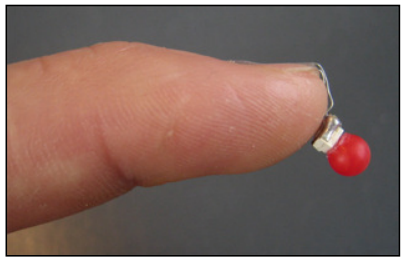
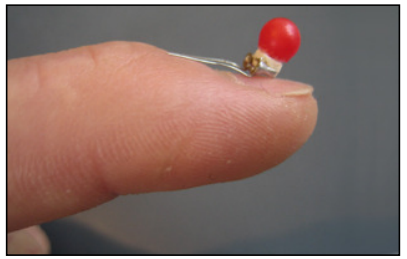
- **At the fingertip**
  - Unique solutions for equations
  - Good usability in VR
  - Problem: Touching objects in AR



- **Under the fingertip**
  - Unique solutions for equations
  - Usability in AR and VR bad



- **On top of finger tip**
  - Best for usability both in VR and AR
  - **BUT**: no unique solutions



Ambiguous finger positions

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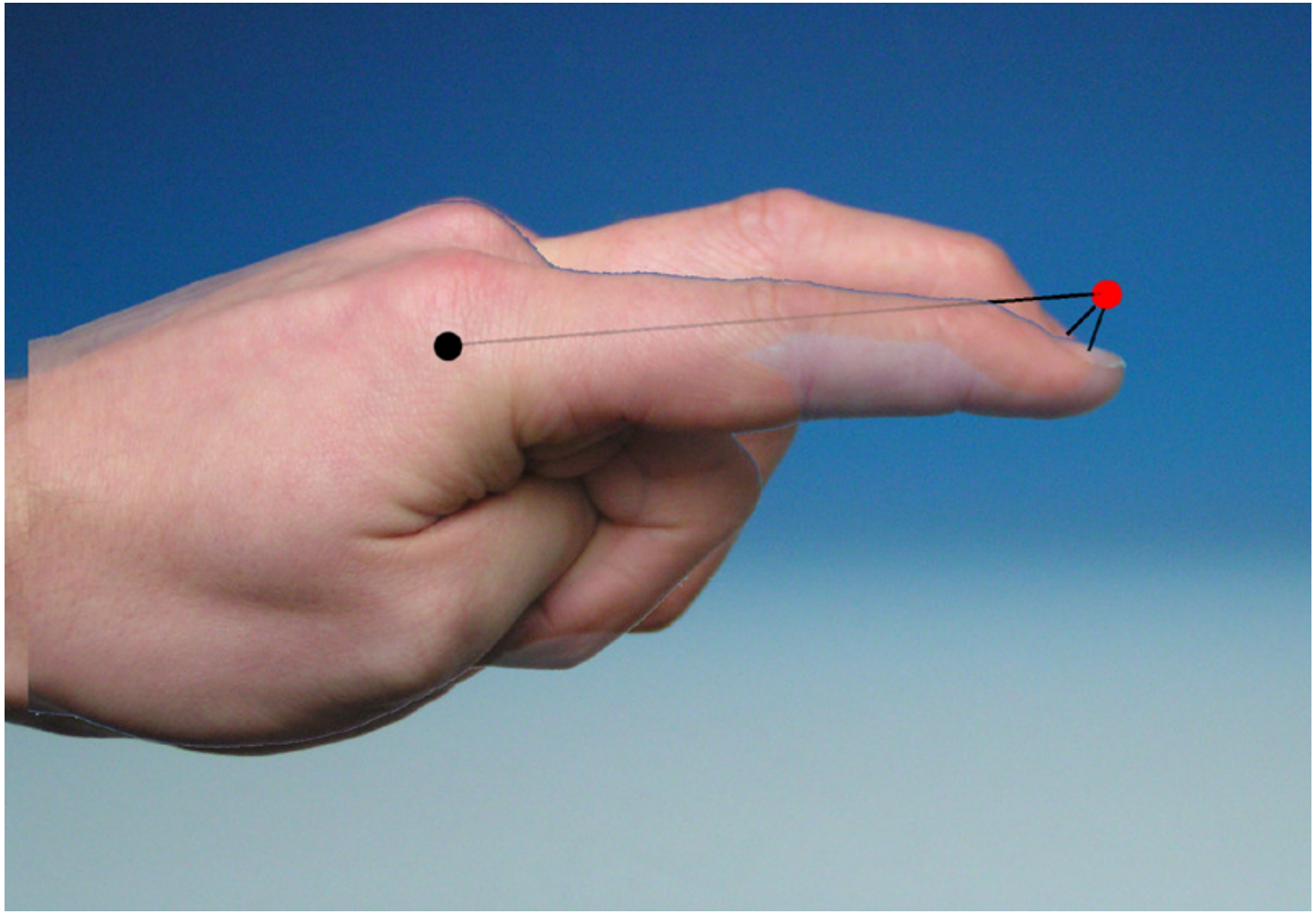
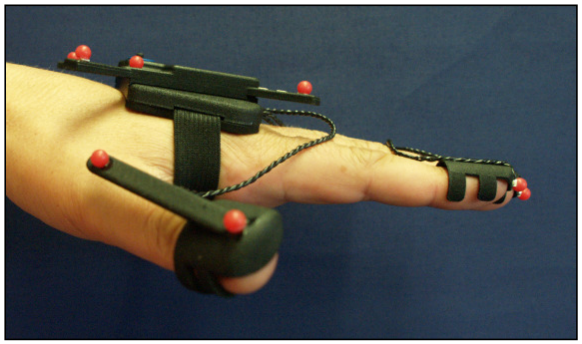


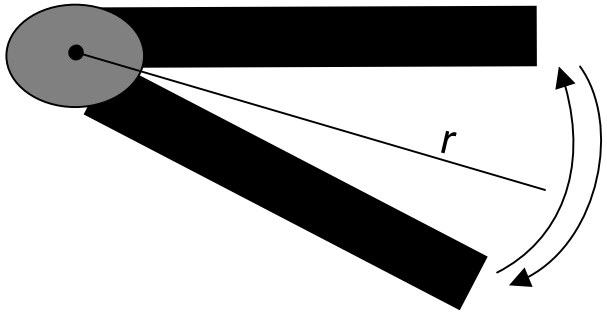
Calibration

advanced realtime tracking

The finger tracking can/must be calibrated to the user's hand

- Movement of fully extended fingers
- Finger length of index and middle fingers are radius of finger marker arc novement
- Centers are the base joint positions
- Phalanx length ratios are assumed to be constant
- Thumb length is calculated from finger lengths

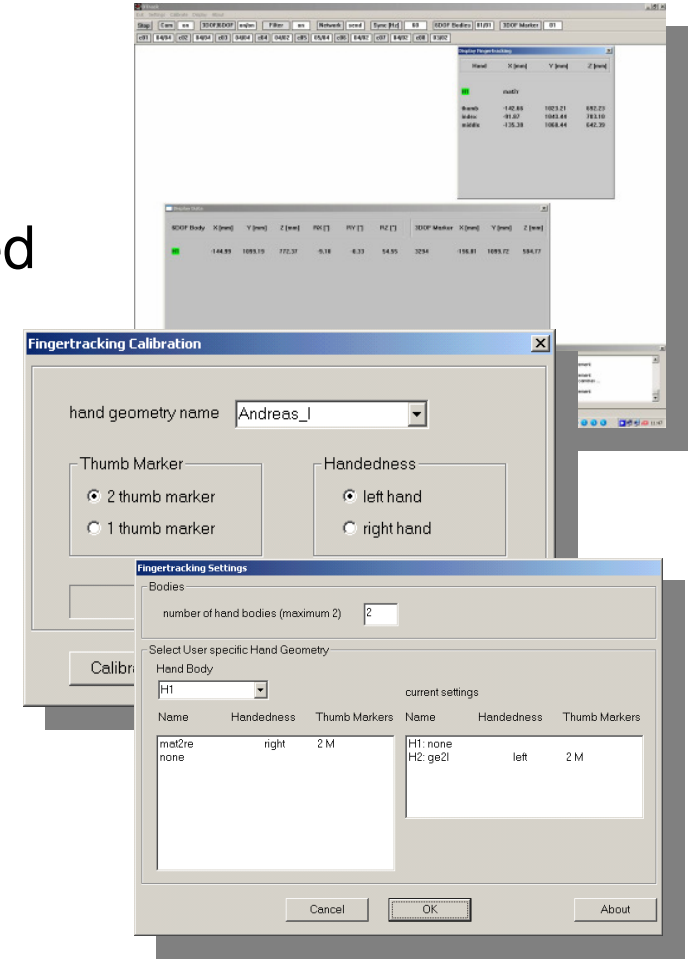




Software

advanced realtime tracking

- **Plug-In for DTrack**
  - Simple Calibration
  - Multiple calibrations can be saved
  - Selection of calibration by name
- **Data sent out by Ethernet**
- **Compatible with all other tracking objects**
  - Flystick
  - Measurement Tool
  - Other targets



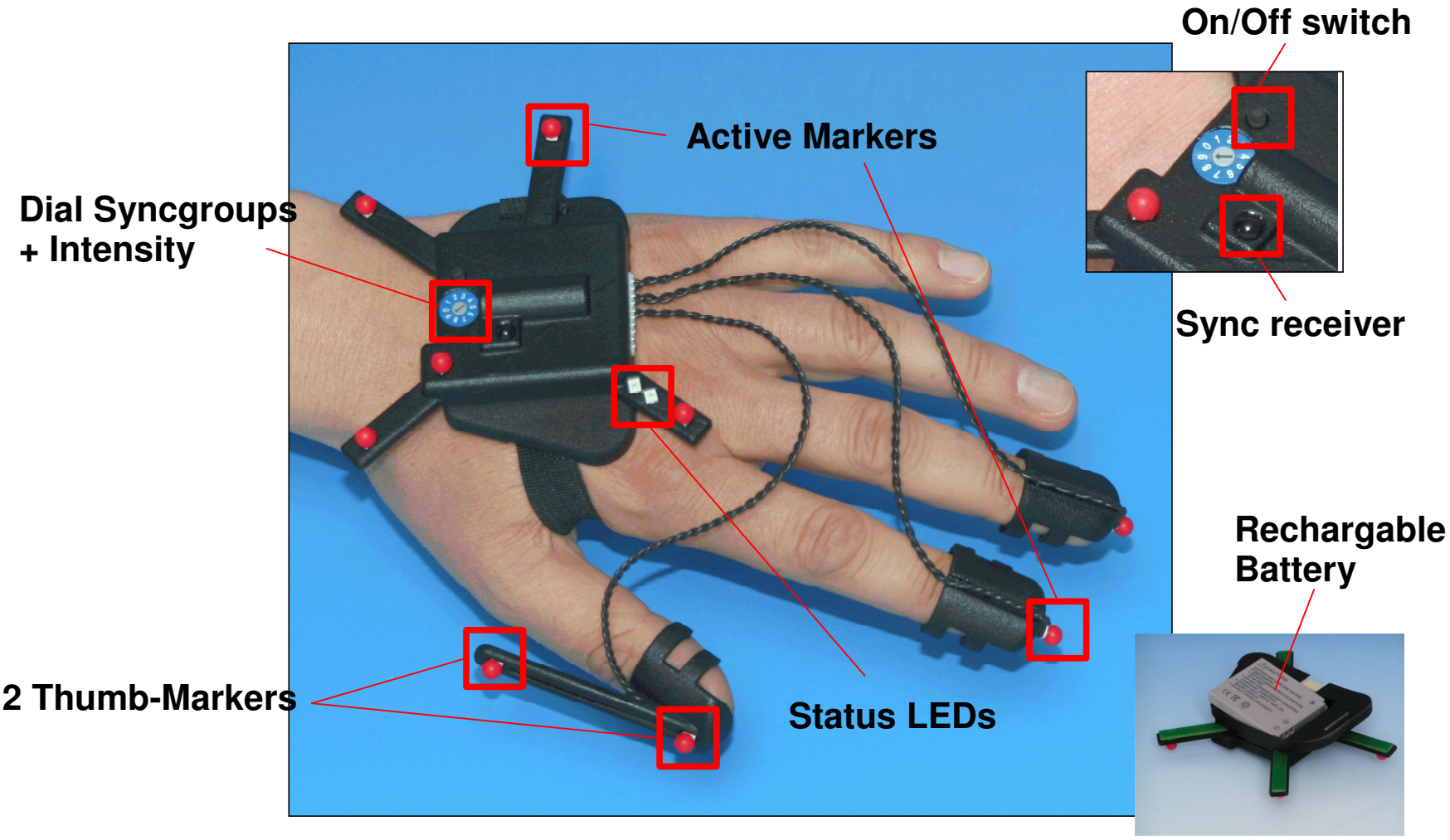
State of the A.R.T.

advanced realtime tracking

- **A.R.T. Fingertracking**
  - 2 Hands
  - Active Markers
  - 3 Finger --> 2 x 1 Marker , 1 x 2 Marker
  - No external Cables (Battery, IR Sync)
  - Hygienic, no glove
  - Changeable Thimbes in different sizes
  - Plug-In for DTrack
  - Simple calibration
  - Multiple Users possible / fast changing between users
  - Weight: 55 g / 1.94 oz (including battery and thimbles)

State of the A.R.T.

advanced realtime tracking



Applications

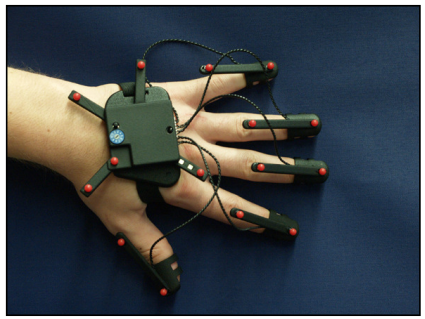
advanced realtime tracking

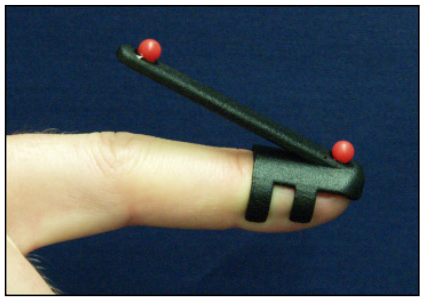
- **Direct interaction**
  - Operating virtual switches / dials / levers / tools
  - Better Human-Computer interfacing
- **Other possibilities**
  - Navigation in VR/AR Szene
  - Intuitive system operation / gesture recognition
- **Software integration**
  - Virtual Design 2 (VD2)
  - Others planned or in work (Maya, …)
  - Source code for data receiver integration available
- **Support by A.R.T. available – just ask!**

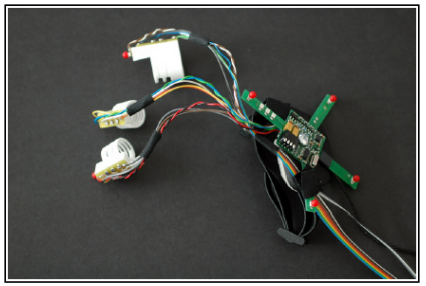
Improvements planned or in work

advanced realtime tracking

- **Five fingers**
  - Use all fingers for interaction
- **Open finger tips**
  - Find a way to get the finger tips free for touching real objects
- **Tactile feedback**
  - Get tactile feedback from the application to the finger tips







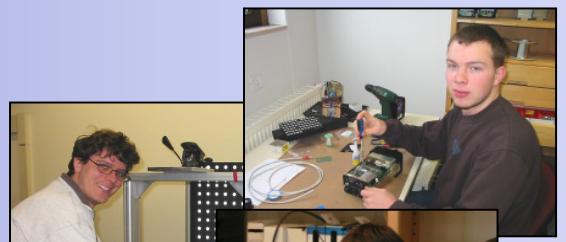
Thanks for your attention !

CEOs & Administration

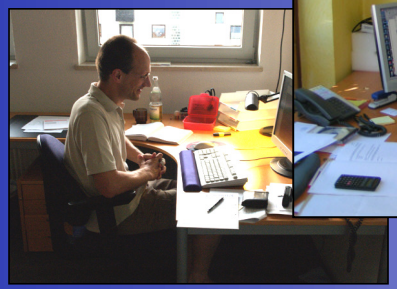
Hard- und Software Development

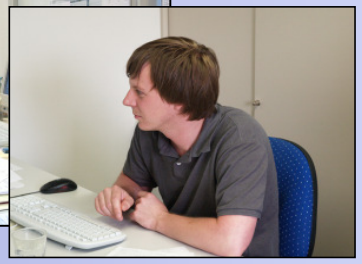
tracking only!

advanced realtime tracking



Production





Sales and Support

A.R.T. – Your expert for IR optical tracking systems