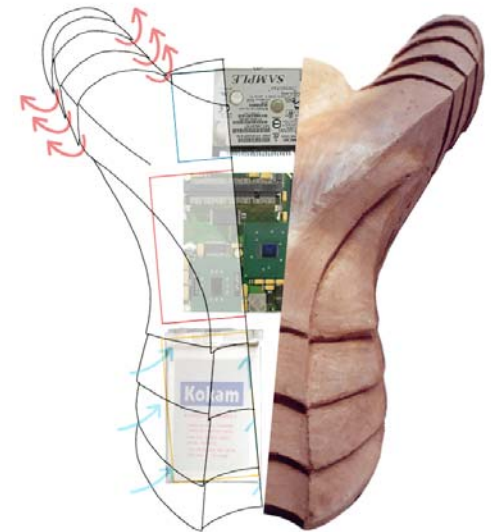


# hands free

a wearable surveying system for building surveying

jun. prof. dr. ing. frank petzold  
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dr. ch. bürgy  
[wearable consult]



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[wearable group]

c. quiatkowski, b. peipert, f. roth  
[application group]

in cooperation with

prof. h. bartels [product design]

prof dr.- ing. d. donath [computer science in architecture]

# overview



- context – building surveying
- hands free
  - wearable computer platform
  - software concept based upon ar-techniques
- further perspectives



# context – building surveying



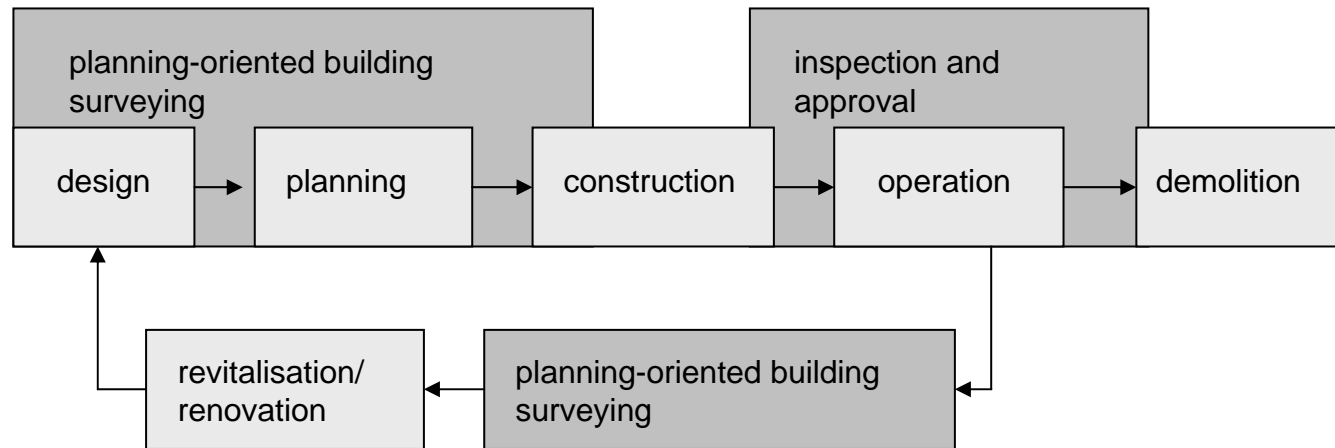
traditional



modern

- more than 60% of planning activity concerns existing buildings
- existing plans and building documentation seldom available or very basic
- many different and individual software and hardware systems
- software and hardware solutions are typically adaptations from other fields
- building surveying neglects (often) non-geometric information
- information transfer only via geometry-based formats

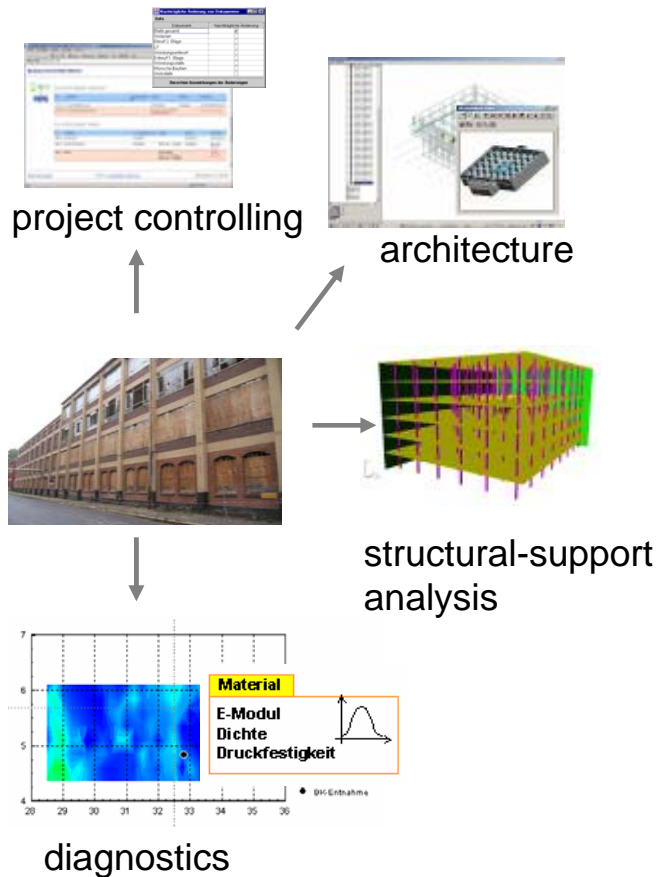
# context – planning within existing buildings



difference - planning for new buildings and within existing built contexts

- building is already present with its own history and life-cycle
- existing building contains a high degree of potential information
- building elements and spaces are not directly measurable (they are perceived and described by their surfaces)

# context- planning within existing buildings



the project requirements determine the information required:

- different types of information
- different structuring of information
- different degrees of detail
- different persons involved
- different phases in the planning stage
- different input-devices

# context - aims of the research project

- to design a practice-relevant software and hardware concept

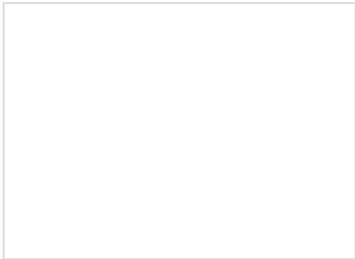
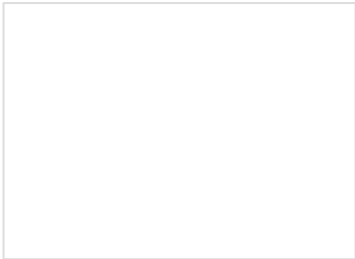
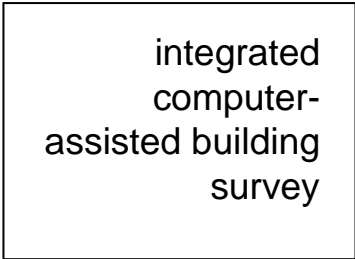
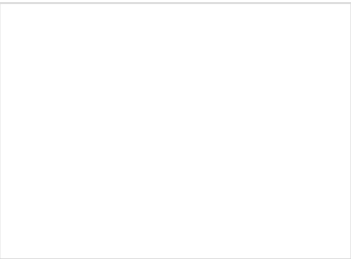
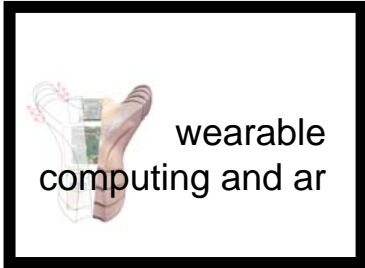
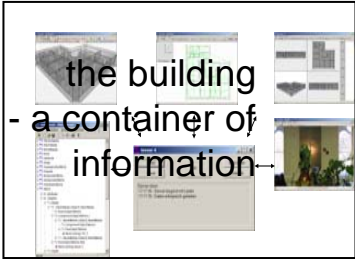
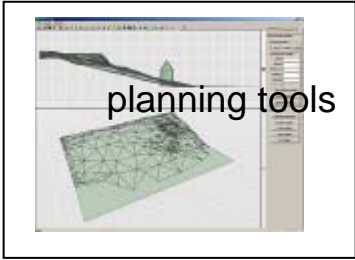
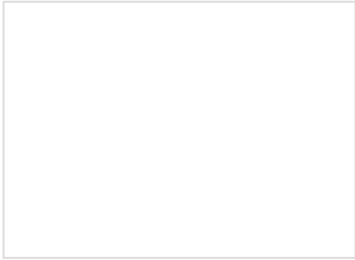
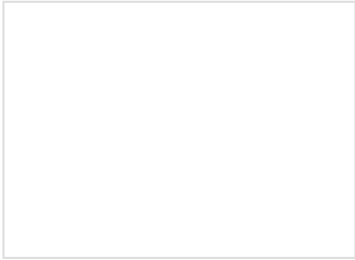
and

- to develop a prototype system for a structured way of capturing and organising building-related information about existing buildings in digital form

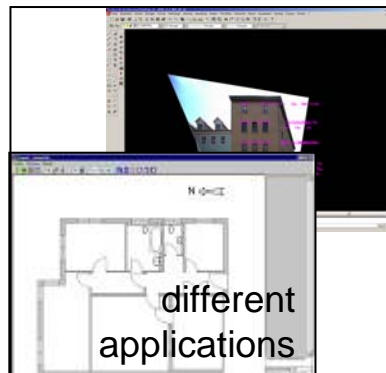


# context - research project presentations

*...particular aspects of the research project*



# hands free - situation on site



- different input and output devices
- special physical conditions (cold, impure, wet etc.)
- often no electricity
- different types of buildings
- building is already present with its own history and life-cycle
- ...

# hands free – technical development



- new input and output devices
- miniaturization
- interaction between real and virtual entities
- tracking and object detection
- augmented and mixed reality sdk's
- ...

Steve Mann's "wearable computer" and "reality mediator" inventions of the 1970s have evolved into what looks like ordinary eyeglasses.



# hands free – background

the building survey is usually undertaken “... by architects and building engineers. they lack perhaps the necessary education with regard to geodetic surveying, however their knowledge of building construction and history makes them obviously well suited to building surveying. as a result the surveying methods and equipment is typically described as basic.” /kehne89, a geodetic surveyor/

→ whereas in engineering surveying (e.g. dam, bridge or details) accuracy is of primary importance, in building surveying the **contact to the building** is of particular importance as **is simple operation (incl. input-devices and applications).**

# hands free

project aims

1. powerful **wearable computer**
2. modular **software solution** based on ar-techniques

based upon an analysis of building surveying processes



# wearable computer platform

## wearable ergonomics

- ergonomic studies using plaster of paris
- simulation of typical movements of building surveying tasks



identification of high motion and dynamic change and areas of the user's body of relative stability



# wearable computer platform



# wearable computer platform

## hardware concept

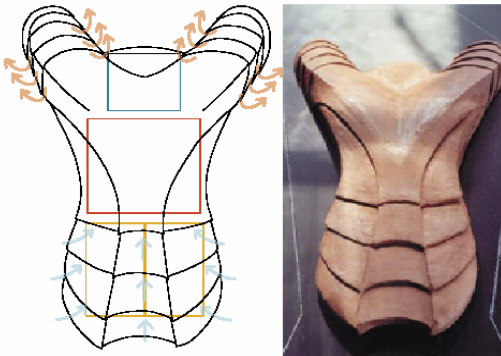
- different input devices, e.g. tape measure, tacheometer, distance-meter, voice recognition, camera
  - output devices, e.g. retinal display, audio
  - investigation into available commercial components
- identification of the location for the computer modules and positioning of the interfaces



# wearable computer platform



# wearable computer platform



## design and evaluation

- favourisation of backpack solution (based on working comfort regulations)
- investigation into “packaging ”materials



cluster of interchangeable units  
(scalable psu, interchangeable hard disk,  
embedded pc, wireless communication modules)

mock-up of internal hardware architecture



# wearable computer platform



pc-mainboard  
(3.7 x 4.5“,  
pentium® m 1.6  
ghz, 512 mb)



rechargeable  
batteries from model  
building technology



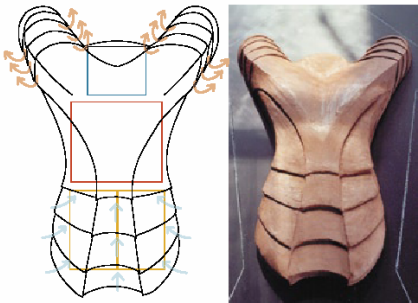
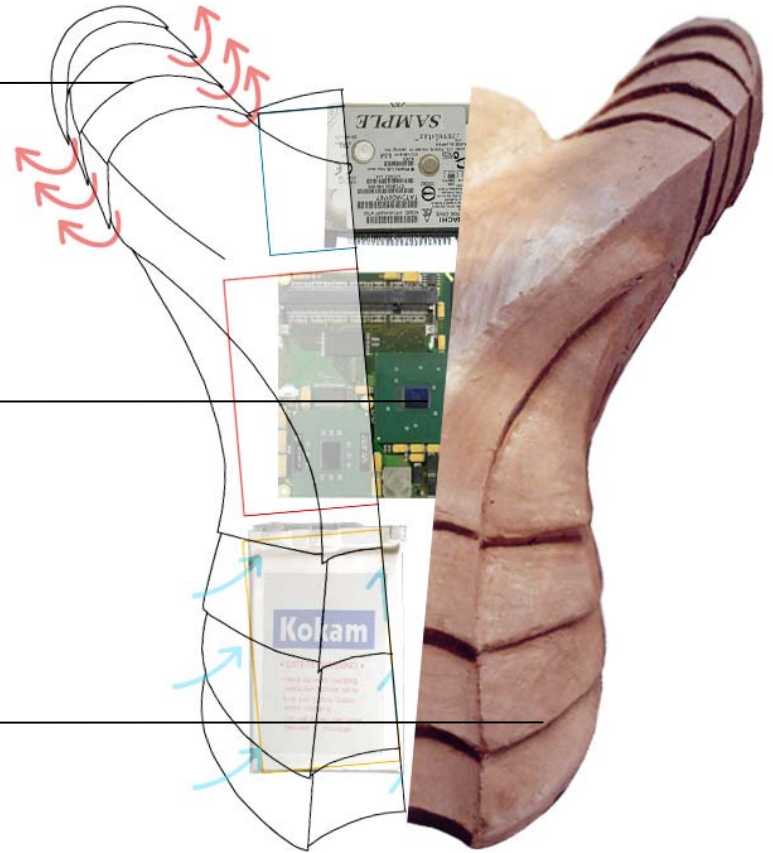
retinal display  
system

# wearable computer platform

ventilation-model

inner parts

clay-model



# wearable computer platform



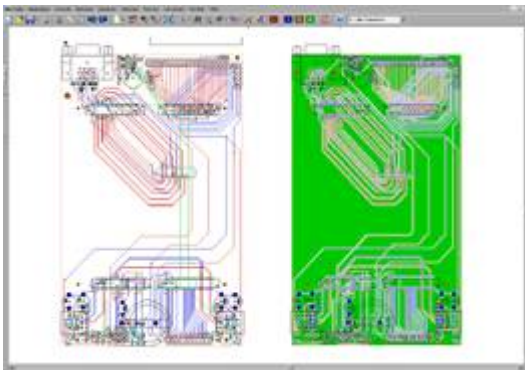
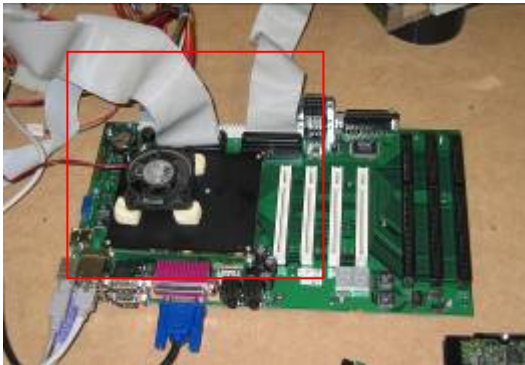
# wearable computer platform

## prototype

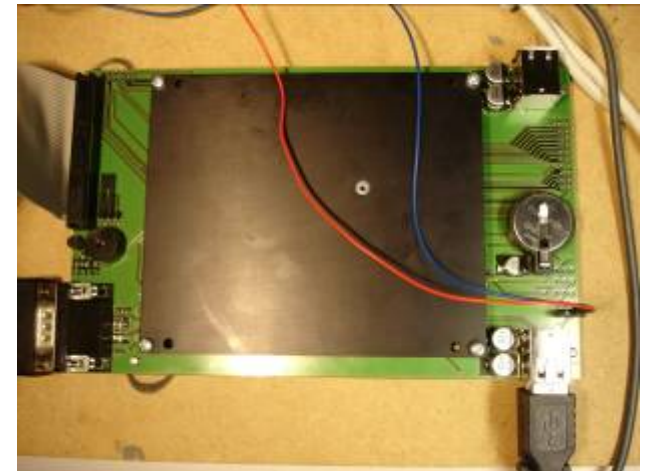
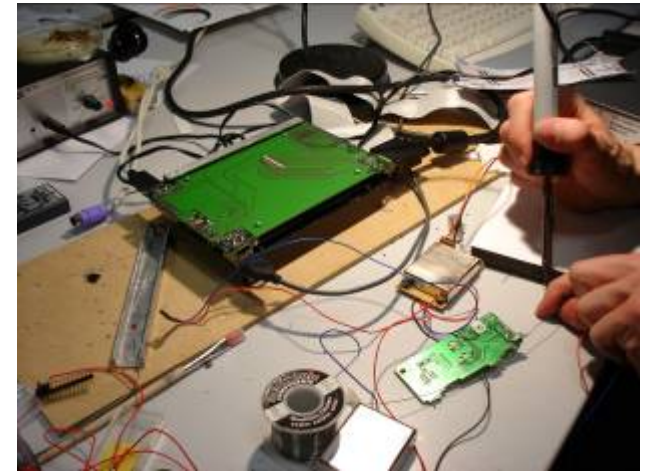
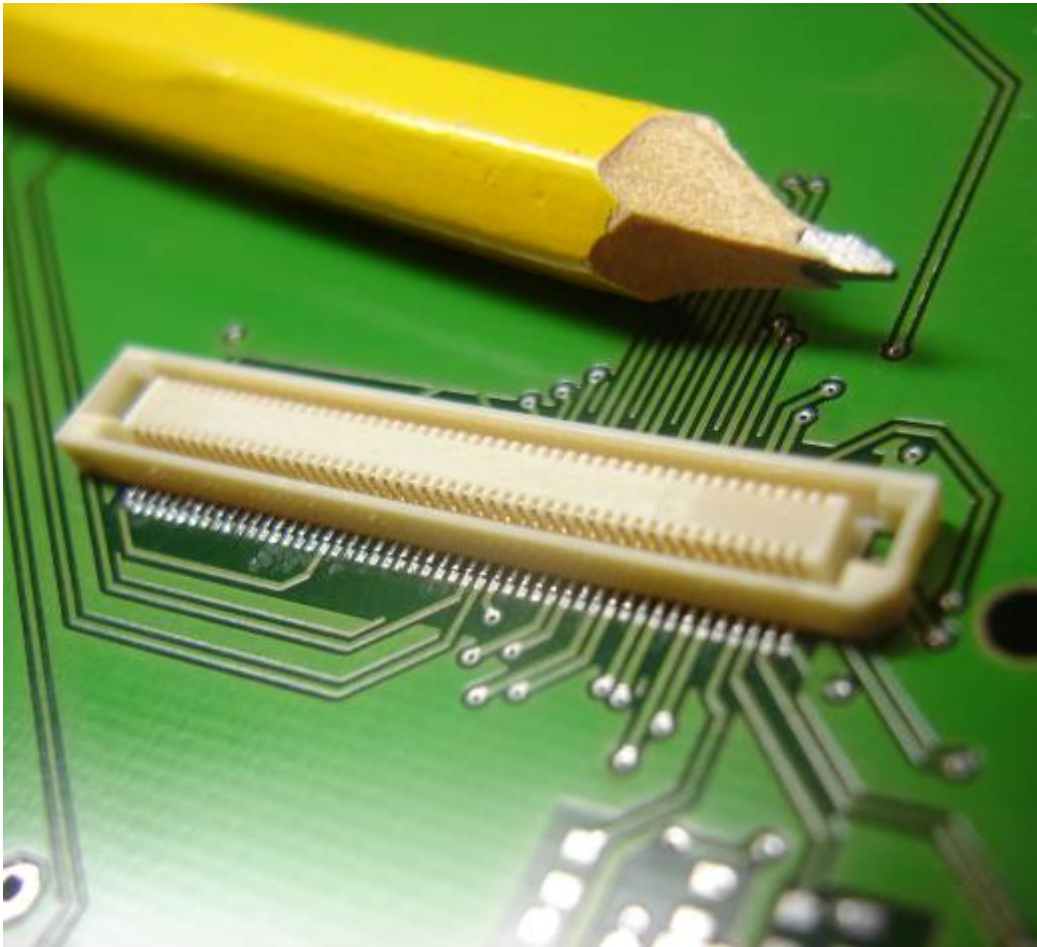
- creation of the “main board” and solder
- assembly of different components
- fabrication of the backpack – the cover based on syntactic material



working wearable prototype  
evaluation under “real conditions”



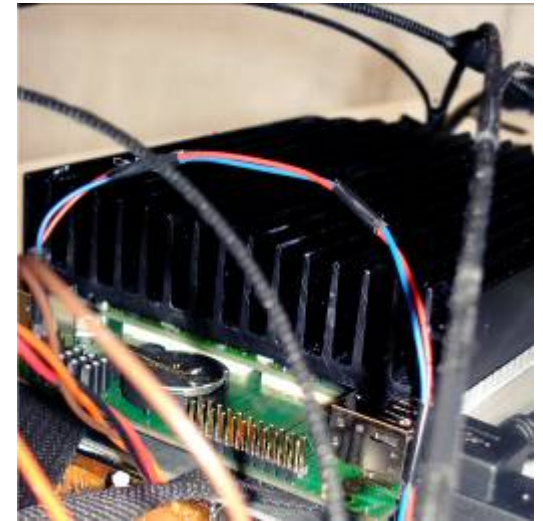
# wearable computer platform



# wearable computer platform



# wearable computer platform



# software concept based upon ar



vision: surveying and planning on site

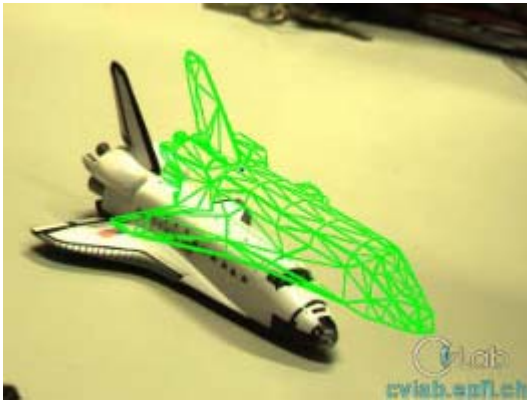
# software concept based upon ar

## investigation

- test of different ar and mr tools and sdk
- investigation into interaction techniques
- investigation into navigation, way finding etc.



selection of possible tools and interface techniques, e.g. image based markerless tracking sdk's (mrtoolkit or vicon based 3d tracking )



# software concept based upon ar



<http://cvlab.epfl.ch/research/augm/augmented.html>

# software concept based upon ar

## integration in the building surveying

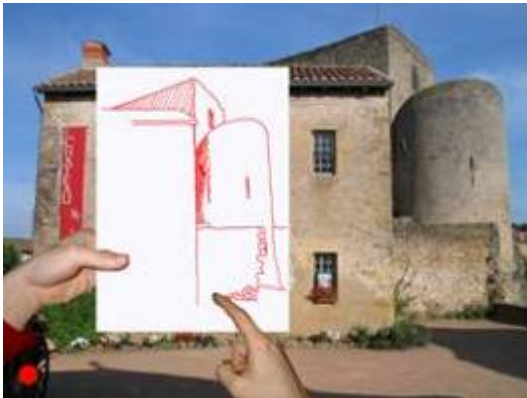
1. first site visit: information about inventory, identification of objects, visible damages
2. **sketch-based spatial information: sizes and volumes, sketches of building**
3. detailed ground plan: detailed analysis of building conditions
4. exact 3d geometry
5. evaluation / check: acceptance of work and facility management



# software concept based upon ar

## application scenarios – 2D sketch survey

- create initial sketch survey of a building
- “input-device” – finger tracking and sketching in the air
- using a transparent virtual sketch book
- control the application - insert tool buttons and menus in the real context
- interaction - gesture recognition and speech recognition



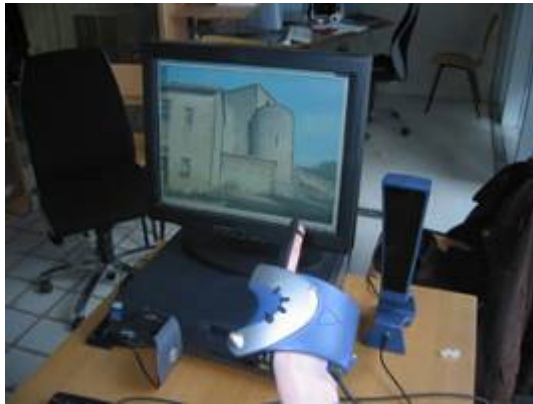
# software concept based upon ar

## application scenarios – 3D sketch survey

- create 3D building oriented sketches
- extension of the 2d sketch book with 3D abilities
- support 3d edge- detection
- integration of other measuring device - laser distance meter
- further information can be added in form of text, texture and pictures



# software concept based upon ar



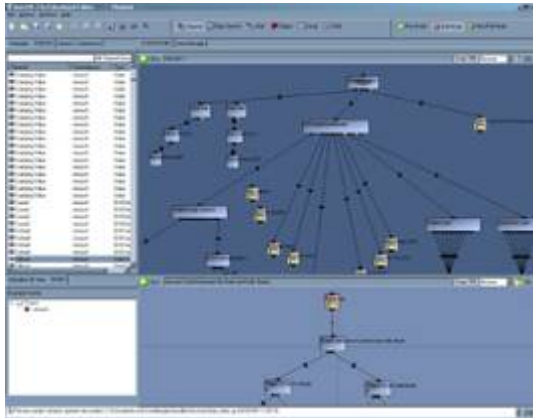
## 1<sup>st</sup> test - sketching in the air

- pre-requisite for the sketch survey
- examination of 2d sketching for describing room perimeters, elevations and details without haptic feedback
- carried out in the office as well as on site
- test equipment - data glasses w/ camera, data glove, test software module



quality satisfactory for sketching purposes

# software concept based upon ar



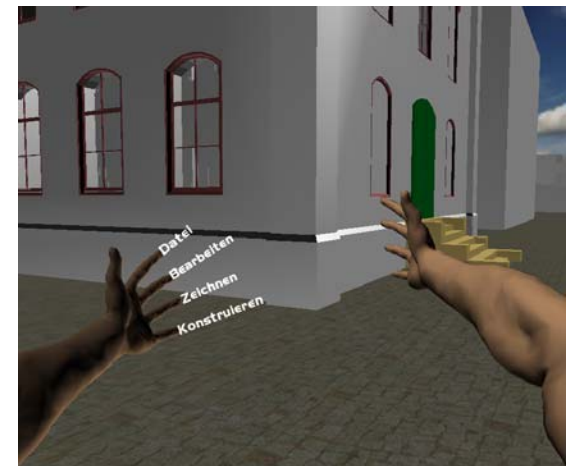
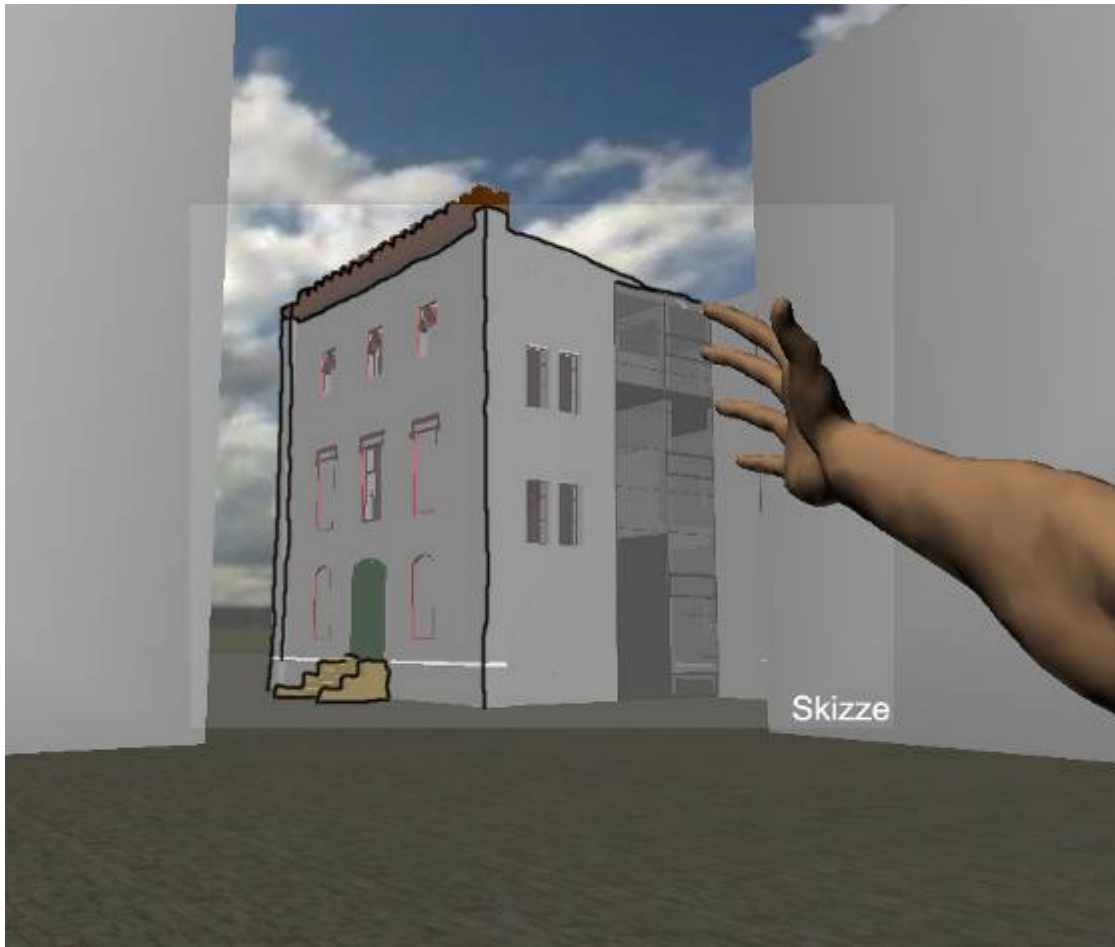
## visualization of hci and interactions

- initial testing – using a interactive programming environment for games (quest 3d vr edition)
- simulation of the user interfaces and interaction
- evaluation of the the acceptance of the design and menu system

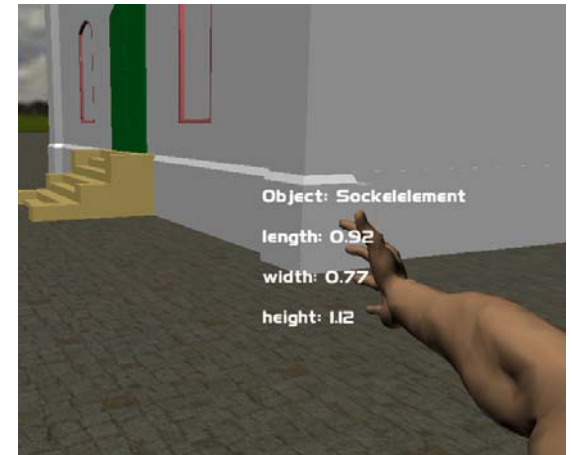
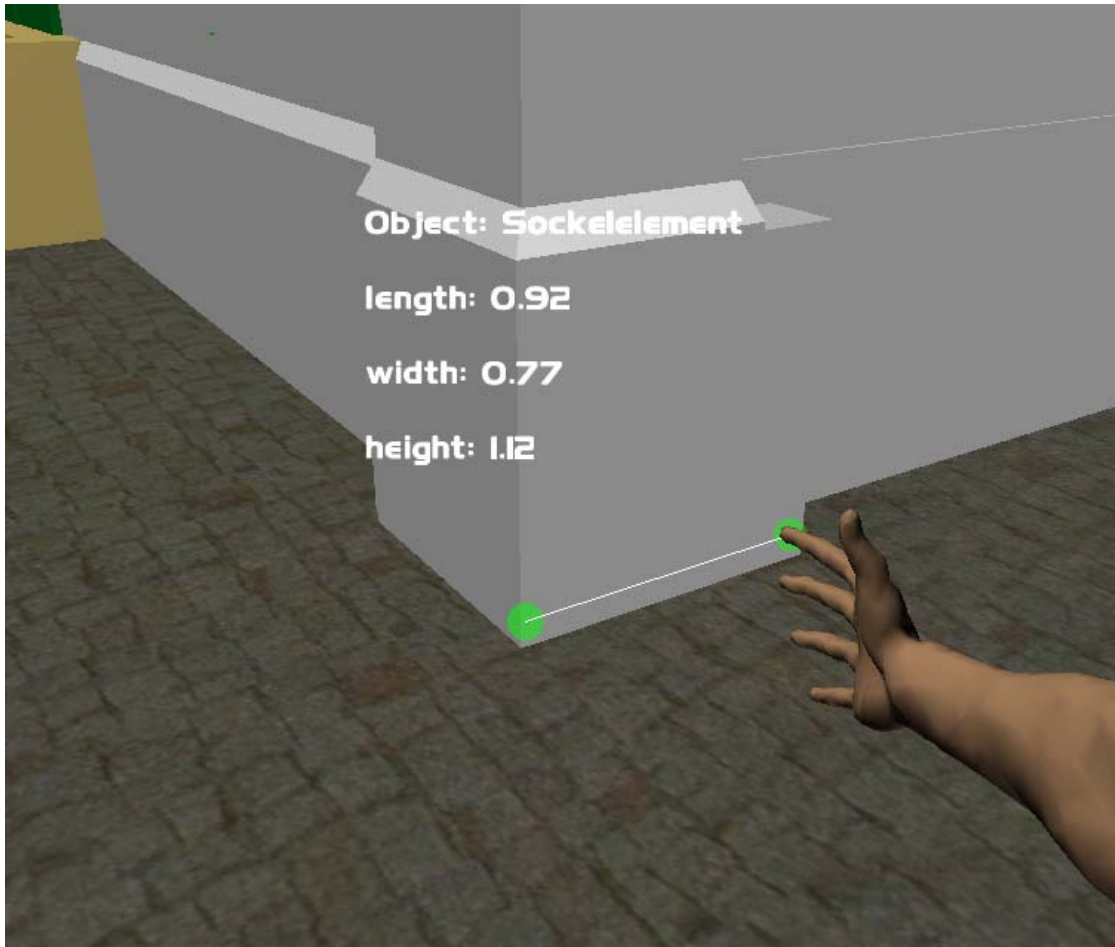


next step is the “real” implementation

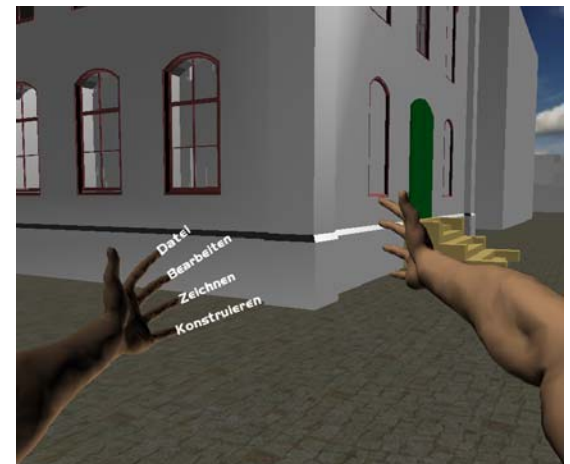
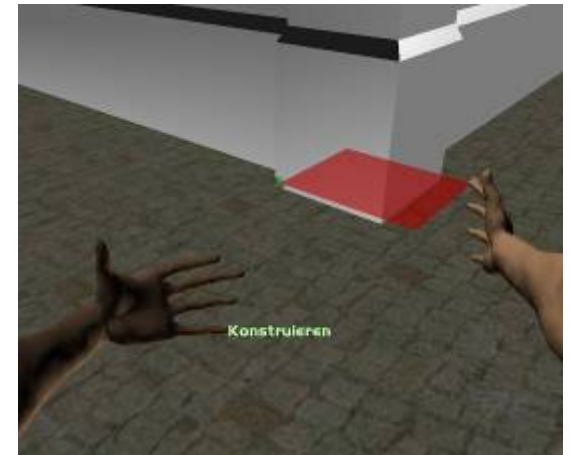
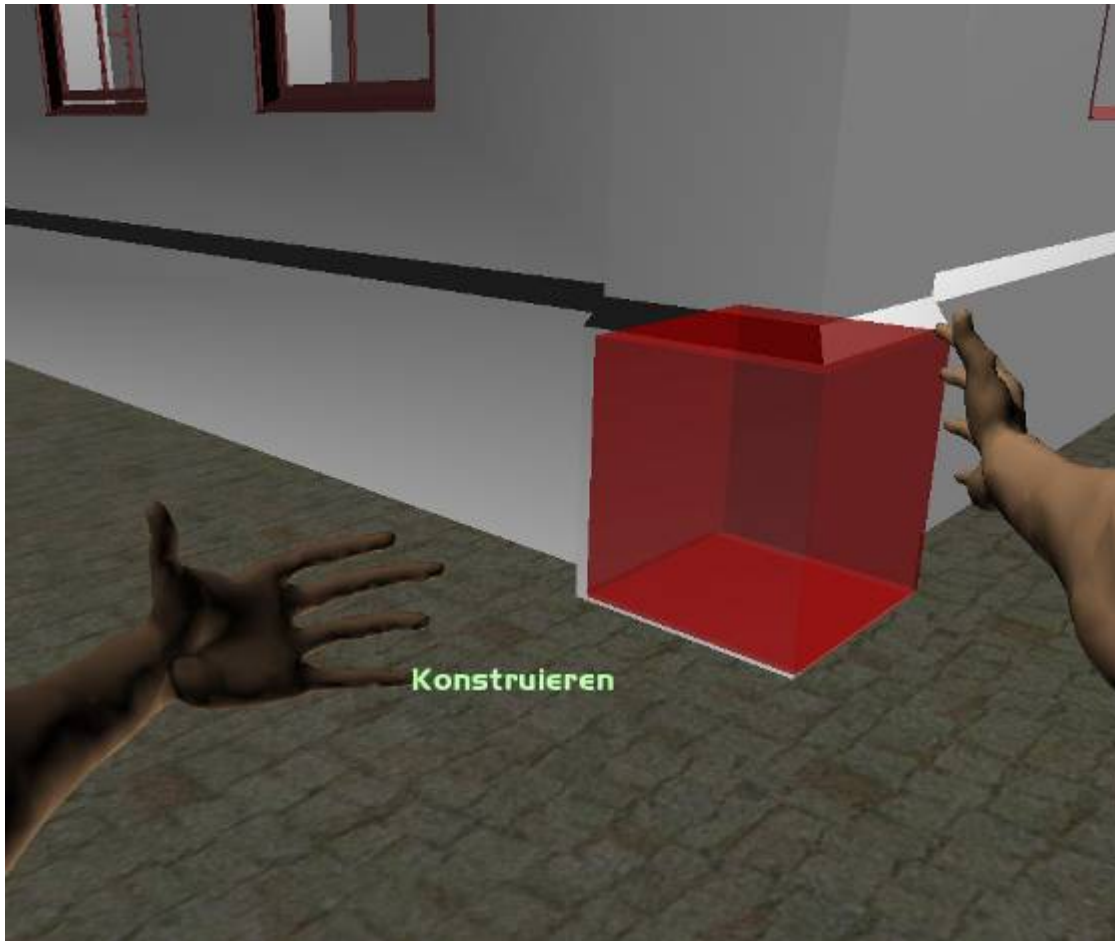
# software concept based upon ar



# software concept based upon ar



# software concept based upon ar



# further perspectives



## wearable computer

- further tests in real environments w/ retinal display
- evaluation of “new” input devices

<http://www.ics.forth.gr/~argyros/research/colortracking.htm>

<http://www.uni-weimar.de/medien/vr/index.html>



## software

- combination of the different api's
- implementation of the software tools
- evaluation of the software prototypes

# wearable computing on site...



**... it's no longer a dream**

<http://www.lokpower.de/personliches/erfindungen/erfindungen.htm>

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