MULTI-VIS

Towards a multi-modal visualisation environment for medical image analysis

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Outline

- Introduction
- Motivation of this project
- Combining desktop and virtual realities:
  - desktop in VR
  - desktop & VR
- Applying adaptive capabilities
- Future plans

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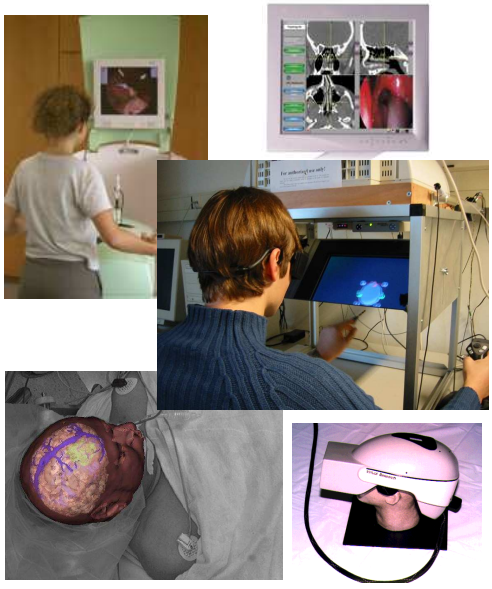
Available technological solutions

Desktop systems

Virtual Reality (VR)
- semi-immersive
- fully-immersive
- hand-immersed

Augmented Reality (AR)

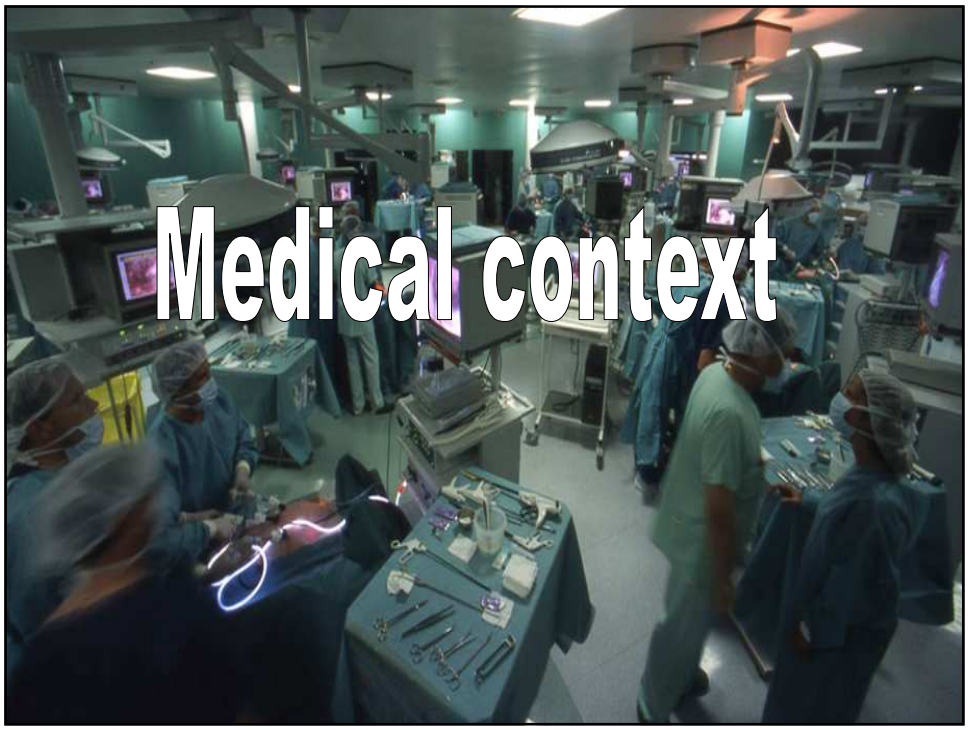
Mixed Reality (MR)



projection modality (Raskin 2000)

Problems and concerns

- Different projection modalities have not been sufficiently compared yet
- There is a lack of knowledge of how to evaluate virtual environments
- Modality allocation: Which projection modality or combination of modalities suits the best to perform particular actions?
- Selection of optimal input/output devices for each projection modality
- Integration of the information from parallel input modes and/or signals for complex modalities
- Human factors have not been sufficiently addressed
- Users' preferences for different projection modalities have not been investigated yet



Contextual analysis

Medical diagnosis & treatment planning for vascular disorders

- Users and tasks
- Environment
  - Social and organisational
  - Physical
  - Technical

Ethnographic / Contextual Inquiry approach

- Actual context
- Interviews & Observation
- Exploratory

Clinical context
9 Dutch Hospitals
(7 interventional radiologists, 7 vascular surgeons)

Results of Contextual Analysis

Users & tasks

Social & Organizational
- cooperation

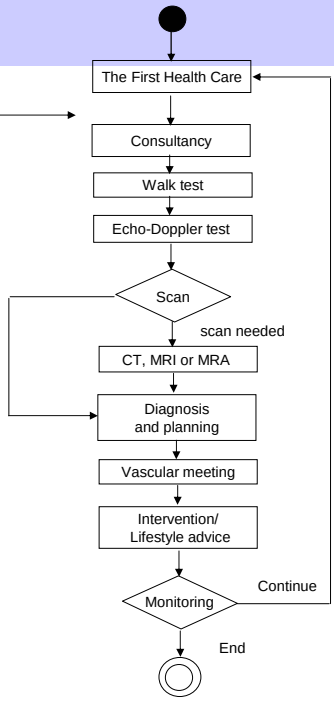
Physical space
- portability

Technological Integration
- data availability
- system compatibility

Efficiency
- automation
- added value

2D & 3D

Desktop or VR?



Desktop or VR?

Quick task-switching is required

Image resolution is crucial (anatomical details)

Performance is vital (real-time interactions)

A user primarily works alone

End-users are less inclined to work

Space/budget limits

'Sense of immersion' is important

3D stereoscopic representation adds to understanding/performance

Insight view is more vital than performance

Support of collaborative work

End-users are willing to learn

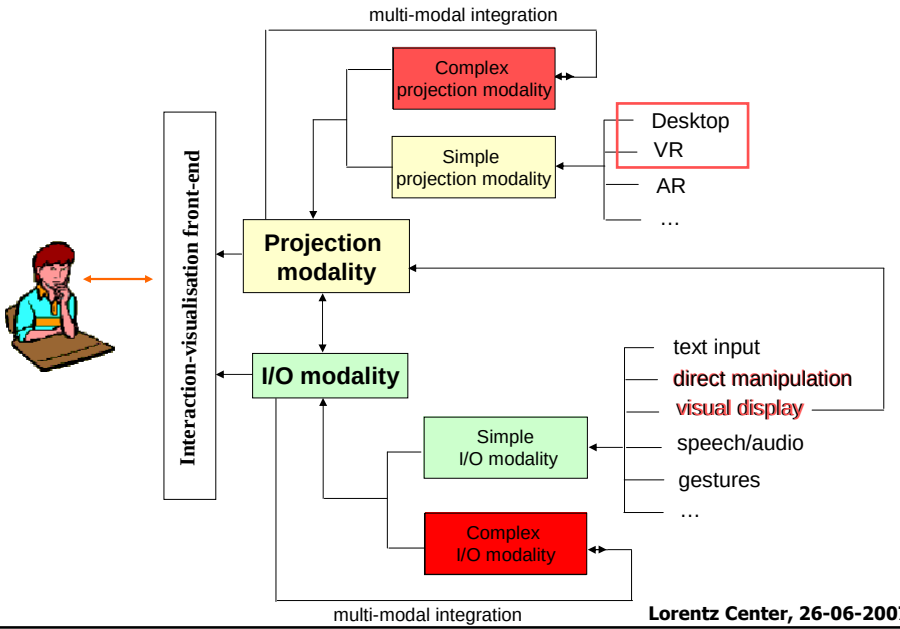
Enough space and budget

A multi-modal visualisation framework

Goal

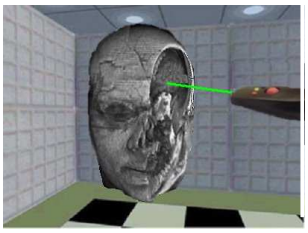
Develop an efficient integrated visualisation environment that combines 2D desktop and 3D virtual realities to assist image-based medical analysis

Multi-modality

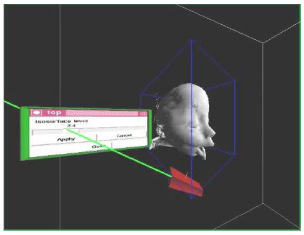


Combining desktop and VR

Desktop in VR



Clipping



GUI "absorption"

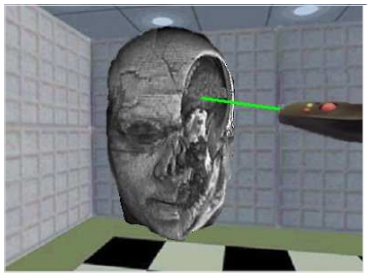
Desktop & VR

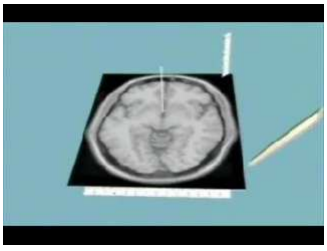
Mixed Realities

Alternating desktop/VR

Desktop in VR (1)

Approach of high-resolution clipping/cutting planes





\+ provides insight view of a high-resolution

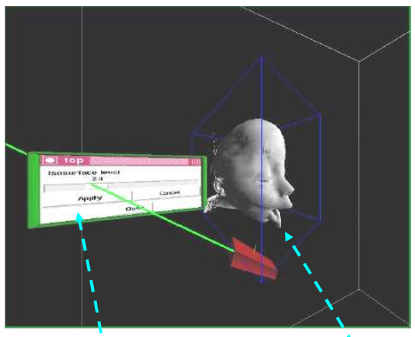
\- spatial interaction tasks only

\- performance dependent on coordination and motor skills

\- real-time interaction in VR can be difficult

Desktop in VR (2)

Absorption of 2D GUIs in immersive VR



2D desktop

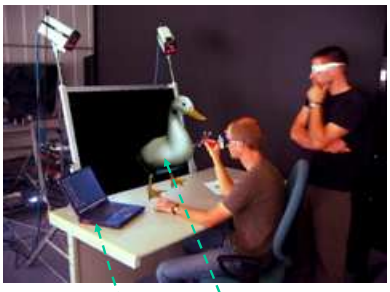
3D VR

+ allows to use the functionality of already existing 2D applications in VR
+ traditional GUI design, does not require extra knowledge

- regular switches between a wand and a keyboard
- user-input requires coordination and motor skills
- navigation and orientation might be difficult if many desktop applications are open and used simultaneously

Desktop and VR: simultaneous support

Combining desktop and VR in a Mixed Reality space



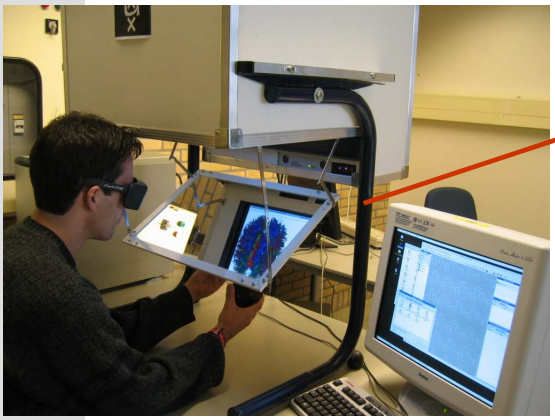
+ easy information sharing
+ allows task-splitting

- putting up/down input devices and 3D glasses
- constant changes of a position

Desktop + Virtual Reality

Mixed Reality

Desktop and VR: simultaneous setup-1

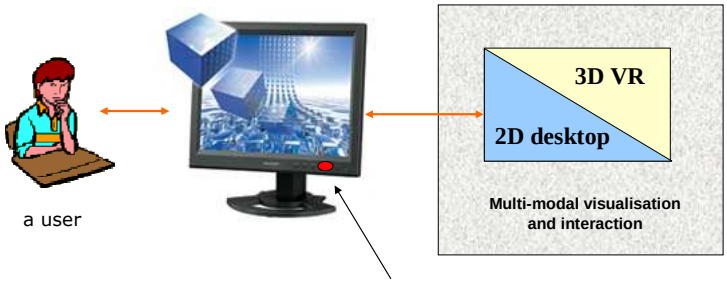


Personal Space Station
a workbench approach

available at SVVR Lab

Desktop and VR: sequential support

Design consideration

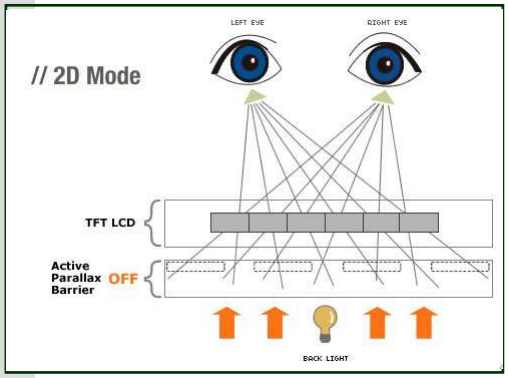


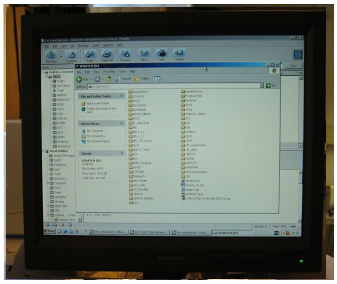
+ no need for 3D glasses
+ no position changes
+ a single set of I/O devices

- information sharing might be difficult for some people
- the user's position has to be fixed

Desktop and VR: sequential setup-2

Alternating desktop and VR





available at SVVR Lab

Sharp LL-151-3D 2D/3D switchable autosteroscopic monitor

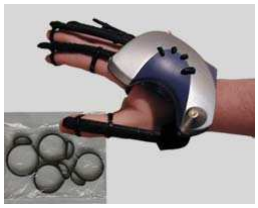
Desktop and VR: interaction devices

desktop

VR

Simultaneous set-up

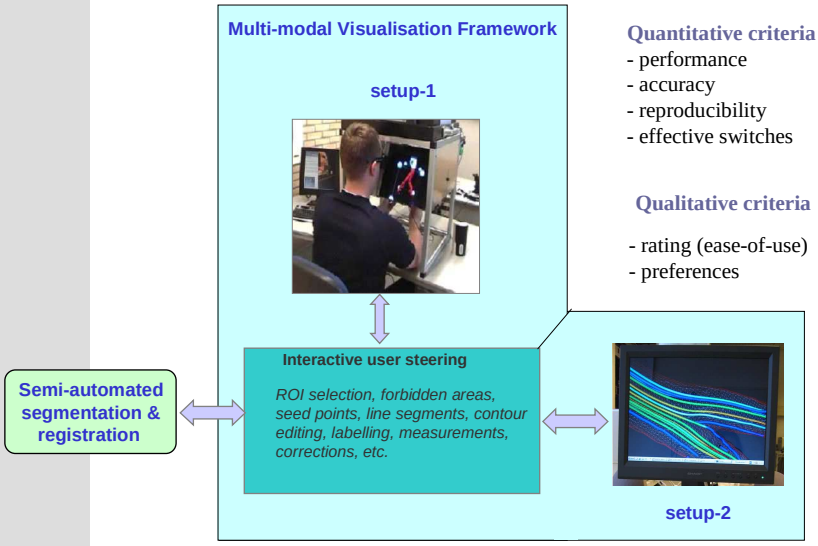
desktop/VR



Essential Reality
P5 Controller

Sequential set-up

Simultaneous vs. sequential - ?



Quantitative criteria
- performance
- accuracy
- reproducibility
- effective switches

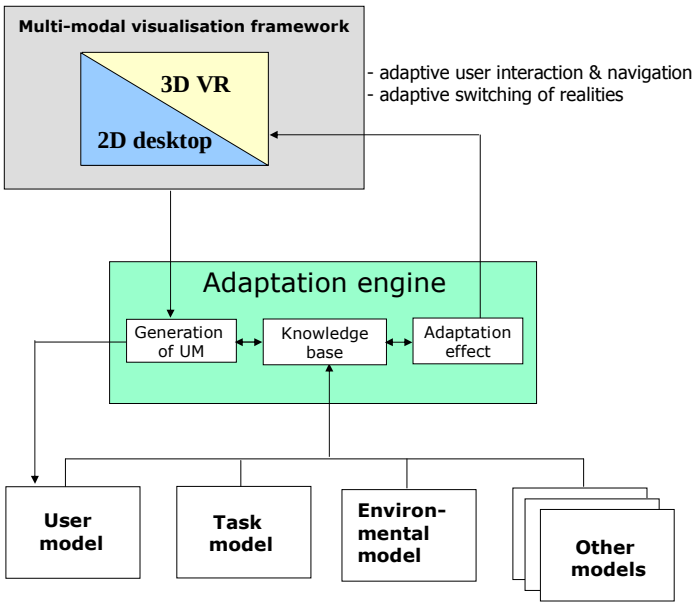
Qualitative criteria
- rating (ease-of-use)
- preferences

Adaptive multi-modal visualisation and interaction

Goal

Develop and apply adaptive multi-modal visualisation and HCI methods to facilitate image-based analysis of medical data in a combined reality exploration environment

Making a multi-modal visualisation environment adaptive



User and task analysis

- users' preferences and values
- personal, social and cultural characteristics of users
- goals (general and specific) and how users achieve them
- users' knowledge and experience
- problems users would like to see the system solve
- tasks to be performed with the system
- other tasks that must be performed while using the system
- physical environment

Influence of human factors

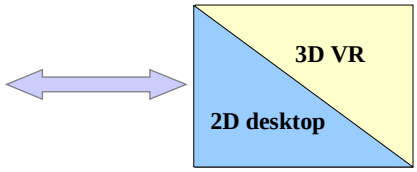
User

- DEMOGRAPHIC FACTORS
  - Age
  - Gender
- PSYCHOLOGICAL FACTORS
  - Locus of control
  - Learning abilities
  - Attitude to innovations
- PSYCHOMOTOR FACTORS
  - Attention focus
  - Stress factors
- COGNITIVE FACTORS
  - Perceptual style
  - Verbal and non-verbal IQs
  - Cognitive strategy
- MOTIVATION
  - Needs
  - Tasks
  - Expectations
- EXPERTISE
  - Professional skills
  - Adaptation level (system experience)
- PREFERENCES
  - Interface layout
  - Specific situations
  - Customs

Task-dependency of user preferences

Semi-automated segmentation & registration

- selection of the region of interest, forbidden areas
- specification of seed points, line segments
- contour editing
- labelling



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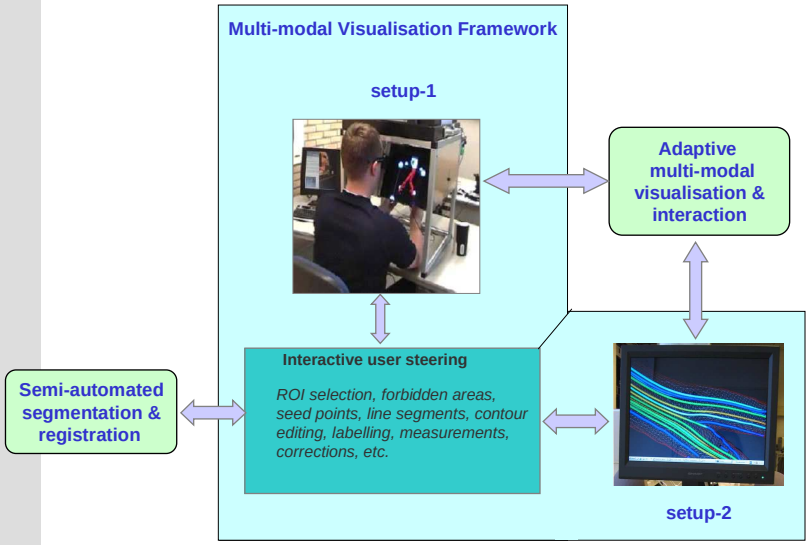
Simultaneous vs. sequential - ?



Future work

- Finish development of sequential and simultaneous multi-modal setups
- Conduct contextual analysis to define a trajectory of interactive exploration tasks related to medical segmentation and registration
- Develop metrics and guidelines for the evaluation of virtual and mixed reality systems
- Compare effectiveness of multi-modal setups to perform semi-automated segmentation tasks (iteratively)
- Develop methods to provide adaptive user interaction and navigation within a combined reality visualisation environment and methods to support dynamical alternating realities
- Investigate task-dependency of people's preferences for different projection modalities and potential influence of personal user characteristics on these preferences
- Develop task and user models and apply them as criteria for dynamic switching of realities
- Compare effectiveness of adaptive multi-modal setups

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Related publications

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