

Diploma Thesis

Attentive User Interfaces for DWARF

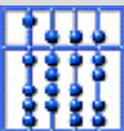
Car Augmented Reality Project

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Aufgabesteller: Prof. Gudrun Klinker, Ph.D.

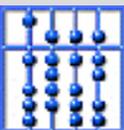
Betreuer: Christian Sandor

Thursday, 13 May 2004



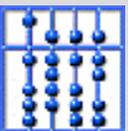
Summary

- Adapt JANUS eye tracker for the use with DWARF.
- Eye tracking including application context.
- Monitoring of eye gaze in real time.
- Implement visionary UI's for demo sessions with the client.
- Find appropriate model of attention that can be implemented.



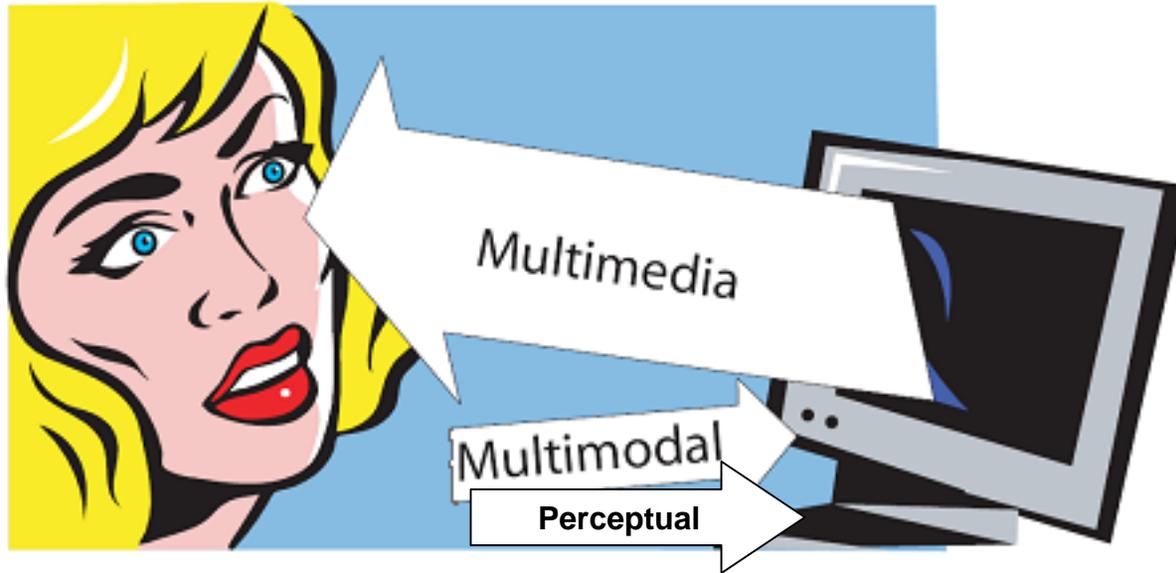
Outline

- Attention
- Scenario
- Related Work
- Implementation
- Conclusion and Future work

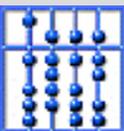


Problem Statement

- Problem: Input from user and output from computer are not in balance.

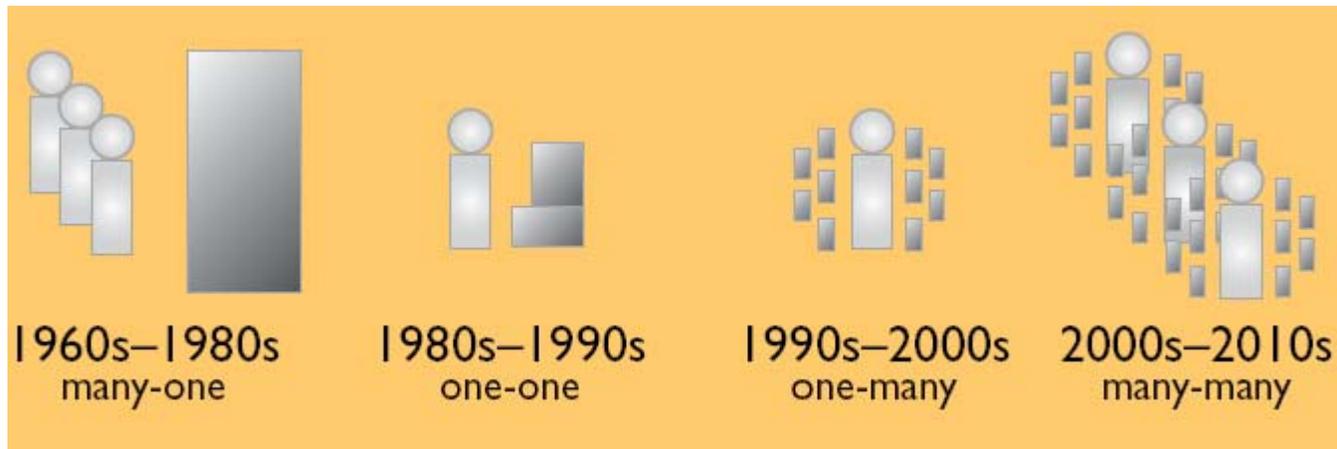


- Proposed solution: Open additional, perceptual input channels.

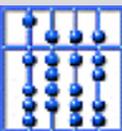


Problem Statement

- One user surrounded by multiple devices (e.g. PDA, cell phone, PC...) → many users surrounded by many devices.

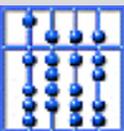


- How does the device know that it's being addressed?
- Proposed solution: Use Attentive User Interfaces.



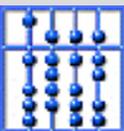
Attentive User Interfaces (AUI)

- AUI's for personal computers developed for several years.
- AUI's for ubiquitous computers since 2003.
- AUI's are:
 - Computational interfaces that are sensitive to user's attention;
 - measure overt characteristics of user attention;
 - follow user's visual attention to detect context.
- Interacting with groups of computers
 - Visual attention to activate communication channels.



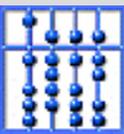
Problem Domain

- Automotive environments.



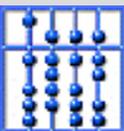
Desktop vs. Automotive Environments

- Desktop
 - Computer is in focus of attention.
 - All tasks are performed using computer.
- Automotive
 - Driving the car is the primary task.
 - Computer gains only bursts of attention.
 - No keyboard and mouse.



Attention

- “*When the things are apprehended by the senses, the number of them that can be attended to at once is small, ‘Pluribus intentus, minor est ad singula sensus.’*”
--William James
- “Many things filtered into few for perception”.
- Attention is the faculty that does the filtering.
- But, we can attend to many things simultaneously...
...sometimes.

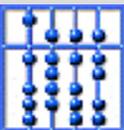


Limitation of visual attention

- Many things filtered into one for visual perception.

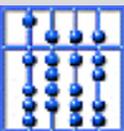


<http://www.funone.com>



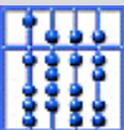
Limitation of visual attention II

- We can attend to only one thing at a time.



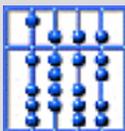
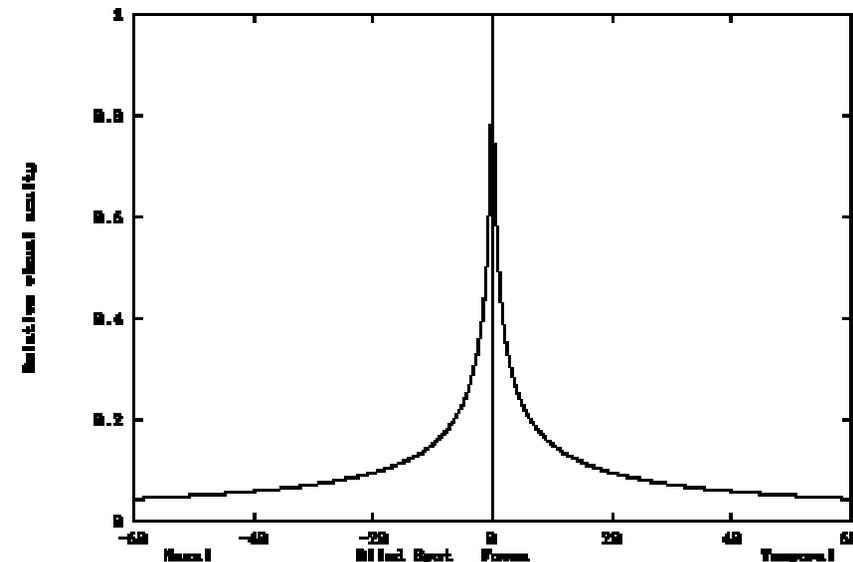
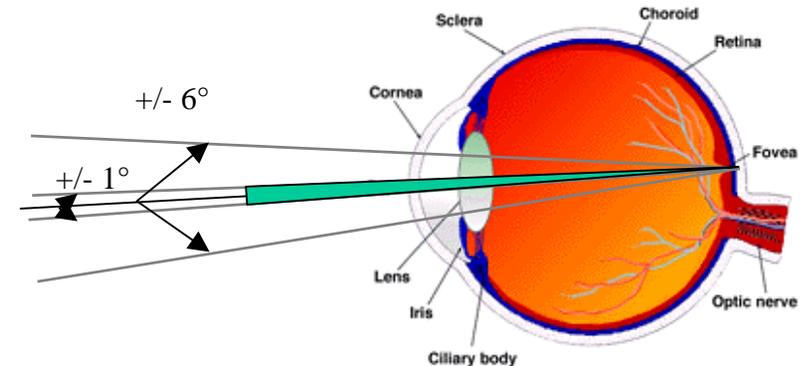
Tracking Visual Attention

- We use Wilhelm Wundt's „Blickpunkt“ and „Blickfeld“ theory to model visual attention.
 - There is a relation between visual attention and eye movements:
 - they share same cortical area.
 - „where“ and „what“ theory.
- we can track visual attention with eye tracking systems.

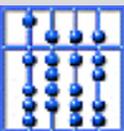
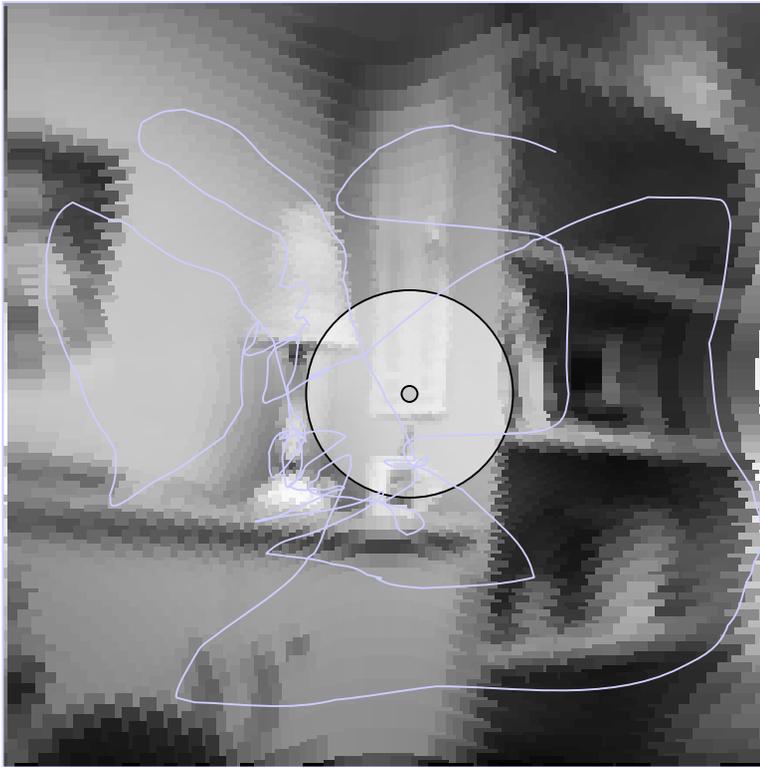


Foveal and Parafoveal area

- Our model goes well with the physiology of the eye.
- The visual system strongly emphasizes the details in the center of view → fovea.
- Fovea → “Blickpunkt“; peripheral field of view → „Blickfeld“.
- Parafoveal area just outside the foveal area ($\pm 6^\circ$ of visual angle).

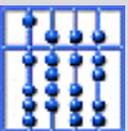


Spotlight of Attention



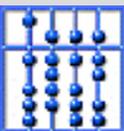
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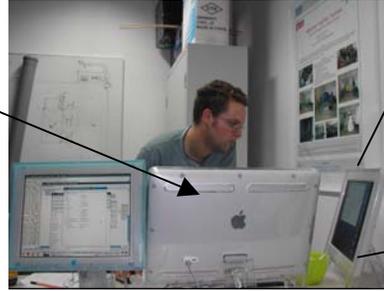
Scenario

- **Scenario: telephoneRings**
- **Actor instances:** Nico: Developer, Max: Driver, CID: AUI
- **Flow of Events:**
 1. Max drives a tangible car through a virtual environment.
 2. Nico uses controller application that simulates the context of the CID to initiate phone call event. He observes the deployment of Max's attention on control display.
 3. CID responds with horizontal movements of the telephone icon on CID display.
 4. Max notices that something is moving in his peripheral field of view and he steers his Eye Direction to see what is happening.
 5. As Max turns his head towards the CID, it stops the movement of the icon and sets the display to the telephone menu.
 6. Max can easily make out what is going on. He picks up the call.



Setup

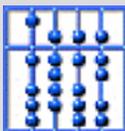
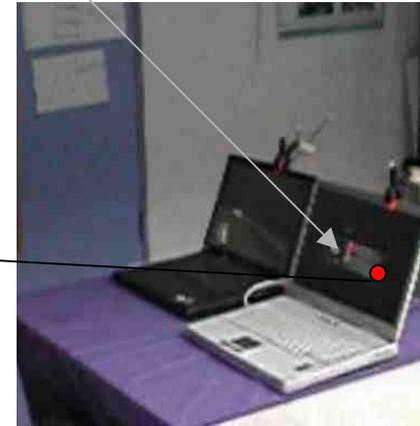
- Monitoring and Manual Context



- Gaze tracking

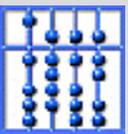


- CID



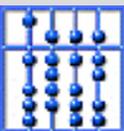
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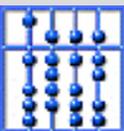
Related work

- Inspired by designers and the vision of Ubiquitous Computing and foreground vs. background Tangible User Interfaces.
- Mies van der Rohe: „Less is more“.
- „Look-To-Talk“ - use of eye contact to open communication channels.



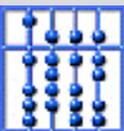
Related work

- Roel Vertegaal at Queens University
- Number of prototypes:
 - eyeCONTACT
 - eyePLIANCES
 - auraMIRROR,
 - eyePHONE
 - ...and many others.



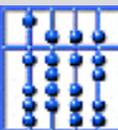
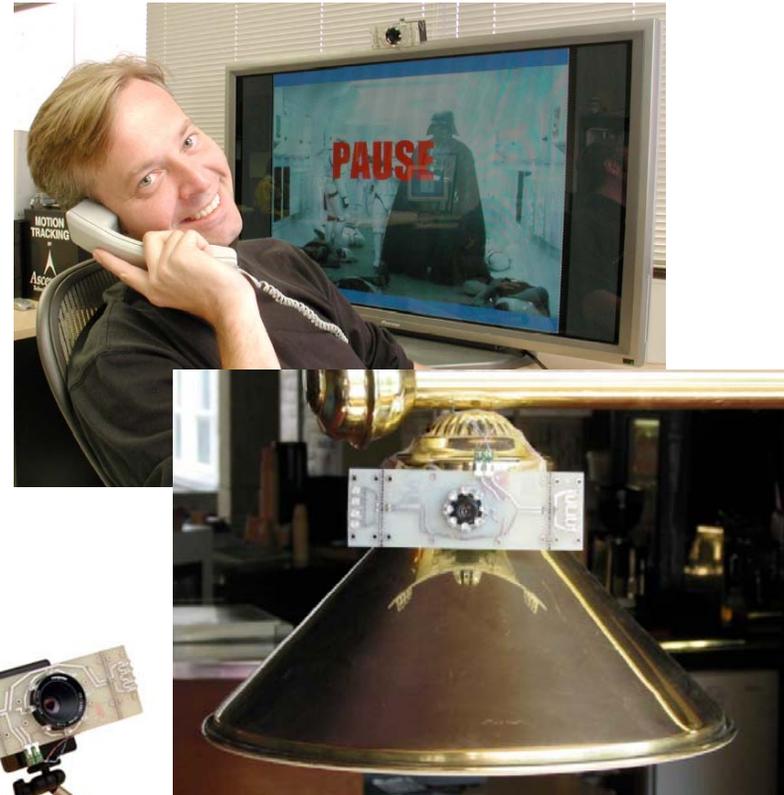
eyeCONTACT

- Developed at Almaden IBM Center.
- Finds pupils within its field of view.
- Detects collision of the eye direction and the camera.
- Used in all other prototypes as an ubiquitous eye tracker.



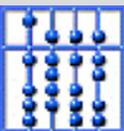
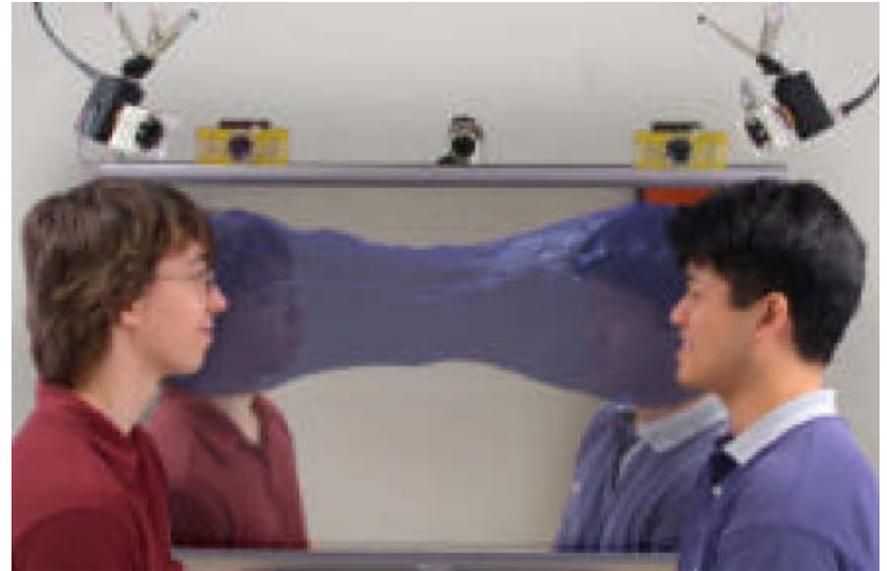
eyePLIANCES

- Ubiquitous devices that detect and respond to human visual attention using eye contact sensors.
- Receive implicit input (eye gaze) and respond by opening communication channels.
- Example: Attentive TV, Attentive Lamp.



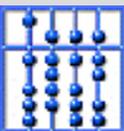
auraMIRROR

- Artistical visualization of attention.
- Representation of attention negotiation in small groups.
- Limited to only two users.



eyePHONE

- Physical proxy of a remote individual.
- Initiates mediated conversation through eye contact.
- Senses and conveys attention using an eyeCONTACT device and a pair of actuated eyeballs.

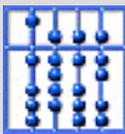


eyePHONE

- Peter's table

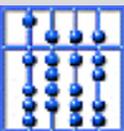


- Max's table



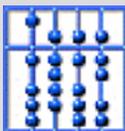
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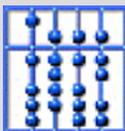
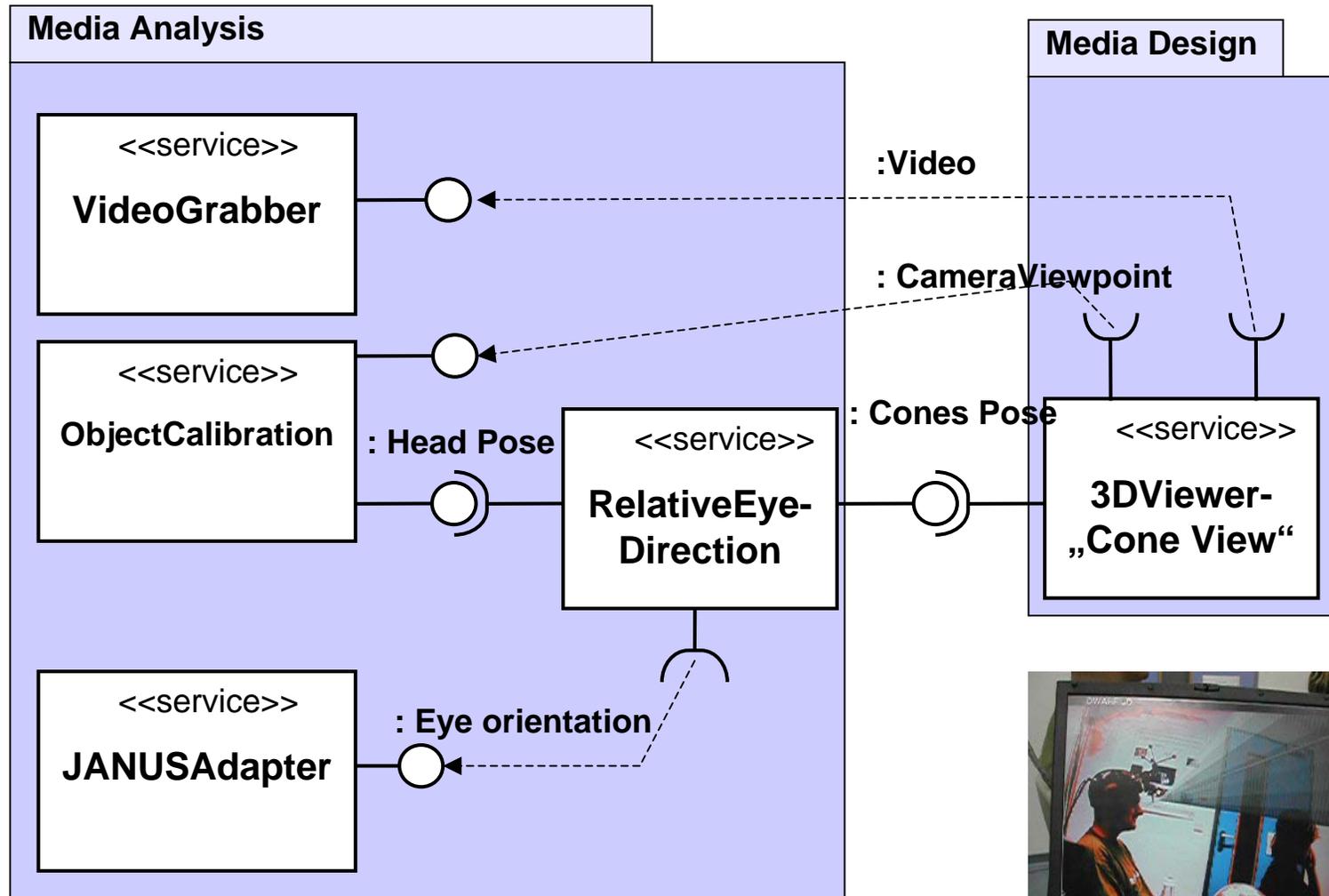


Implementation

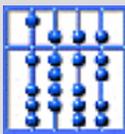
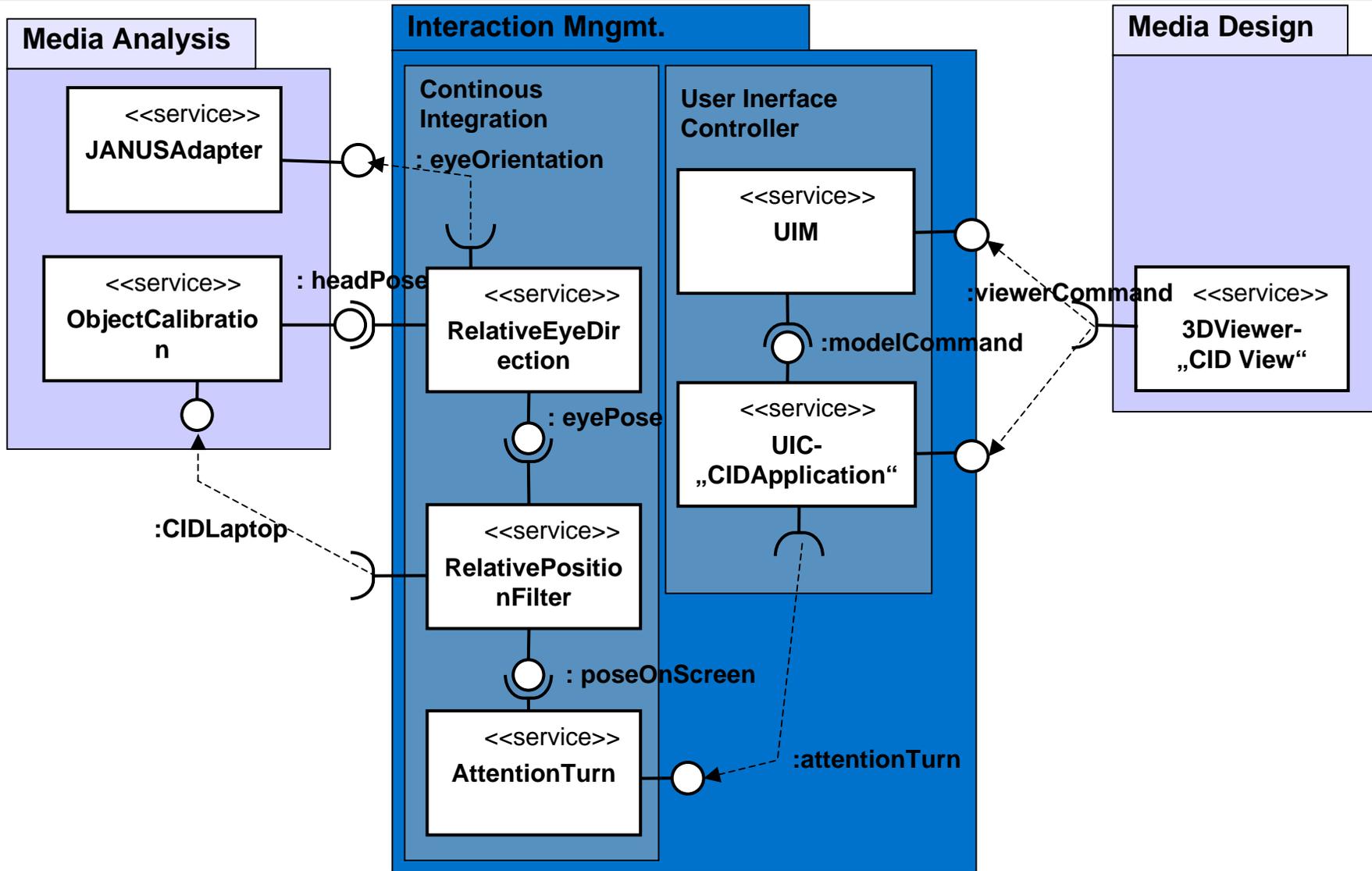
- Implemented all components as DWARF services.
- Reused existing services: ARTTracker, ObjectCalibration, Middleware, 3DViewer, UIC (implemented by Otmar during CAR project).
- Implemented new services:
 - **UIModel**: used to maintain the state of objects represented in viewer (in combination with new UIC and Viewer → MVC Architecture)
 - **JANUSAdapter**: adapter for JANUS eye tracker
 - **RelativeEyeDirection**: calculates the pose of eye gaze in 3D.
 - **AttentionTurn**: generates a discrete event every time gaze enters the display.
- Two applications: Cone view and Central Information Display AUI (CID).



System Decomposition – Cone View



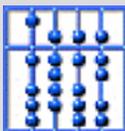
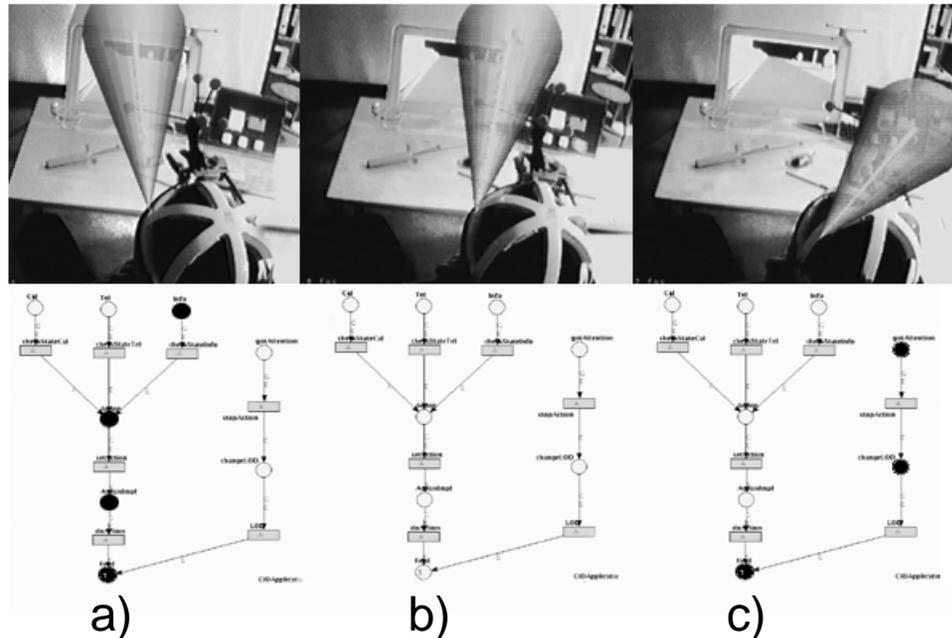
System Decomposition - CID



CID Application

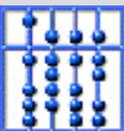
- Flow of events:

- Developer initiates an event in the ManualCtxt.
- UIC remains idle; CID performs an action to attract the user's attention.
- User steers his attention toward CID; UIC gets an AttentionTurn event and notifies the CID, which displays a corresponding dialogue.



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Conclusion

- We presented a monitoring application that can be used to evaluate different UI's and devices.
- We can monitor the deployment of the attention within the application context.

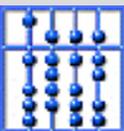


Eye-camera video

vs.

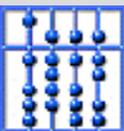


Virtual Cones



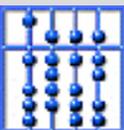
Conclusion II

- Attention: from model to application.
- Popularity of ubiquitous computing and mobile, wireless devices requires new interaction techniques → AUI's.
- AUI's that sense user's attention to open communication channels.
- Virtual cocktail party effect.



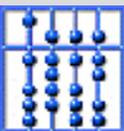
Future Work

- Research the usability of our monitoring application together with LfE.
- Use of cheap, ubiquitous, non-obtrusive, wearable eye tracking systems like eyeCONTACT.
- Improve the quality of developed services (they were implemented under pressure).
- Develop more advanced attention management (machine learning, Bayesian networks).

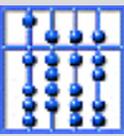


Thank you for your attention...

...questions?



Questions?



Divided Attention (Time Sharing)

- Performing more than one task simultaneously.
- Mechanisms: Schedule, Switch, Resource demand and allocation.
- Data-Limited vs. Resource-Limited.
- Single Resource Theory
 - one Pool of resources
 - one task performs better on expense of other task.
- Multiple Resources Theory
 - Processing stages
 - Modalities
 - Codes

