



Intelligent Rooms

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Overview



- Motivation
- Design Principles
- Examples
 - The Intelligent Room Project
 - The Self-Organizing Desk

Motivation



- Bring computation into the real world
- Allow people to interact with computational systems the way they would with other people
- Rather than make computer-interfaces for people, make people-interfaces for computers

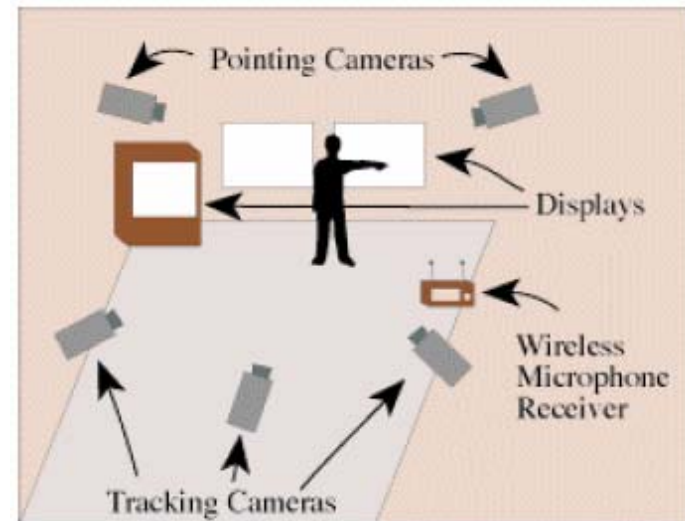
Design Principles



- Why this isn't Ubiquitous Computing:
 - Unencumbered interaction with non-augmented non-computational objects
 - No high-tech gadgetry attached to the human's body
- A.I.-Approach: Use of synergy to allow imperfect modalities to reinforce and support each other

An Example: The Intelligent Room Project

- MIT Artificial Intelligence Lab
- Specifications:
 - 27' x 27'
 - 50 distinct and intercommunicating software agents
 - 12 steerable video cameras
 - Computer controlled devices (VCR's, LCD projectors, lights, curtains, audio systems, etc.)
 - Conference area
 - Separated area for computation and debugging



The Intelligent Room Project: Scenarios

- **Scenario 1:
Command Center for planning
hurricane disaster relief in the
Caribbean**

User: *"Computer, <pause> stay awake."*

[The room will now listen for utterances without requiring they be prefaced by the word *Computer.*]

User: *"Show me the Virgin Islands."*

Room: *"I'm a showing the map right next to you."*

[Room shows map on video display *closest* to the user.]

User: [now points at St. Thomas.] *"Zoom in. How far away is Hurricane Marilyn?"*

Room: *"The distance between Hurricane Marilyn and the city of Charlotte Amalie located in St. Thomas is 145 miles."*

User: *"Where's the nearest disaster field office?"*

[Room highlights them on the map.]

Room: *"The St. Thomas disaster field office is located one mile outside of Charlotte Amalie. Michael, there is a new weather forecast available. Do you want to see it?"*

User: *"Yes, show me the satellite image."*

- **Scenario 2:
Combination of home/office**

I walk into Hal¹ and lie down on the sofa after shutting the door.

Hal sees this, dims the lights, closes the curtains, and then puts on Mozart softly in the background.

Hal then asks, "Michael, what time would you like to get up?"?

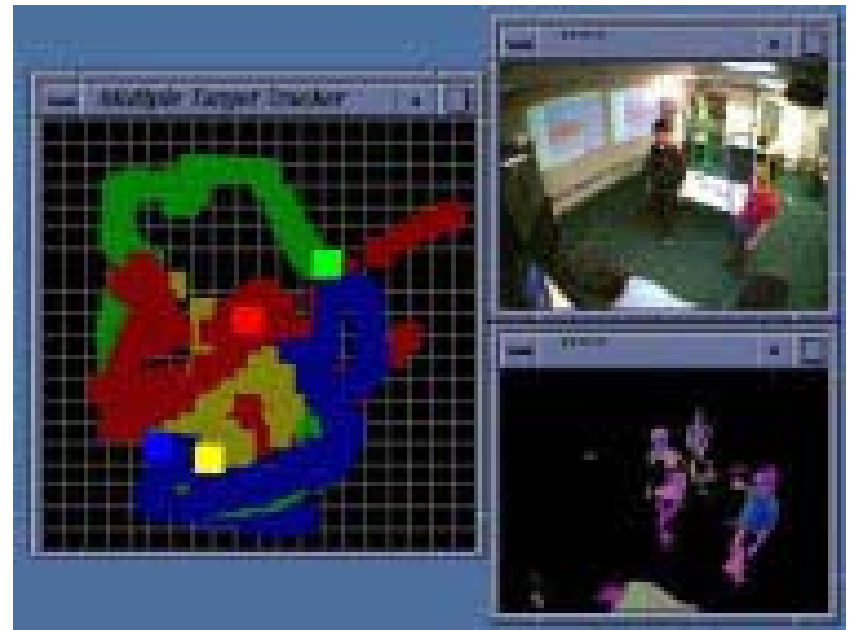
1) named after the computer in the movie, *2001: A space odyssey*

The Intelligent Room Project: Person Tracking - Overview

- Tracking of up to four people via two wall-mounted cameras (stereo vision)
 - Where?
 - How many?
 - What objects people are next to?
- Three steerable cameras for optimal views of people
- Synergetic effects

The Intelligent Room Project: Person Tracking – How does it work?

- Background segmentation
- 3D reconstruction through a neural network
- People are differentiated via color histograms
- Issues
 - Changing lighting conditions and shadows
 - Training of the neural network
 - Lack of robustness
 - Know-how



The Intelligent Room Project: Pointing

- Finger and laser pointing interaction
- Selection or moving of displayed screen objects
- Virtual whiteboard
 - Draw upon displayed image
 - Recall drawings and handwritings at anytime
 - Handwriting recognition in the future

The Intelligent Room Project: Interactive Table



- Recognition of hand-pointing gestures and newly placed documents on the table
- Assign particular functions to Post-It™ notes placed on the surface
- Self-Organizing Desk

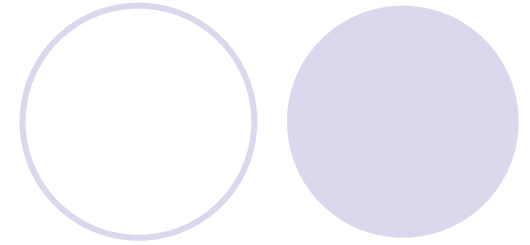
The Intelligent Room Project: Speech Interactions

- Unimodal speech interactions
 - No screens or keyboards
 - Not only a keyboard or mouse replacement
 - Multiple interactions simultaneously
- Wireless lapel microphones
- By default the room ignores spoken utterances and gives vocal responses only if necessary
- Two different speech recognition systems used parallel for improved robustness
- Issues:
 - Combinatorial increase in parsing time vs. accuracy and allowing people to express them freely (→ Specialized context-sensitive grammars)

Another Example: The Self-Organizing Desk

- Enhance a physical desktop with electronic information
- The Self-Organizing Desk should **remember**, **organize**, **update** and **manipulate** the information contained in the documents on the desk.

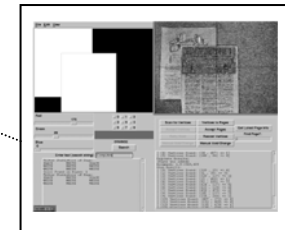
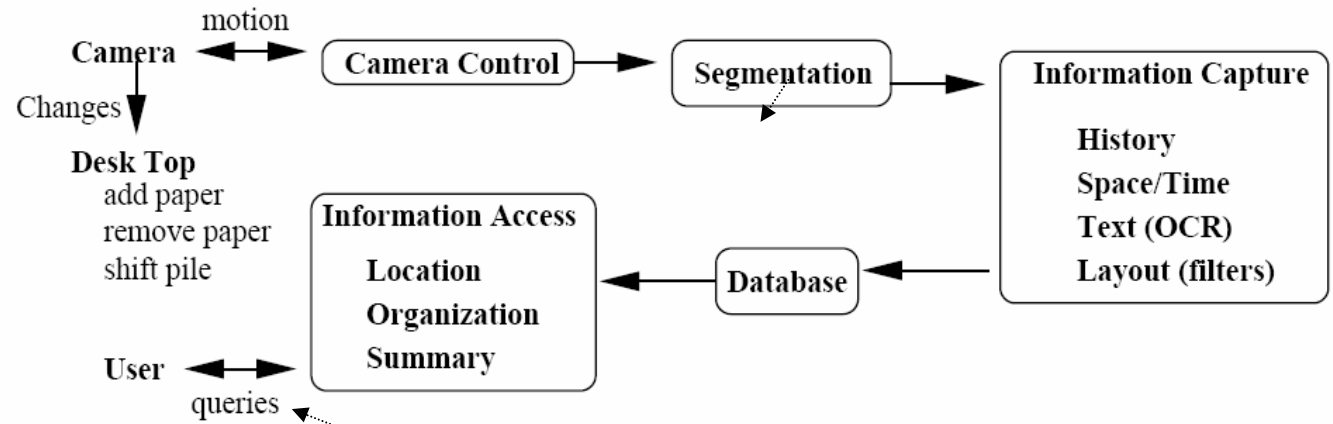
The Self-Organizing Desk: Specifications



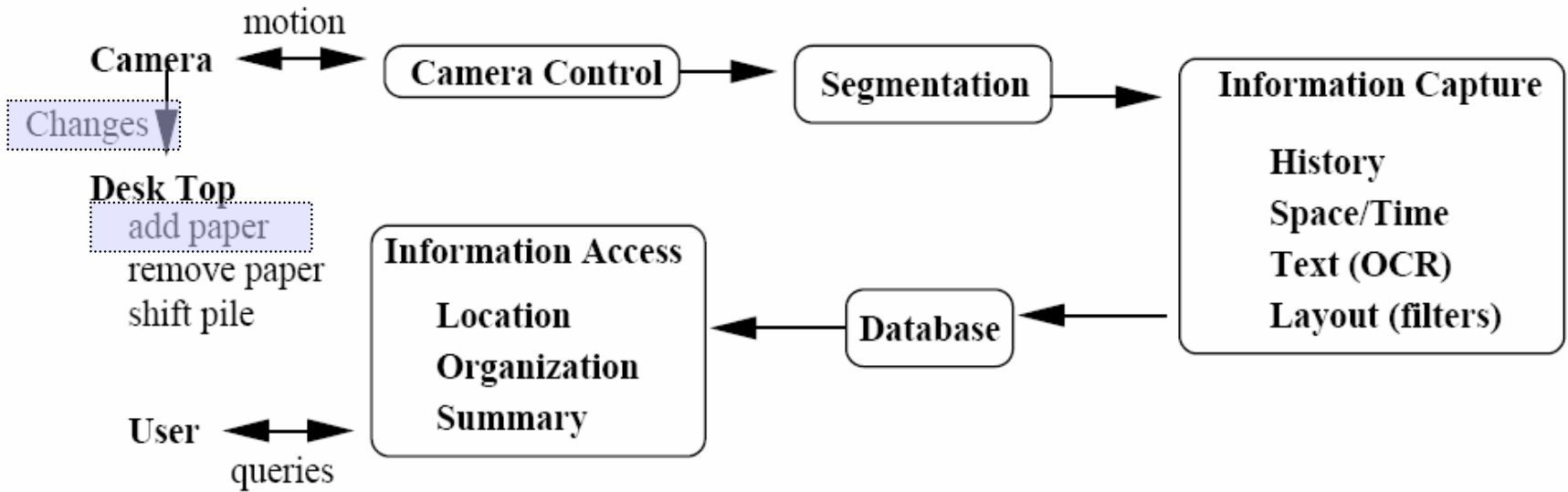
- Simple robot eye for surveying the desk
- Modules for...
 - ...smart information extraction (with camera)
 - ...representing the information in multiple views
 - ...user interaction

The Self-Organizing Desk: Operations

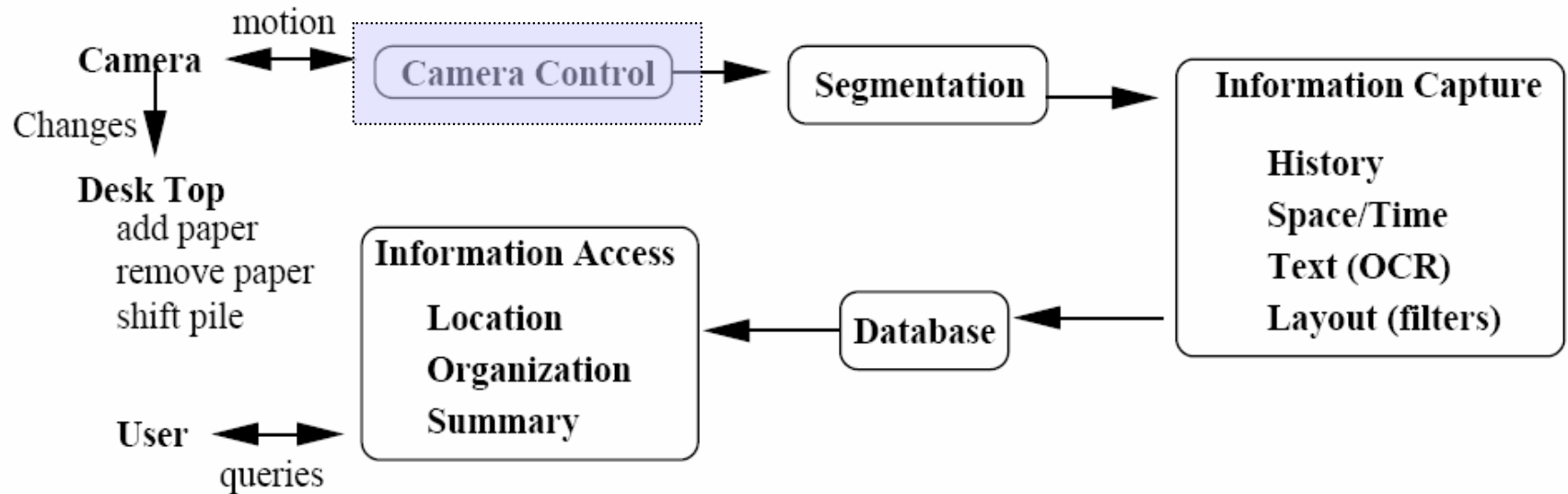
- Add
- Remove
- Shift
- Query (GUI)



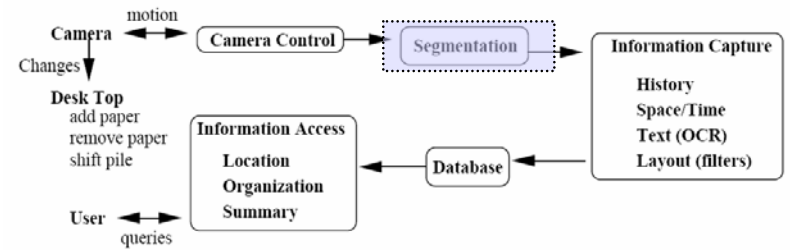
Example: Adding a paper



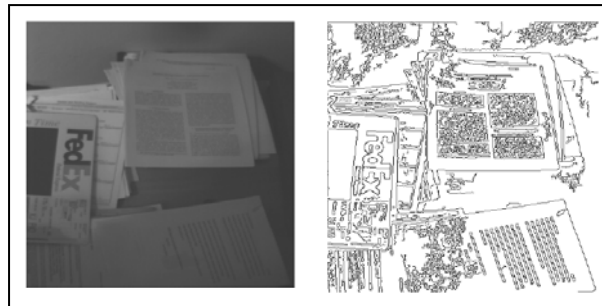
Example: Adding a paper II



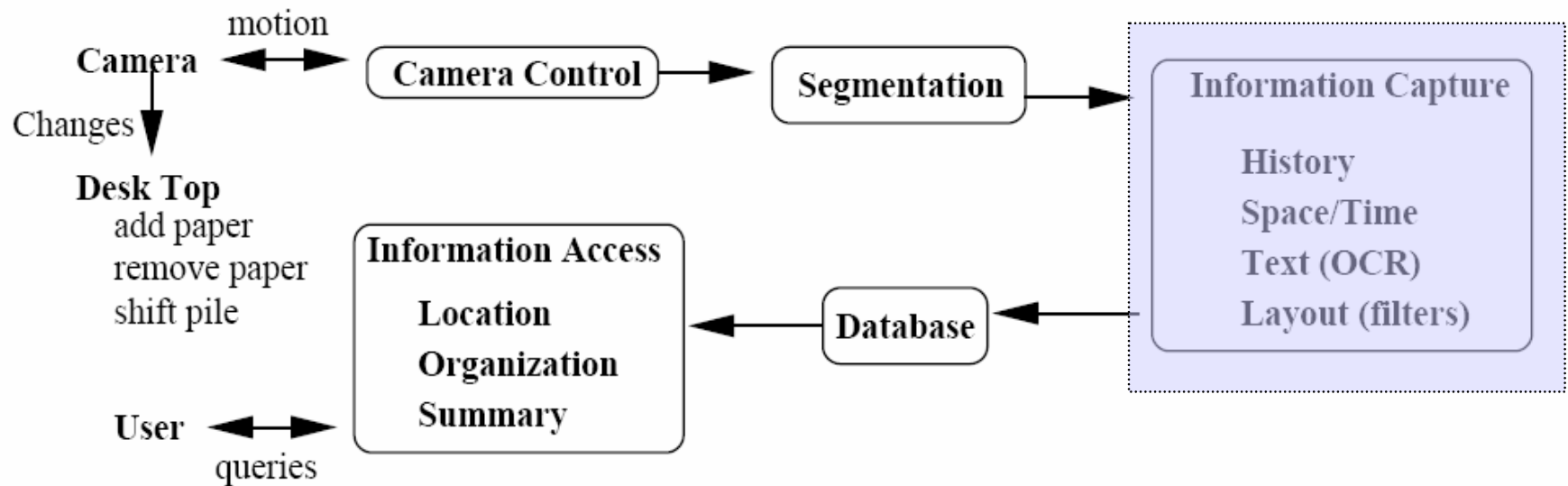
Segmentation III



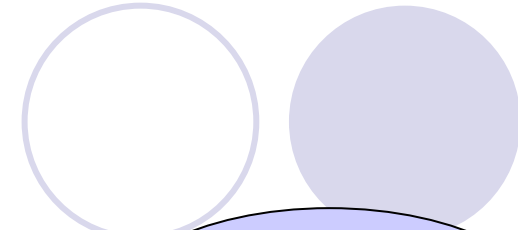
- Camera image resolution is too low
- Divide into n subimages, doing linear interpolation, combine and feed to OCR
- Helps improving OCR text recognition 60% → 90%



Example: Adding a paper IV



The Self-Organizing Desk: Visualization and Queries



Orange in upper right corner and distributed mobile robotics

Query by:

- Time
- Color
- Layout
- Text

Results:

- Full text
- position on desk
- Links to other documents (similarity)

File Edit View

Red 175 0 1 2 3 4 5 6 7 8

Green 89

Blue 0

ORANGE Search

Enter text (search string): Computers

Filter Statistics of Page:
BLACK WHITE BLACK
WHITE WHITE WHITE
WHITE WHITE WHITE
Color Found in Pages: 1
Filter Statistics of Page:
BLACK WHITE BLACK
WHITE WHITE WHITE
WHITE WHITE WHITE

Scan for Vertices Vertices to Pages
Accept Vertices Accept Pages Get Latest Page Info
Retry Scan Rescan Vertices Find Page?: 2
Manual Add/Change Manual Add/Change

```
[ (4) Vertices found: (24 , 407) => 1 ]  
[ (5) Vertices found: (143 , 64) => 4 ]  
Paginate Results:  
[Paper was added]  
Document: 1,0->319,409  
Scan Results:  
[ (0) Vertices found: (320 , 25) => 4 ]  
[ (1) Vertices found: (31 , 30) => 3 ]  
[ (2) Vertices found: (320 , 127) => 1 ]  
[ (3) Vertices found: (25 , 408) => 1 ]  
[ (4) Vertices found: (82 , 195) => 3 ]  
[ (5) Vertices found: (424 , 127) => 4 ]  
[ (6) Vertices found: (422 , 126) => 4 ]  
[ (7) Vertices found: (432 , 479) => 2 ]  
[ (8) Vertices found: (141 , 137) => 3 ]  
[ (9) Vertices found: (138 , 269) => 1 ]  
[ (10) Vertices found: (407 , 272) => 4 ]  
[ (11) Vertices found: (132 , 408) => 4 ]  
[ (12) Vertices found: (135 , 479) => 1 ]  
[ (13) Vertices found: (135 , 479) => 4 ]
```



Issues and future use

- OCR accuracy / camera resolution
- Recognition of page borders (overlapping)

Future:

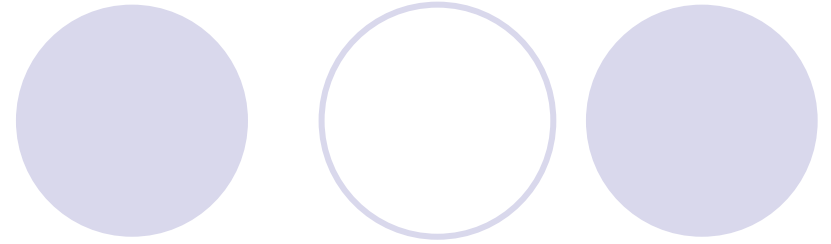
- Self-organizing filing cabinet
- Better filters

Conclusion

The slide features a decorative header with the word 'Conclusion' in a large, bold, black font. Above the text are five circles of varying shades of light purple and white, arranged horizontally. The first circle is solid light purple and partially overlaps the 'C' in 'Conclusion'. The second circle is white with a light purple outline and overlaps the 'o' and 'n'. The third circle is solid light purple. The fourth circle is white with a light purple outline. The fifth circle is solid light purple.

- No more need to preset systems
- Sensors or language to capture events instead of manual input
- Enables real world system that are context-sensitive
- Can be used in smart homes

It's up to you...



Questions?