RWTH Aachen
Media Computing Group

Post-Desktop User Interfaces Seminar

Map Navigation for Smartphones

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Contents

- **Introduction**
- **Navigation Techniques**
  (panning, zooming, multiple views, focus+context views)
- **Interaction Techniques**
  (keypad, motion, touch screen, voice)
- **Problems & Solutions**
  (desert fog, visualizing off-screen locations, mapping between the provided information and the real world)
- **Existing Applications**
  (features, classification, comparison, demo)
- **Questions & Answers**

What is a smartphone?

Map navigation for **smartphones**

- Introduction
- Navigation Techniques
- Interaction Techniques
- Problems & Solutions
- Existing Applications
- Q & A

Mobile phone vs Smartphone vs PDA

Introduction
Navigation Techniques
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Q & A

What is this all about?

Problem:

- Large information space
- Tiny display

Solutions:

- Multiple designs
- Adaptable user interface elements
- Navigation techniques

Navigation Techniques

Introduction

Navigation Techniques

Interaction Techniques

Problems & Solutions

Existing Applications

Q & A

- Panning Techniques
- Zooming Techniques
- Multiple Views
- Focus+Context Views
- Comparison of some Navigation Techniques

Panning - Sliding Window

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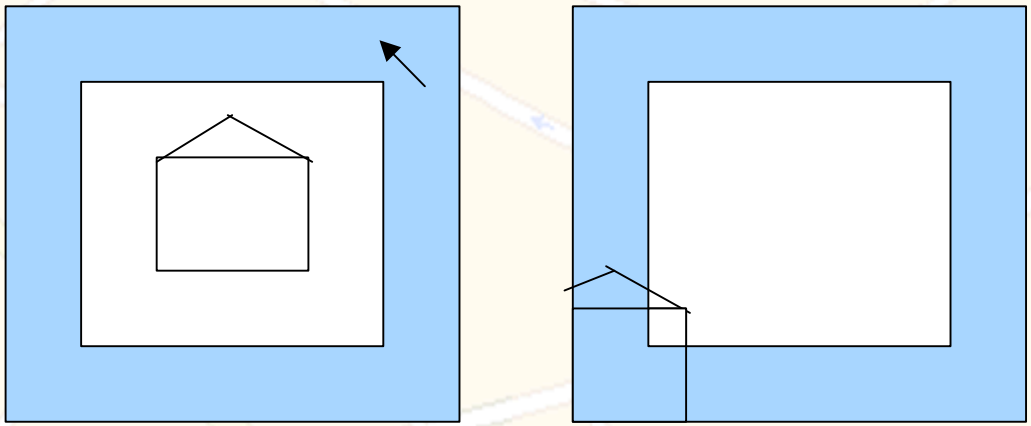
Panning by pointing to the edge of the view



+ Whole display area available for content
+ Limited pan speed control

- Requires a pointing device
- Interference with editable content

Panning - Arrows

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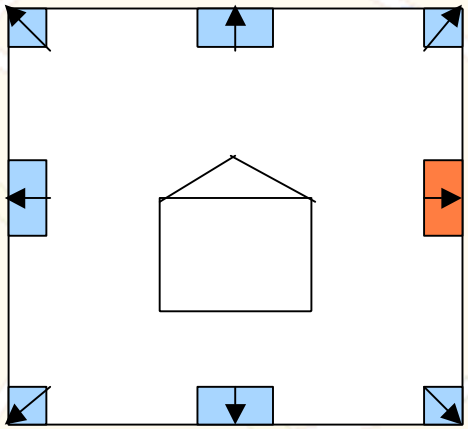
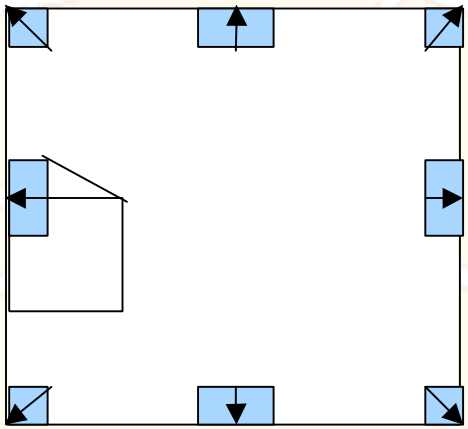
Panning by pressing an arrow



Press right arrow



+ No interference with content
+ Intuitive for different interaction techniques

- Shrinks available content display area

Panning - Dragging

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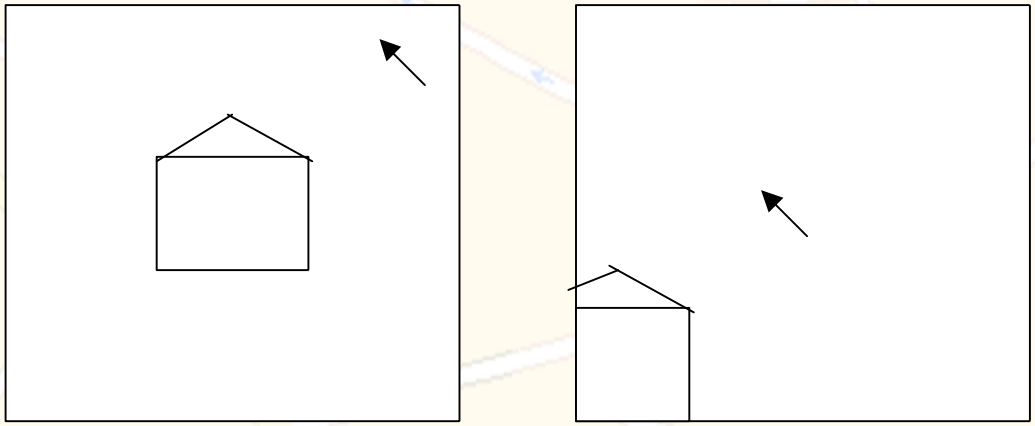
Panning by clicking, holding, moving and releasing the pointer



+ Whole display area available for content

- Requires a pointing device
- Dragging reserved for panning

Panning - Scrollbars

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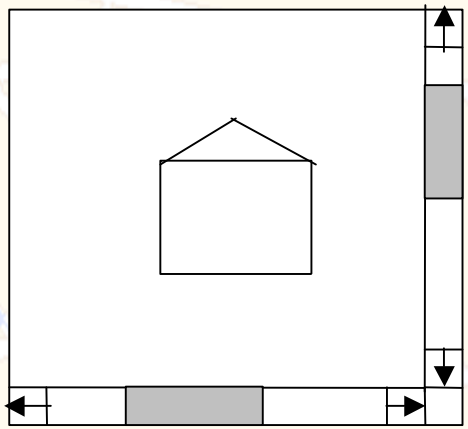
Panning by operating a scrollbar

+ Familiar panning technique
+ Pan speed control
+ Indicates position within context
+ Indicates size relation between displayed and complete content

- Requires a pointing device
- Shrinks available content display area



Panning – Select a new centre of view

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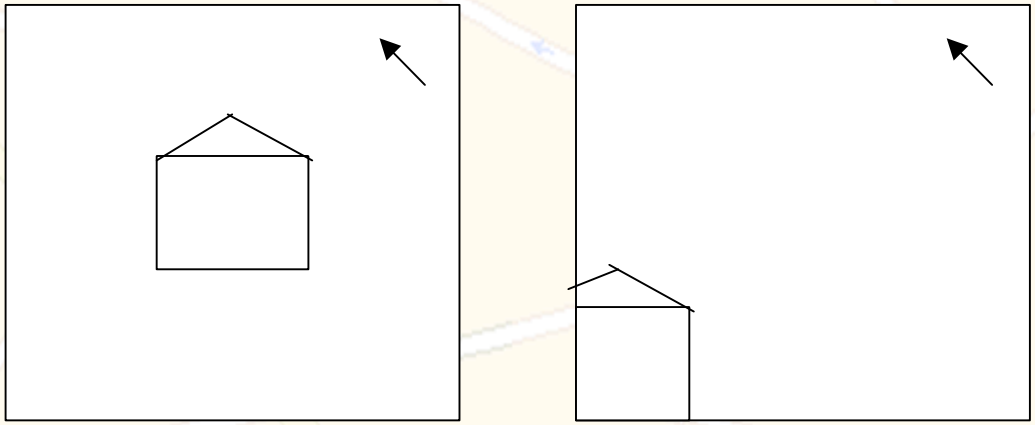
The clicked location becomes the new centre of the view



+ Whole display area available for content

- Requires a pointing device
- Clicking reserved for panning

Panning – Peephole Displays

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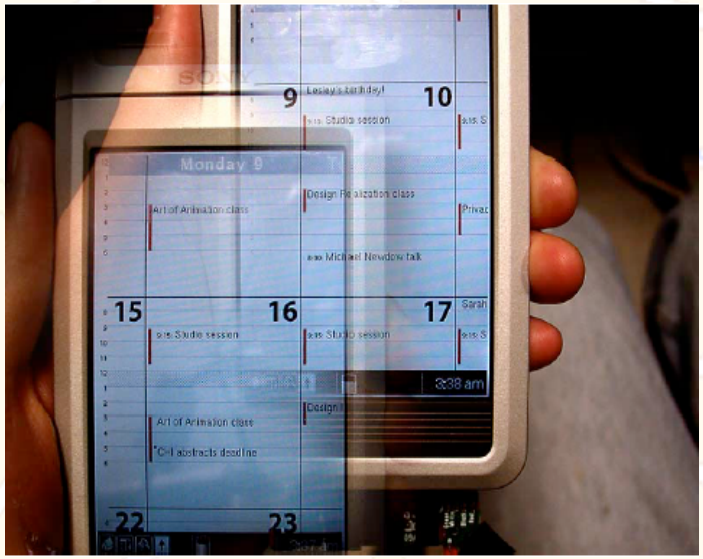
User moves the device to pan the content



+ Whole display area available for content

- Special device features required

Panning – Conclusion

	Sliding Window	Arrows	Dragging	Scroll-bars	Select centre	Peephole
Whole display area available for content	Yes	No	Yes	No	Yes	Yes
Limits interaction possibilities with content	No	No	Yes	No	Yes	No
Requires special device features	PD	No	PD	PD	PD	Motion aware device

PD = Pointing Device

Zooming – Screen Segmentation (1)

- Screen divided into 9 segments
- Zooms into the selected segment
- Special zoom out key

Zooming – Screen Segmentation (2)

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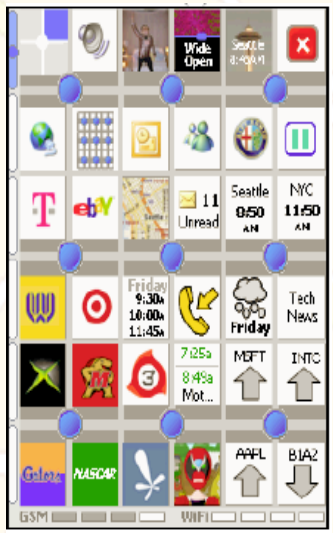
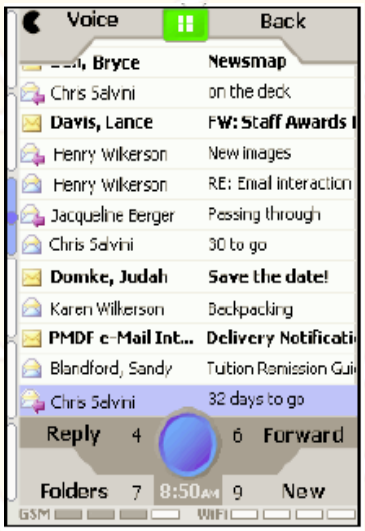
- 2-layer segmentation
- 36 applications visible in world view
- 4 applications visible in zone view



World View

Zone View



Application View

Zooming – Geometric Zoom

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- Scale linearly determines the size of objects
- Most common technique on generic zoomable user interfaces

Advantage:

- Does not require special knowledge about the displayed content

Disadvantage:

- On a low zoom scale objects can not be distinguished

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Zooming – Constant Density Zoom

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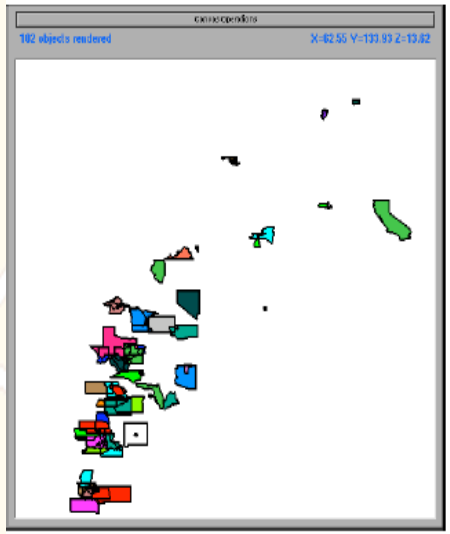
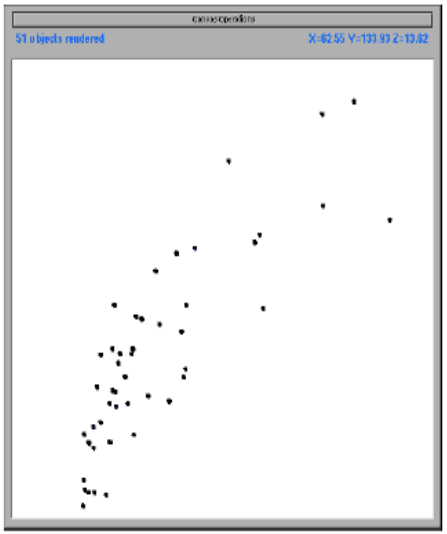
- Number of simultaneously visible objects is constant

Technique:

- Hide objects in high object density regions
- Indicate hidden objects by small dots



Geometric zoom



Objects-dots

Constant density zoom

Zooming – Semantic Zoom

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- Maps contain numerous objects of different size: counties, cities, villages, streets, landmarks
- Zoomed out view: only large objects are shown, cities, highways connecting cities
- On zoom-in: smaller streets, villages get visible
- Typical zoom technique for maps

Zooming – Non linear zooming

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- Goal directed zoom
  - Objects have different representations
  - System pans and zooms according to chosen representation
- Combined panning and zooming
  - Extensive panning leads to zooming
- Automatic zoom
  - Clicking on an object centres the view on the object and zooms to an appropriate scale

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Zooming – Jump versus Animated Zoom

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- Jump Zoom: instant change of scale

- Animated Zoom: smooth transition from old to new scale
  - Optimal transition time: 1 second
  - Optimal number of scale changes during transition: 8 per second

- Animated Zoom leads to a better understanding of the map's topology, but takes more time to complete the zoom operation

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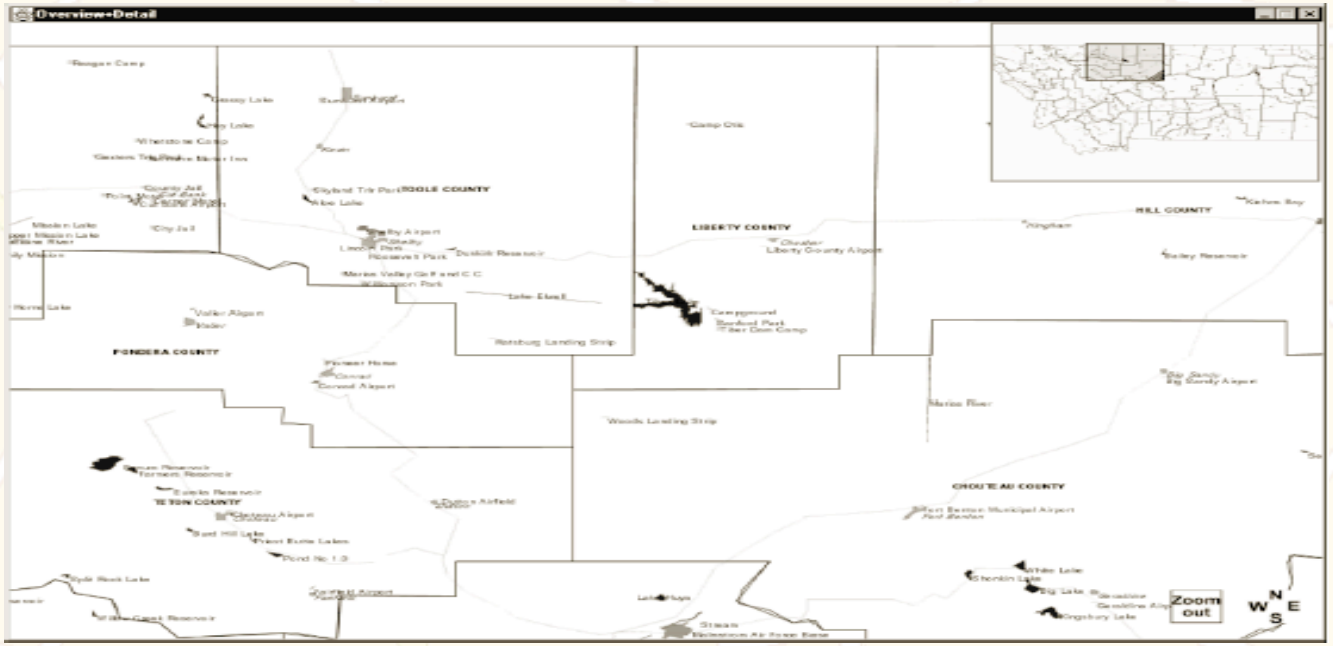
Multiple Views – Overview and Detail (1)

Problem: Difficult to keep track of current position within the whole map

Solution: Overview window



- Overview window shows the whole map
- Rectangle indicates the current position and scale within the map
- Overview window can be used to pan and zoom

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Multiple Views – Overview and Detail (2)

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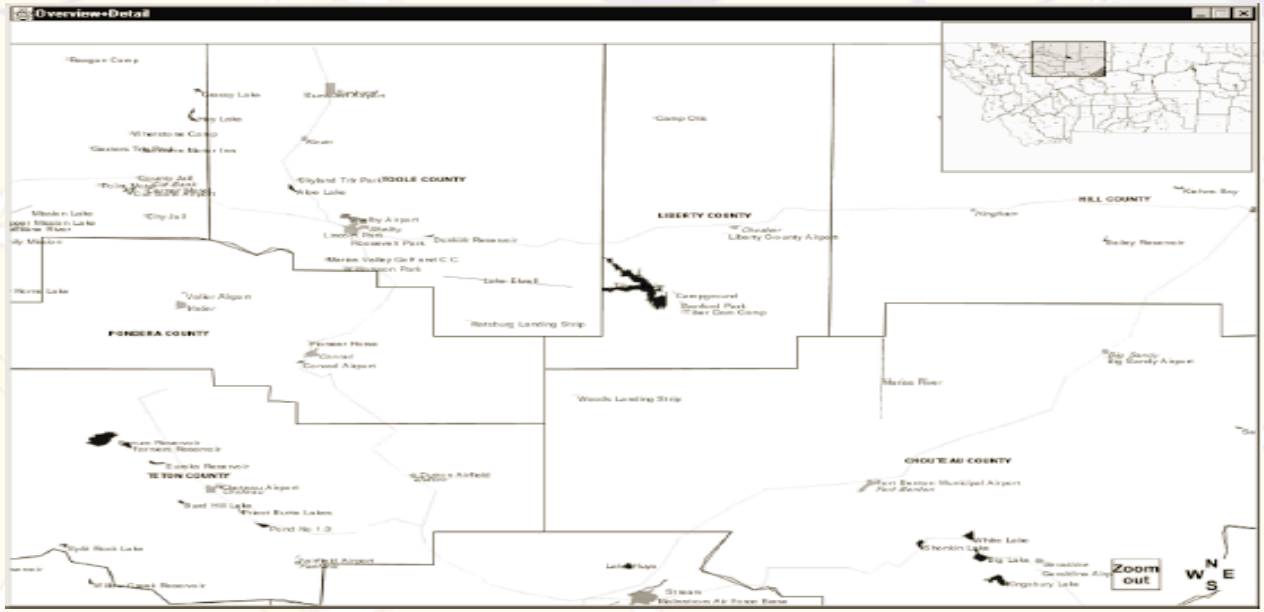

- Important:
  - "tight coupling" between overview and detail window
- Drawback:
  - Display space used by overview window is unavailable for detail window

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Multiple Views – Focus+Context View (1)

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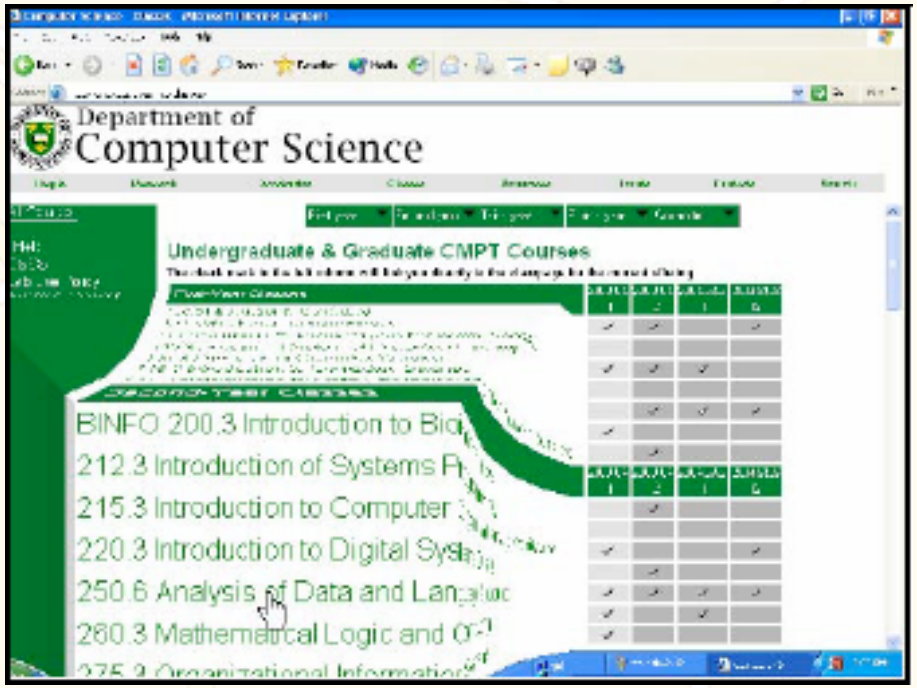
Idea: Overview and detail view in the same window

- Highlighted area is displayed at a raised zoom scale
- Remaining information is displayed at normal zoom scale
- Distortion algorithm calculates the zoom scale interpolation between those two areas



Comparing Focus+Context, Panning, Two-Level Zoom (1)

Tasks:

- Edit a PowerPoint presentation
- Navigate to a page on a web site
- Monitor events and respond appropriately

Navigation Systems:

- Panning only system
- Two-Level Zoom system
- Fisheye system

Comparing Focus+Context, Panning, Two-Level Zoom (2)

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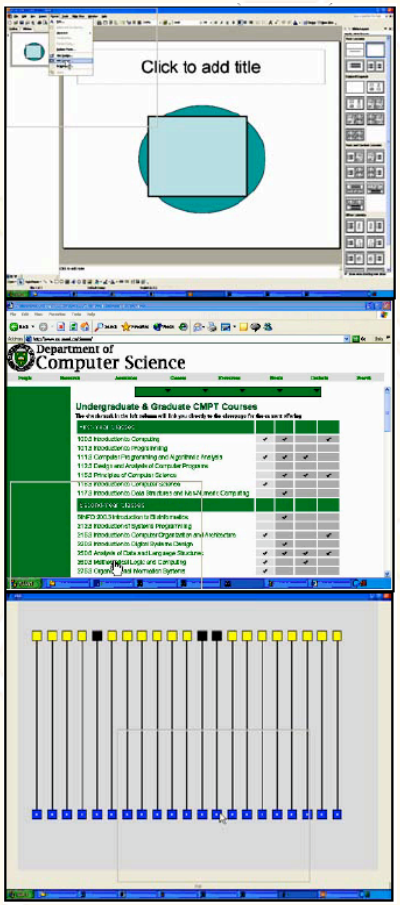
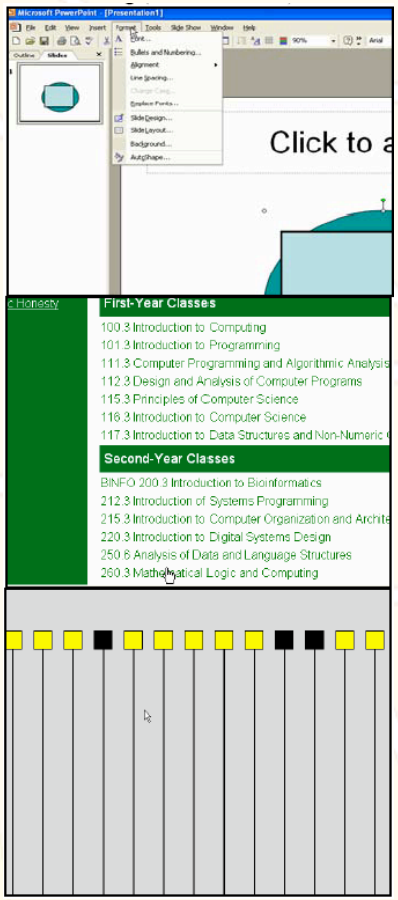
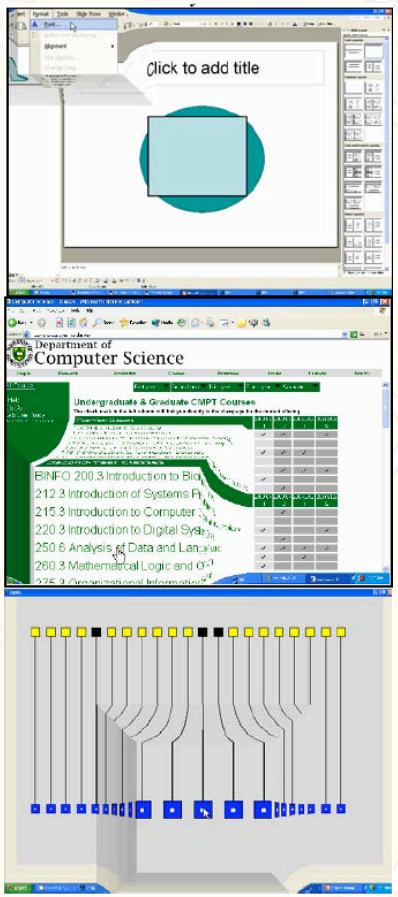
2-level zoom (zoomed out)



Panning



Focus+Context



Comparing Focus+Context, Panning, Two-Level Zoom (3)

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Results: Mean completion times for the 3 tasks, user preferences

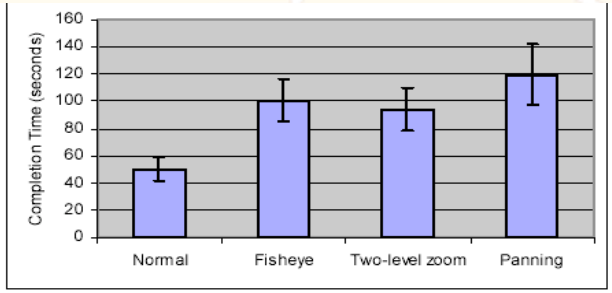

Figure 5. Mean completion times for the presentation editing task. Error bars show standard deviation.

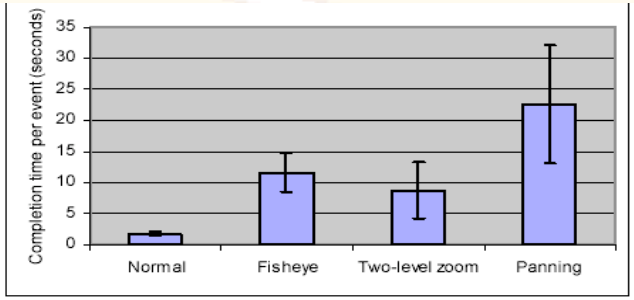

Figure 7. Mean completion times for the monitoring task. Error bars show standard deviation.

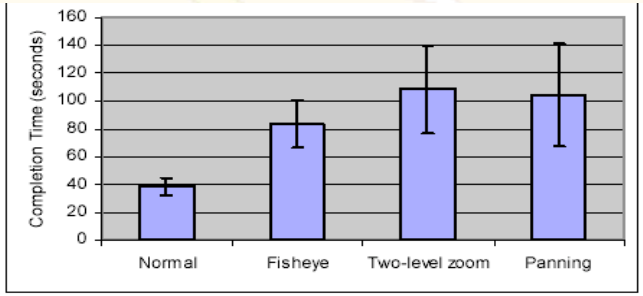

Figure 6. Mean completion times for the web navigation task. Error bars show standard deviation.

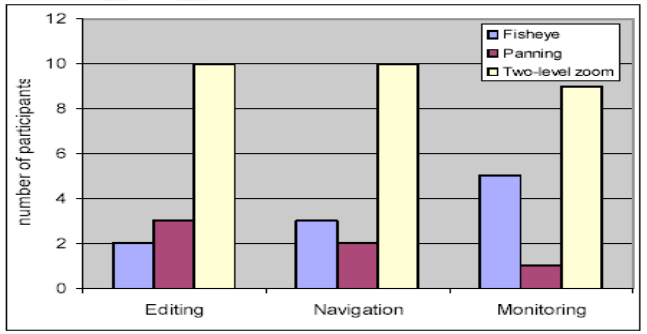

Figure 8. Participant preferences.

- Map Navigation: Focus+Context hinders the user to estimate distances

Interaction Techniques

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- Interaction with a Keypad
- Interaction with Motion
- Interaction with Gestures on a Touch-Sensitive Display
- Interaction with Voice

Interaction with a Keypad

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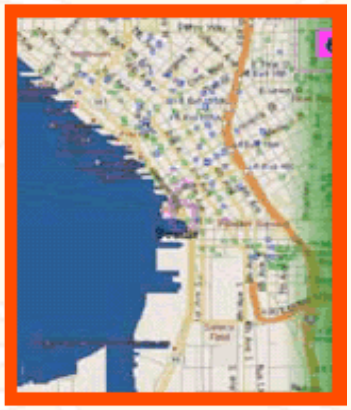
Types of keypads: single-tap and multi-tap alphanumeric keypads, as well as miniature thumb keyboards

Technique: ZoneZoom

Initial view

"6" key press



Sector 6 zoomed-in

- support for glance gestures

Interaction with a Keypad on a Large Display

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- Smartphone as a pointing device

Technique: Point & Shoot

- Absolute cursor positioning by visual codes
- User attention on smartphone screen

Technique: SpotCode Interfaces [Demo]

- Based on visual codes
- Recognizes simple motion gestures

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Interaction with a Keypad on a Map

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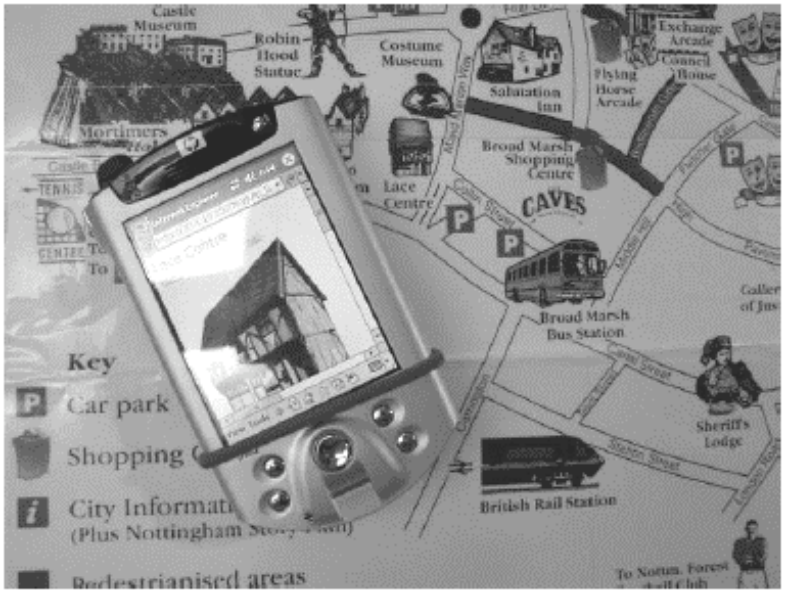
RFID-based interfaces

- Smartphone with an RFID-reader
- RFID tags for each POI



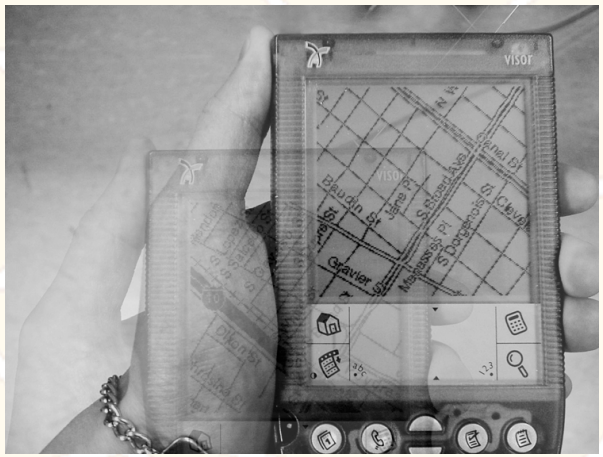
RFID advantages:

- No line-of-sight required
- Harsh environment withstand

Interaction with Motion (1)

Technique: Peephole Displays [Demo]

- Based on situating information in physical space
- Providing a movable window on that space



- Objects maintain a fixed position w. r. t. outside world → employing spatial memory to model the overall layout of the space
- Continuously controlled scrolling and zooming

Interaction with Motion (2)

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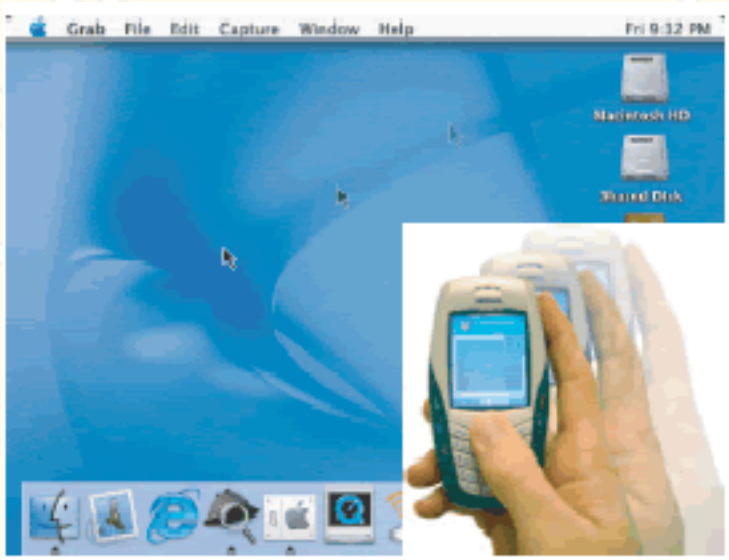
Technique: Sweep

- Relative cursor movement by optical flow image processing
- User attention on large display
- Comfortable arm posture



Interaction with Motion (3)

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GPS-based interfaces

• GPS device keeps track of its current position

• Movement calculation: based on multiple coordinates recorded over time

- Detection of short range movements is not possible, due to GPS resolution (10m)

+ Suited for tracking long range movements, for example while travelling in a car

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Interaction with Gestures on a Touch-Sensitive Display

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Technique: AppLens

- Gestures for:
  - directional navigation- up, down, left, right
  - widget interaction- activate, cancel
  - convenience- forward, backward
- Differences in performance and error rate
  - directional navigation much easier than object interaction gestures
- Allows one-handed interaction

Interaction with Voice

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Voice as input:

- Using **ASR** technology
  - users; training; speech; noise; vocabulary; context; ASR location
- MNS: not widely used
- Car navigation: Alk Technologies' CoPilot Truck GPS LapTop4 and DeLorme's Street Atlas 2005

Voice as output:

- Using **TTS** systems, such as Microsoft's

  text → symbolic linguistic representation → synthesized speech waveform
  - naturalness and intelligibility of the generated sound
- MNS: widely used; turn-by-turn instructions; choice of preferred voice

Interaction Techniques: Review

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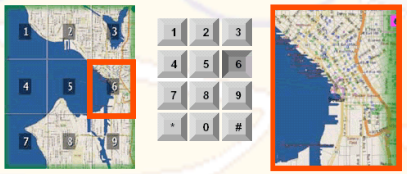
- Interaction with a Keypad



- Interaction with Motion

- Interaction with Gestures on a Touch-Sensitive Display

- Interaction with Voice

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Problems & Solutions

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- Desert Fog Problem
- Visualizing Off-Screen Locations
- Mapping between the Provided Information and the Real World

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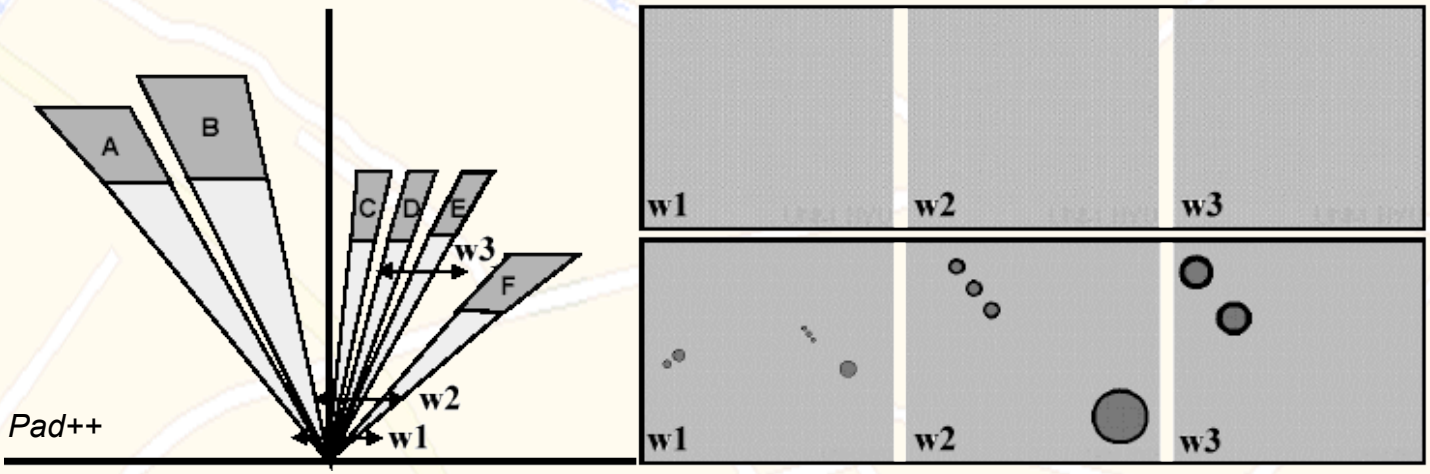
Desert Fog Problem (1)

Desert fog:

- View with no information for navigation
- Zoom in, zoom out or pan – what should we do?



Solution:

- Providing a multi-scale residue for objects

Desert Fog Problem (2)

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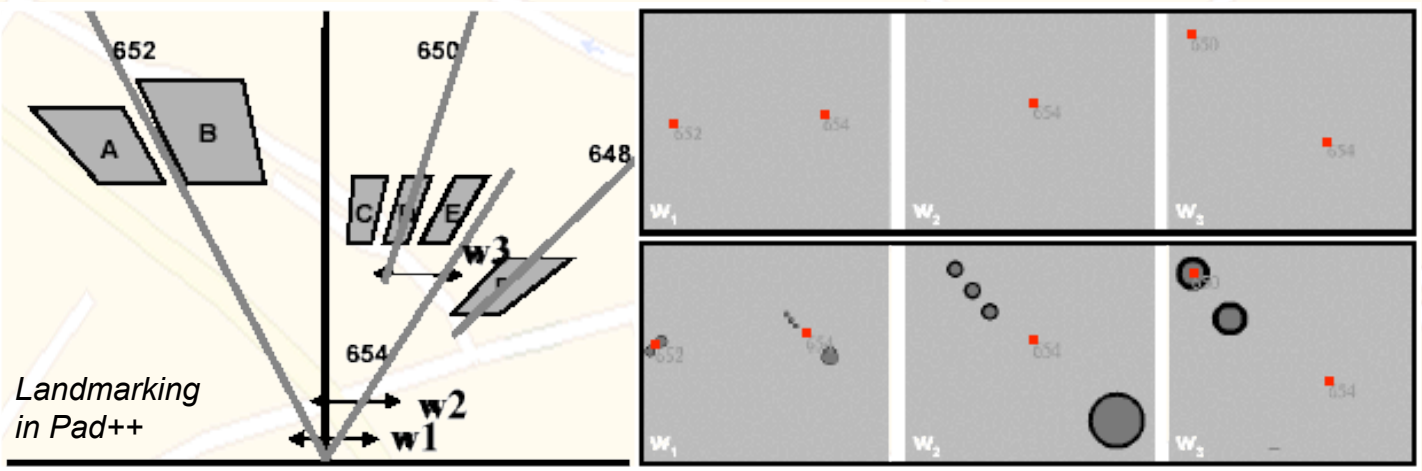
Solution 1:

- Based on cluster analysis
- Hierarchical structure of clusters



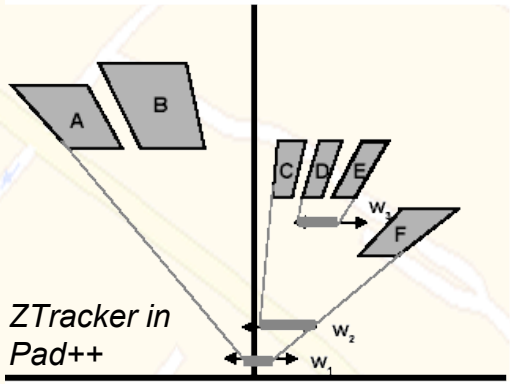
Disadvantages:

- Geometrical center is not a good representative of the cluster
- Hierarchical structure, not intended by the author of the space

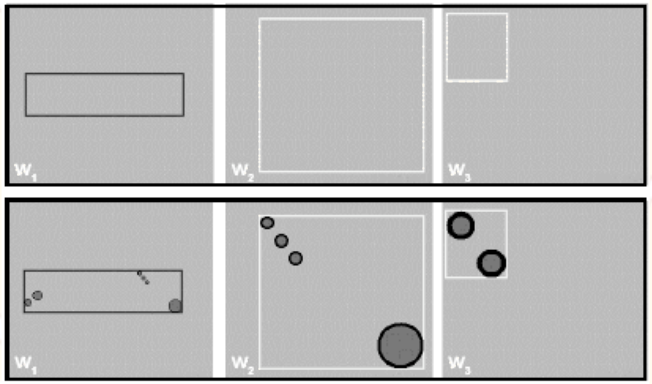
Desert Fog Problem (3)

Solution 2:

- Based on “critical zones”, interesting vs desert fog views
  - single critical zone algorithm

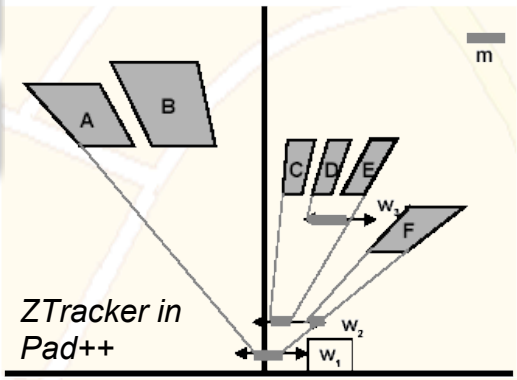


ZTracker in Pad++

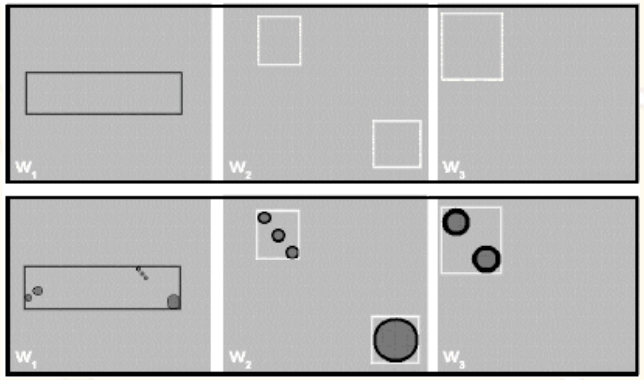


Disadvantage: contains too much desert fog

  - recursive critical zone algorithm



ZTracker in Pad++



refining critical zones

Visualizing Off-Screen Locations (1)

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Solution 1: **multi-window arrangements**, ex. overview+detail

Solution 2: **focus-plus-context techniques**, ex. fisheye

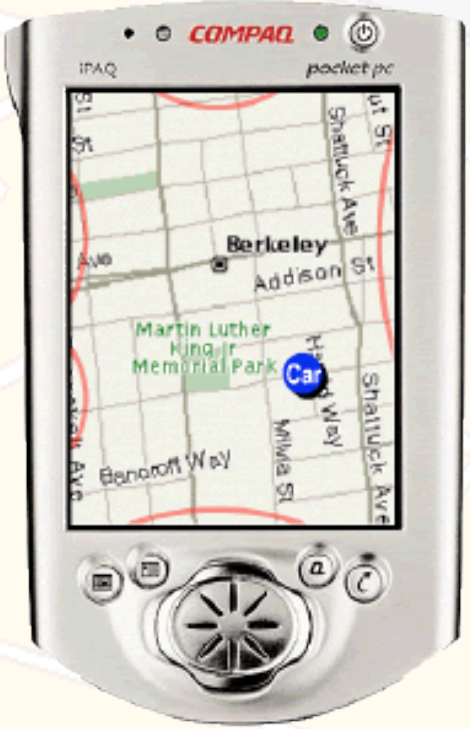
Solution 3: **arrow-based visualization**

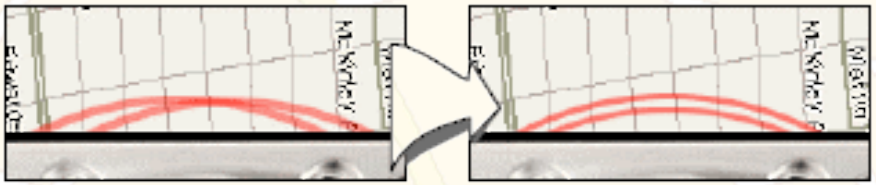
- Arrows, pointing from the centre of the screen to the off-screen location
- Distance annotation on each arrow
- Need for scale indicator for each scene

Visualizing Off-Screen Locations (2)

Solution 4: **arc-based visualization** (**Technique: Halo**)

- Off-screen objects, surrounded with rings
- All needed information encoded in the arc
- Scales to large number of locations





eliminating arc overlapping

Mapping between the Provided Information and the Real World

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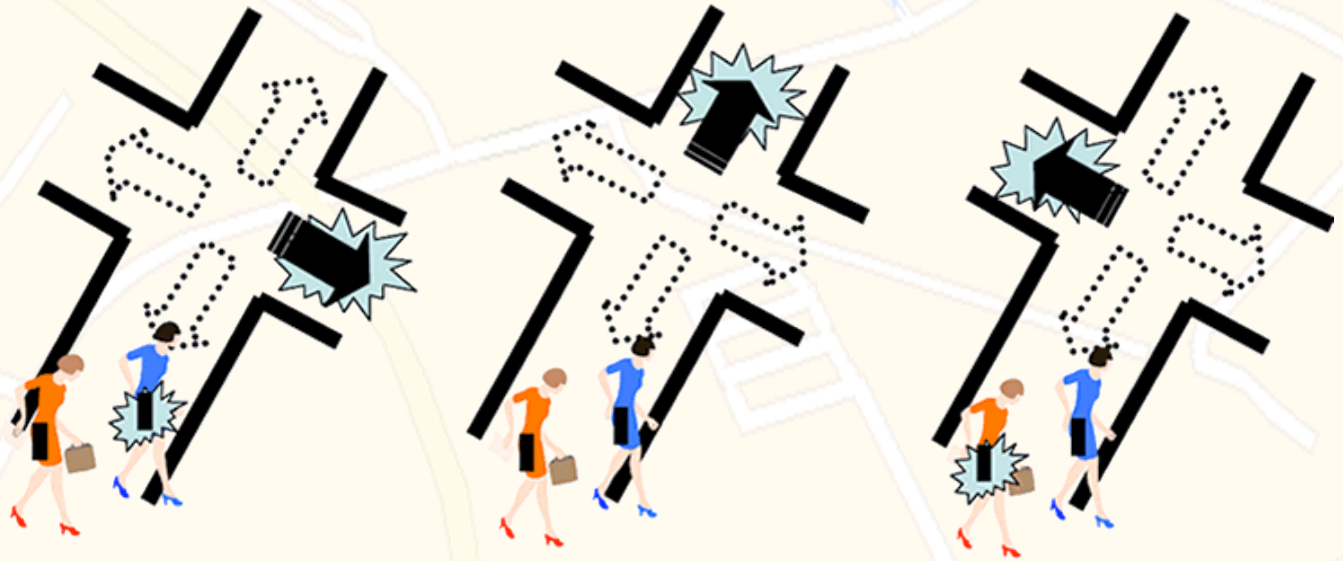
Technique: Rotating Compass

- Synchronized navigation system: public displays and personal devices
- Unobtrusive vibrating alerts
- Two ways for implementation



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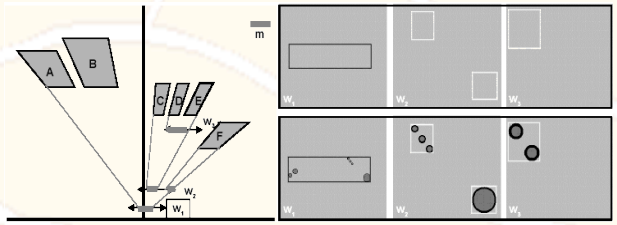
1) Desert Fog



1) Visualizing Off-Screen Locations

1) Mapping between the Provided Information and the Real World

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- Features
- Classification
- Comparison (on-line vs. off-line navigation software)
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Features:

- 2D / 3D maps, voice instructions turn-by-turn
- Route planning by car, by bike, on foot
- Calculating alternatives, avoiding or traveling via certain roads/ motorways/ places of interest, etc.

Classification by:

- Brand- TomTom, Wayfinder Systems, Destinator, ALK Technologies, Route 66, HP, etc.
- OS- Symbian, Windows Mobile, etc.
- Receiver- integrated GPS or separate GPS Bluetooth receiver
- Place of data storage and route calculation- on-board, off-board

Off-board navigation software (1)

Product name	3soft-Navigation	activepilot	T-Navigate	Wayfinder
Producer	3soft-Navigation	Fa. Jentro	T-Mobile	Wayfinder Systems
Operating systems	Symbian	Symbian	Symbian, Win Mobile	Symbian
Software size	5 MB	900 KB	3 MB	900 KB
Avoiding motorways	yes	yes	no	no
Walking / Biking	no	no	no	no
Night mode	yes	no	no	no
Software price	230 € (incl. GPS device)	Free (GPS device 130 €)	Free (GPS device 130 €)	Free (GPS device 130 €)
Price per route	Only with subscription	1,49 €	1,99 €	Depends on map mode
Subscription price	99 € / year	99 € / year	-	99 € / year

Off-board navigation software (2)

Product name	3soft-Navigation	activepilot	T-Navigate	Wayfinder
Test smartphone	Nokia 6670	Siemens M65	MDAcompact	Nokia 6600
Test network	E-Plus	Vodafone	T-Mobile	E-Plus
Route calculation time	1 min	3 min	2 min	2 min
Route recalculation time	1 min	2 min	30 sec	2 min
Menu structure	Good	Satisfactory	Good	Bad
Destination input	Good	Satisfactory	Good	Bad
Destination guidance	Good	Bad	Bad	Good
System stability	Very good	Satisfactory	Satisfactory	Very bad

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On-board navigation software (1)

Product	copilot	Destinator	Navicore	Route 66	Smart2Go	TomTom5
Producer	Alk Tech, UK	Destinator Europe	Navicore, Finnland	Route66, NL	Gate5, Berlin	TomTom, NL
Operating system	Windows Mobile	Windows Mobile	Symbian 60	Symbian 60 and up	Symbian 60 and up	Symbian 60
Memory card	SD-mini, 256 MB	SD-mini, 256 MB	MMC, 256 MB	MMC, 256 MB	MMC, 512 MB	MMC, 256 MB
Available maps	Germany, West EU	Germany, West EU	Germany, 7 West EU	Germany, EU	Germany, the Alps	Germany, West EU
POI	yes	yes	yes	yes	yes	yes
Avoiding motorways	no	no	no	no	no	yes
Route planning	yes, over internet	yes	yes	yes	no	yes
Walking / Biking	no / no	no / no	no / no	yes / no	yes / no	yes / yes
Night mode	yes	no	yes	yes	yes	yes
Software price	199 €	179 €	299 € (incl. GPS)	199 €	299 € (incl.GPS)	299 € (incl.GPS)

On-board navigation software (2)

Product	copilot	Destinator	Navicore	Route 66	Smart2Go	TomTom5
Test smartphone	T-Mobile-SDA, Motorola MPx220	T-Mobile-SDA, Motorola MPx220	Nokia 6600, Nokia 6670	Nokia 6600	Nokia 6600, Nokia 9300	Nokia 6670
Test network	T-Mobile	E-Plus	T-Mobile, E-Plus	T-Mobile	T-Mobile	E-Plus
Time route calculation	fast	slow	fast	medium	medium	fast
Time route recalculation	< 2 sec	< 2 sec	< 5 sec	< 5 sec	< 5 sec	< 5 sec
Menu structure	satisf.	satisf.	good	good	bad	good
Destination input	bad	satisf.	good	good	satisf.	good
Destination guidance	good	good	very good	satisf.	bad	good
System stability	good	good	very good	satisf.	very bad	very good

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Used devices:

Nokia 7610

TomTom 5 GPS
Bluetooth device

Route planning: Aachen Ponttor → Aachen Ahornstrasse 56

[Demo]

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Questions & Answers

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Thank you for your attention!

Q & A

Possible Question 1

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Which smartphones on the market are:

- **motion gesture – enabled?**

  Samsung SPH-S4000 and SCH-S400,
  camera-based phones with motion detection software

- **voice recognition enabled?**

  Samsung SCH-A970, SCH-i300 and SPH-V8400

Possible Question 2

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Our choice for on-board navigation software:

TomTom 5 Navigator

Our choice for off-board navigation software:

3soft-Navigation