Introduction

Mobility

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Mobility: a broad concept

(1) moving between devices - hot-desking
(2) moving within an instrumented environment - intelligent buildings and intelligent appliances
(3) devices within moving vehicles - computers in cars
(4) small devices that move with you - smartphones, watches

Alan Dix (Lancaster University)

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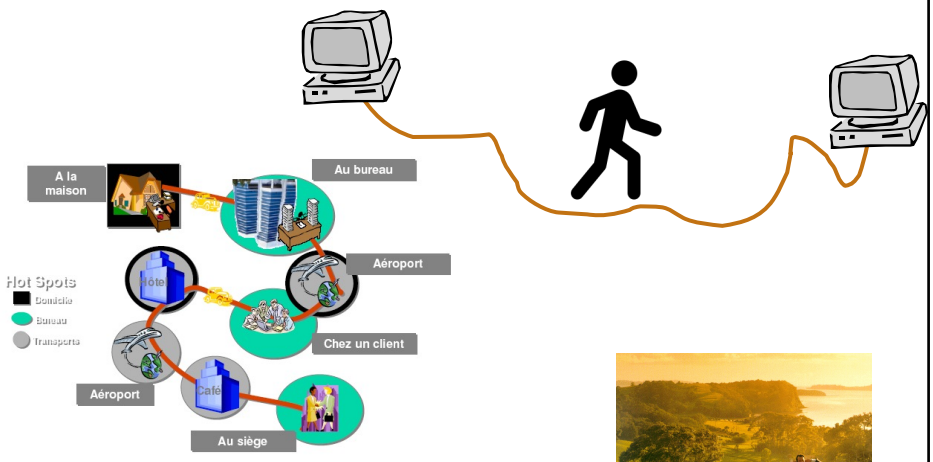
Mobility: moving between devices



- Nomadic computing

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Mobility: a broad concept

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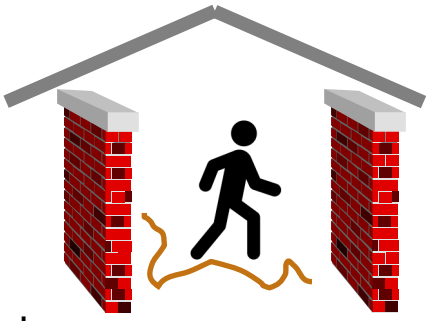
Moving within an instrumented environment



- Examples:
  - Smart spaces
  - Augmented classroom / museum / supermarket

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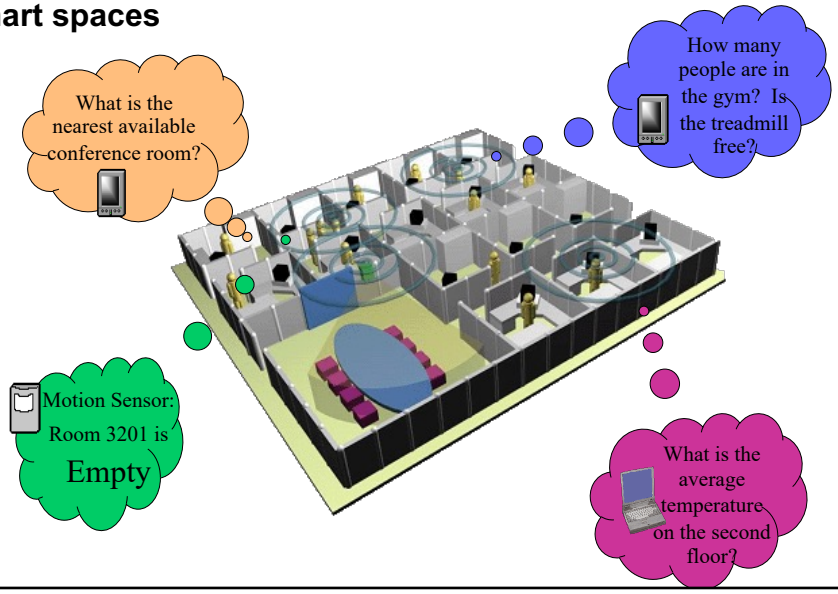
Moving within an instrumented environment

Smart spaces



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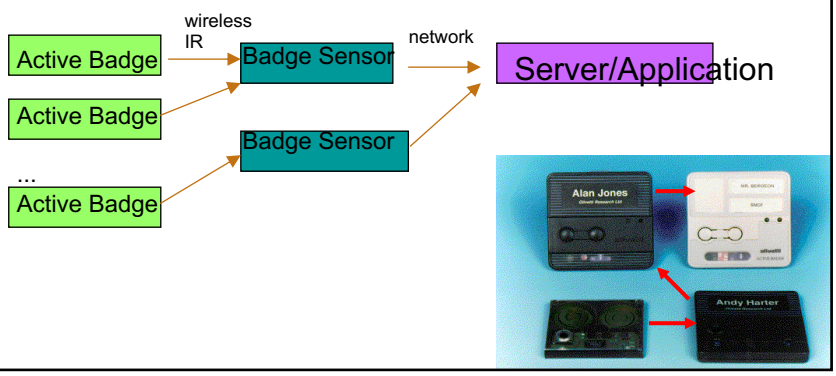
Moving within an instrumented environment

- Olivetti Research Laboratory in Ca
  UK, in 1990-92
- Active Badge: location-aware systems



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Moving within an instrumented environment

- Active Badge
  - Experimented with 32 staffs in ORL company in 2 weeks
  - All staff wearing badge that emits IR signal every 15 seconds
  - Intended to aid telephone receptionist
    - FIND(name)
      - Provides current location of the named badge
    - WITH(name)
      - Locates a named badge and other badges around the badge
    - LOOK(location)
      - Provides badges near the specified location
    - HISTORY(name)
      - Generates report of the location history for the named badge

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Moving within an instrumented environment

- Server
  - Network Control
    - Polling all sensors on the network
  - Representation
    - Builds linked list of (ID, location, time) in time order
  - Data Processing
    - Process large amount of data from the active badge network
  - Display Interface
    - Showing textual information

ORL/STL Active Badge Project

Name	Location	Prob.	Name	Location
P Ainsworth	X343 Accs	100%	J Martin	X310 Mc Rm
T Blackie	X222 DVI Rm.	80%	O Mason	X307 Lab
M Chopping	X410 R302	TUE.	D Milway	X307 Drill
D Clarke	X316 R321	10:30	B Miners	X202 DVI Rm.
V Falcao	X218 R435	AWAY	P Mital	X213 PM
D Garnett	X232 R310	100%	J Porter	X398 Lib.

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Moving within an instrumented environment

- ATT Lab Cambridge: Active Bat 2001
  - Sentient Computing: a form of ubiquitous computing which uses sensors to perceive its environment
    - A "follow-me phone" which would cause the telephone nearest the recipient to ring.
    - Teleporting desktops via VNC just by clicking their Active Bat near the computer.

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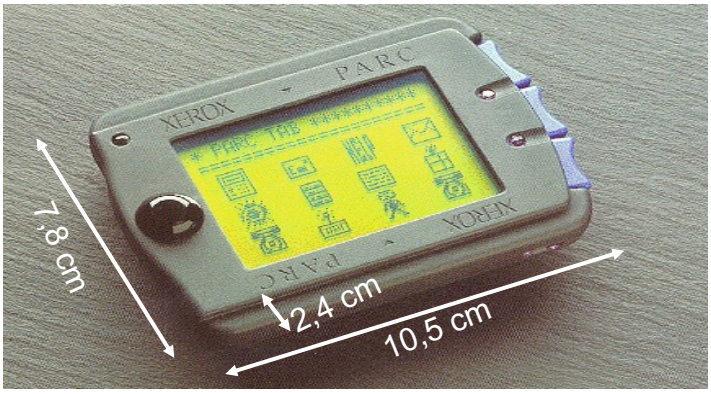
Moving within an instrumented environment

- ParcTab (Rank Xerox)1995



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Moving within an instrumented environment

Projet
EasyLiving
Microsoft 2001

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Moving within an instrumented environment

- Location-aware system (within a buidling)
- Context-triggered actions are simple IF-THEN rules used to specify how context-aware systems should adapt

Like living in a rule-based expert system

```
Coffee   Kitchen  arriving   "play -v 50 ~/sounds/rooster.au"
schilit  *        attention  "emacs -display $NEARESTHOST:0.0"
```

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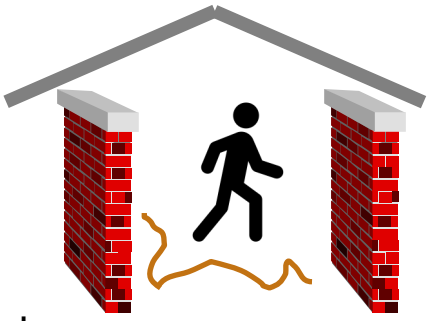
Moving within an instrumented environment



- Examples:
  - Smart spaces
  - Augmented classroom / museum / supermarket

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Wireless supermarket concepts

- The Shopping Buddy wireless touch-screen device attached to a shopping cart
  - scans in items placed in the cart by shoppers
  - delivers personalized services and incentives when activated with a frequent-shopper card
  - RFID which triggers certain offers and can help shoppers find anything in the store and draw a path to find it.

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Wireless supermarket Operation

- As you shop, you can scan in each item
  - keeps a running total of how much you are spending
  - eliminates the need to wait in line at the check-out
  - you can also check the price of each item before you buy
- As you walk down the aisles
  - promotions and paperless coupons “pop-up” on the screen
  - Reminders of articles you search
  - Directions to articles
- You can place an order at the deli (ex. Half a kilo of ham) from anywhere
  - notification to pick it up (No more taking a number and standing in line)

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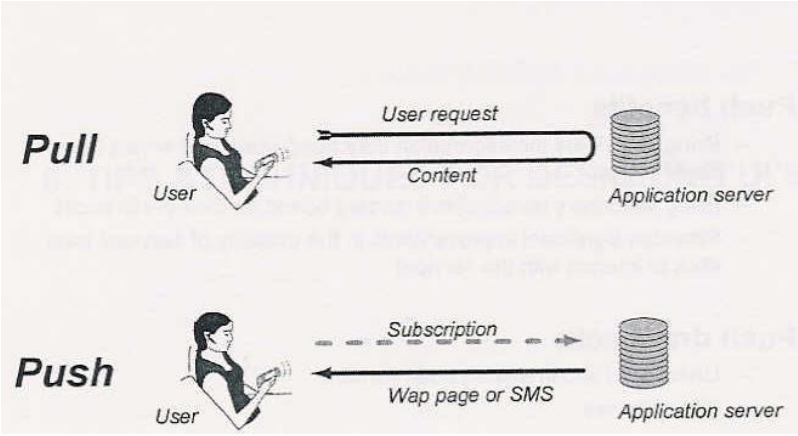
Wireless supermarket Operation



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Wireless supermarket Operation

- The Everywhere Display (IBM)
- Beamed
  from the supermarket ceiling
- transforms any surface
  into an interactive computer
  - On the floor
  - On the items

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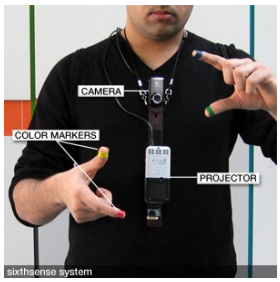
Wireless supermarket Operation

- The Everywhere Display (IBM) transforms any surface into an interactive computer

- A MIT project: Sixthsense 2010
  - wearable gestural interface that augments the physical world around us with digital infor
  - Video SixthSense.mp4



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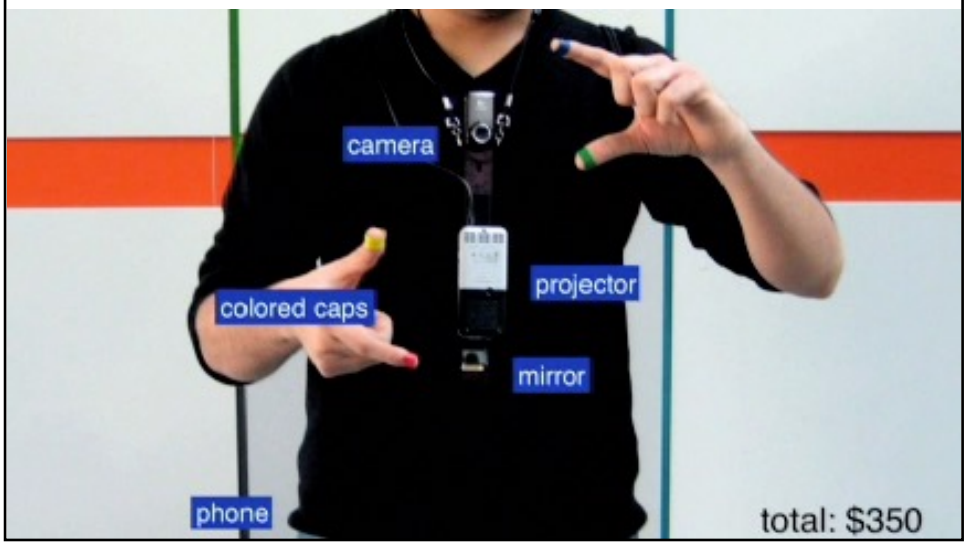
Wireless supermarket Operation

- Sixthsense 2010



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Moving within an instrumented environment

- Technological approach
  - 1. Augment the user
    - The user wears or carries a device to obtain information about physical objects.
    - => similar to the case 4 « small devices that move with you »
  - 2. Augment the physical object
    - The physical object is changed by embedding input, output or computational devices on or within it.
  - 3. Augment the environment surrounding the user

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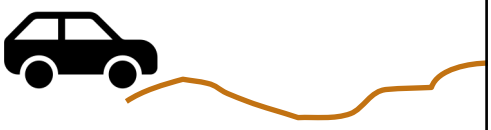
Devices within moving vehicles



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Devices within moving vehicles

- AutomotiveUI 2017
- Scrolling a list of songs
- Touch / Pressure
- Haptic feedback

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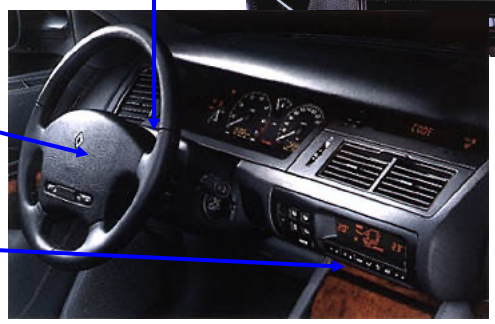
Devices within moving vehicles



micro

Tactile Surface

Keyboard

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Devices within moving vehicles

- FutureLab of Ars Electronica (Austria)
- Augmented Reality
  - *Instar.mov video*

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Devices within moving vehicles

- DGA project
- Augmented cockpit (Rafale)

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Devices within moving vehicles: microgestures

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M[eye]cro for Low-Priority task

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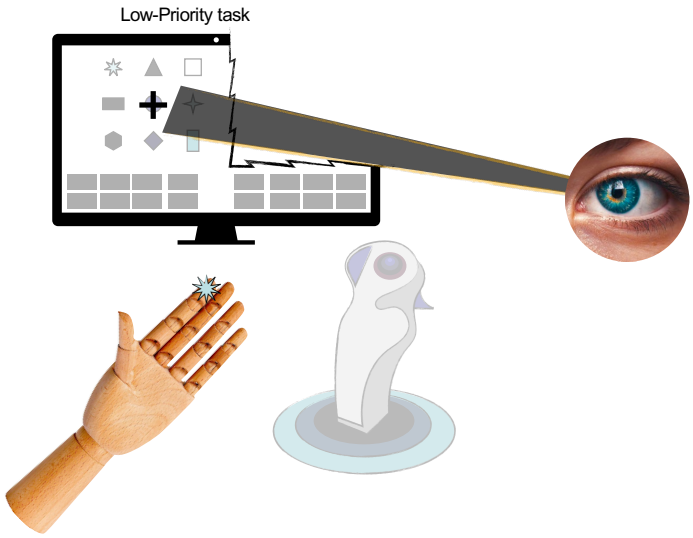
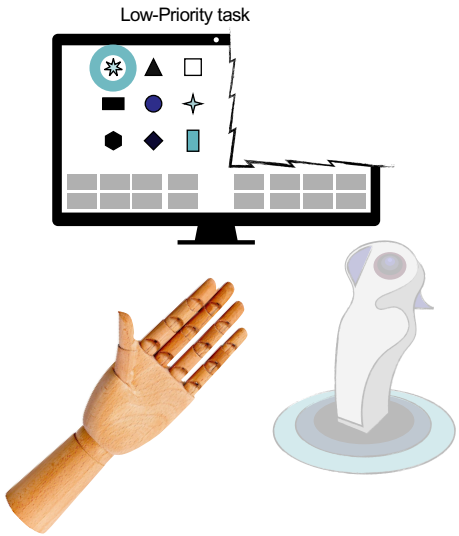
M[eye]cro for Low-Priority task



31

31

M[eye]cro for Low-Priority task

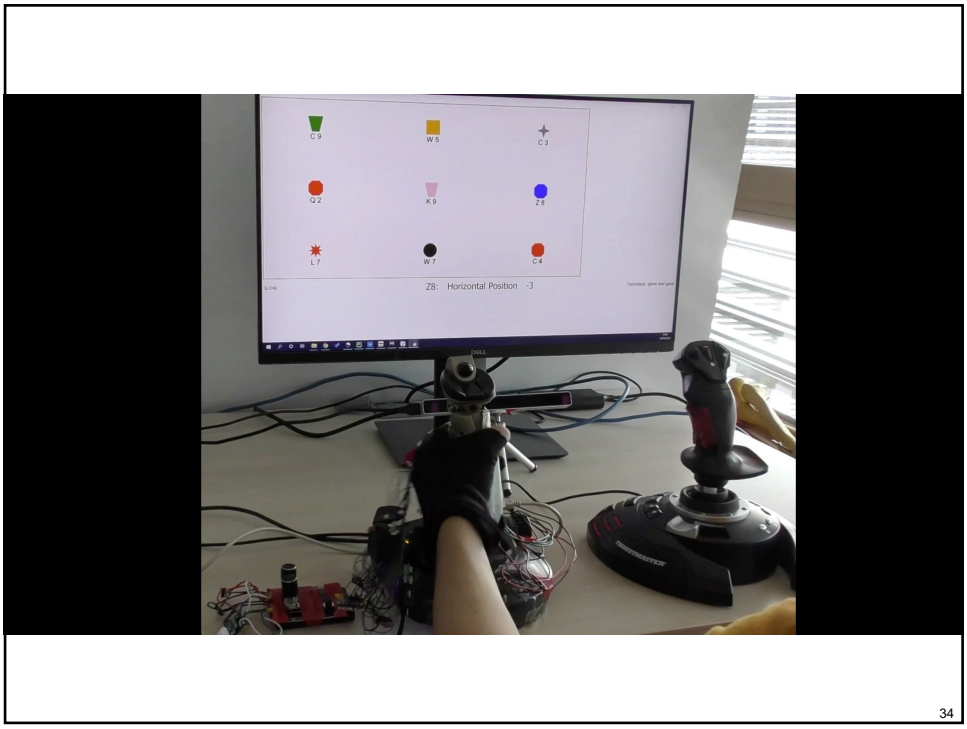


32

32


M[eye]cro for Low-Priority task
Low-Priority task

33


Z8: Horizontal Position -3
34

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De plus en plus de dispositifs mobiles utilisés

Image : http://mspmentor.net

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Evolution des dispositifs mobiles

- Nombreuses possibilités d'interaction
- Capacités matérielles proches de celles des ordinateurs de bureau ou portables
- Facilité de récupération des données

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De plus en plus de commandes sur dispositifs mobiles sur des écrans ayant toujours une taille réduite

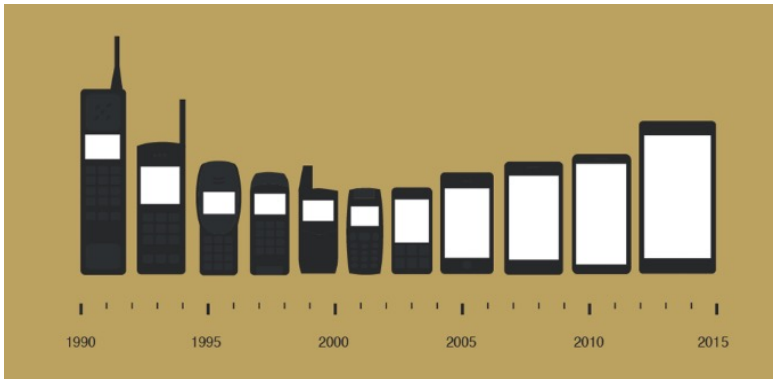

Image :
https://edutalk.entersocio.com

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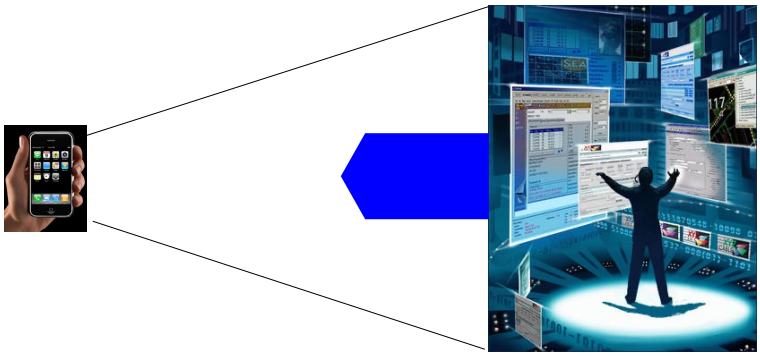
Input/Output Interaction



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Mobile devices

- Touch screen
- Few buttons
- Finger occlusion problem
- Long lists of items

We need menus …

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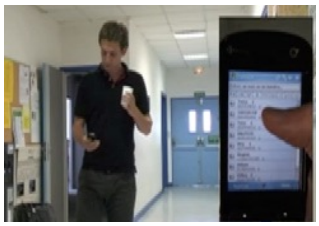
Menu techniques

We need menus which are well adapted for:

- Touch screen mobile devices
- Long list of items
- Mobile situations



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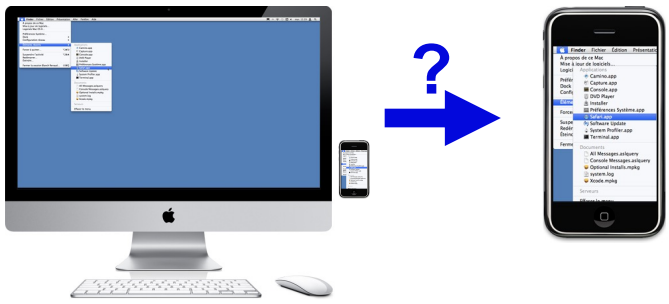
Menu techniques

- Shall we reasonably copy/paste linear menus from the PC world?
  - Limited screen space
  - Small items
  - No shortcuts
  - No eyes-free selection



42

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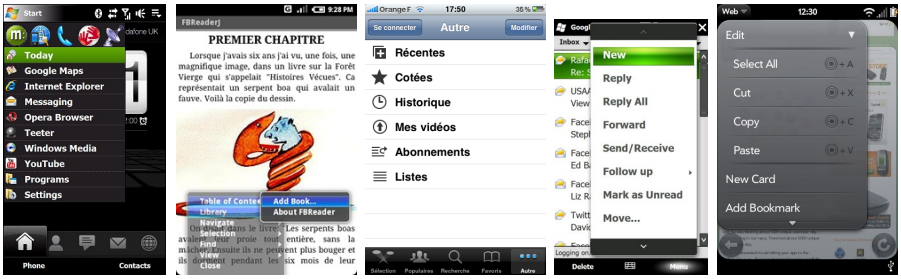

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Menu techniques

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➡ **We need new menu techniques**

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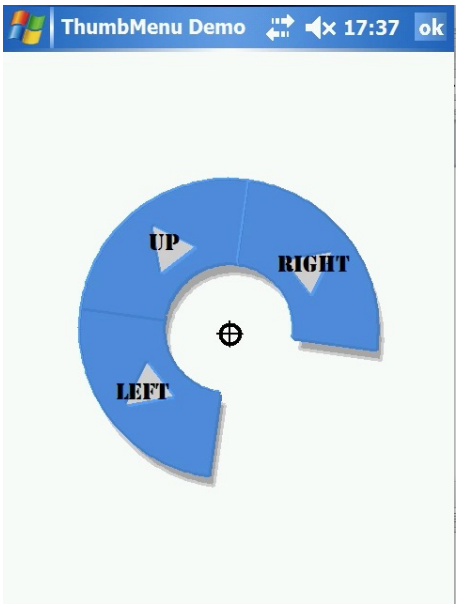
Menu techniques

- **Arch and Thumb menus**



ArchMenu and ThumbMenu, Huot et al., IHM 2007

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Menu techniques

- **Arch and Thumb menus**

✓ No thumb occlusion
✓ Previsualization (browsing submenus)
✓ Easy to learn

✗ Menu breadth limitation
✗ No expert mode

ArchMenu and ThumbMenu, Huot et al., IHM 2007

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Menu techniques

- **earPod**

✓ Eyes-free selection
✓ Expert mode
✓ Easy to learn

✗ Menu breadth limitation
✗ No previsualization

earPod, Zhao et al., CHI 2007

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Menu techniques

- **Leaf menu**
- **Video leaf_01.mov**

Leaf menu, Roudaut et al., INTERACT 2009

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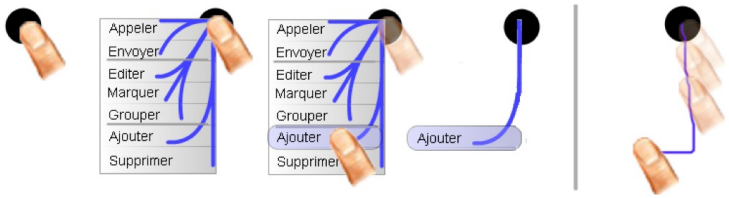
Menu techniques

- **Leaf menu**



✓ Expert mode
✓ Easy to learn

✗ Menu breadth limitation
✗ No previsualization

Leaf menu, Roudaut et al., INTERACT 2009

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Menu techniques

- **Wavelet menu**

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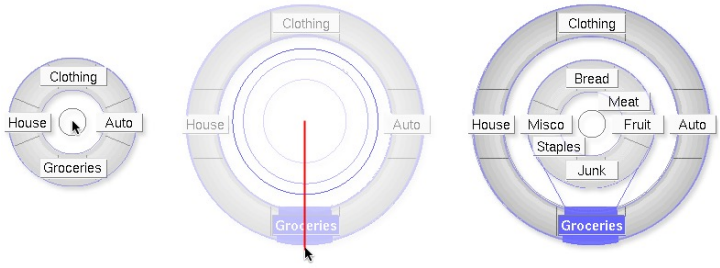
Wavelet menu: Novice mode

- An adaptation of the Wave menu
  - Inverted concentric layout
  - Parent menus surround submenus



Menu appears | Menu is enlarged | Submenu appears at the center

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Wavelet menu: Novice mode

- **Efficient screen space management**
- Focus of attention = Last opened submenu displayed at the center
- Interaction still possible even if the parent menus are outside the screen

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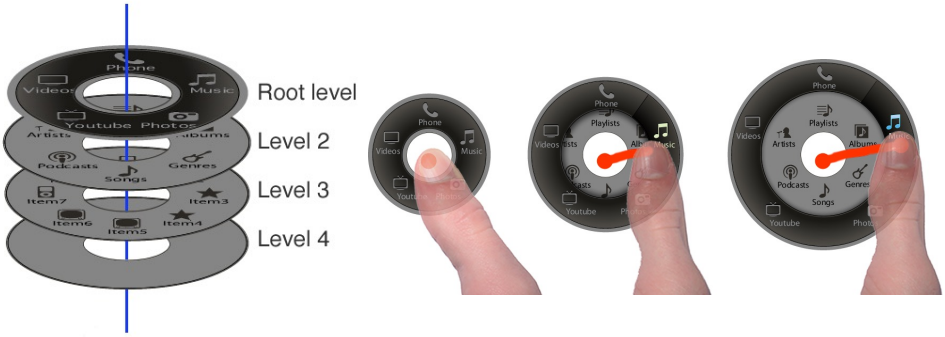
Wavelet menu: Novice mode

- **Stacking metaphor** to better understand the inverted concentric layout
  - To reinforce the perception of the hierarchy
  - To hide the strokes behind a stack handling



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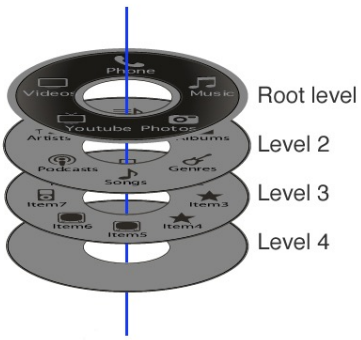

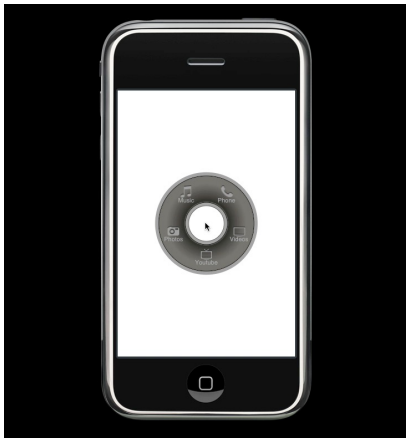

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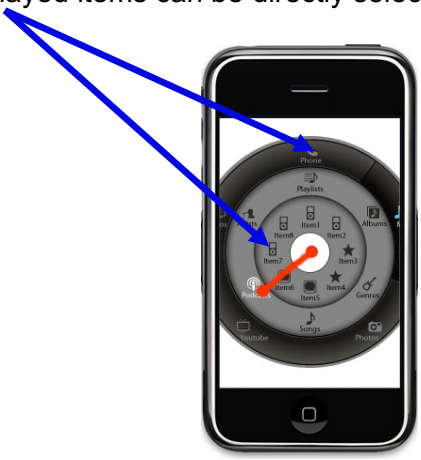
Wavelet menu: Novice mode

- **Direct manipulation**
- All displayed items can be directly selected



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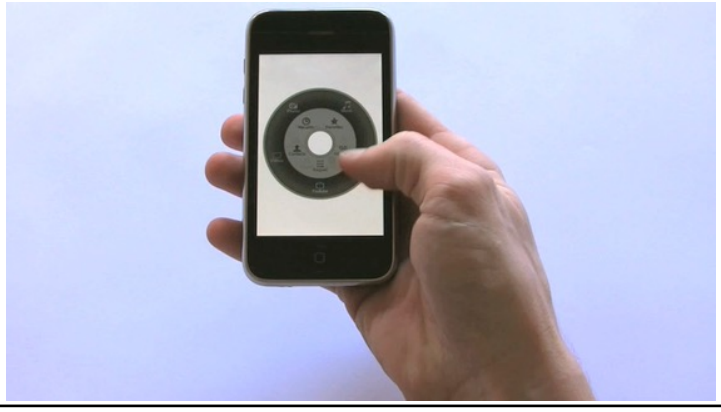
Wavelet menu: Novice mode

- **Submenus previsualization**
- Exploration of the menu tree: Rapid scan of submenus



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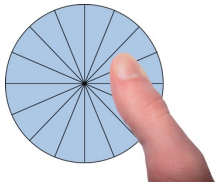
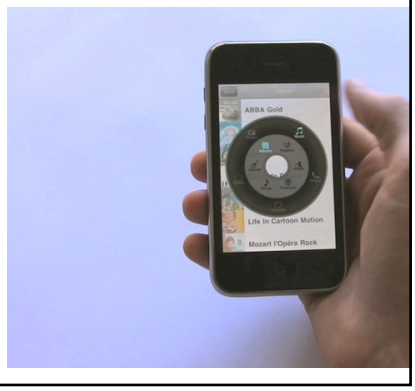
Wavelet menu: Novice mode

- **Breadth and depth of the menu system**
  - Circular layout:
    - Limited number of items



  - Hybrid layout:
    - Linear menus integration for handling long lists



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Evolution des dispositifs mobiles

- Nombreuses possibilités d'interaction
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- Facilité de récupération des données

58

De plus en plus **de données** à appréhender sur dispositifs mobiles sur des écrans ayant toujours une taille réduite

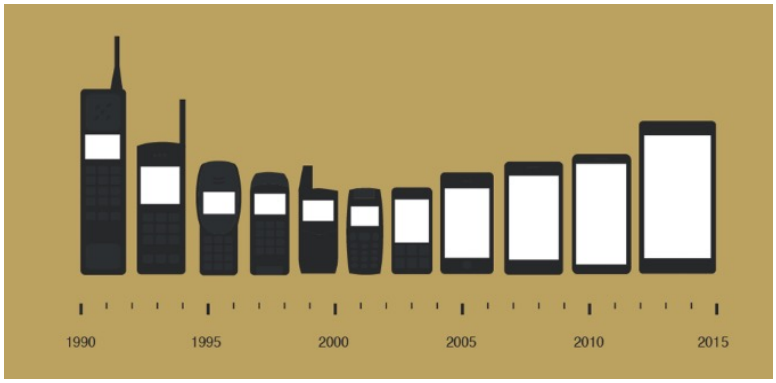

Image :
https://edutalk.entersocio.com

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De plus en plus de données à appréhender sur dispositifs mobiles sur des écrans ayant toujours une taille réduite

Image :
http://cpon.infocom-nancy.fr

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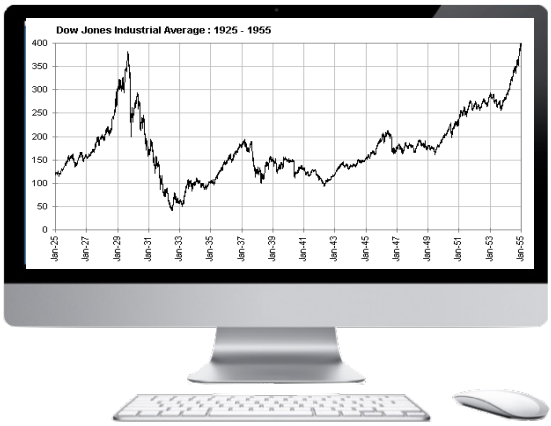
Double problématique



1) Visualisation
2) Navigation

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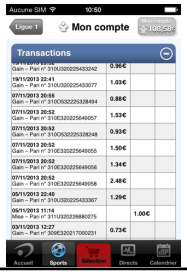
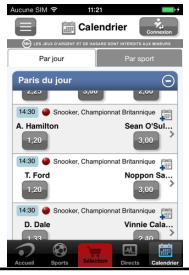
Données à une dimension et/ou temporelles

- Données fréquemment utilisées sur dispositifs mobiles
- Techniques de visualisation actuellement utilisées non optimales





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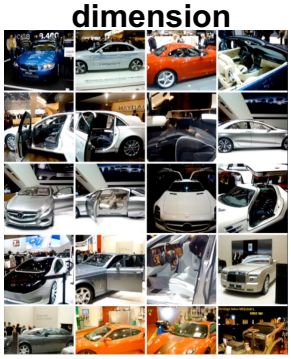
Données à une dimension et/ou temporelles

Données à une dimension



Séquence d'éléments

Données temporelles

Séquence d'éléments ordonnés selon le temps

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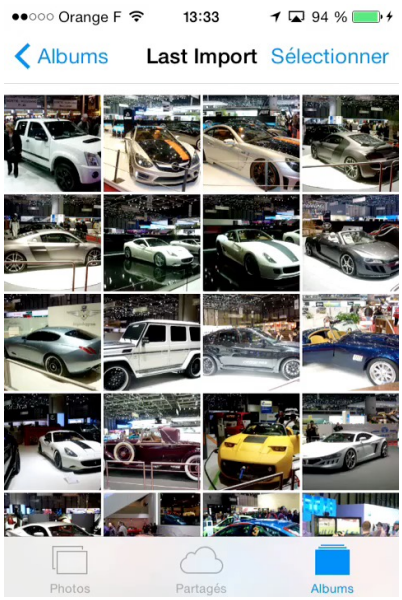
Besoin



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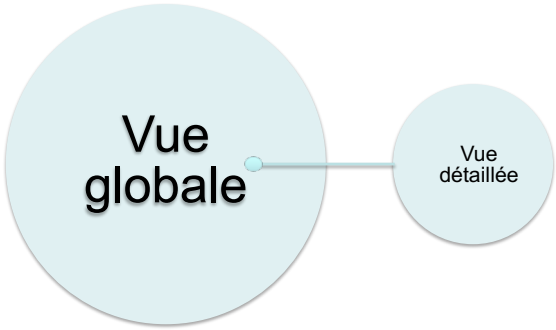
Besoin



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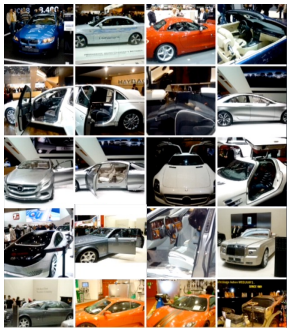
Approche par multiplexage

- Multiplexage temporel
- Multiplexage spatial
- Mutiplexage en profondeur



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Approche par multiplexage

- Multiplexage temporel
- Multiplexage spatial
- Mutiplexage en profondeur

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Approche par multiplexage

- Multiplexage temporel
- Multiplexage spatial
- Mutiplexage en profondeur

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Approche par multiplexage

- Multiplexage temporel
- Multiplexage spatial
- Mutiplexage en profondeur

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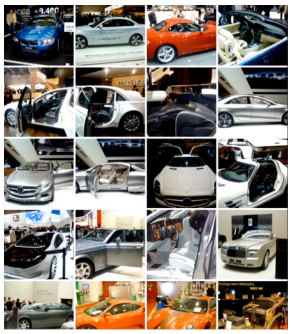
Approche par multiplexage

Multiplexage temporel	Multiplexage spatial	Multiplexage en profondeur
		
Pas d'affichage simultané des deux vues	Partage de l'espace à l'écran	Surcharge d'informations à l'écran

70

Multiplexage spatial

Indices contextuels

[Baudisch & Rosenholtz, 2003]

- Informations sur la vue globale limitées
- Bords de l'écran surchargés si beaucoup d'informations

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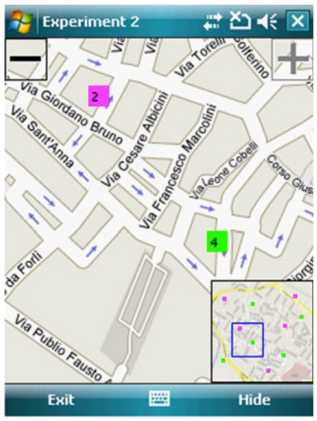
Multiplexage spatial

Vue globale + Détails



[Burigat & Chittaro, 2013]

- Compromis sur les tailles des deux vues difficile
- Effort mental pour faire le lien entre les deux vues

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Multiplexage spatial

Focus + Contexte

[Wang & Chi, 2011]

- Compromis sur les tailles des deux espaces difficile
- Transition entre focus et contexte difficile à appréhender si la déformation est trop importante

73

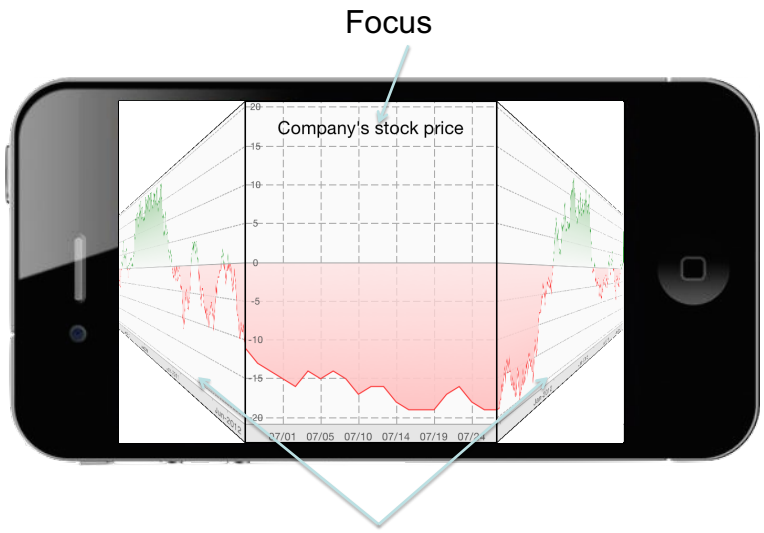
Multiplexage spatial & Focus + Contexte

- Indices contextuels
  - Peu d'information sur les données du contexte
- Vue globale + Détails
  - Pas d'optimisation de l'espace à l'écran à cause des deux vues

⇒**Focus + Contexte**
  - **Choix de la taille du focus et du contexte**

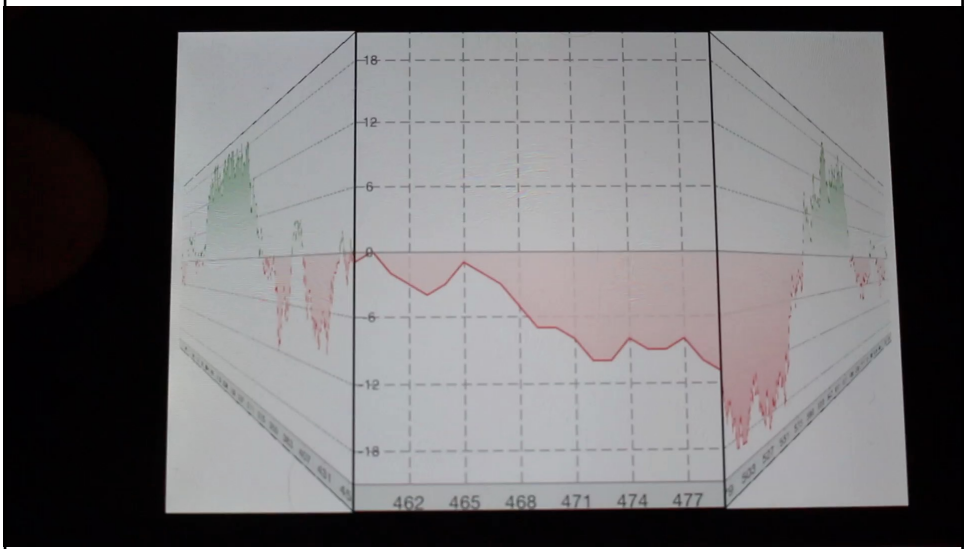
74

Implémentation d’une vue bifocale



75

Implémentation d’une vue bifocale



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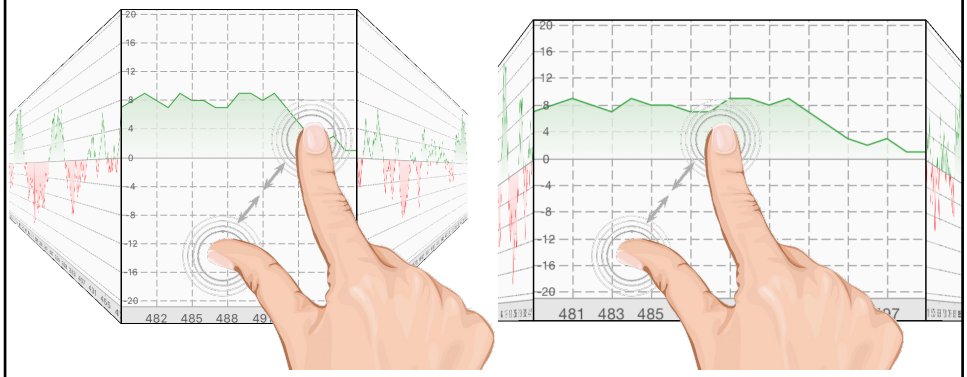
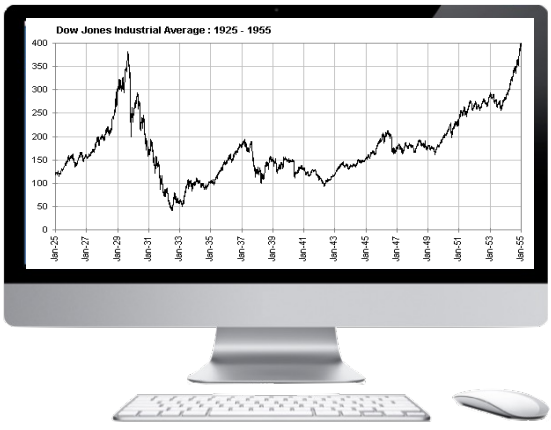
Implémentation d'une vue bifocale

- Possibilité de redimensionnement par un geste de *Pinch*



77

Double problématique



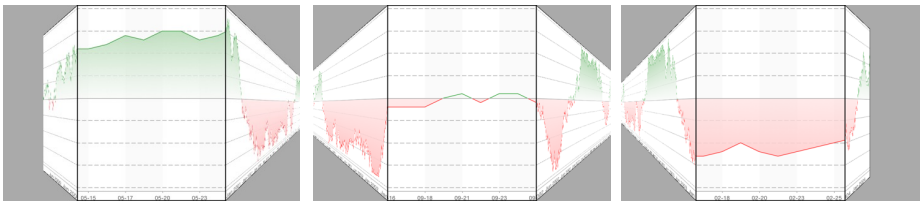
1) Visualisation

2) Navigation

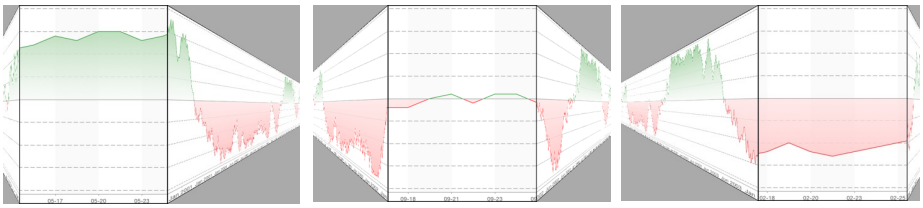
78

Deux métaphores d'interaction

- Métaphore d'interaction du ruban



- Métaphore d'interaction de la loupe



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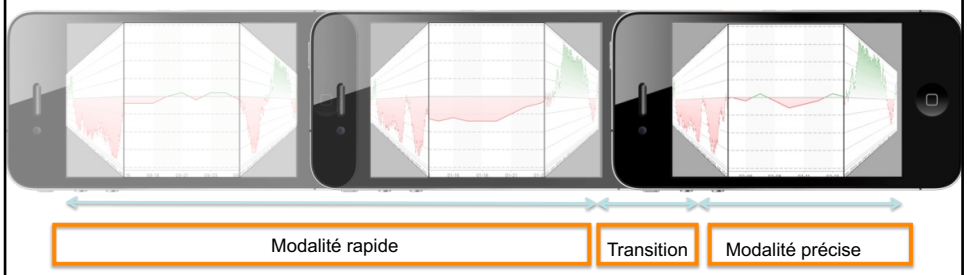
Navigation dans une vue bifocale

- Accès rapide aux données dans la zone de contexte
- Interaction précise dans la zone de focus

- Deux échelles de navigation :
  - Celle du contexte
  - Celle du focus

80

Modèle de navigation en trois phases



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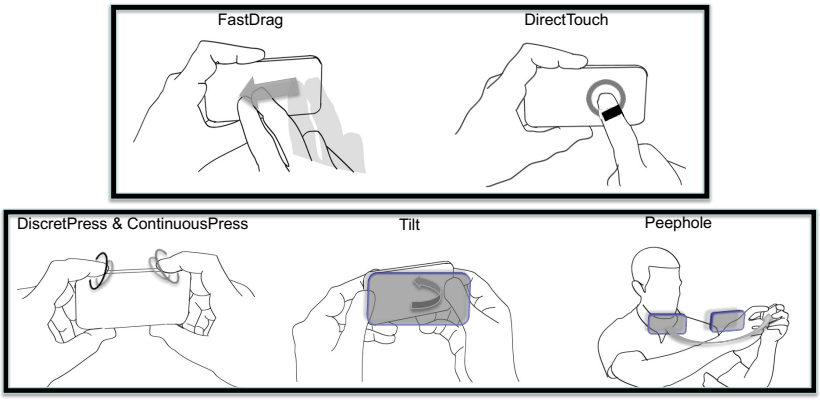
Conception de techniques de navigation multimodale

- Phase de navigation précise : modalité Flick
- Phase de navigation rapide :



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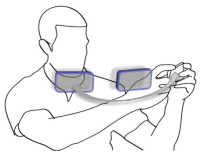
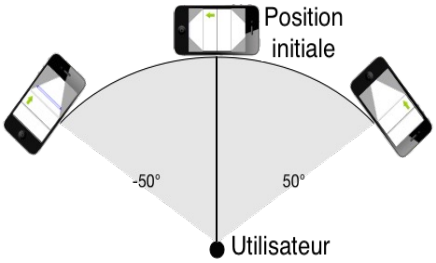
Technique Peephole



Utilisation du magnétomètre

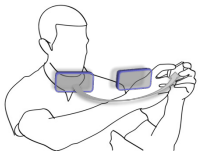
Déplacement du dispositif de manière sphérique

– Amplitude de [-50°, 50°]
– Activé grâce à un des capteurs



83

Technique Peephole



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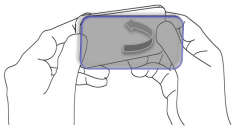
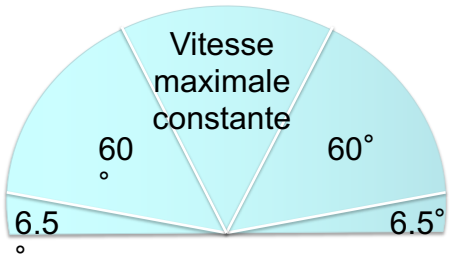
Technique Tilt



Conversion linéaire de l'angle en vitesse
Zone stable de 13°
Amplitude de [-60° , 60°]



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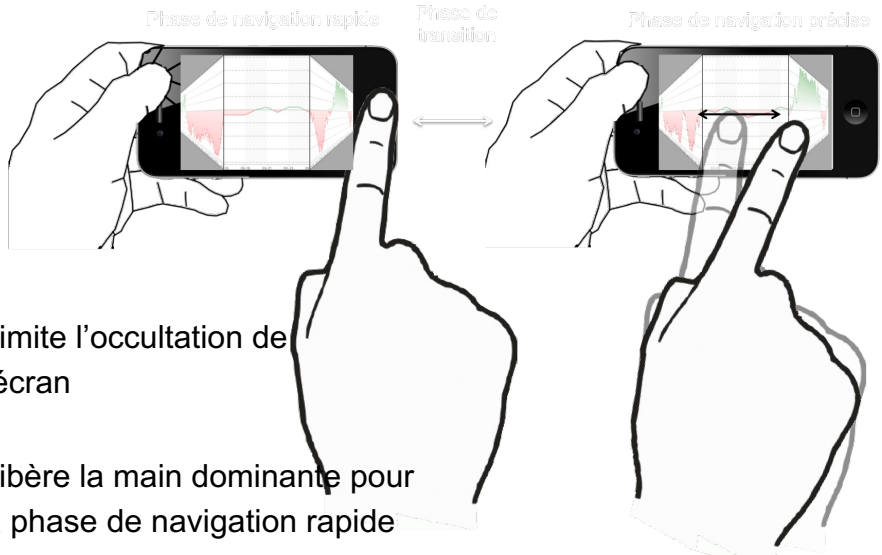
Technique basée sur la pression



- Limite l'occultation de l'écran
- Libère la main dominante pour la phase de navigation rapide

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Evolution des dispositifs mobiles

- Nombreuses possibilités d'interaction
- Capacités matérielles proches de celles des ordinateurs de bureau ou portables
- Facilité de récupération des données

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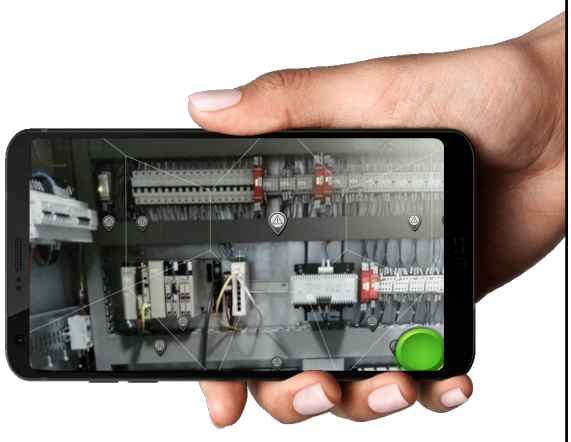
Réalité Augmentée interactive sur dispositifs mobiles



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Pointing in handheld AR

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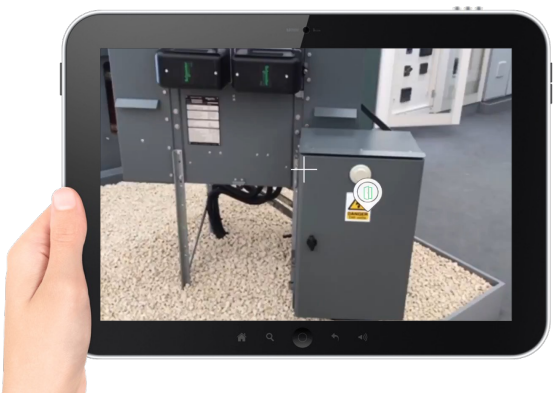
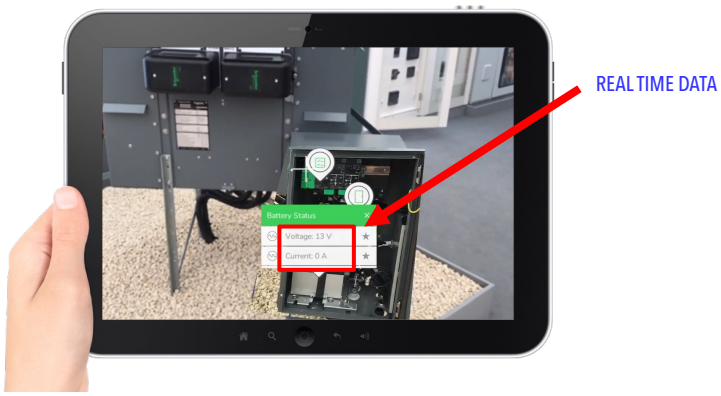
Pointing in handheld AR



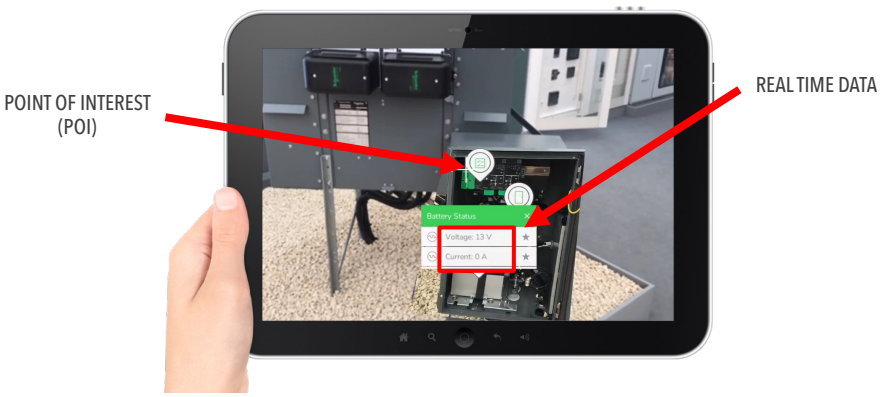
90

Pointing in handheld AR



91

Pointing in handheld AR



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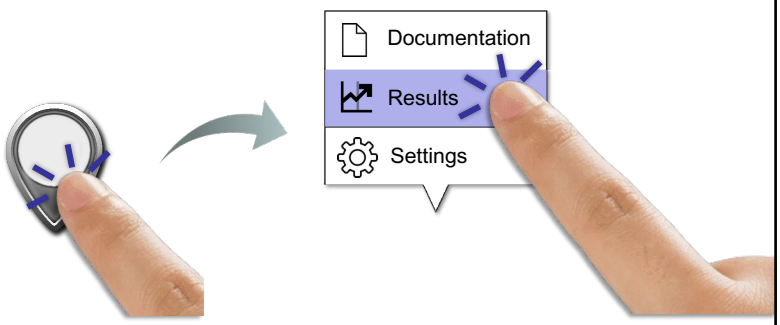
Pointing in handheld AR

93

Pointing in handheld AR



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Pointage : Loi de Fitts

– T = I.log 2D/L

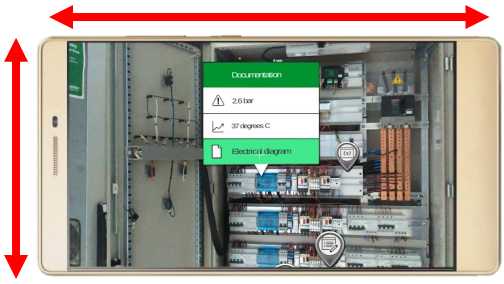
avec D : distance à parcourir, L : largeur de la cible, I = 0,1 sec

– Temps proportionnel à la distance à parcourir pour atteindre la cible et inversement proportionnel à la taille de la cible

95

Pointing in handheld AR

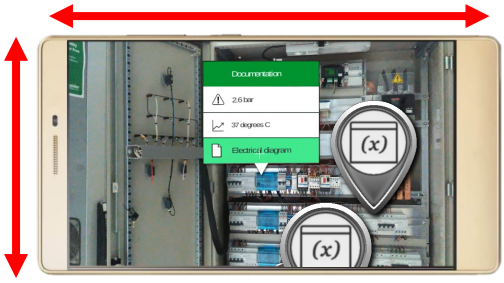
1. Limited screen' size
2. Digital targets anchored to physical world
3. Information contained inside digital targets



96

Pointing in handheld AR

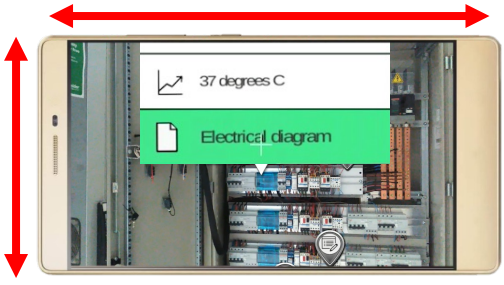
1. Limited screen' size
2. Digital targets anchored to physical world
3. Information contained inside digital targets



97

Pointing in handheld AR

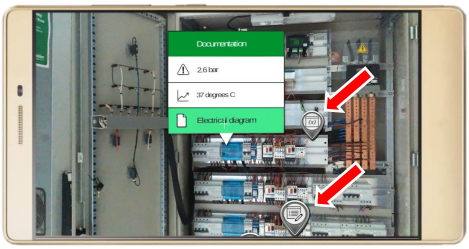
1. Limited screen' size
2. Digital targets anchored to physical world
3. Information contained inside digital targets



98

Pointing in handheld AR

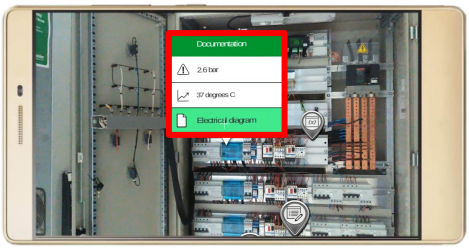
1. Limited screen' size
2. Digital targets anchored to physical world
3. Information contained inside digital targets



99

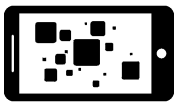
Pointing in handheld AR

1. Limited screen' size
2. Digital targets anchored to physical world
3. Information contained inside digital targets



100

Pointing in handheld AR



Limited intrusion on screen

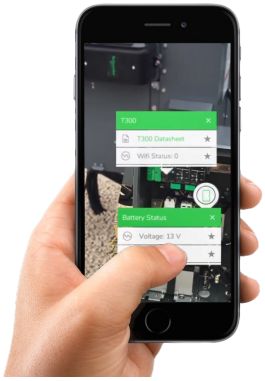
Digital – physical link

Access AR information

101

Types of pointing

Direct pointing

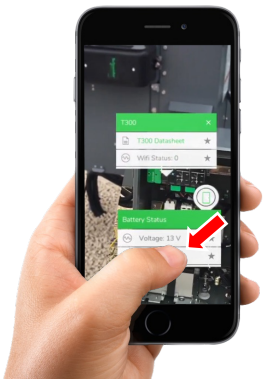


Indirect pointing

102

Types of pointing

Direct pointing

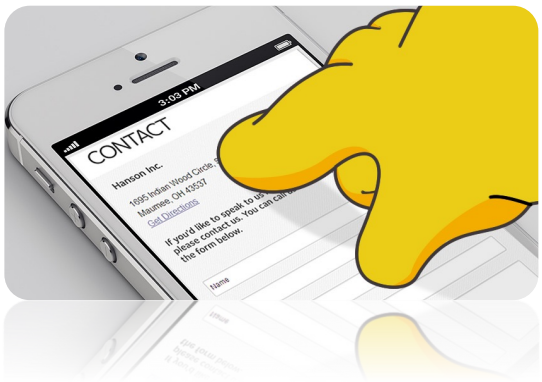


Indirect pointing

103

Problems with direct pointing

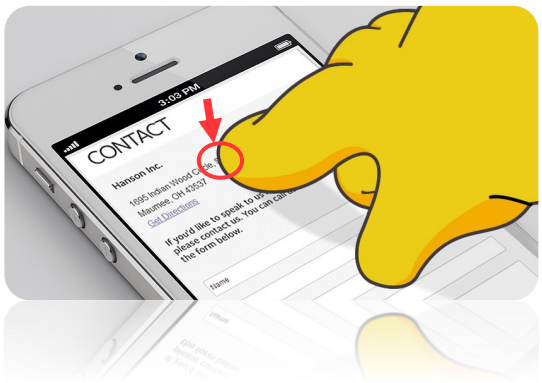
- **Target occultation**
- Ambiguous selection area
- Unreachable screen areas
- Instability



104

Problems with direct pointing

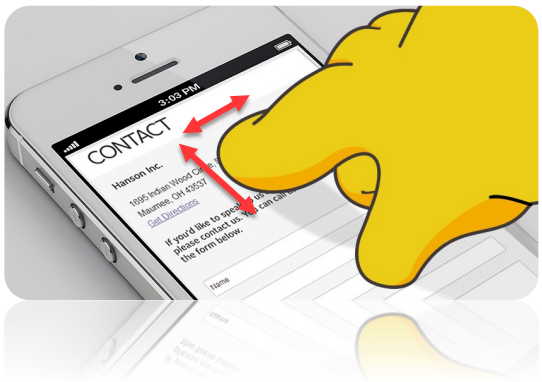
- **Target occultation**
- Ambiguous selection area
- Unreachable screen areas
- Instability



105

Problems with direct pointing

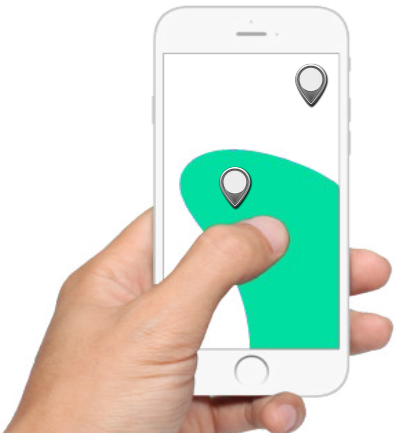
- Target occultation
- **Ambiguous selection area**
- Unreachable screen areas
- Instability



106

Problems with direct pointing

- Target occultation
- Ambiguous selection area
- **Unreachable screen areas**
- Instability



107

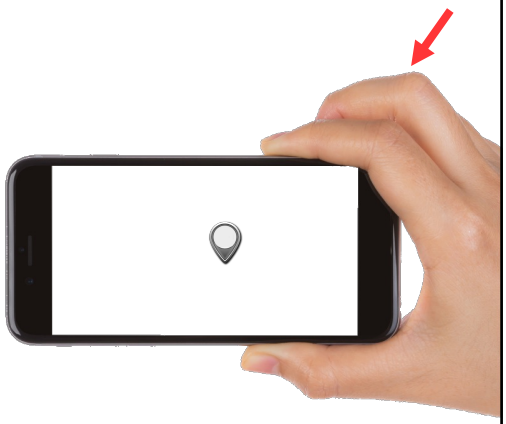
Problems with direct pointing

- Target occultation
- Ambiguous selection area
- **Unreachable screen areas**
- Instability

108

Problems with direct pointing

- Target occultation
- Ambiguous selection area
- Unreachable screen areas
- **Instability**



109

Problems with direct pointing

- Target occultation
- Ambiguous selection area
- Unreachable screen areas
- **Instability**

110

Solution

Indirect pointing

111

Solution

Indirect pointing

✓ No target occultation

112

Solution

- ✓ No target occultation
- ✓ No ambiguous selection area

Indirect pointing

113

Solution

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas

Indirect pointing

114

Solution

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability

Indirect pointing

115

Solution

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability

Indirect pointing

116

Solution

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability

Indirect pointing

117

Solution

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability

Indirect pointing

118

Increasing the size of targets

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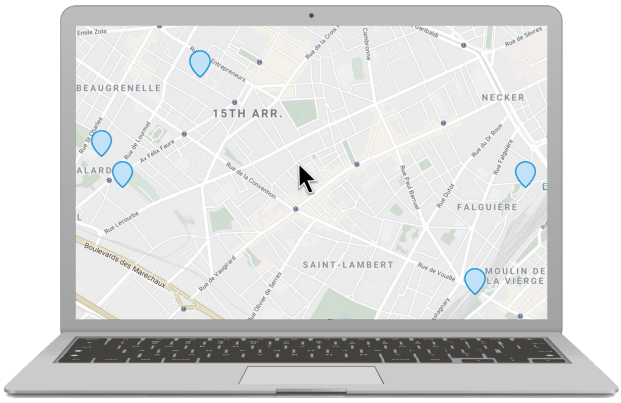
Target expansion

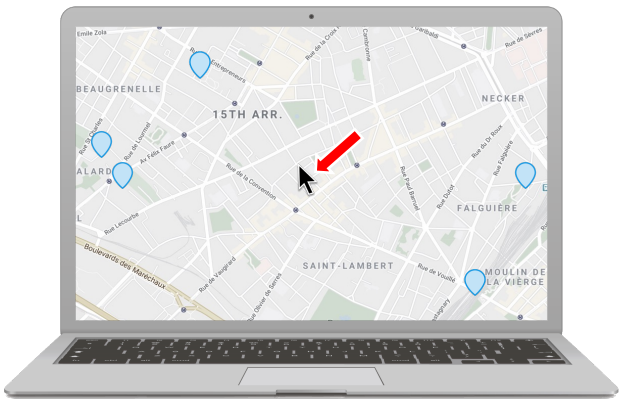
Example



120

Target expansion

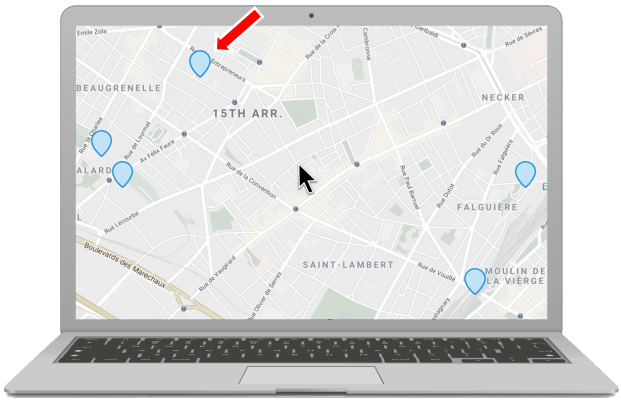
Example



121

Target expansion

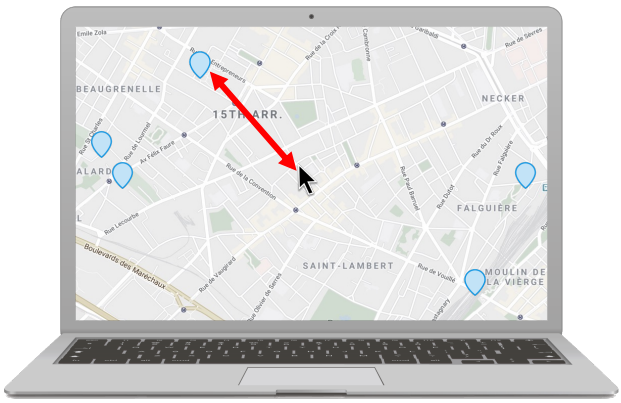
Example



122

Target expansion

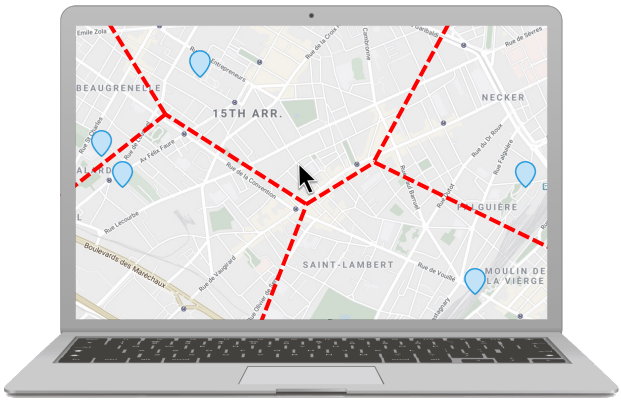
Example



123

Target expansion

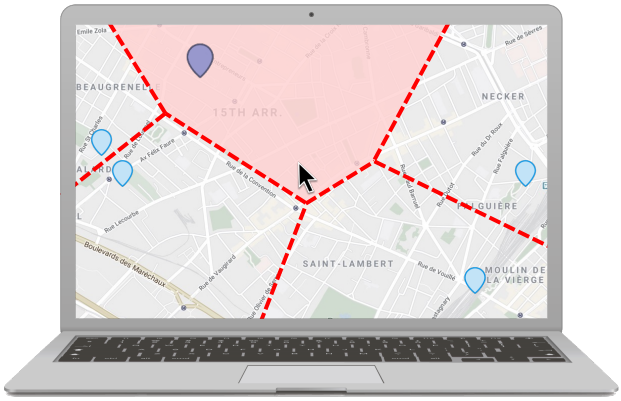
Example



124

Target expansion

Example

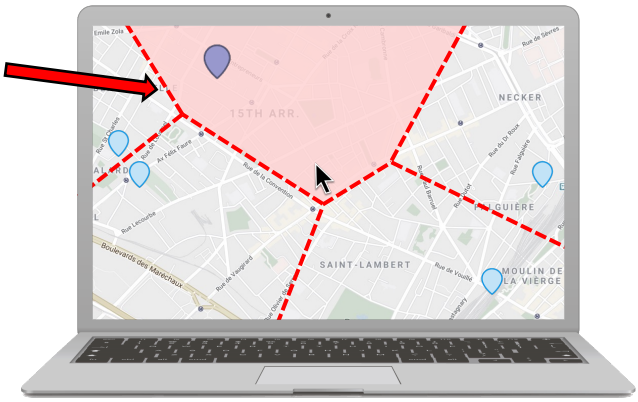


125

Target expansion

Example

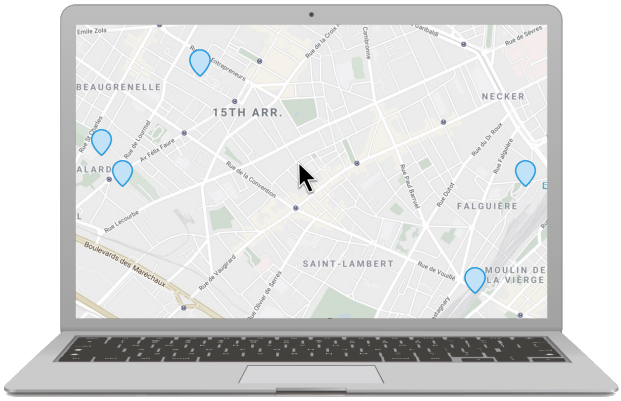
VORONOÏ



126

Target expansion

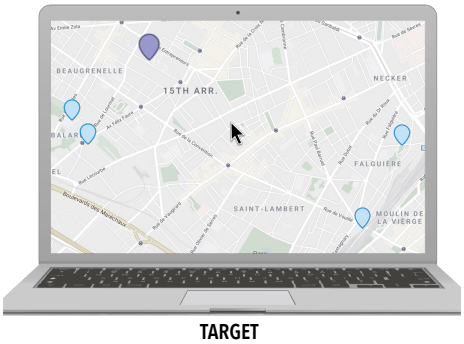
Example



127

Target expansion

Example



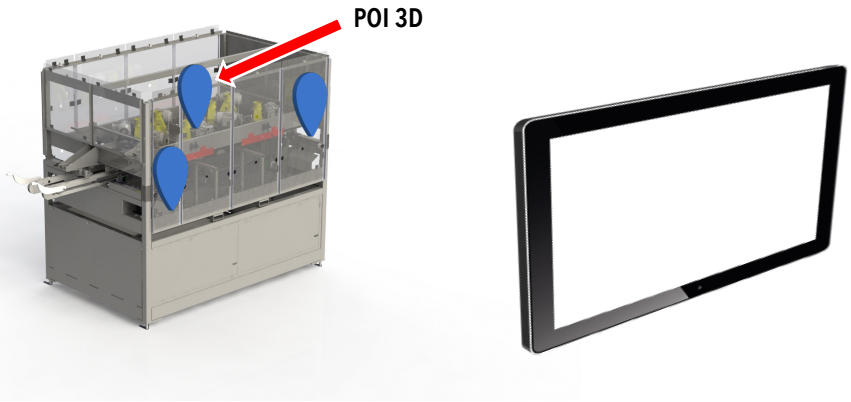
TARGET

CELL PAINTING

128

Target expansion

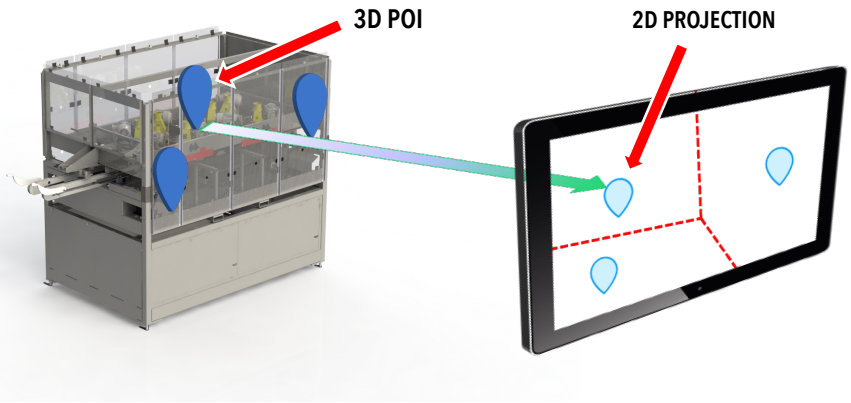
Handheld AR adaptation



129

Target expansion

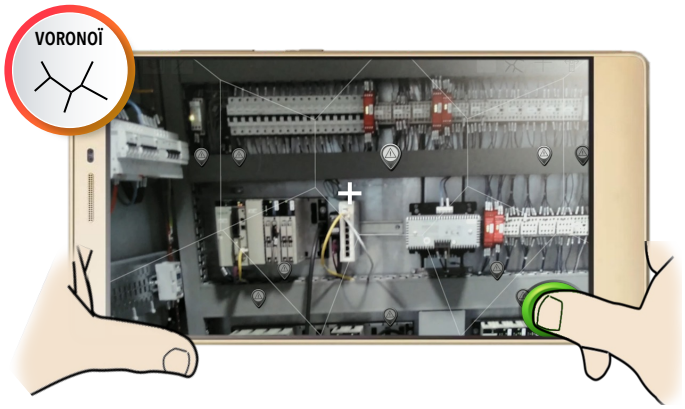
Handheld AR adaptation



130

Target expansion

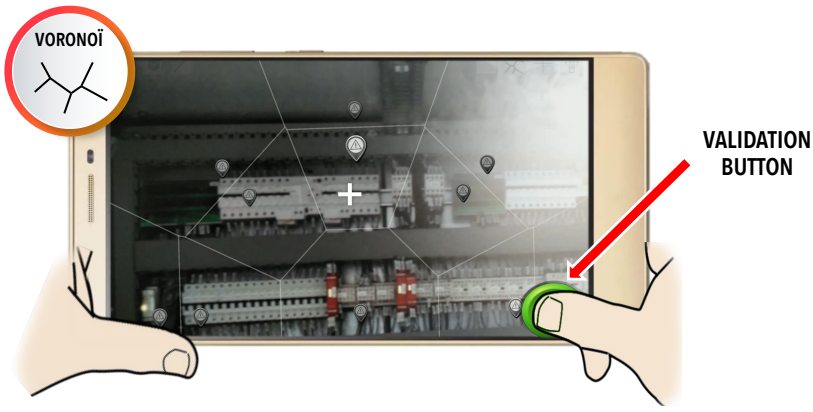
Handheld AR adaptation



131

Target expansion

Handheld AR adaptation



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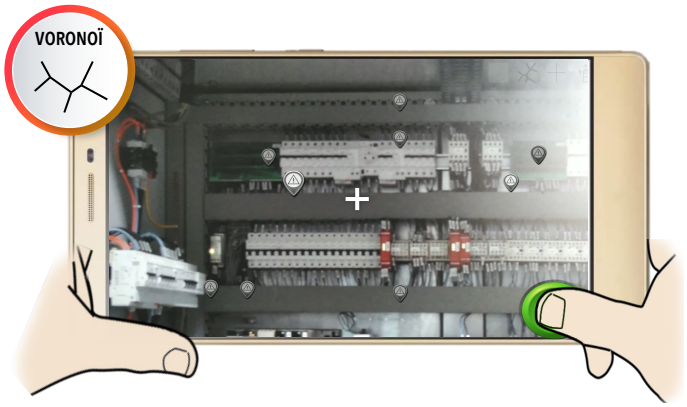
Digital information access

Problem



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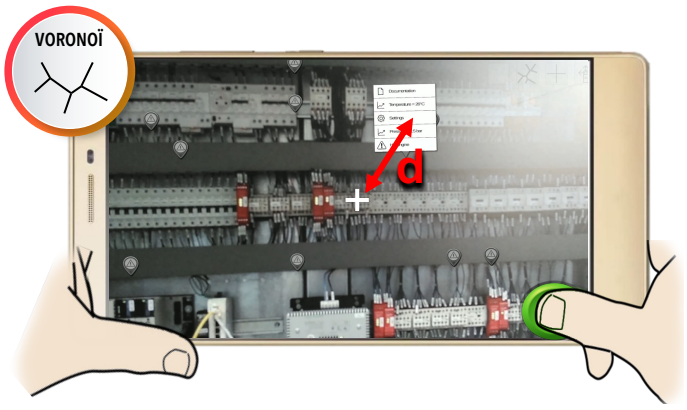
Digital information access

Problem



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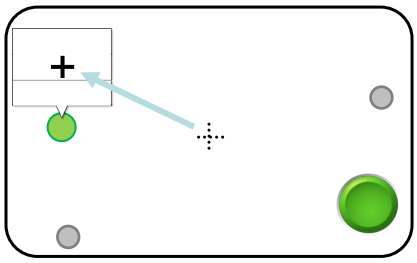
Digital information access

Different strategies

1. How to make the cursor **jump** ?
2. How to **manipulate** the cursor?



Jumping cursor

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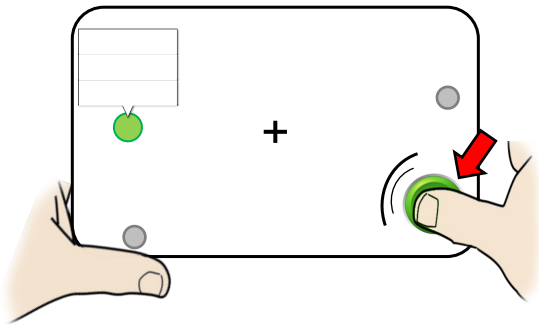
Digital information access

Jumping cursor



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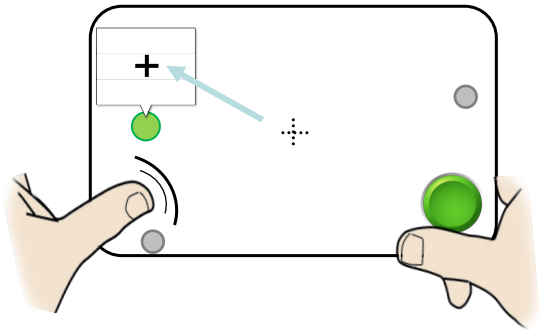
Digital information access

Jumping cursor



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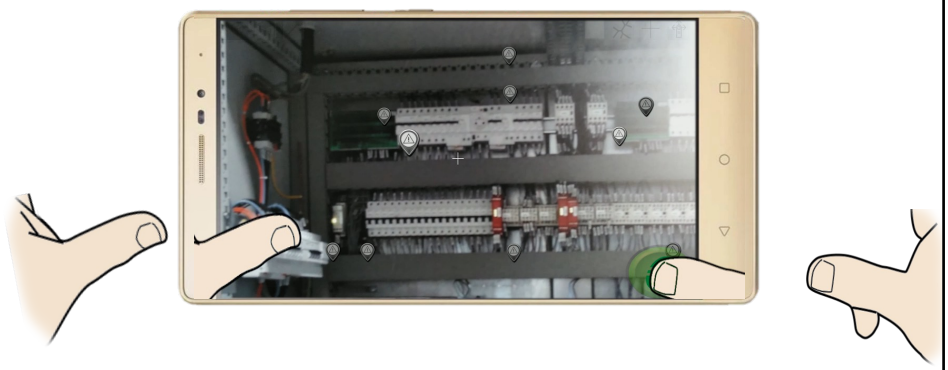
Jumping cursor



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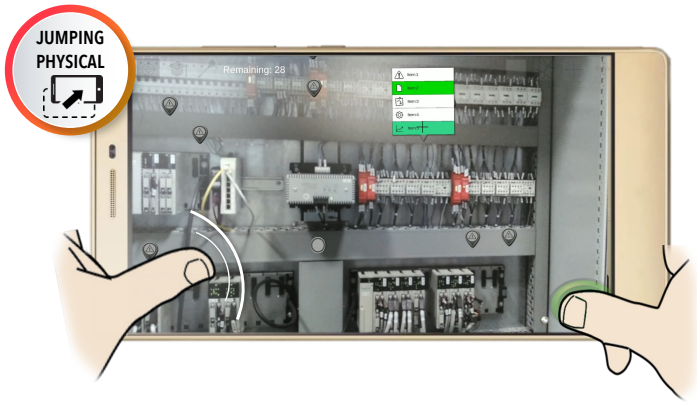
Digital information access

Cursor manipulation



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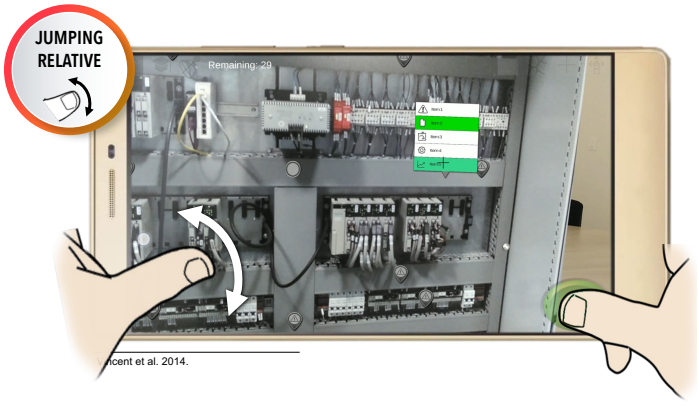
Digital information access

Cursor manipulation



ncent et al. 2014.

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Evolution des dispositifs mobiles

- Nombreuses possibilités d'interaction (multimodalité) pour :

- Accès à de nombreuses commandes
- Accès à de grandes quantités de données
- Réalité augmentée interactive mobile

Conclusion
Mobility: a broad concept

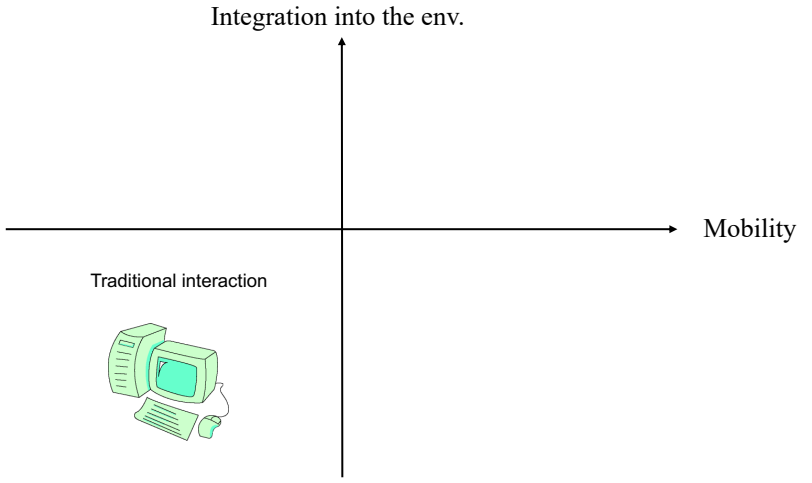
(1) moving between devices - hot-desking

(2) moving within an instrumented environment - intelligent buildings and intelligent appliances

(3) devices within moving vehicles - computers in cars

(4) small devices that move with you - smartphones, watches

Conclusion:
From WIMP to Post-WIMP



[Lyytinen & Yoo 2002]

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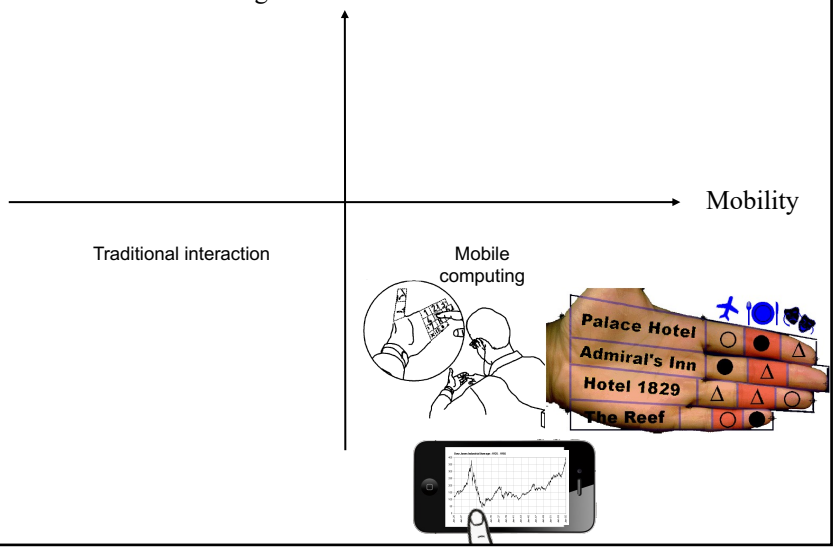
Conclusion:
From WIMP to Post-WIMP



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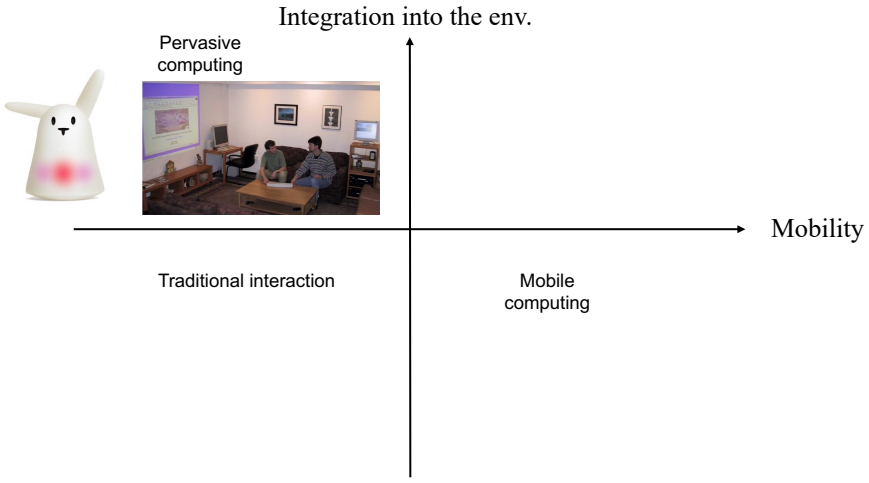
Conclusion:
From WIMP to Post-WIMP



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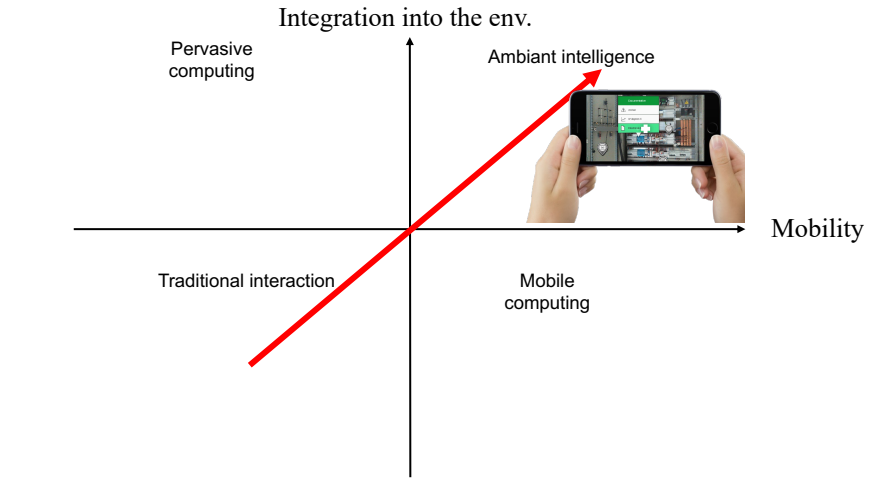
Conclusion:
From WIMP to Post-WIMP



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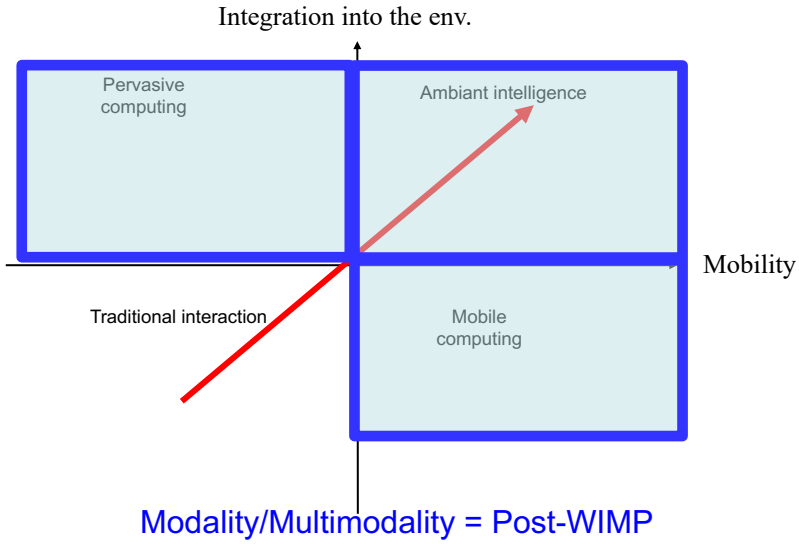
Conclusion:
From WIMP to Post-WIMP



Modality/Multimodality = Post-WIMP

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