



LUDWIG-
MAXIMILIANS-
UNIVERSITÄT
MÜNCHEN



LFE Medieninformatik • Wolfgang Reithmeier
Diploma Thesis – final report

Complex Gestures for Mobile Interaction with Dynamic NFC-Displays

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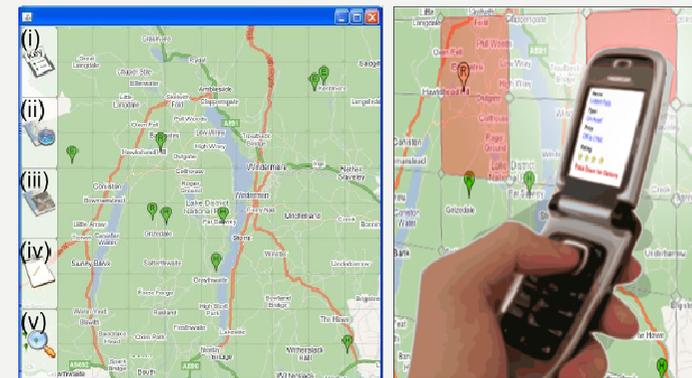
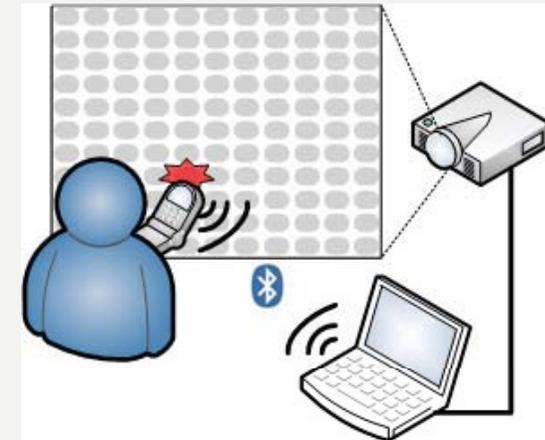
Hochschullehrer: Prof. Hußmann

20. October 2009



Motivation

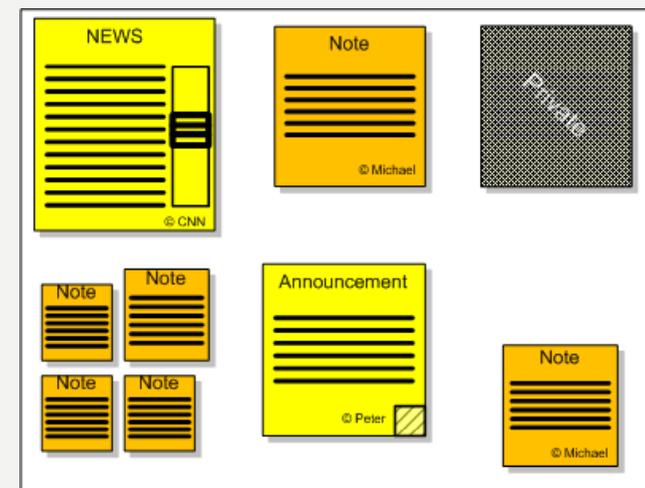
- Dynamic NFC displays
 - Grid of ordered NFC tags
 - Projected dynamic interface
- Comparison with public displays and touchscreens
 - Direct interaction
 - Personalized interaction
- Work on dynamic NFC-display in the context of the MULTITAG-project (DOCOMO, Lancaster University)



(Hardy et al., 2008)

Task Description

- Extension of the project thesis (NFC Display Framework)
- Investigation of interaction techniques (e.g. Touch-Select, Click-Select) and gestures on dynamic NFC-displays
- Looking for suitable scenarios, e.g. NFC-Billboard
- Comparison of interaction techniques and gestures for different application features
 - Which interaction techniques and gestures are technically feasible?
 - Which interaction techniques and gestures are useful/intuitive/accepted/... ?
 - What is the best mapping between interaction techniques, gestures and application features?



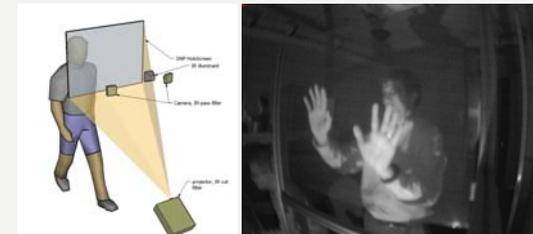
Overview

- Related Work
- Analysis & Requirements
- Use Case Scenario
- Implementation of Interaction Techniques
- User Study
- Outlook

Selected Related Work

Public Display Interaction

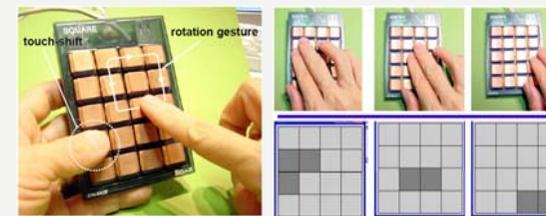
- TouchLight [Wilson, 2004]



(Wilson, 2004)

Gesture Techniques

- Presense [Rekimoto. 2003]
- HoverWidgets [Grossmann, Baudisch. 2006]



(Rekimoto. 2003)

Physical Mobile Interaction

- Hovering [Välkkynen. 2006]
- Marked-up Maps [Reilly. 2004 / 05]



(Välkkynen. 2006)

Analysis & Requirements

Desktop Interaction Modalities (comp. WIMP)

- (Double-) Click, Right-Click / Context Menu, Multi Select / Clear, Resize, Mouse Gestures...



Touch & Pen based Interaction

- Some special enhancements / adaptations
- Drag & Drop alternatives (e.g. Pick-and-Drop [Rekimoto, 97]), Tap & Hold, Pen Gesture (characters, strokes, ...)
- Mode switching techniques [Li et al., 2005]

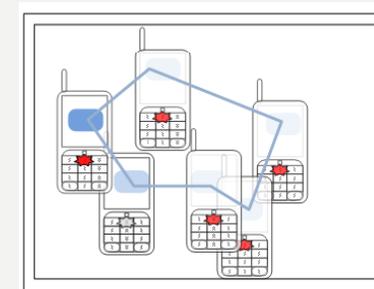


(<http://optimoz.mozdev.org/gestures/>, 2009)

NFC touch based interaction

[Reilly 2005, Vetter 2006, Hardy, Rukzio 2008/09]

- Touch Select / Hovering, Click-Select, Path-Select, ...
- Multi-Select / Multi-Selection, Polygon-Select, ..



Use Case Scenario: NFC-Billboard

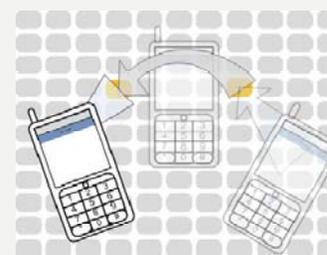
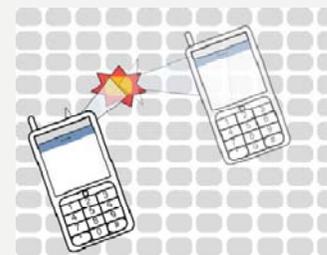
- **Rich application for different interaction techniques and gestures**
- **Adopts concept of paper-based billboard**
 - Creation of messages on mobile device
 - Posting and retrieval of messages, pictures, etc. by touching the NFC-display
 - Easy browsing of many messages
 - Additional functionalities e.g. via toolbar
- **Use case already applied in practical – positive feedback**



Implementation of Interaction Techniques 1/7

- **Techniques used by the Prototype**

- **(Double-)Touch-Select**
- **Press&Hold, Click-Select**
- **Multiple Selection (indirect)**
e.g. via Bounding-Box
- **Single Selection (direct)**
Mode Switch + Touch-Select
- **Drag & Drop**
via *Pick&Drop, Press&Hold,...*
- **Mode Switch**
via Phone-Menu and Toolbar
- **Gestures**
OneStroke, Offset-(Shape)-Gesture
- **Cancel**
via key, gesture or toolbar



Implementation of Interaction Techniques 2/7

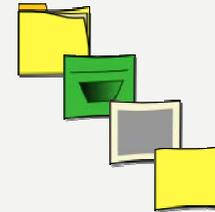
Pinboard Application-specific Features

- **Items**

- Different types (Messages, Pictures, Coupons, Folders)
- Items have two states: collapsed / expanded

- **Toolbar**

- Provides features for all items (views, filters and modes)



← filters

← views

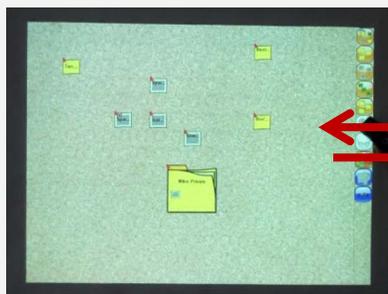
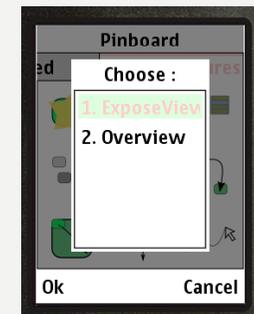
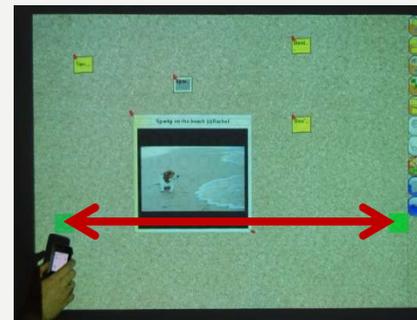
← modes

Implementation of Interaction Techniques 3/7

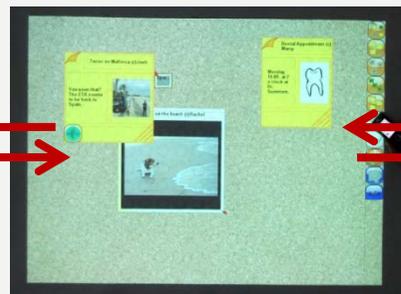
Pinboard Application-specific Features

- **Views**

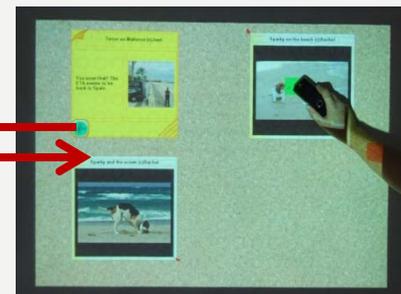
- Three different view:
Overview, Standard-View and Exposé
- Three different options:
Toolbar, phone-menu and gestures



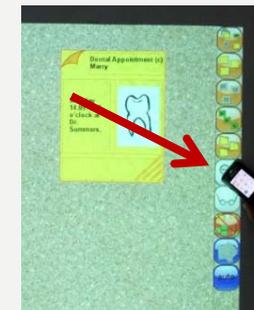
Overview
(all items collapsed)



Standard view
(items collapsed
or expanded)



Exposé
(overview of expanded,
overlapping items)



Implementation of Interaction Techniques 4/7

Pinboard Application-specific Features

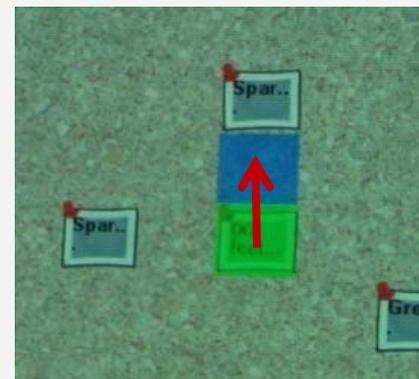
- **Tooltip**

- Shows meta information on the mobile device



- **Collapse / expand items**

- Show / hide content of the item

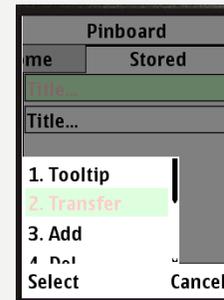


Implementation of Interaction Techniques 5/7

Pinboard Application-specific Features

- **Create / Upload items**
 - Transfer items to the pinboard
 - Place (and size) items

- **Download items**
 - Transfer items to the phone



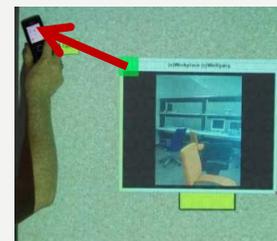
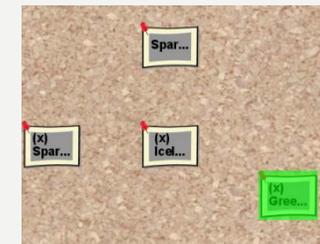
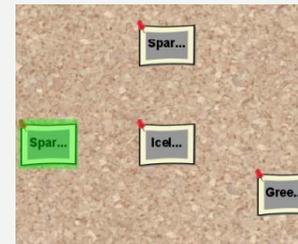
Implementation of Interaction Techniques 6/7

Pinboard Application-independent Features

- **Single Selection**
 - (De-)Select one item per action

- **Multiple Selection**
 - Select multiple items per action

- **Drag & Drop**
 - Moving items around the board



Implementation of Interaction Techniques 7/7

Pinboard Application-independent Features

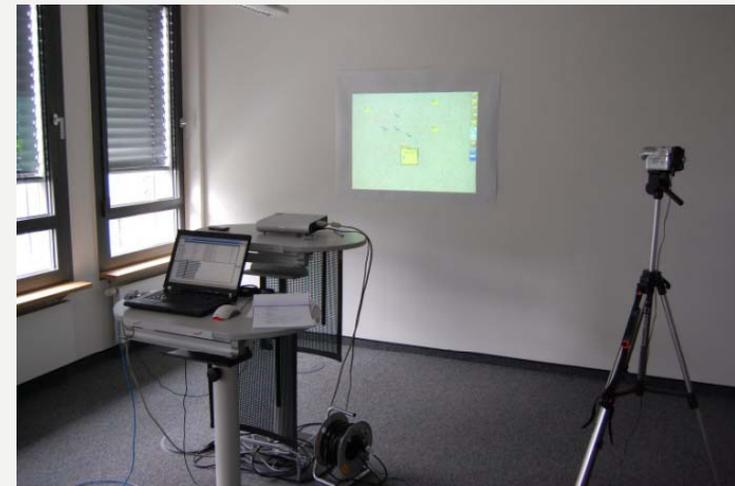
- **Context-Menu / Right-Click**
 - Two different type of menus (item and empty space)
- **Cancel current gesture**
 - Abort all interaction modalities
- **Mode-Switch**
 - Mode: Scope restriction of a gesture, allows reuse of e.g. Touch-Select



User Study 1/6

Setup & Preparation

- **Qualitative evaluation**
 - 11 subjects (8 students)
 - 10 male, 1 female, average age 27
- **Comparison of interaction techniques and gestures for different application features**
- **Each feature triggered by exchangeable interactions (flexible rules / grammar)**
- **Fixed order of tasks, randomized order of interactions for each task**
- **Questionnaires to evaluate specific features**
- **Analysis of task completion time (logs), errors and attention shifts (video analysis)**



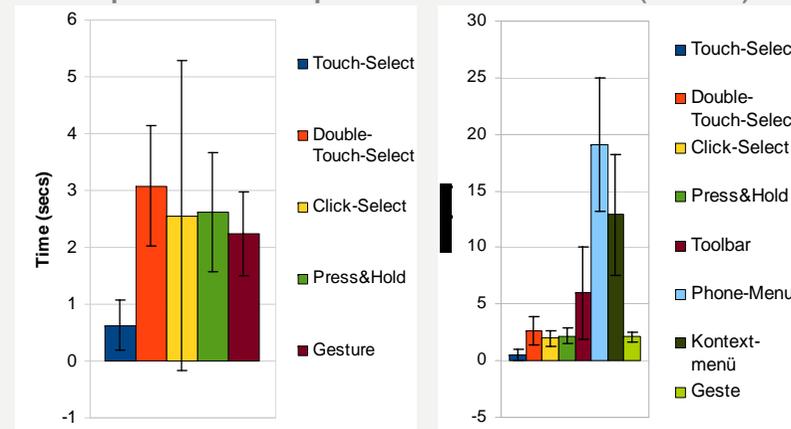
User Study 2/6

Results

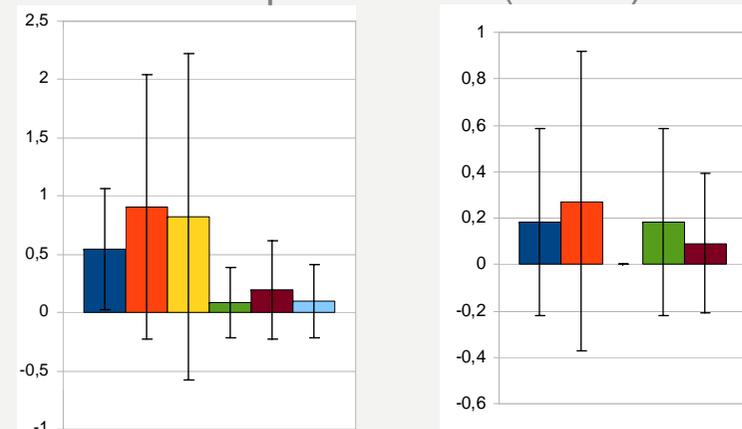
- **Touch-Select**
 - Subjects: Intuitive and fast
 - Adequate for simple actions

- **Double-Touch-Select**
 - Subjects: Uncomfortable
 - Users seem to stick on behavior of *Double-Click*
 - error-prone

Expand/Collapse & Download (Time)



Tooltip & Context (Errors)



User Study 3/6

Results

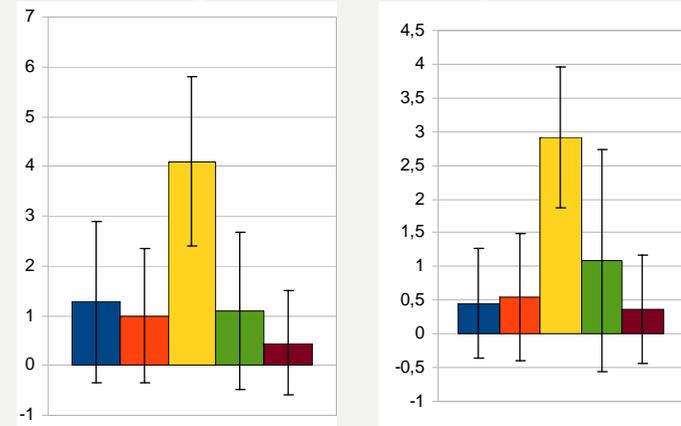
- Click-Select**

- Subjects: Different opinions + User feels in-control
- Additional attention shifts

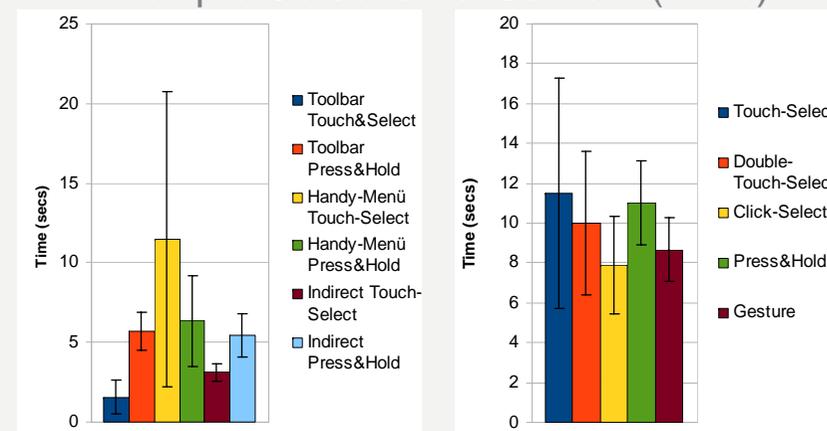
- Press&Hold**

- Subjects: Problems with delay
- Not suitable for repetitive interactions like *Multiple Selection*
- Prior Knowledge: Context-Menu (2nd place)

Expand/Collapse & Context (Attention Shifts)



Multiple Selection & Context (Time)



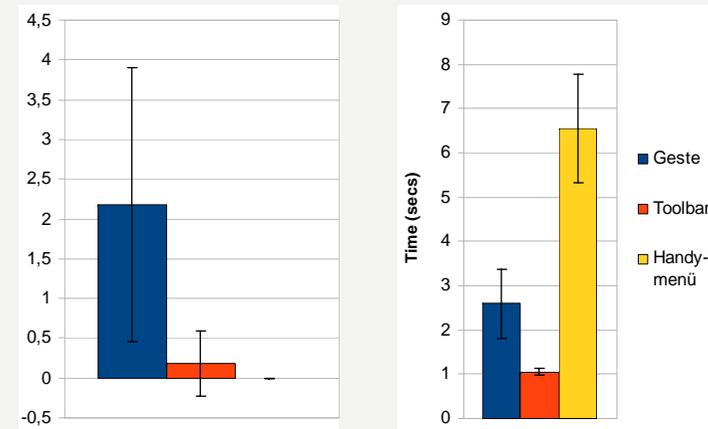
User Study 4/6

Results

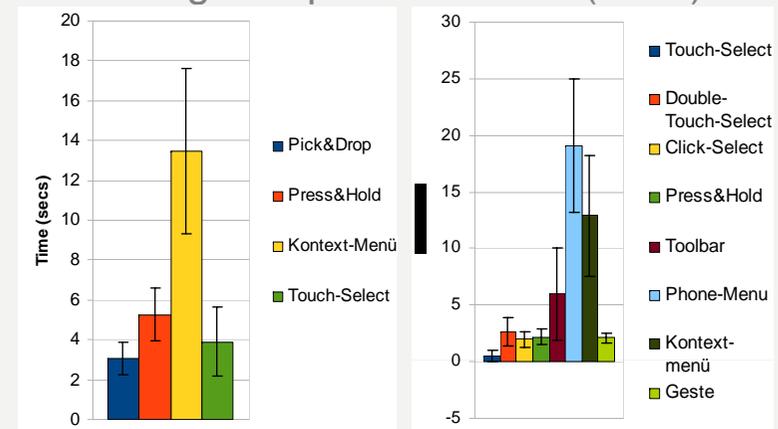
- **Gestures**
 - Subjects: Very interesting, good alternative
 - Top-ranked for downloading / open context menu
 - Short and intuitive gestures preferred

- **Context-Menu**
 - Subjects: Additional action not always comfortable
 - Most suitable for direct interactions like downloading

View (Errors + Time)



Drag&Drop & Download (Time)

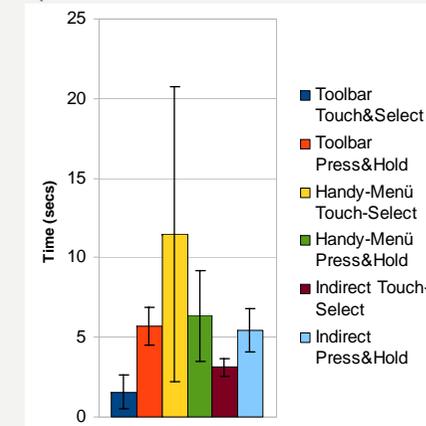
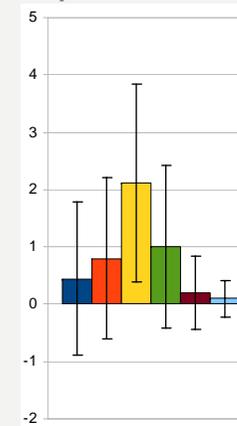


User Study 5/6

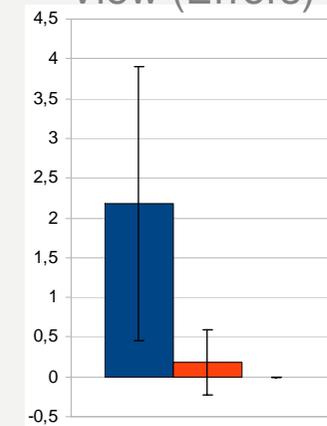
Results

- **Two different impl. of Mode-Switch**
 - Useful for repetitive tasks
 - Allows reuse of e.g. *Touch-Select*
- **Toolbar**
 - Most adequate method for Mode-Switch in general
 - No need to switch focus
- **Phone-Menu**
 - Subjects: Uncomfortable, additional attention-shifts and complexity
 - More adequate for direct actions like switching views

Multiple Selection (Attention Shifts + Time)



View (Errors)



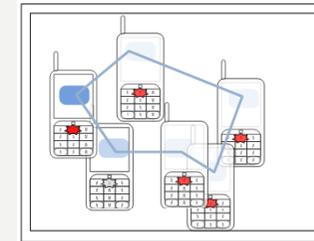
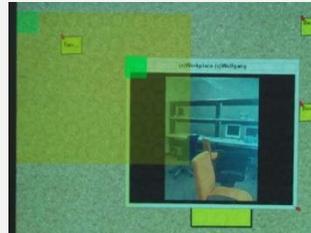
User Study 6/6

Summary

- **Touch-Select preferred for most interactions**
 - Easy to learn and use, fast, familiar and intuitive
 - Alternatives needed for different interactions
 - Mode switches, especially toolbar, suitable to differ between interactions
- **Click-Select, Double-Touch, Press&Hold not well received**
 - Mostly redundant compared to *Touch-Select*
 - Often too much for simple interactions
 - Only suitable for specific interactions, e.g. explicit triggering of actions
- **Mixed results for gestures**
 - Simple 2-tag-gestures well accepted
 - Effort for gestures should not be too great (see view)

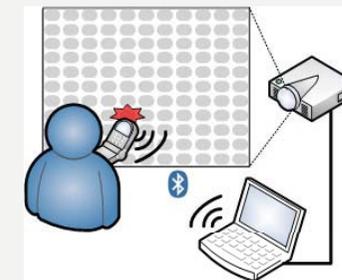
Outlook

- **Try to generalize findings of the different interactions (e.g. Fitts's Law tests)**
- **Exhaust abilities of the grammar, build new / different type of interactions**
- **Go towards real multi-user environments**
- **Solve problems concerning shadowing (e.g. small-angle projection)**



Thanks For Listening !

Questions ?!



Details on Implementation

- **Formalize interactions (create Rules)**

- **Constants:** T=Touch, R=Release, $K_{press} / K_{release} = \text{down} / \text{up}$
- Min / Max **occurrence:** 0^n
- **Sequences:** $[\text{Const}_1 \mid \text{Seq}_1, \dots, \text{Const}_n \mid \text{Seq}_n]$
- **Restrictions** $[\text{restriction}]$:
 $[d < 1000]$ (delay), $[p1=p2 (0,1,2,\dots)]$ (point equality), $[== (0,1,2,\dots)]$ (equality), $[==]$ (self-equality), $[x, y, w, h]$ (area-restriction), $[k=\text{code}]$ (key-code equality), $[NN (0,1,2,\dots)]$ (Neighbouring) or $[\{1, -1\} (0,1,2,\dots)]$ (offset)
- (optional) CheckPoints

- **Sample:**

- $[[T, R][p1=p2][d > 1000]]$ (**Press&Hold**)
- $[[[[T, R][p1=p2]][p1=p2, 0], [[T, R][p1=p2]] 0^*, [[T, R][p1=p2]][p1=p2, 0]]$ (**Polygon-Select**)

Advantages of dynamic NFC-Displays

- **Direct interaction instead of remote driven interactions of the most public displays**
- **More personal than standard touch screens, uses the users' own device instead of touching with the finger**
- **Additional advantages coming along with the NFC-technology used (Identification of users, ease of connection-establishment, environmental robustness, ...)**
- **Having privacy-relevant information on the users' display**
- **Combination of dynamic and static displays**
- **Already existing and supported technology with ongoing distribution**