Complex Gestures for Mobile Interaction with Dynamic NFC-Displays

Betreuer: Dipl. Medieninf. Gregor Broll (LMU/DOCOMO)
Dr. Matthias Wagner (DOCOMO)
Hochschullehrer: Prof. Hußmann

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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]

Gesture Techniques
• Presense [Rekimoto, 2003]
• HoverWidgets [Grossmann, Baudisch, 2006]

Physical Mobile Interaction
• Hovering [Välkkynen, 2006]
• Marked-up Maps [Reilly, 2004/05]
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 / adaptions
• Drag & Drop alternatives (e.g. Pick-and-Drop [Rekimoto, 97]), Tap & Hold, Pen Gesture (characters, strokes, …)
• Mode switching techniques [Li et al., 2005]

NFC touch based interaction


• Touch Select / Hovering, Click-Select , Path-Select, …
• Multi-Select / Multi-Selection, Polygon-Select, …

http://optimoz.mozdev.org/gestures/, 2009
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)
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
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)
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
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
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, \( K_{\text{press}} / K_{\text{release}} = \text{down} / \text{up} \)
  - Min / Max **occurrence**: \( 0^n \)
  - **Sequences**: \([\text{Const}_1 | \text{Seq}_1, \ldots, \text{Const}_n | \text{Seq}_n]\)
  - **Restrictions** [restriction]:
    - \([d < 1000]\) (delay), \([p_1=p_2 (0,1,2,\ldots)]\) (point equality), \([= (0,1,2,\ldots)]\) (equality), \([=]\) (self-equality), \([x, y, w, h]\) (area-restriction), \([k=\text{code}]\) (key-code equality), \([NN (0,1,2,\ldots)]\) (Neighbouring) or \([\{0,1,2\ldots\}]\) (offset)
  - (optional) CheckPoints

- **Sample**:
  - \([T, R][p_1=p_2][d > 1000]\) (Press&Hold)
  - \([[[T, R] [p_1=p_2]] [p_1=p_2, 0], [[T, R] [p_1=p_2]] 0^*, [[T, R] [p_1=p_2]] [p_1=p_2, 0]]\) (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