Design and Distribution of Physical and Mobile Interfaces for Multi-Tag Interaction

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Diploma Thesis
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Outline

• Motivation
• Topic of the Thesis
• Related Work
• Preliminary Classification of Multi-Tag Interaction
• 1st User Study: Navigation and Selection
• Outlook
- Interaction between mobile devices and smart objects [Rukzio et al., 2007]

- Goals
  - More intuitive, simpler and direct interaction
  - Overcoming the adversities of mobile devices

- Physical Mobile Applications
  - E.g. ticketing, information services, access control, selections

- Physical Mobile Interaction often as first step in the interaction process with a service

Sources: www.touchandtravel.de, www.visa-asia.com
**Single-Tag Interaction**
- Interaction with single tag
- No real physical interface & interaction
- Suggested classification [Herting et al., 2008]:
  - Presentation of Information
  - Physical Hyperlinks
  - Tagging
  - Broadcasting
  - Tag Emulation
  - 2-Way-Interaction

**Multi-Tag Interaction**
- Interaction with more than one tag or object
- Stronger focus on physical interface & interaction
- No suggested classification
• Investigation of interface and interaction design distributed between physical objects and mobile devices

• Classification of Multi-Tag Interactions and Applications

• Comparison and evaluation of different designs for Single-Tag Interaction and Multi-Tag Interaction
  • Categories of Multi-Tag Interaction
  • Specific example applications
  • Different designs for Single-Tag Interaction and Multi-Tag Interaction

• Best practices for design of multi-tag applications and interfaces
• **Enabling Technologies**
  • Numeric Identifiers, Bluetooth, Infrared, Visual Markers, Laser Pointer, RFID, Near Field Communication (NFC)

• **Basic Physical Mobile Interaction Techniques**
  • Touching [Rukzio et al., 2007]
  • Pointing
  • Scanning
  • User Mediated Object Interaction
  • Hovering [Välkkynen, 1997]
• **Advanced Physical Mobile Interaction Techniques (Multi-Tag Interaction)**
  
  • Point & Shoot [Ballagas et al., 2005]
    • Selection with a grid of visual markers
  
  • Collect & Drop [Broll et al, 2008]
    • Action Items and Data Items
  
  • Selection Techniques [Reilly et al., 2005]
    • Click-Select, Path-Select, Lasso-Select etc.
  
  • Touch & Interact [Hardy et al., 2008]
    • Interaction with public display (cf. touch screens)

Sources: [Ballagas et al., 2005], [Broll et al., 2008], [Hardy et al., 2008]
Preliminary Classification of Multi-Tag Interaction

- **Navigation**
  - Interaction-specific
  - Navigation within an application accomplished through physical interaction
  - Different tags offer different entry points to an application

- **Selection**
  - Interaction-specific
  - Selection of options/items accomplished through physical interaction

- **Combination of Information**
  - Application-specific
  - Combination of same/different types of information (e.g. actions and objects)

- **Mapping**
  - Application-specific
  - Mapping of specific application-features to specific tags
The First User Study

- **Tested pattern**
  - Selection
  - Navigation

- **Use case**
  - Ordering in a restaurant with the help of an NFC enhanced menu

- **Workflow**

```
Start <-> Welcome <-> C. 1 <-> C. 2 <-> C. 3 <-> C. 4 <-> Summary <-> Submit <-> Confirmation
```

- Navigation
  - Handy
  - Poster
    - STI
    - MTI #1
    - MTI #2
    - MTI #3
• Tag-Enhanced Poster & Mobile Application
Multi-Tag Interaction #1

- Tag-Enhanced Poster & Mobile Application

![Diagrams of mobile application interfaces for Osteria Italiana]
• Tag-Enhanced Poster & Mobile Application

**Osteria Italiana**

To order start the application "Osteria Italiana" on your mobile device.

**Choose Appetizer**
- Antipasti Mix
- Bruschetta
- Bruschetta al Funghi
- Prosciutto e Melone
- Panzanella al Tomate
- Penne alla Norma
- Insalata Caprese

**Choose Main Course**
- Pizza Panna
- Pizza Margherita
- Pizza Funghi
- Pizza Ruggina
- Pasta al Tomate
- Spaghetti Bolognese
- Spaghetti Carbonara

**Choose Dessert**
- Tiramisu
- Panna cotta al Cioccolato
- Panna Cotta
- Tartu di Cioccolato
- Vanille EISEN
- Chocolito EISEN

**Choose Drink**
- Table Water
- Apple Juice
- Orange Juice
- Cranberry Juice
- Sprite
- Ginger
- Coca Cola
Multi-Tag Interaction #3

• Tag-Enhanced Poster & Mobile Application

Choose Appetizer
- Antipasti Misti
- Bruschetta
- Bruschetta al Tramonto
- Prosciutto e Melone
- Transcontinental Tramezzino
- Pani D’Avola Manciato
- Insalata Caprese

Choose Main Course
- Pizzette
- Pizzette Napolitane
- Pizzette Napoletane
- Pizzette Torriana
- Spaghetti Bolognese
- Spaghetti Carbonara

Choose Dessert
- Torta Napolitana
- Panettone
- Panettone Xmas
- Panettone Green Xmas
- Gelato & Cake
- Carabba’s Split
- Apple Pie

Choose Drink
- Table Wine
- Apulian Ch loudly
- Orange Juice
- Limoncello
- Spritz
- Beer
- Coca Cola

Welcome to the menu of Osteria Italiana

You successfully placed your order. We’ll bring you your food and drink in a short while.

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Independent Variables

- **Interface Complexity**
  - Single-Tag Interaction
  - Multi-Tag Interaction #1 (Navigation)
  - Multi-Tag Interaction #2 (Wizard, Selection)
  - Multi-Tag Interaction #3 (Free Selection)

- **Interaction Complexity**
  - Short List (7 items)
  - Long List (14 items)

- **Task Complexity**
  - Without corrections
  - With two corrections
• **Implementation**
  - J2ME, Nokia 6131 NFC SDK, J4ME

• **User Study Design**
  - 16 Participants (Latin Square Design)
  - Demographic Questionnaire, Standardized IBM “Computer System Usability Questionnaire”, Comparing Questionnaire
  - Video Analysis
  - Dependent Variables: Attention Shifts, Errors and Execution Time
  - Beforehand analysis with the Keystroke-Level-Model
  - Evaluation with SPSS
• **Attention Shifts**
  - Between mobile device and poster
  - Constant using Single-Tag Interaction and Multi-Tag Interaction #1 due to the design of the prototypes
  - Task complexity has a stronger influence than interface complexity
• **Errors**
  - Hardly any errors
    - Explanation and practice beforehand
  - Problems:
    - Usage of radiobuttons
    - Handling of NFC
• **Execution Time**
  - Time from “Start” to “Submit”
  - MTI #2 additionally was timed with help of the video
  - The more tags, the faster execution
  - STI and MTI #1 task- and interface complexity affect equally
  - MTI #2 und MTI #3 task complexity affects more
  - Comparison with Keystroke-Level Model: nearly the same times
Qualitative Evaluation

• **Multi-Tag Interaction #3**
  - Preferred by all participants
  - Got the highest rating in all (applicable) questions of the IBM questionnaire
  - Reasons: No given order, easy correction, no permanent switching between mobile device and poster

• **Suggestions of Improvements**
  - Additional information when touching a tag e.g. ingredients, price
  - More graphical design e.g. pictures of the meals
  - Search or filter function for the long lists using STI and MTI #1
  - “Submit” not only as NFC-tag but as button on the mobile device, gives feeling of being in control
Outlook

- **Two further user studies**
  - Action and Objects: Combination of Information
    - Objects: 7 Sights; Actions: Information, Route, Photos
  - GUI Widgets: Selection
    - Selection via GUI Widgets (Dropdown, Textfield, Radiobuttons, Checkboxes)
Questions?

Thank You!

<table>
<thead>
<tr>
<th>Selection</th>
<th>Navigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poster</td>
<td>Handy</td>
</tr>
<tr>
<td>STI</td>
<td>MTI #1</td>
</tr>
<tr>
<td>MTI #2</td>
<td>MTI #3</td>
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</tbody>
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