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

Doris Hausen - 19.05.2009

Diploma Thesis

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- **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 vs. Multi-Tag Interaction



- **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



Source: www.touchandtravel.de

- **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]

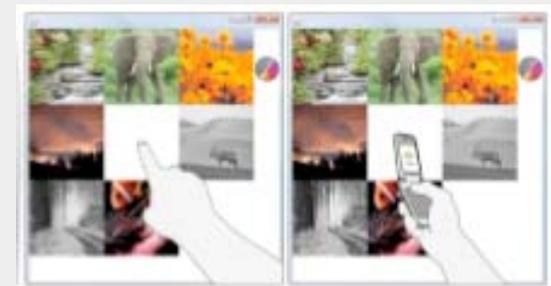


Source: [Rukzio et. Al , 2007]



- **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]



- **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



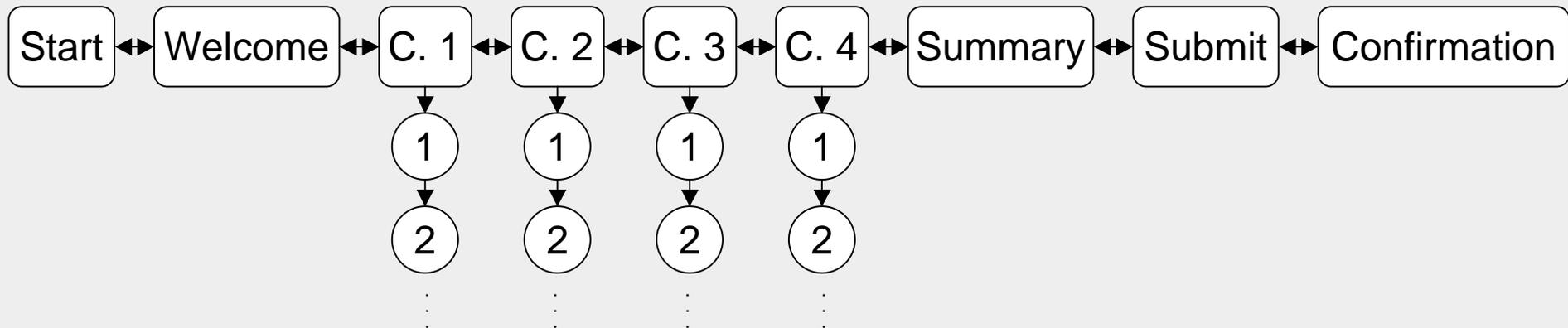
- **Tested pattern**

- Selection
- Navigation

- **Use case**

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

- **Workflow**



Navigation

Handy Poster

Selection
Poster Handy

STI	MTI #1
MTI #2	MTI #3



- **Tag-Enhanced Poster & Mobile Application**





- **Tag-Enhanced Poster & Mobile Application**

Osteria Italiana

					
Start Order	Choose Appetizer	Choose Main Course	Choose Dessert	Choose Drinks	Submit Order

a) Welcome to the menu of Osteria Italiana. Just touch the different tags to order the food and drink you want.

b) Choose Dessert menu with options: Tiramisu (checked), Frutti con Crema, Profiterol, Panna Cotta, Torta di Cioccolata, Chocolate Icecream, Vanilla Icecream, Strawberry Icecream, Lemon Icecream, Peppermint Icecream.

c) Summary screen showing: Appetizer: Antipasti Misti, Main Course: Pizza Pane, Dessert: Tiramisu, Drink: Table Water.

d) Confirmation screen: You successfully placed your order. We'll bring you your food and drink in a short while. (98718)



- Tag-Enhanced Poster & Mobile Application

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

Choose Appetizer

Antipasti Misti Bruschetta Bruschetta ai Funghi Prosciutto e Melone Tramezzini al Tonno Panini alla Mozzarella Insalata Caprese

Choose Main Course

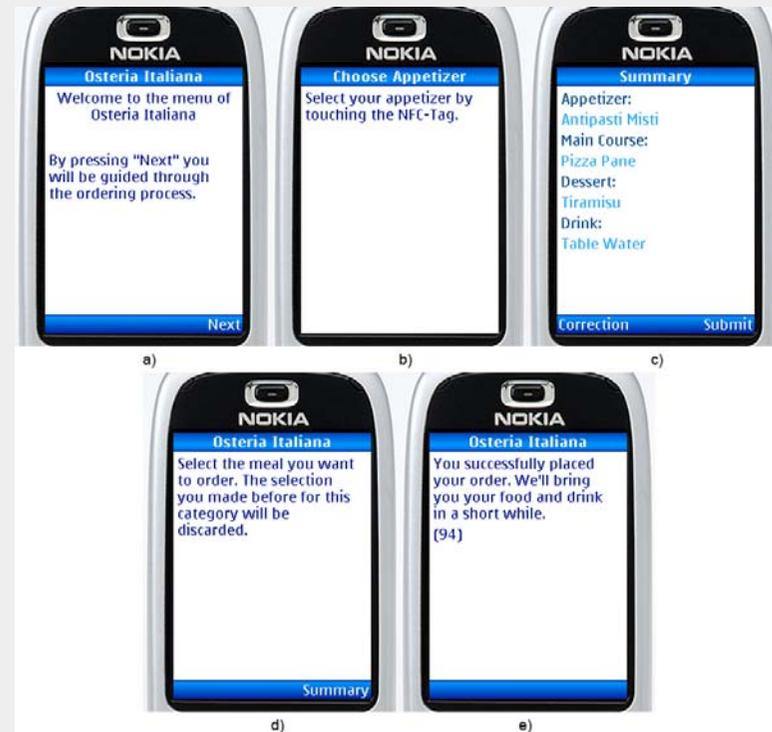
Pizza Pane Pizza Margherita Pizza Funghi Pizza Regina Pizza al Tonno Spaghetti Bolognese Spaghetti Carbonara

Choose Dessert

Tiramisu Frutti con Crema Profiterol Panna Cotta Torta di Cioccolata Vanilla Icecream Chocolate Icecream

Choose Drink

Table Water Apple Juice Orange Juice Cranberry Juice Sprite Fanta Coca Cola





- Tag-Enhanced Poster & Mobile Application

Osteria Italiana Start Order Submit Order

Choose Appetizer

Antipasti Misti	Bruschetta	Bruschetta ai Funghi	Prosciutto e Melone	Tramezzini al Tonno	Panini alla Mozzarella	Insalata Caprese
Insalata Frutti di Mare	Insalata di Arance	Peperoni Marinati	Funghi Marinati	Cipolle al Balsamico	Carpaccio	Tomato Soup

Choose Main Course

Pizza Pane	Pizza Margherita	Pizza Funghi	Pizza Regina	Pizza al Tonno	Spaghetti Bolognese	Spaghetti Carbonara
Spaghetti al Limone	Pasta al Gorgonzola	Tortellini al Forno	Lasagne	Canneloni	Gnocchi di Patate	Risotto ai Funghi

Choose Dessert

Tiramisu	Frutti con Crema	Profiterol	Panna Cotta	Torta di Cioccolata	Vanilla Icecream	Chocolate Icecream
Stracciatella Icecream	Strawberry Icecream	Lemon Icecream	Peppermint Icecream	Hazelnut Icecream	Banana Split	Apple Pie

Choose Drink

Table Water	Apple Juice	Orange Juice	Cranberry Juice	Sprite	Fanta	Coca Cola
White Wine	Red Wine	Beer	Coffee	Espresso	Hot Chocolate	Tea





- **Interface Complexity**

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

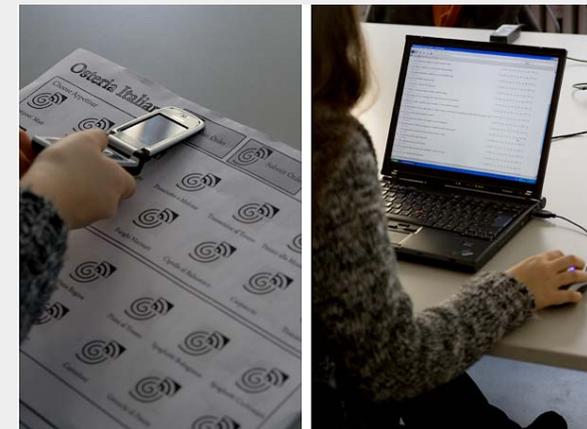


- **Interaction Complexity**

- Short List (7 items)
- Long List (14 items)

- **Task Complexity**

- Without corrections
- With two corrections





- **Implementation**

- J2ME, Nokia 6131 NFC SDK, J4ME

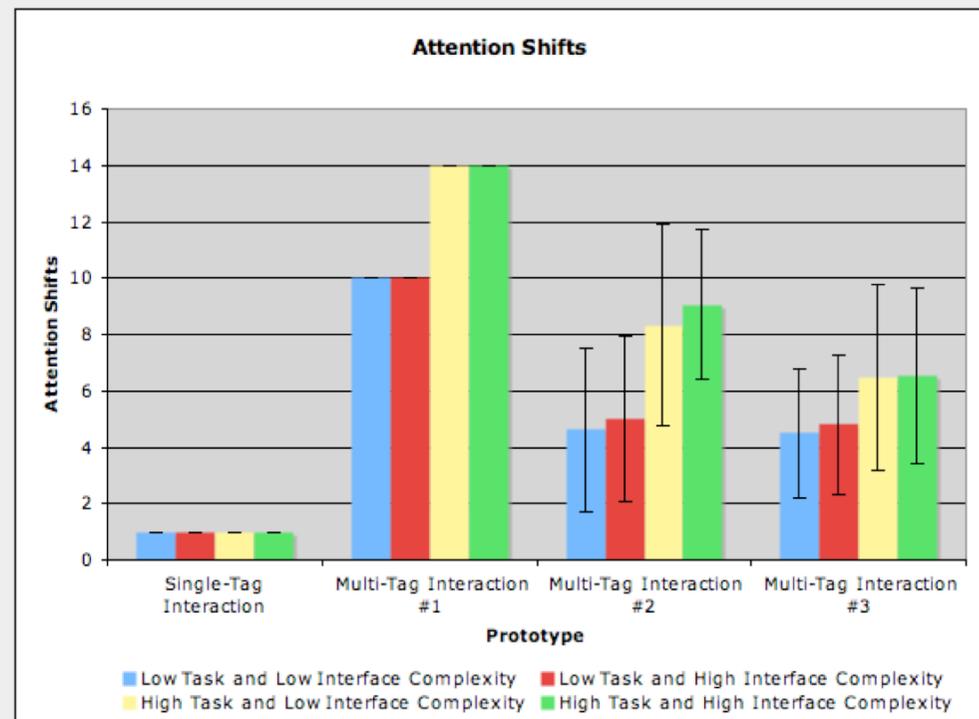
- **User Study Design**

- 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

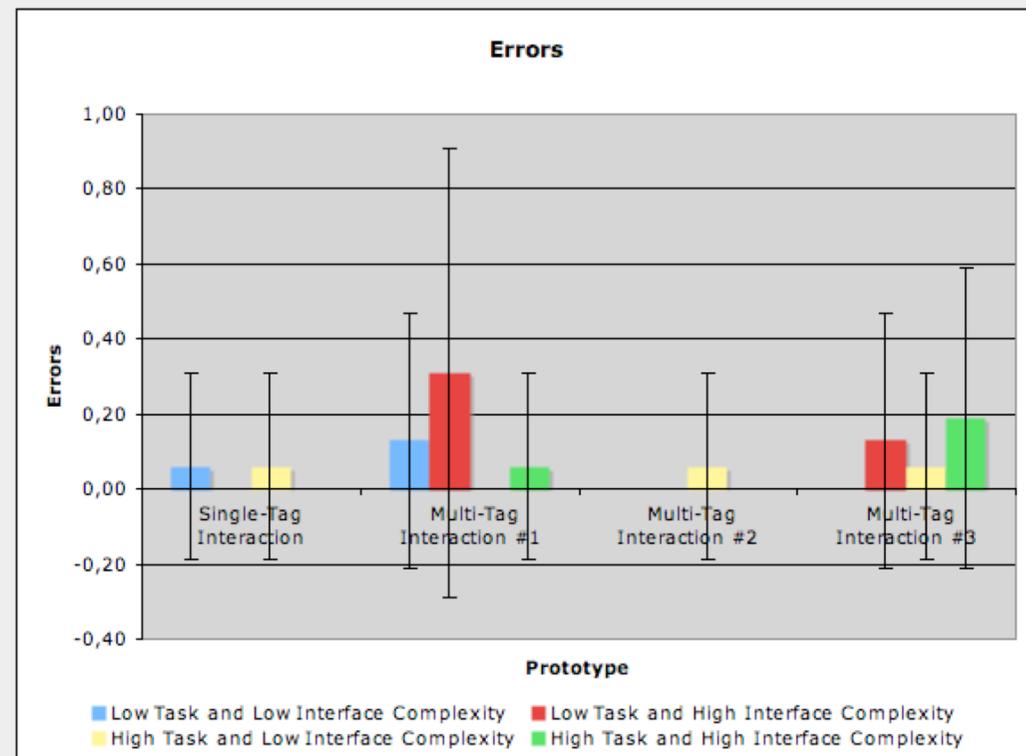
- Between mobile device and poster
- Constant using Single-Tag Interaction and Multi-Tag Interaction #1 due to the design of the prototypes
- Task complexity has a stronger influence than interface complexity





- **Errors**

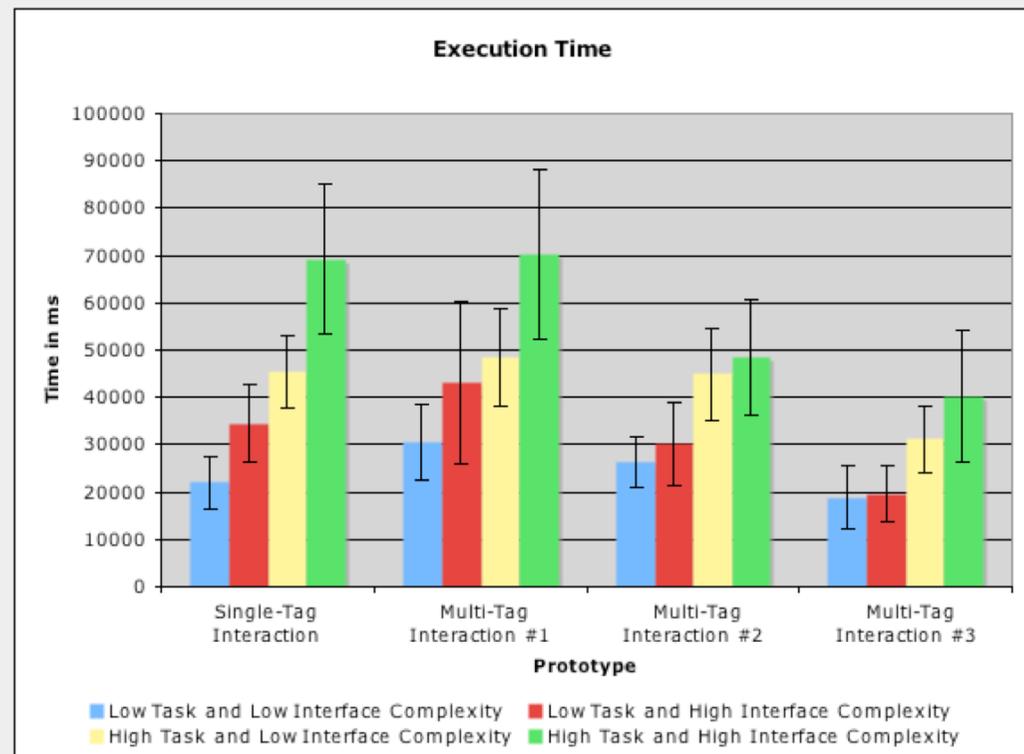
- Hardly any errors
 - Explanation and practice beforehand
- Problems:
 - Usage of radiobuttons
 - Handling of NFC





• 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





- **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

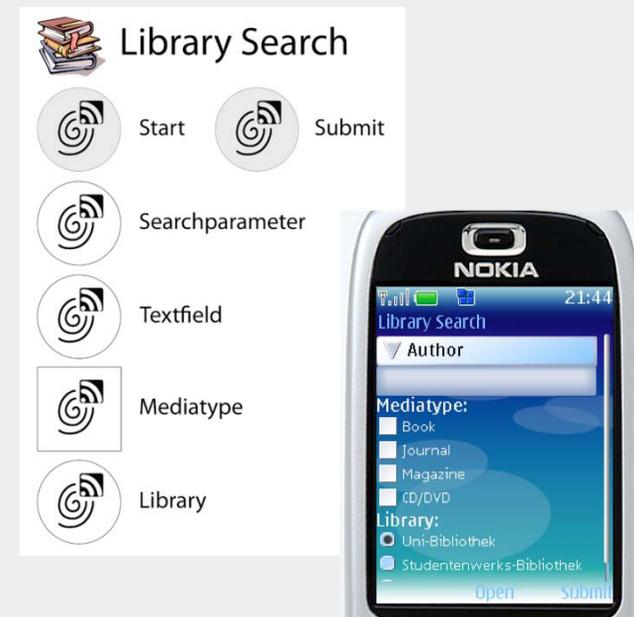
- **Suggestions of Improvements**

- 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



- **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!



Navigation

Handy Poster

Selection
Poster Handy

STI	MTI #1
MTI #2	MTI #3

