

Visualization of Uncertainty in Context Aware Mobile Applications

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- Huge interest in context aware mobile service
 - Gathering, structuring and usage of context (Chen and Kotz 2000)
 - Context information like location or current activity of a person is often imprecise or unreliable
 - *“[...] Concerning our experiment [...] under normal usage [...] recognize this contexts with a certainty of more than 87 percent [...]”* (Schmidt and Laerhoven 2001)
- Visualization of uncertainty, impreciseness and unreliability
- *“Inform the user of the current contextual system capabilities and understandings”* (Bellotti and Edwards 2001)
 - *„People should be able to see what context the system thinks it has inferred.”* (Greenberg 2001)
 - *“Our experiments show that when system confidence is displayed, users more often rely on the system.”* (Antifakos et al. 2005)

- Manually filling in forms on mobile devices
 - Time consuming task, forms are rarely used
- Automatic form filling on mobile devices
 - Similar to form filling in MSN Search Toolbar and Google Toolbar
 - Based on user data (name, address) stored on the mobile device
 - Fills existing forms automatically with this information
 - *The probability is X% that this field should be filled with the family name of the user.*
 - Prototype implemented using Nokia Series 60 phones (6630/6600/N90), Java ME / MIDP 2.0 / CLDC 1.0/1.1
- **Is it better (regarding errors, time) to show the uncertainty of the application to the user?**
 - Error: Incorrectly filled in input field that was not recognized

A screenshot of a mobile form with several input fields. The text in the fields is auto-filled in green. The fields and their values are: First Name: Marco; Last Name: Polo; Address: Polostr. 33; Postal Code: 80333; City: München; Phone Number: 555-352612; Email: marco@polo.ifg.

First Name:	Marco
Last Name:	Polo
Address:	Polostr. 33
Postal Code:	80333
City:	München
Phone Number:	555-352612
Email:	marco@polo.ifg

- 18 participants, 9 woman, aged from 20 to 26, students
- 1st phase: preliminary interview and explanations
 - Explaining the concept of automatic form filling
 - Asked for personal data (first name, last name, address, postal code, city, phone number and email-address) used for automatic form filling
 - Some forms showed the calculated probability that a field was correctly filled in
 - Red = “danger”: probably not the correct content
 - Yellow = “pay attention”: there might not be the correct content in this field
 - Green = “ok”: there is probably the correct content
 - Explaining the meaning of colors to the participants

First Name:

Last Name:

Address:

Postal Code:

City:

Phone Number:

Email:

First Name: ■

Last Name: ■

Address: ■

Postal Code: ■

City: ■

Phone Number: ■

Email: ■

First Name: ■

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Phone Number: ■

Email: ■

- 2nd phase: 14 different test cases, randomly generated test sequence

No.	Visualized uncertainties	Number of included errors (how visualized)
1	No	0
2	No	1
3		2
4		0
5	5 green, 1 yellow, 1 red	1 (■)
6	1 red	1 (■)
7	■■■■■●■	1 (■)
8	3 green, 2 yellow, 2 red	0
9	■■■■●■■■	2 (■■)
10		2 (■■)
11		2 (■■)
12		2 (■■)
13		2 (■■)
14		2 (■■)

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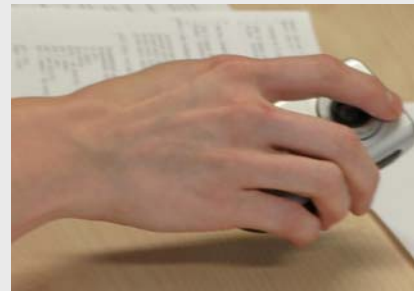
Postal Code:

City:

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- 2nd phase
 - Selecting a test case (Nr. 1 - 14) (repeated 20 times)
 - Loading the pre-filled form
 - Put mobile phone on the table display faced down
 - Test person: turn mobile phone: t(1)
 - Test person: check the pre-filled form and find potentially existing errors
 - Test person: turn the mobile phone around again when ready: t(2)
- Measured time $t(m) = t(2) - t(1)$
- Asked the user if the form was correctly filled in. Which errors were recognized?



- 3rd phase: Further questions

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- The visualization of probabilities did not have any influence on the frequency of errors.
- Participants were not faster when checking the forms in case probabilities were visualized (compared to the cases without visualization).

Included errors	Visualized probabilities	Submitted forms with wrong content	Average time in seconds
0	No	0%	5,19
	 (5 g, 1 y, 1 r)	0%	5,30
	 (3 g, 2 y, 2 r)	0%	5,83
1	No	2%	5,66
	 (5 g, 1 y, 1 r)	2%	5,83
2	No	11 %	6,26
	 (3 g, 2 y, 2 r)	12%	6,70

- 83% would use such an automatic form filling function
- 100% responded they did not pay attention to the colors
- 22% think the colors were more disturbing than helpful
- 28% prefer the visualization of the probabilities
- 89% think they needed more time when the probabilities were visualized
- Participants mentioned
 - they were distracted by the colors
 - they would check every pre-filled field (booking a hotel room)
 - they would use the automatic form filling, would carefully check every field
 - they double-checked every yellow and red marked field

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- Previous research argued for the visualization of uncertainty in context aware mobile systems.
 - If the user can control or monitor the current state or the behavior of the system, then this improves the usability of such a system.
- Our research
 - Visualization of uncertainty was not helpful for the form filling application
 - Users needed more time and did recognize slightly more errors than before
- **If you remember nothing else, remember this**
 - **Visualization of uncertainty in a context aware mobile system can be counterproductive**
 - **Test whether the visualization is useful or not**

- No significant differences in the time needed for the different test cases
- The more errors were included the more time the participants needed for completing a run and the more errors they made.

Included errors	0	1	2
Average time in seconds	5,34	5,75	6,55
Runs	90	108	162
Submitted forms with an input field that contains not the right content (sum of all errors)	0% (0 of 90)	2% (2 of 108)	12% (19 of 162)

