

Integration of medication monitoring and communication technologies in designing a usability-enhanced home solution for older adults

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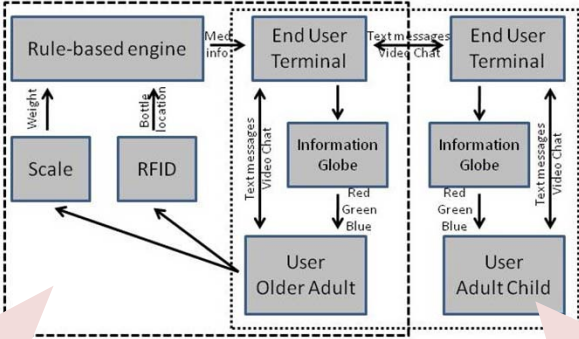

1. Introduction
2. System design & architecture
3. Field study design
4. Results
5. Concluding remarks



BACKGROUND & MOTIVATION	1. INTRODUCTION
<ul style="list-style-type: none"> • Implications of aging population <ul style="list-style-type: none"> - Aging in place: older adults wish to live in their own homes longer without having to move to support facilities (AARP 1996; Willis 1996; Russell 1999) - Multiple correlated issues <ul style="list-style-type: none"> - Difficulties in daily tasks due to physical and mental changes (Blaschke 2009) - Isolation and loneliness (Weeks 2004) - Health issues: chronic diseases that require self-management of medications (Lahey et al. 2009) • Technology-enabled solutions for aging in place <ul style="list-style-type: none"> - Assistive technologies and ICTs for self-care and telecare - Effective, efficient and sustainable support structure for independent, active and healthy aging (Bettio & Plantenga 2004; European Commission 2007; Walsh & Callan 2011) - The potential to effectively monitor, manage and motivate behaviors that lead to better health outcomes (Coughlin et al. 2006) - Enabled by improvements in sensors, data recorders, controls, displays and communication networks (Coughlin et al. 2007; Kang et al. 2010; Piper et al. 2010) 	
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BACKGROUND & MOTIVATION	1. INTRODUCTION
<ul style="list-style-type: none"> • Previous studies have focused on point solutions <ul style="list-style-type: none"> - Solutions for medication non-compliance <ul style="list-style-type: none"> - RFID-based Medication Adherence Intelligence System (RMAIS) (McCall & Zou 2010) - RFID-based in-home medication reminder system (Moh et al. 2008) - Identification of user needs for developing an assistive system for medication compliance (Lee et al. 2009) <ul style="list-style-type: none"> ➔ ✓ Focused more on system performance and less on user perceptions ✓ User inputs not fully incorporated into system design ✓ Lack of user validation - Solutions for isolation and loneliness <ul style="list-style-type: none"> - Casablanca Project for prototyping an awareness indicator and a message board for remote communication (Hindus et al. 2001) - Development and user evaluation of a home communication system (Rodriguez et al. 2009) <ul style="list-style-type: none"> ➔ ✓ User evaluations based on insufficient understanding and experience ✓ Novelty effects 	
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OBJECTIVES	1. INTRODUCTION
<ul style="list-style-type: none"> • The need for a user-centered approach <ul style="list-style-type: none"> - Design for usability: perceived usefulness, simplicity and reducing cognitive load - The importance of a more extensive user evaluation • The need for a more holistic solution <ul style="list-style-type: none"> - Current solutions are limited to addressing one issue at a time - Systems approach: multiple interrelated issues • Study objectives <ul style="list-style-type: none"> - Design a system that integrates RFID-based medication monitoring and remote communications technology for older adults to use in their own homes - Design the system's end-user interface to be simple and intuitive - Extensively assess the system usability by conducting a long-term field trial <p style="text-align: center;">  Apply a user-centered design approach to a process of developing and evaluating a home technology solution for aging in place </p>	
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OVERALL ARCHITECTURE	2. SYSTEM DESIGN
<ul style="list-style-type: none"> • Composed of two main components, or subsystems, that use a variety of different technologies to complement one another 	
 <p>The diagram illustrates the overall architecture of the system. It is divided into two main modules: the Medication management module and the Communication module. The Medication management module includes a Rule-based engine, a Scale, and an RFID component. The Scale sends 'Weight' data to the Rule-based engine, and the RFID sends 'Bottle location' data. The Rule-based engine sends 'Med. info.' to the End User Terminal for Older Adults. The Communication module includes an End User Terminal for Adult Children, an Information Globe, and the User Adult Child. The End User Terminal for Adult Children sends 'Text messages' and 'Video Chat' data to the Information Globe, which then sends 'Red', 'Green', and 'Blue' data to the User Adult Child. The User Adult Child also sends 'Text messages' and 'Video Chat' data back to the Information Globe, which sends them to the End User Terminal for Adult Children. The End User Terminal for Older Adults also sends 'Text messages' and 'Video Chat' data to the Information Globe, which sends them to the User Older Adult. The User Older Adult also sends 'Text messages' and 'Video Chat' data back to the Information Globe, which sends them to the End User Terminal for Older Adults.</p>	
<p>Medication management module Focuses on older adults' medication compliance</p>	<p>Communication module Focuses on communication between the older adult and adult child</p>
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OVERALL ARCHITECTURE
2. SYSTEM DESIGN

Adult child

Home terminal

Older adult

Home terminal

RFID Reader

Scale

Concept design

Medication Table (for OA)

e-Home Terminal

Information Globe

Development outcome

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COMMUNICATION MODULE
2. SYSTEM DESIGN

• Sticky notes

Yellow

- ✓ Local note
- ✓ Not shared
- ✓ Note to yourself

Blue

- ✓ Shared note
- ✓ Message to study partner
- ✓ Both sides can post, edit & delete

• Video chat

- ✓ Initiated by clicking on phone icon
- ✓ Only between the two sides

• Information globe

- ✓ Color changes according to system status
- ✓ Communicates info even when screen is off

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MEDICATION MODULE
2. SYSTEM DESIGN

- Sticky notes

Feb 24, 01:07 PM
Time to take 1 Heart Med.

Green

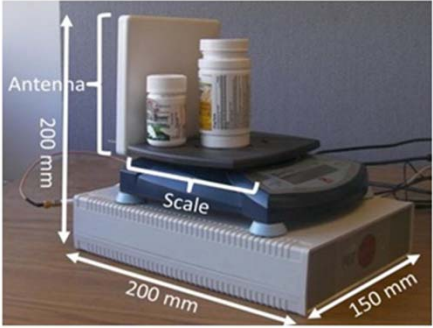
 - ✓ Reminder to take medication on time
 - ✓ Automatically disappears upon consumption

Feb 24, 02:00 PM
Heart Med is forgotten to be taken.
Please take 1 Heart Med.

Red

 - ✓ Late warnings
 - ✓ Replaces green notes
 - ✓ Automatically disappears upon consumption

- Medication table



 - ✓ RFID for identifying and detecting medication consumed
 - ✓ Scale for determining weight change and hence the dosage
 - ✓ Operated with rule-based engine


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PARTICIPANT SELECTION
3. FIELD STUDY DESIGN

- Four pairs of older adult and adult child
- Selected through online questionnaire and phone interview
- Selection criteria
 - Older adult
 - Age: 60+
 - Lives alone w/o home health care services
 - At least one medication on a daily basis
 - Adult child
 - At least 25 miles (40 min) from OA

No.	Side	Age	Medication(s)	Distance (mi.)
1	OA	68	1 at 8am and 3 at 6pm	38.3
	AC	50	n/a	
2	OA	65	3 at 12pm	35.3
	AC	31	n/a	
3	OA	67	1 at 8am	29.0
	AC	40	n/a	
4	OA	76	3 at 11am and 1 at 8pm	33.4
	AC	35	n/a	



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SYSTEM MODES


3. FIELD STUDY DESIGN

- System modes
 - 2 different modes: shared & local
 - Differed in whether medication information was shared or not

	Shared mode	Local mode
Blue & yellow notes	Fully functional in both sides	Fully functional in both sides
Green & red notes	Displayed on both sides' screens	Displayed only on older adult's screen

- Mode changes

	First 3 weeks	Next 3 weeks	Last 2 weeks
2 pairs	Shared mode	Local mode	Their choice
2 pairs	Local mode	Shared mode	Their choice

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PARTICIPANT VISITS


3. FIELD STUDY DESIGN

- Visits to field sites (participants' homes)

3 weeks

1st visit (3/7-13)


- ✓ System installation
- ✓ Participant training
- ✓ Pre-study questionnaire



3 weeks

2nd visit (3/30-31)


- ✓ Mode change
- ✓ Interim questionnaire



2 weeks

3rd visit (4/21-27)


- ✓ Mode change
- ✓ Interim questionnaire




4th visit (5/10-12)

- ✓ Deleting SW
- ✓ Collecting HW
- ✓ Post-study questionnaire
- ✓ In-depth interview


Visits were also made at other times during the study period for technical support

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DATA COLLECTION		3. FIELD STUDY DESIGN
<ul style="list-style-type: none"> Multiple methods used together for comprehensive evaluation of usability <ul style="list-style-type: none"> Subjective (user perception) & objective (system usage) data collection Quantitative & qualitative data collection 		
Method	Time of collection	What was collected
Questionnaire	<ul style="list-style-type: none"> At each visit 4 times 	<ul style="list-style-type: none"> Info on system usage, perception of system, relationships and communications, etc. Demographics State of mind
	<ul style="list-style-type: none"> Throughout the study period 8 weeks 	<ul style="list-style-type: none"> Time and initiator for StickyNotes and Meeting Plaza Info on medication compliance (time, errors, etc.)
In-depth interview	<ul style="list-style-type: none"> At the last visit 1 time, about 30 min 	<ul style="list-style-type: none"> Detailed feedback on system features and effect on medication & communication Ideas for future possibilities

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USABILITY METRICS		4. RESULTS
<ul style="list-style-type: none"> Modification of common descriptions of usability factors to specifically address system features 		
Factor	ISO 9241 Definition	Factor
Effectiveness	The accuracy and completeness with which users achieve goals	Usefulness
	The resources expended in relation to the accuracy and completeness with which users achieve goals	
Efficiency	The freedom from discomfort, and positive attitudes towards the system	Ease of use
Satisfaction		Satisfaction
		Definition
		Usefulness
		Ease of use
		Satisfaction

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USEFULNESS
4. RESULTS

- How useful or helpful was the system in adhering to medication regimens and communicating with family?

- ✓ No missing points during study period for all older adults
- ✓ No reminders went unnoticed: all removed by consumption or voluntary removal
- ✓ Less confusion in taking meds on time

"My pill taking was erratic, and this stabilized it."

"Sometimes I forget and don't know whether to take it or not. But with this, that won't happen."

"It was a good tool to keep track of what was going on with my mom and if she was taking her medications or not."

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USEFULNESS
4. RESULTS

- How useful or helpful was the system in adhering to medication regimens and communicating with family?

1: much less useful than expected, 5: much more useful than expected

System components	Mean score		
	Older adults	Adult children	Both groups
Overall system	4.5	3.5	4
Video chat	4	3.75	3.88
Yellow notes	4.5	3.75	4.13
Blue notes	4.25	3.75	4
Green notes	4.67	4	4.29
Red notes	5	4	4.5
Information globe	4.5	3.5	4

- ✓ All participants, especially older adults, perceived the overall system and its components to be useful
- ✓ Older adults' responses showed that they generally perceived the system to be more useful in shared mode

"I think this gave us a connection like we could touch each other at any time."

"It was a great way for us to keep in touch ... because we don't see each other that often."

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EASE OF USE

4. RESULTS

- How easy or difficult was it to use the system and its features?

1: much more difficult than expected, 5: much easier than expected

System components	Mean score		
	Older adults	Adult children	Both groups
Overall system	4.75	3.75	4.25
Video chat	4.25	4	4.13
Yellow notes	4.5	4.25	4.38
Blue notes	4	3.75	3.88
Green notes	5	4	4.5
Red notes	5	4	4.5

- ✓ A few experienced minor difficulties in using the system at first, but were solved quickly and easily
- ✓ All participants, especially older adults, perceived the overall system and its components to be easier to use than expected

"It was easier, I think, than (logging on and emailing)."

"I liked the way it worked."

"To have the notes on the screen was nice, because I don't have to have a bunch of paper that falls off, and it's just easy to do."

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SATISFACTION

4. RESULTS

- How satisfied were you with the system and its features?

1: very dissatisfied, 5: very satisfied

System components	Mean score		
	Older adults	Adult children	Both groups
Overall system	4.75	4.5	4.63
Video chat	4.25	4.25	4.25
Yellow notes	5	4.5	4.75
Blue notes	4.75	4	4.38
Green notes	5	4.5	4.75
Red notes	5	4.75	4.88

- ✓ All participants, especially older adults, were generally satisfied with the system features and components
- ✓ Older adults' responses showed that they were more satisfied about the system in shared mode


"It's really nice. It makes you feel like you're visiting physically."

"It was pretty exciting, so I enjoyed it."

"It was a good sort of bonding thing, with not only me and her, but my children, who were fascinated by the globe. They really liked it."

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SUMMARY	5. CONCLUSION
<ul style="list-style-type: none"> • Integration of two functional modules for developing a home technology solution to assist aging in place <ul style="list-style-type: none"> - Medication management module: sensor technologies (RFID and scale) - Communication module: online tools (instant messaging and video chat) • Long term field trial for extensive evaluation <ul style="list-style-type: none"> - Eight weeks in which four pairs of older adult and adult child freely used the system to manage their medications and to communicate with each other - Collection of objective and subjective data using multiple methods including questionnaires, in-depth interview and log data collection • Usability evaluation <ul style="list-style-type: none"> - Data processing and analysis in terms of three key usability factors: usefulness, ease of use and satisfaction - Participants evaluated the system to be useful, easy to use and satisfactory <ul style="list-style-type: none"> - Older adults gave higher scores for all three aspects of usability - Higher scores when in shared mode 	
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DISCUSSION	5. CONCLUSION
<ul style="list-style-type: none"> • Contributions <ul style="list-style-type: none"> - While previous studies focused on individual issues, this study proposed a more holistic solution for two different yet related issues of aging-in-place - Went further than previous studies in that the system was extensively used, tested and evaluated by potential users • Limitations <ul style="list-style-type: none"> - Due to small sample size, no statistical significance can be stated although the trends are easily observable - Lack of pre-study data to compare the results to • Directions for future work <ul style="list-style-type: none"> - Studying a larger sample <ul style="list-style-type: none"> - More meaningful and statistically significant results - Better understanding of user characteristics: clustering, pattern finding, etc. - Pre vs. post comparison by getting data on user behavior without such system 	
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