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UPDATED USER AND CONTEXT REQUIREMENTS

UNDERSTANDING USERS AND CONTEXT – version 2

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1 ABOUT THE DOCUMENT

This document is part of the working documentation that follows the iterative requirements process from the first day of the project. This document shows how the initial user requirements (described in D 1.1) are refined by letting evaluations not only influence the iterative design of the prototypes, but also add to new understanding of the requirements for navigation aids for older persons with mild cognitive problems.

The work package 1 deepens our understanding of the end users, the usage and context in which the system will be used, and communicates information to the designers and developers. Understanding the user and the usage context is investigated by conducting a series of user studies, including surveys, expert interviews, focus groups, and field trials with potential end users. To communicate the insights within the projects we are (1) involving designers and developers directly in the studies and (2) conducting workshops where the results are presented in interactive sessions. This will ensure that the designers and developers understand the end users, and will take their needs into account when developing the prototype.

We are identifying the usage context and the user requirements that are specific for users with MCI. Besides classical survey methods (interviews, focus groups) we are carrying out in-situ (in a real context, as opposed to lab context) field observations to get a better understanding of the context of use. We involve the primary target users but also other stakeholders, including care takers and family members. The abilities of the target users, usage frequency, and the context of use will be identified.

1.1 OUTLINE OF DOCUMENT

This deliverable together with the previous document D 1.1 makes it possible to follow the process of the user requirements and prototype evaluation work in the first part of the project. In this project, two subsequent versions will be delivered that together provide one document on the user requirements elicitation in the NavMem project.

In D1.1 (User & Context Requirements 2013) we summarized the results of the initial user investigations made by the partners in the NavMem project. Chapter 2 reported literature studies on MCI related problems that have relevance for the navigation context. The literature covers also more severe cognitive problems, such as dementia in the later stages to inform the design process even if this user group is not the primary target of the intended system. Chapters 3-5 were devoted to the different studies performed by the partners involved in the WP1 work. The partners Roessingh Research and Development, Lund University and SIEMENS performed initial user investigations for three different groups, care personnel of persons with dementia, persons who have had a stroke and persons who are elderly. These user investigations were primarily carried out to inform the design process, and as such, outliers in the targeted user group of persons with mild cognitive problems were included in the interviews, primarily when interviewing care personnel. Chapter 6 presented the first iteration of the requirements lists, based on the interviews and literature studies.

The current document starts with repeating the first iteration of the requirements list that appeared in chapter 6 in D 1.1. In November 2013 until February 2014 user tests of the first prototype designs were carried out. These tests were carried out in Malmö, Sweden (by SSA and ULUND), in Paderborn, Germany (by SIEMENS) and in Enschede, the Netherlands (by RRD). The user tests are reported in chapters 7 until 9. Each test is reported by cross-checking the initial list of requirements (chapter 7) with the results of the evaluations and the recommended changes to be made to the prototypes. To present and refine the recommendations, as well as transfer knowledge between researchers involved in testing and developers of the prototypes, a workshop was carried out in Enschede, the Netherlands on March 17th 2013. Chapter 10 reports about this workshop in brief. The concluding chapter 11 presents the updated requirements. The original requirements and proposed changes were discussed at a developer workshop in Enschede, March 17th 2014, and the document revised according to the result of the discussions there.

2 FIRST ITERATION OF REQUIREMENTS

These initial user investigations provide background information for the development to be done in NavMem. Although the user investigations have targeted different groups (dementia, stroke, elderly) a common theme of simplicity emerges. Current day smartphones and GPS devices are seen as too complicated, and there is seen to be a real need for simple and easy to use navigation applications.

The device/application to be developed should be easy to use – but also safe to use (it is important the user does not get suddenly stranded or led into areas not suited for walking). The designs need to take different sensory abilities into account – the user may have limited eyesight or have hearing problems. A specific requirement from the stroke investigations is that the device should be possible to manipulate with one hand only.

Although “Simple and easy to use” comes out as an overall requirement, what an individual user finds simple/easy varies greatly, and the continued development within the project needs to iteratively test designs with target users. Another consideration that needs to be taken into account is that it is useful if both simple and more complex alternatives exists - although the more advanced functionality should be designed in such a way as not to clutter the interface & confuse users who want the simple alternative (one possibility is to have “simple mode” and “advanced mode” with simple mode as the default).

2.1 USER REQUIREMENTS, DEMENTIA

- A1. The system should support an active lifestyle
- A2. The system should support in doing daily activities outside
- A3. The system might provide navigation support inside
- A4. The system should support in doing social activities (e.g. visit to friends/family)
- A5. The system should automatically recognize a disorientation event
- A6. The system should provide support in case of disorientation
- A7. The system should only provide navigation support when needed
- A8. The system should support the user in navigation and orientation in an unobtrusive manner
- A9. The system should facilitate help provided by (a informal) caregiver automatically when needed
- A10. The user can contact an informal caregiver in times of need
- A11. The (informal) carer could also contact the user (two-way communication)
- A12. The device should also be used by bystanders to call for help when necessary
- A13. The system must contain “tracking at a distance”
- A14. The system could monitor the activities performed by the user
- A15. The system should be easy to use
- A16. The system should be easy to learn
- A17. The system should be reliable
- A18. The interface should be very simple
- A19. The interface could include information about the surroundings to support memory
- A20. The system should also be suitable for wheelchair use
- A21. The system could be compatible with other memory aid systems (e.g. digital calendar)

2.2 USER REQUIREMENTS, STROKE

- B1. The system should provide simple memory aid
- B2. The system should provide a lifeline
- B3. The system should provide accessible routing
- B4. The system should allow both for simple and more advanced information
- B5. Safe and secure
- B6. Flexible and adaptable
- B7. Possible to manipulate with one hand only
- B8. Easy to manipulate
- B9. Easy to bring

- B10. Easy to remember
- B11. Keep texts short
- B12. Minimize numbers of steps
- B13. Limit the amount of information
- B14. Provide appropriate reminders
- B15. Consider using images
- B16. Information available multimodally
- B17. Clear information on directions and avoid coded information or mental rotations

2.3 USER REQUIREMENTS, ELDERLY USERS (NAVIGATION DEVICES)

- C1. Easy to use
- C2. Keys and screen needs to be large enough
- C3. Clear and easy to understand information
- C4. Important not to get lost
- C5. The device needs to be robust and reliable
- C6. If a special device, small, light and long power supply
- C7. Display has to be readable under all lighting conditions
- C8. The system should contain a GSM unit in order to call for help in an emergency
- C9. One can decide who should be called and who should be able to determine the whereabouts

2.4 USER REQUIREMENTS, ELDERLY USERS (MOBILE DEVICES)

- D1. Mobile devices should be compatible with hearing aids
- D2. Mobile devices should have a wide range of volume levels
- D3. Several input modalities should be included (audio hints can help for reduced vision)
- D4. Slide-out keyboards should be avoided
- D5. Program and command naming should be carefully considered and in accordance with the users' mental models
- D6. Provide large, clear and bright screens
- D7. Provide large buttons
- D8. Eliminate buttons on the sides and rear of devices
- D9. Provide the possibility to zoom in on small text
- D10. Provide clear confirmation of target capture (i.e. button press, visited link). The user should not be expected to detect small changes
- D11. Older users should not be expected to double click because of slower hand movements
- D12. A single, consistently placed button for returning to the home state should be included
- D13. Graphics should be relevant and not for decoration.
- D14. Images should have alt tags
- D15. Icons should be simple and meaningful and also labeled (with a large enough font)
- D16. Clear navigation should be provided
- D17. Tapping often preferred to drag and drop
- D18. Provide current location in the interface
- D19. Clearly show which tasks are active
- D20. Important features should be available directly via a labeled button and not via menu navigation
- D21. Avoid pull down menus
- D22. Do not have very deep hierarchy and group information into meaningful categories
- D23. Important information should be highlighted
- D24. Information should be concentrated mainly in the centre
- D25. Provide ample time to read information
- D26. Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choice to the user
- D27. Main navigation always the same and critical functions should not disappear
- D28. Colours should be used conservatively

- D29. Blue green tones should be avoided
- D30. Background screens should not be pure white or change rapidly in brightness between screens. Also, a high contrast between the foreground should exist.
- D31. Avoid moving text
- D32. Avoid fancy font types
- D33. An online help should be provided
- D34. Error message should be simple and easy to follow

In general the requirements for the different groups are well aligned – easy to use (big buttons, multimodal presentation, no menus etc), simple, reliable and secure appear in all the lists. Specific for dementia is the larger focus on tracking and monitoring while the stroke group has the one handed use as a specific requirement. Differences, in the lists is in some part due to method differences and we suggest the overall requirements for elderly users are taken as a starting point, but that the development focuses on the specific needs of the users with dementia and stroke.

3 METHOD AND MATERIAL

All test sites (see chapters 4-6) based their field trials on the same basic principles and used the same two prototypes. Some variation in the method was present, see individual reports.

3.1 FIELD TEST METHOD

In this test the first task was to use the NavMem explorer to find a location some distance away and the second task was to use the Home Compass to be guided to a location considered as “home”. To check that people didn’t just remember the starting point, the Home Compass pointed to a location a short distance away from the starting point.

The test was conducted as real-time observation, and additionally a video camera was filming from a distance.

The different activities related to the tests were (example from ULUND tests, other locations may differ in details):

1. Greeting – moving indoors
2. Information and signing consent forms
3. Carrying out basic questionnaire – as an interview
4. Showing smart phone use (basics, and only if needed)
5. Rigging microphones on users
6. Going outside
7. Starting filming and introducing OFFIS app
8. Doing OFFIS app test. Asking for “on-the-go”-experience midway through the walk.
9. Short debrief with NASA RTLX on OFFIS app.
10. Introduction to Home compass app
11. Doing Home compass app test. Asking for “on-the-go”-experience midway through the walk
12. Short debrief with NASA RTLX on Home compass app
13. Turning off video recording
14. Going inside, taking off mikes and serving coffee and cake
15. Asking post-test-questions (while recording the audio as well)
16. Asking if participants need reimbursements for travel and handing out gift certificates

See also Appendices for additional protocol templates.

3.2 PROTOTYPES

Based on the initial studies (D 1.1) two prototypes were developed, one simple “Home Compass” (by ULUND) and one more advanced “NavMem Explorer” (by OFFIS). The Home Compass allows you to save one location and then you can be guided back to this location by visual, auditory and haptic feedback. The audio and haptic feedback works in a similar way – when the device is pointed towards the goal you will hear or feel the feedback. To make it more pleasant to use, the vibratory feedback feels a bit like a heartbeat.

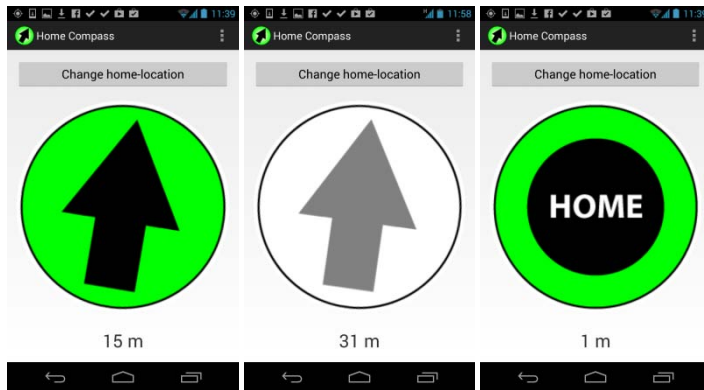


Figure 1. The Home Compass directions (left: good GPS, middle: poor GPS) and arrival message (right).

The visual feedback is an arrow pointing towards the goal. The app points towards the goal “as the crow flies” – it does not rely on any map information. To inform the user about GPS accuracy the visual feedback changes if the precision is poor (Figure 1 middle). The arrival message is triggered once the user is within 10 m from the target. The auditory message is a fanfare, the haptic message is three longer vibrations and the visual indication is a screen that says “HOME”.

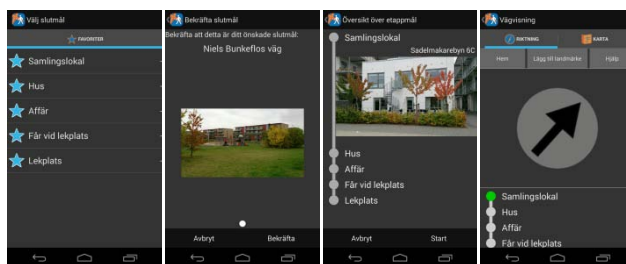


Figure 2. The NavMem Explorer (far left: select destination, middle left: confirm destination, middle right: route overview, far right: navigation display)

The NavMem Explorer (Figure 2) is a more advanced navigation app which leads the user to the goal past a series of landmarks. The first prototype of the app provides visual feedback. When you start the app you get a list of available (personalized) goals. Selecting a goal gives you an image of the goal and an address. If you confirm this is indeed your goal you will come to an overview presentation of the route. Touching landmarks in the list shows the corresponding image. After this you come to the navigation screen. Just as for the Home Compass there is an arrow, but the NavMem explorer has route information and will guide you along streets and foot paths indicating when you need to turn.

4 TEST REPORT UNIVERSITY OF LUND AND SWEDISH STROKE ASSOCIATION

Prototype tests were carried out in Lund, Sweden, during November and December 2013. In all, 13 persons participated in the tests, which were carried out in a real navigation task in a realistic context outdoors.

4.1 TEST TASKS AND PROCEDURE

In this test the first task was to use the NavMem explorer to find a location some distance away and the second task was to use the Home Compass to be guided to a location considered as “home”. To check that people didn’t just remember the starting point, the Home Compass pointed to a location a short distance away from the starting point. We did not counterbalance the order in which the applications were tested – using the NavMem explorer to find an unknown location and then the Home Compass to go “home” was thought to make the task more realistic (the aim of the test was to generate design feedback and not to compare the two apps). Before the test, informed consent forms were filled in, and a short demonstration of how a smart phone works was given in an indoor location. A post-test interview was performed in the same indoor location. The area selected for the test was a residential area outside Malmö, Sweden. The area had a good road grid with several intersections while at the same time being fairly quiet (no heavy traffic). The houses in the area are mostly grey concrete apartment buildings, something which is quite common in many residential areas. In this area we also had access to an indoor location where we could have introductions and perform interviews . Given that we had test users who may tire easily (motor problems and/or brain tiredness) the length of the test was limited. The total walking distance was around 900 m and the interview was kept short. The total test time (including introduction, test and post-test interview) was 1-1.5 h.



Figure 3 Example of surrounding area of test

4.2 USERS

Thirteen persons did the test (5 women and 8 men). Three of these persons used electrical wheelchairs and two persons used walkers. All test persons except one was recruited through the Swedish stroke organization – 8 persons had had a stroke and 4 persons were relatives or partners and had not had a stroke. One person who had had an extensive brain injury was recruited externally (after the test this person was also diagnosed with early dementia). Two persons reported having severe navigation/orientation difficulties, four persons reported having moderate navigation difficulties, four persons reported reasonable navigation/orientation skills (they would only get lost occasionally) and three persons reported excellent navigation skills. One person reported severe vision problems, one reported moderate vision problems, four persons reported minor vision problems and seven persons reported having no vision problems. one person reported moderate hearing problems, two persons reported minor hearing problems and the rest could hear well. Two persons reported severe motor problems, three persons reported moderate motor problems, one person reported minor motor problems and seven were fully mobile (it should be noted that one person using an electric wheelchair

reported moderate motor problems). The age on the participants ranged from 58 to 80 years with an average of 70 years. One of our test persons had hemispatial neglect.

Characteristic	Value
Age (years)	58-80 yrs (average 70)
Gender	5 women, 8 men
Navigation (selfreporting)	2 with severe difficulties 4 with moderate difficulties 4 with good skills 3 with excellent skills
Hearing	1 moderate hearing problems 1 minor hearing problems
Vision	1 with severe vision problem 1 with moderate vision problems 4 with minor vision problems 7 with full vision
Motor abilities	3 used electrical wheelchairs 1 used a manual wheelchair 2 used walkers 7 fully mobile

Table 1: demographic characteristics pre-test

4.3 PRELIMINARY RESULTS

All test users were able to follow the directions indicated by the arrows in the two apps. Eleven of the 13 participants completed both exercises and reached the two goals in the test (the one indicated by the NavMem Explorer and the one indicated by the Home Compass). One person walked to fast leading to exhaustion and had to stop and rest (we picked this person up with a car) - but up to this point the person had had no problems in following the directions from the NavMem Explorer (two turns/intersections were passed). One person had severe motor problems (used a walker) and due to heavy rain and wind, this person only tested the interfaces indoors. One person with more severe cognitive/memory problems was able to follow the arrow but found it hard to understand the test setting (what am I supposed to do, why am I supposed to go there?) – it is possible that this person may find the system easier to use if the person had had a wish of their own to go to these locations.

The fact that the Home Compass didn't point to the place where the test had started caused confusion for several users – we had decided on this design to be able to test that people really could reach an unknown location, but it is clear that this design made the test somewhat less realistic. In general it was quite easy to follow the NavMem explorer since it guided you turn by turn – despite this there were a few problems: if the GPS stopped updating it was hard to detect this, and if a participant wanted to walk an alternative path this was not well supported. Another problem with the current design was the discrete arrival message – most of the test persons had to be reminded to check the screen to see that they had arrived. The fact that the Home Compass provided direction information also in several modalities was appreciated and the visual design was commented on as clear and easy to see. Since the Home Compass points towards the goal “as the crow flies” users would sometimes be led towards a house. If they asked for help we would tell them that they had to decide where to go by themselves (and that the arrow only pointed the direction towards the goal). Some users found this behavior complicated, while others appeared to find it easy to deal with. It is interesting to note that the person with more severe cognitive/memory problems found this design easy to use – this person was already trying to memorize the direction of locations in a similar way, and thus the app design well matched the cognitive strategy used by this person.

4.4 REQUIREMENTS EVALUATION – NAVMEM EXPLORER

For each item in the original requirements list (chapter 6), the tests are used as a case. Each requirement that is fulfilled will get a **Y**, if it is partly fulfilled it will get a **P** and if it is not at all fulfilled it will get an **N**. **N/A** means not applicable to this test/prototype.

For each item, especially **N** and **P** marked ones, there is a comment explaining the result in relation to the requirement. The aim of this work is to double-check that requirements have been followed, but also to revise the requirements.

A. User requirements, dementia	Fulfilled (Y) Partly fulfilled (P) Not fulfilled (N)	Comment
1. The system should support an active lifestyle	Y	
2. The system should support in doing daily activities outside	Y	
3. The system might provide navigation support inside	N	
4. The system should support in doing social activities (e.g. visit to friends/family)	P	No specific functions for social activities, but being able to go out at all supports this.
5. The system should automatically recognize a disorientation event	N	This indicates some form of intelligence to the system – is this a goal for the project?
6. The system should provide support in case of disorientation	P	Not automatically, but that is the point with any navigation support
7. The system should only provide navigation support when needed	P	This indicates some form of intelligence to the system – is this a goal for the project?
8. The system should support the user in navigation and orientation in an unobtrusive manner	P	The system still need to be held in the hand and close attention needs to be kept on the screen. Here, based on our observations, we suggest use of (non-visual) notifications before a turn and on arrival to the destination, possibly non-visual guiding.
9. The system should facilitate help provided by (a informal) caregiver automatically when needed	N	
10. The user can contact an informal caregiver in times of need	N	
11. The (informal) carer could also contact the user (two-way communication)	N	
12. The device should also be used by bystanders to call for help when necessary	N	
13. The system must contain “tracking at a distance”	N	
14. The system could monitor the activities performed by the user	N	
15. The system should be easy to use	P	Based on observation by one user with dementia-like problems, the arrow is easy to follow. Generally, there are problems with the visibility (bad contrast, small pictures and small print) in the app. The start sequence

		<p>has too many steps and makes no sense to the user. The use of pictures is hidden and makes the step-wise navigation route meaningless for the users – but this could be due to the choice of landmarks and the test task. Buttons are too small and too close to system (soft) buttons.</p> <p>Ideas for change:</p> <ul style="list-style-type: none"> • Enhance contrast (follow guidelines for low vision users) • Use color • Use thumbnail pictures in route overviews and larger pictures. Allow zooming in pictures. • Review the start sequence. • Move buttons and/or resize them. <p>This requirement is too high level and needs to be complemented by concrete requirements as well as good examples.</p>
16. The system should be easy to learn	P	We need to discuss this point. For dementia (as well as stroke etc) learning is not an option. If you have a memory decline, a system should need in principle no leaning time (walk-up-and-use type of system).
17. The system should be reliable	N	Crashes when interrupted. Not extensively tested in this set-up. Needs to make full use of Android create/pause/resume/stop.
18. The interface should be very simple	N	See A15 above.
19. The interface could include information about the surroundings to support memory	P	Pictures to contain landmarks are included, but these are hidden.
20. The system should also be suitable for wheelchair use	N	<p>We had no users with dementia using wheelchairs, but had problems in combination with wheel chairs:</p> <ol style="list-style-type: none"> 1. Electrical wheelchairs, as well as steel constructions (of e.g. walkers with baskets) disturb the magnetic compass, thus making it point the wrong way. 2. The need to operate a wheel chair with both hands (manual wheel chair) or one and when the other is occupied or not usable (due to stroke, for example) is hindering the use of a mobile for pointing or just holding it in hand.
21. The system could be compatible with other memory aid systems (e.g. digital calendar)	N	Aim of project?

B. User requirements, stroke	Fulfilled (Y) Partly fulfilled (P) Not fulfilled (N)	Comment
1. The system should provide simple memory aid	N	Does this fit the aim of the project?

2. The system should provide a lifeline	N	
3. The system should provide accessible routing	N	
4. The system should allow both for simple and more advanced information	P	In a way this is true as some of the pictures are hidden.
5. Safe and secure	P	The apps are in a mobile phone, making it possible to call for help.
6. Flexible and adaptable	N	The prototype is more or less a vertical prototype just for navigation of predefined routes. This requirement is also a bit too high-level and gives no help. Flexible and adaptable according to what?
7. Possible to manipulate with one hand only	P	It is hard to actually do manipulation of on-screen elements with just one hand. That requires some dexterity, and especially being used to selecting with a thumb. There is also the question about being able to cope with one hand in an entire activity – what if your good hand is already occupied? By a wheelchair joystick or something else?
8. Easy to manipulate	P	Touch screen manipulation in general comes natural for some, but not for others. See also item A15.
9. Easy to bring	Y	Smart phone is quite small. Fits in pocket. Comes in different sizes.
10. Easy to remember	N	See learnability above, or is this referring to that it should be easy to remember to bring?
11. Keep texts short	P	Most of the text is quite short. There needs to be a check on the language used.
12. Minimize numbers of steps	N	Startup sequence too long (see “easy to use” above).
13. Limit the amount of information	Y	Information is kept short and limited. Perform double-check on the type of information (+ the start-sequence).
14. Provide appropriate reminders	N	Unclear what kind of reminders are meant here.
15. Consider using images	P	Images used for landmarks. Less images used for interaction elements. Ideas for redesign could be to make an adaptable interface that uses text or pictures, or both.
16. Information available multimodally	N	Feedback entirely visual. Suggest all available modalities be considered while redesigning.
17. Clear information on directions and avoid coded information or mental rotations	Y	Arrow navigation very clear and easy to understand. Sub-routes not used. Map not used.

C. User requirements, elderly users (navigation devices)	Fulfilled (Y) Partly fulfilled (P) Not fulfilled (N)	Comment
1. Easy to use	P	See item A15.

2. Keys and screen needs to be large enough	P	Smart phones have (almost) no physical keys which in itself is a problem for some users without experience with touch screens. The phones used had large enough screens (SONY Experia Z and Nexus 4).
3. Clear and easy to understand information	P	See items A15 and B12.
4. Important not to get lost	P	High level requirement
5. The device needs to be robust and reliable	N	Not tested explicitly. For the stability of the app, see A17.
6. If a special device, small, light and long power supply	N/A	N/A
7. Display has to be readable under all lighting conditions	N	Not tested explicitly. Contrast in app too low. See also A15.
8. The system should contain a GSM unit in order to call for help in an emergency	Y	
9. One can decide who should be called and who should be able to determine the whereabouts	N	Not implemented

D. User requirements, elderly users (mobile devices)	Fulfilled (Y) Partly fulfilled (P) Not fulfilled (N)	Comment
1. Mobile devices should be compatible with hearing aids	N/A	We can't influence this when using smart phones.
2. Mobile devices should have a wide range of volume levels	P	
3. Several input modalities should be included (audio hints can help for reduced vision)	N	Not in this version of prototype
4. Slide-out keyboards should be avoided	?	What does this refer to?
5. Program and command naming should be carefully considered and in accordance with the users' mental models	P	Language is relatively simple, but needs to be re-considered in every iteration.
6. Provide large, clear and bright screens	N/A	
7. Provide large buttons	N	No physical buttons due to smart phone app. Soft button sizes and placements must be checked for next revision. See A15.
8. Eliminate buttons on the sides and rear of devices	N/A	
9. Provide the possibility to zoom in on small text	P	Text enlarges well with system sizes, but there is a maximum size. Revision needed.
10. Provide clear confirmation of target capture (i.e. button press, visited link). The user should not be expected to detect small changes	N	The difference between startup sequence screens is too small. Either they are not necessary, or they need to be more clearly separable. Also check button behavior.
11. Older users should not be expected to double click because of slower hand movements	Y	No double click required.

12. A single, consistently placed button for returning to the home state should be included	Y	Android home button possible to map to "Navmem home". May be confusing. Discuss at design meeting.
13. Graphics should be relevant and not for decoration.	Y	All graphic elements relevant. Maybe a too conservative use of graphic elements. Icons could help. Buttons should be button-shaped to aid user understanding, for example.
14. Images should have alt tags	N	Not tested
15. Icons should be simple and meaningful and also labeled (with a large enough font)	P	See A15, D9, D14.
16. Clear navigation should be provided	Y	Arrow easy to understand and follow.
17. Tapping often preferred to drag and drop	Y	No drag and drop in app.
18. Provide current location in the interface	N	Information is there, but not displayed to user. We should discuss in what form this should be.
19. Clearly show which tasks are active		
20. Important features should be available directly via a labeled button and not via menu navigation	Y	No menus at this stage
21. Avoid pull down menus	Y	
22. Do not have very deep hierarchy and group information into meaningful categories	Y or N/A	
23. Important information should be highlighted	P	Next landmark is highlighted, but the sequence was not understood by most users.
24. Information should be concentrated mainly in the centre	P	Arrow in the center, buttons more peripheral
25. Provide ample time to read information	N/A	No time limit to reading
26. Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choice to the user	N/A	App not complex enough to check for this.
27. Main navigation always the same and critical functions should not disappear	N/A	App not complex enough to check for this.
28. Colors should be used conservatively	Y	Colors not used at all except for images. This recommendation should be revised and exemplified, as colors are good for separating elements. Too extensive use of colors could be considered as cluttered or childish, though.
29. Blue green tones should be avoided	Y	No color used
30. Background screens should not be pure white or change rapidly in brightness between screens. Also, a high contrast between the foreground should exist.	P	Background not white. Contrast needs to be higher. Use guidelines for contrast design in combination with color use.

31. Avoid moving text	Y	
32. Avoid fancy font types	Y	
33. An online help should be provided	N	Early prototype
34. Error message should be simple and easy to follow	N	No error messages displayed (?)

4.4.1.1 WELL FULFILLED REQUIREMENTS IN NAVMAM EXPLORER:

- Arrow navigation – simple and understandable.
- Different levels of detail: arrow could be used, but a map could also be used. This gives a flexible system, but the map was not explicitly tested in Malmö.
- Use of pictures for landmarks. This was not tested enough, as the task was generalized, and thus, the use of “artificial” landmarks made no real sense to users. We need to discuss the specifics of this, when and how it can work.

4.4.1.2 SUGGESTED ACTION POINTS FOR REVISING THE NAVMEM EXPLORER IN ORDER OF PRIORITY:

- Stability
 - Needs to be able to handle that other things can happen on the phone and app be interrupted. Use Android create/pause/resume/stop.
- Fix graphics
 - Enhance contrast (follow guidelines for low vision users)
 - Consider the use of colors on the arrow
 - Move buttons and/or resize them – they are too close to system soft buttons.
- Startup
 - Review the start sequence – too long and has no meaning for users. Screens do not differ.
- Images
 - Consider using thumbnail pictures in route overviews and use larger pictures when displaying them (landscape mode?). Allow zooming in pictures.
- Multimodal notifications
 - Use multimodal notifications before a turn, possibly at a landmark, and on arrival to the destination, e.g. sound + image + vibration
 - Consider the use of non-visual guiding
- Functions
 - How do we communicate weak location signal and low compass accuracy to the user
 - Where am I? (discuss this)
- (Re)decide the use scenario: provided it still has to do with creating predefined routes the next step needs to be **route creation**
 - Automatic
 - Custom off location
 - Custom on location (walk and annotate)
 - Mixed
- Emergency contact
- Map design – not tested in our evaluation, discuss map design
- Localized reminders
- Customization
 - Color schemes

- Simple and advanced mode / individualization

4.5 REQUIREMENTS EVALUATION – HOMECOMPASS

For each item in the original requirements list (chapter 6, in version 1), the tests are used as a case. Each requirement that is fulfilled will get a **Y**, if it is partly fulfilled it will get an **F** and if it is not at all fulfilled it will get an **N**. **N/A** means not applicable to this test/prototype.

For each item, especially **N** and **P** marked ones, there is a comment explaining the result in relation to the requirement. The aim of this work is to double-check that requirements have been followed, but also to revise the requirements.

A. User requirements, dementia	Fulfilled (Y) Partly fulfilled (P) Not fulfilled (N)	Comment
1. The system should support an active lifestyle	Y	Self-evident for the project goal, should this be moved to a “meta”-category?
2. The system should support in doing daily activities outside	Y	
3. The system might provide navigation support inside	N	To be removed?
4. The system should support in doing social activities (e.g. visit to friends/family)	P	No specific functions for social activities, but being able to go out at all supports this.
5. The system should automatically recognize a disorientation event	N	This indicates some form of intelligence to the system – is this a goal for the project?
6. The system should provide support in case of disorientation	P	Not automatically, but that is the point with any navigation support
7. The system should only provide navigation support when needed	P	This indicates some form of intelligence to the system – is this a goal for the project?
8. The system should support the user in navigation and orientation in an unobtrusive manner	P	The system still need to be held in the hand and pointed in the intended direction to walk. Guiding is provided by navigation, which is discreet.
9. The system should facilitate help provided by (a informal) caregiver automatically when needed	N	Does this fit the aim of the project?
10. The user can contact an informal caregiver in times of need	N	See above
11. The (informal) carer could also contact the user (two-way communication)	N	See above
12. The device should also be used by bystanders to call for help when necessary	N	See above
13. The system must contain “tracking at a distance”	N	See above
14. The system could monitor the activities performed by the user	N	See above
15. The system should be easy to use	P	Based on observation by one user with dementia-like problems and other users who had a stroke, the arrow is easy to follow. It has good visibility and contrast.

		<p>The figure indicating distance to the goal was used by some of the test persons as a confirmation that they got closer to the goal. All users did not comment on this (and possibly did not notice it either).</p> <p>The need to make fine-grained navigation decisions (for example which direction to take around a house) because of the app showing the way “as the crow flies” was difficult for some users, but easy for others. There is an interesting research angle on supporting users to make some navigation on their own, or giving them all the help we can provide.</p> <p>This requirement is too high level and needs to be complemented by concrete requirements as well as good examples.</p>
16. The system should be easy to learn	P	We need to discuss this point. For dementia (as well as stroke etc) learning is not an option. If you have a memory decline, a system should need in principle no leaning time (walk-up-and-use type of system).
17. The system should be reliable	Y	Not explicitly tested in this set-up, but no breakdowns occurred.
18. The interface should be very simple	N	See A15 above.
19. The interface could include information about the surroundings to support memory	N	
20. The system should also be suitable for wheelchair use	N	<p>We had no users with dementia using wheelchairs, but had problems in combination with wheel chairs:</p> <ol style="list-style-type: none"> 1. Electrical wheelchairs, as well as steel constructions (of e.g. walkers with baskets) disturb the magnetic compass, thus pointing the wrong way. 2. The need to operate a wheel chair with both hands (manual wheel chair) or one and when the other is occupied or not usable (due to stroke, for example) is hindering the use of a mobile for pointing or just holding it in hand. <p>To be usable for persons in wheel chairs, attachment to the chair needs to be considered as well as the potential impact of magnetic fields.</p>
21. The system could be compatible with other memory aid systems (e.g. digital calendar)	N	Aim of project?

B. User requirements, stroke	Fulfilled (Y) Partly fulfilled (P) Not fulfilled (N)	Comment
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1. The system should provide simple memory aid	N	Does this fit the aim of the project?
2. The system should provide a lifeline	N	See above
3. The system should provide accessible routing	N	
4. The system should allow both for simple and more advanced information	N	Not in this prototype.
5. Safe and secure	P	The app is in a mobile phone, making it possible to call for help.
6. Flexible and adaptable	N	The prototype is more or less a vertical prototype just for navigation to a predefined point. This requirement is also a bit too high-level and gives no help. Flexible and adaptable according to what?
7. Possible to manipulate with one hand only	P	It is hard to actually do manipulation of on-screen elements with just one hand. That requires some dexterity, and especially being used to selecting with a thumb. There is also the question about being able to cope with one hand in an entire activity – what if your good hand is already occupied? By a wheelchair joystick or something else?
8. Easy to manipulate	P	Touch screen manipulation in general comes natural for some, but not for others. See also item A15.
9. Easy to bring	Y	Smart phone is quite small. Fits in pocket. Comes in different sizes.
10. Easy to remember	N	See learnability above, or is this referring to that it should be easy to remember to bring?
11. Keep texts short	Y	
12. Minimize numbers of steps	Y	
13. Limit the amount of information	Y	Information is kept short and limited. Should anyway perform double-check on the type of information.
14. Provide appropriate reminders	N	Unclear what kind of reminders are meant here.
15. Consider using images	P	Not extensive use of images. Arrows and a kind of “stop”-image used.
16. Information available multimodally	Y	Visual, haptics and sound.
17. Clear information on directions and avoid coded information or mental rotations	Y	Arrow navigation very clear and easy to understand.

C. User requirements, elderly users (navigation devices)	Fulfilled (Y) Partly fulfilled (P) Not fulfilled (N)	Comment
1. Easy to use	P	See item A15.

2. Keys and screen needs to be large enough	P	Smart phones have no physical keys which in itself is a problem for some users without experience with touch screens. The phones used had large enough screens (SONY Experia Z and Nexus 4).
3. Clear and easy to understand information	P	See items A15 and B12.
4. Important not to get lost	?	This requirement makes no sense, should be rephrased.
5. The device needs to be robust and reliable	N	Not tested explicitly. For the stability of the app, see A17.
6. If a special device, small, light and long power supply	N/A	N/A
7. Display has to be readable under all lighting conditions	?	Not tested explicitly. Contrast good. See also A15.
8. The system should contain a GSM unit in order to call for help in an emergency	Y	
9. One can decide who should be called and who should be able to determine the whereabouts	N	Not implemented

D. User requirements, elderly users (mobile devices)	Fulfilled (Y) Partly fulfilled (P) Not fulfilled (N)	Comment
1. Mobile devices should be compatible with hearing aids	N/A	
2. Mobile devices should have a wide range of volume levels	Y	
3. Several input modalities should be included (audio hints can help for reduced vision)	N	Not in this version of prototype
4. Slide-out keyboards should be avoided	?	What does this refer to?
5. Program and command naming should be carefully considered and in accordance with the users' mental models	Y	
6. Provide large, clear and bright screens	N/A	
7. Provide large buttons	N/A	No physical buttons due to smart phone app.
8. Eliminate buttons on the sides and rear of devices	N/A	
9. Provide the possibility to zoom in on small text	N	Not tested – need to check if the text enlarges with the system. Text large and well visible as baseline.
10. Provide clear confirmation of target capture (i.e. button press, visited link). The user should not be expected to detect small changes	P	Revise activity which saves a location for later use.
11. Older users should not be expected to double click because of slower hand	Y	No double click required.

movements		
12. A single, consistently placed button for returning to the home state should be included	N/A	
13. Graphics should be relevant and not for decoration.	Y	
14. Images should have alt tags	N/A	
15. Icons should be simple and meaningful and also labeled (with a large enough font)	Y	
16. Clear navigation should be provided	Y	Arrow easy to understand and follow.
17. Tapping often preferred to drag and drop	Y	No drag and drop in app.
18. Provide current location in the interface	N	Information is there, but not displayed to user. We should discuss in what form this should be presented.
19. Clearly show which tasks are active	N/A	
20. Important features should be available directly via a labeled button and not via menu navigation	Y	No menus at this stage
21. Avoid pull down menus	Y	
22. Do not have very deep hierarchy and group information into meaningful categories	Y or N/A	
23. Important information should be highlighted	Y	
24. Information should be concentrated mainly in the centre	Y	Arrow in the center
25. Provide ample time to read information	N/A	No time limit to reading
26. Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choice to the user	N/A	App not complex enough to check for this.
27. Main navigation always the same and critical functions should not disappear	N/A	App not complex enough to check for this.
28. Colors should be used conservatively	Y	Colors used in combination with shape change of navigation symbol. Two different colors + greyscale is used.
29. Blue green tones should be avoided	Y	Light green is used for coloring the background of the arrow. The contrast difference between this and the grey arrow (for weak GPS signal) could be double checked.
30. Background screens should not be pure white or change rapidly in brightness between screens. Also, a high contrast to the foreground should exist.	N	Background white (or very light). Needs to be revised or recommendation checked. No users report any problems with this.

31. Avoid moving text	Y	
32. Avoid fancy font types	Y	
33. An online help should be provided	N	Early prototype
34. Error message should be simple and easy to follow	N	No error messages displayed in test.

4.5.1.1 WELL FULFILLED REQUIREMENTS IN HOME COMPASS

This app is planned to be a baseline for the “simplest” mode. Therefore no additional functions are planned. Maybe the arrow design can be reused in the NavMem explorer.

- Arrow navigation and design.
- Has a very limited amount of information
- Uses vibration to show the direction (looking at the screen not necessary)
- Simple but reliable (if a crash should occur, the home position is still the same)

4.5.1.2 CHANGES SUGGESTED FOR HOME COMPASS

UI

- Remove “Cancel” button on home position save screen
- Remove meter figure when arriving at “home” position
- Change arrival signal (individual choice would be best)
- Consider redesigning home position save screen/activity
- Consider changing the screen background to less bright white (more like parchment or similar)

Intro / tutorial

- Add tutorial at startup
- Add notification when compass precision is low and give instructions to calibration

Other

- Evaluate the UI components that communicates positioning accuracy

4.6 SUGGESTIONS FOR IMPROVING THE REQUIREMENTS

By separating guidelines / recommendations list for the different user categories, some overhead is created when making sure that recommendations are followed. We need to assess whether the separation in user groups has any practical implications, or if we could have a single, more condensed, checklist.

Furthermore, the recommendations in chapter 6 are mixing small matters, important matters, high-level recommendations, suggestions for functions and detailed interface requirements. This is confusing and also does not help in deciding which functions need to be prioritized. We need to design a prioritized checklist that possibly makes use of some hierarchy. We suggest also, that the prioritization is made by functional analysis [1, 2], where it is made clear which functions are (e.g.) main functions, necessary functions, desired functions or even unnecessary functions in a specific context of use. See sketch in chapter 10.

References

- [1] Magnusson et al. (2009) *User Study Guidelines*, Haptimap project. Online document: http://www.english.certec.lth.se/haptics/papers/HaptiMap_d12.pdf Accessed 140304.
- [2] Baxter, M. (1995) *Product Design: Practical methods for the systematic development of new products*, CRC Press.

5 TEST REPORT ROESSINGH RESEARCH AND DEVELOPMENT

Seven elderly participated in the NavMem test in the Netherlands. This test is performed in order to make changes to the navigation applications that are of benefit to the user groups. The test is performed outside (realistic context) with elderly. The targeted end-users, patients with mild dementia, are not approached to participate in the NavMem-test, because user-test with a demo-version of a navigation system is too convulsion for patient suffering of mild dementia and for this kind of test an approval by the appropriate ethics committee is necessary.

Characteristic	Value
Age (years)	64,9 (4,9) (Range: 60-75)
Gender	2 male 5 female
Hearing	7 full hearing
Vision	4 full vision 3 minor vision problems
- color blind?	None
Motor abilities	7 fully mobile
Dominant hand	6 right / 1 left
Mini-Mental State Examination (MMSE)* (1)	29,6 (0.5) (range 29-30) No cognitive impairment (MMSE > 24)

Table 1: Demographic characteristics of the included elderly

All elderly owned a mobile phone. Four elderly used a smartphone (2x HTC / 2x Samsung) and three elderly used a feature phone (3x Nokia). The participating elderly had minimal experience with using a GPS device or GPS app on a mobile phone. Mainly the GPS device was used for navigation. Two elderly rated their sense of direction excellent and 5 elderly rated their sense of direction reasonable.

5.1 USER EXPERIENCE NAVMEM NAVIGATOR

In addition, at Roessingh t usability was assessed with the System Usability Scale (SUS) (2). The SUS presented ten statements about the perceived usability of the service. The SUS score ranges from 0 to 100 (low and high usability, respectively). The average SUS score for the NavMem Navigator was 53.6 (SD 24.6; range 20-77,5), indicating low acceptability (2). The overall satisfaction with the NavMem Navigator was assessed with a question to rate the service on a scale from 0 to 10 (low and high satisfaction, respectively) and a question whether elderly would recommend the service to another. Elderly rated the NavMem Navigator with a 4 or higher. The average rate was a 5.4 (SD 2.0; range 4-9) and two elderly recommend the service to another. In most cases the NavMem Navigator did not worked well for the elderly. In the direction modus elderly had trouble with understanding the purpose of the presented arrow. The arrow moved fast and many times and this confused the elderly, made them in some cases insecure. The map modus was clearer to the elderly. But the map was too small and hard to understand at a glance. In two cases, elderly were trying to understand the map and giving no notion the traffic around them which almost led to a dangers situation. The task to navigate with the NavMem navigator had an average NASA task load index of 15.0 (SD 7.4; range 7-28)

5.2 USER EXPERIENCE HOME COMPASS

The average SUS score for the Home Compass was 81.4 (SD 9.8; range 65-90). An acceptable service (2). Elderly rated the Home Compass with a 4 or higher. The average rate was a 7.8 (SD 1.7; range 4-9) and six elderly recommend the service to another, indication high acceptability (2). Figure 17 shows the SUS scores of both navigation apps.

In most cases the Home Compass worked well for the elderly. The service was intuitive and the elderly needed only a few seconds to understand the service. Especially the vibration, when the walking direction was correct, was appreciated by almost all elderly. Some of them suggested increasing the vibration, so they could put the mobile phone in the pocket and still feel the vibration. Another suggestion was to add a sound next to the vibration. Most elderly felt secure during the use of this navigation app and had full attention for the traffic around them.

The task to navigate with the Home Compass had an average NASA task load index of 9.1 (SD 2.7; range 6-12)

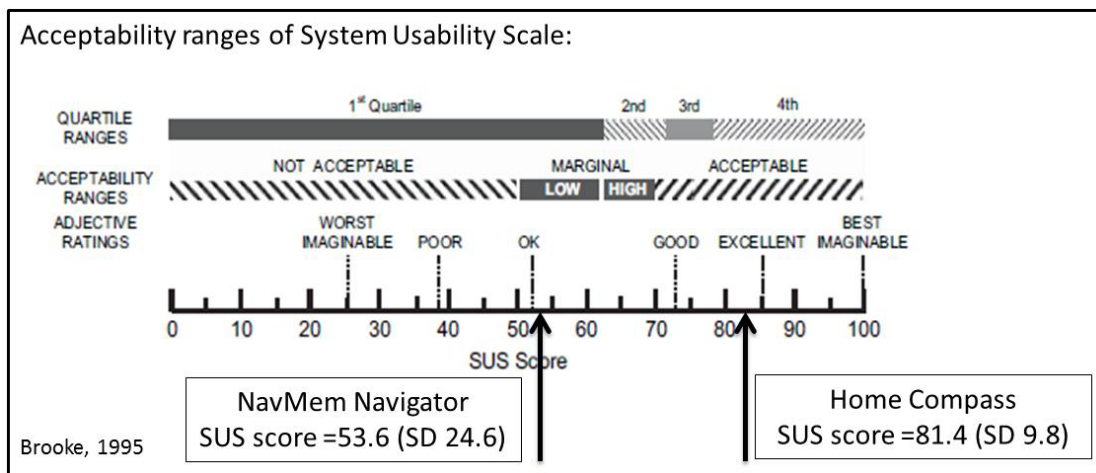


Figure 1. Acceptability range of System Usability Scale

5.3 REQUIREMENT CHECK FOR NAVMEM NAVIGATOR

*These requirements were not a subject in the user-test / functionality not yet incorporated

<i>User requirements, dementia</i>		
The system should support an active lifestyle	N	*
The system should support in doing daily activities outside	N	*
The system might provide navigation support inside	P	When there was GPS signal elderly were able to navigate inside.
The system should support in doing social activities (e.g. visit to friends/family)	N	*
The system should automatically recognize a disorientation event	N	*
The system should provide support in case of disorientation	P	Only when elderly understand how to interpret the arrow / map
The system should only provide navigation support when needed	P	-
The system should support the user in navigation and orientation in an unobtrusive manner	P	To navigate elderly have to hold and look at the mobile phone

The system should facilitate help provided by (a informal) caregiver automatically when needed	N	*
The user can contact an informal caregiver in times of need	P	Elderly could use the mobile phone to contact an informal caregiver
The (informal) carer could also contact the user (two-way communication)	P	The carer could use the mobile phone to contact the user
The device should also be used by bystanders to call for help when necessary	P	Bystanders could use the mobile phone to call for help when necessary
The system must contain "tracking at a distance"	N	The tracking only visible for the user, not "at a distance"
The system could monitor the activities performed by the user	N	*
The system should be easy to use	P	By filling out the SUS (question 3) 4 of the 7 elderly stated that the system was easy to use
The system should be easy to learn	P	By filling out the SUS (question 10) 4 of the 7 elderly stated that they need to learn a lot of thing before they could get going with this system.
The system should be reliable	P	Three elderly were not able to success fulfill the navigation task with this system.
The interface should be very simple	N	Elderly had trouble with interpret the map / arrow
The interface could include information about the surroundings to support memory	P	Minimal information about the surrounding was included (e.g. streetnames / buildings)
The system should also be suitable for wheelchair use	N	No wheelchair users participated in this user-test
The system could be compatible with other memory aid systems (e.g. digital calendar)	N	*
<i>User requirements, stroke</i>		
The system should provide simple memory aid	N	*
The system should provide a lifeline	N	*
The system should provide accessible routing	Y	You provide routes were accessible
The system should allow both for simple and more advanced information	P	The system provides an arrow (simple informative) and a map (advanced information)
Safe and secure	N	Two elderly were trying to understand the map and giving no notion the traffic around them which almost led to a dangers

		situation
Flexible and adaptable	N	-
Possible to manipulate with one hand only	N	Elderly need two hand to manipulate the system
Easy to manipulate	P	The number of buttons do not make it easy
Easy to bring	Y	The mobile phone is easy to bring
Easy to remember	P	By filling out the SUS (question 8) 3 of the 7 elderly stated that they found the system very cumbersome to use.
Keep texts short	Y	-
Minimize numbers of steps	P	Quite a number of steps were needed to start the navigation
Limit the amount of information	Y	Amount of information was limited to the navigation task
Provide appropriate reminders	N	*
Consider using images	Y	
Information available multimodally	N	Only available on mobile phone
Clear information on directions and avoid coded information or mental rotations	P	Both direction and map modus where not clear to all elderly
<i>User requirements, elderly users (navigation devices)</i>		
Easy to use	P	By filling out the SUS (question 3) 4 of the 7 elderly stated that the system was easy to use
Keys and screen needs to be large enough	N	Elderly stated that the screen was too small
Clear and easy to understand information	P	By filling out the SUS (question 8) 3 of the 7 elderly stated that they found the system very cumbersome to use.
Important not to get lost	Y	None of the elderly got lost
The device needs to be robust and reliable	P	Three elderly were not able to success fulfill the navigation task with this system.
If a special device, small, light and long power supply	P	Mobile phone are accepted by elderly
Display has to be readable under all lighting conditions	P	Dependent of the used mobile phone
The system should contain a GSM unit in order to call for help in an emergency	Y	Mobile can be used
One can decide who should be called and who should be able to determine the whereabouts	N	*
<i>User requirements, elderly users (mobile devices)</i>		
Mobile devices should be compatible with hearing aids	N	No elderly with hearing aids participated in this user-test

Mobile devices should have a wide range of volume levels	Y	-
Several input modalities should be included (audio hints can help for reduced vision)	N	*
Slide-out keyboards should be avoided	Y	
Program and command naming should be carefully considered and in accordance with the users' mental models	Y	*
Provide large, clear and bright screens	P	Elderly stated that the screen was too small
Provide large buttons	Y	-
Eliminate buttons on the sides and rear of devices	Y	-
Provide the possibility to zoom in on small text	N	This possibility was not provided
Provide clear confirmation of target capture (i.e. button press, visited link). The user should not be expected to detect small changes	Y	-
Older users should not be expected to double click because of slower hand movements	Y	-
A single, consistently placed button for returning to the home state should be included	N	Not working correctly
Graphics should be relevant and not for decoration.	Y	-
Images should have alt tags	?	?
Icons should be simple and meaningful and also labeled (with a large enough font)	N	Icons are hardly used
Clear navigation should be provided	P	Three elderly were not able to success fulfill the navigation task with this system.
Tapping often preferred to drag and drop	Y	-
Provide current location in the interface	Y	On the map with a arrow
Clearly show which tasks are active	Y	-
Important features should be available directly via a labeled button and not via menu navigation	P	Features such as "direction", "map", "home" and "help" are directly available
Avoid pull down menus	Y	-
Do not have very deep hierarchy and group information into meaningful categories	Y	-
Important information should be highlighted	P	Are separate buttons
Information should be concentrated mainly in the centre	Y	-
Provide ample time to read information	Y	-
Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choice to the user	N	*
Main navigation always the same and critical functions should not disappear	N	*
Colours should be used conservatively	Y	-
Blue green tones should be avoided	Y	-
Background screens should not be pure white or change rapidly in brightness between screens. Also, a high contrast between the foreground should exist.	Y	-

Avoid moving text	Y	-
Avoid fancy font types	Y	-
An online help should be provided	N	Help button does not work
Error message should be simple and easy to follow	N	No error message appeared during the user-tests

5.3.1 WELL FULFILLED REQUIREMENTS:

- The system should provide accessible routing: the routing provided by the system were accessible for all elderly. The trails were easily accessible and there were no obstructions. Most of the trails were in a traffic-free environment.
- Easy to bring: A mobile phone was use for the NavMem navigator app and a mobile phone is accepted and easy to bring
- Limit the amount of information: the amount of information was limited to the navigation task
- Important not to get lost: During the user-test none of the elderly got lost

5.4 REQUIREMENT CHECK FOR HOME COMPASS:

*These requirements were not a subject in the user-test / functionality not yet incorporated

<i>User requirements, dementia</i>		
The system should support an active lifestyle	N	*
The system should support in doing daily activities outside	N	*
The system might provide navigation support inside	N	System only provided an home direction
The system should support in doing social activities (e.g. visit to friends/family)	N	*
The system should automatically recognize a disorientation event	N	*
The system should provide support in case of disorientation	Y	-
The system should only provide navigation support when needed	P	-
The system should support the user in navigation and orientation in an unobtrusive manner	P	To navigate elderly have to hold and look at the mobile phone
The system should facilitate help provided by (a informal) caregiver automatically when needed	N	*
The user can contact an informal caregiver in times of need	P	Elderly could use the mobile phone to contact an informal caregiver
The (informal) carer could also contact the user (two-way communication)	P	The carer could use the mobile phone to contact the user
The device should also be used by bystanders to call for help when necessary	P	Bystanders could use the mobile phone to call for help when necessary
The system must contain "tracking at a distance"	N	The tracking only visible for the user, not "at a distance"
The system could monitor the activities performed by the user	N	*
The system should be easy to use	Y	By filling out the SUS (question 3)

		all elderly stated that the system was easy to use
The system should be easy to learn	y	By filling out the SUS (question 10) none of the elderly stated that they need to learn a lot of thing before they could get going with this system.
The system should be reliable	Y	All elderly were able to success fulfill the navigation task with this system.
The interface should be very simple	Y	All elderly state that the interface was very simple
The interface could include information about the surroundings to support memory	Y	No information about the surrounding was included
The system should also be suitable for wheelchair use	N	No wheelchair users participated in this user-test
The system could be compatible with other memory aid systems (e.g. digital calendar)	N	*
<i>User requirements, stroke</i>		
The system should provide simple memory aid	N	*
The system should provide a lifeline	N	*
The system should provide accessible routing	P	The system provides the direction the elderly chooses the routing
The system should allow both for simple and more advanced information	N	The system only allows simple information
Safe and secure	Y	-
Flexible and adaptable	Y	-
Possible to manipulate with one hand only	N	Elderly need two hand to manipulate the system
Easy to manipulate	Y	Only one screen and one button
Easy to bring	Y	The mobile phone is easy to bring
Easy to remember	P	By filling out the SUS (question 8) none of the elderly stated that they found the system very cumbersome to use.
Keep texts short	Y	minimal texts
Minimize numbers of steps	Y	Only one step is necessary to start the Home Compass
Limit the amount of information	Y	Barely any information is provided
Provide appropriate reminders	N	*
Consider using images	Y	No images are used
Information available multimodally	N	Only available on mobile phone
Clear information on directions and avoid coded information or mental rotations	Y	-
<i>User requirements, elderly users (navigation devices)</i>		
Easy to use	P	By filling out the SUS (question 3)

		all elderly stated that the system was easy to use
Keys and screen needs to be large enough	Y	-
Clear and easy to understand information	P	By filling out the SUS (question 8) none of the elderly stated that they found the system very cumbersome to use.
Important not to get lost	Y	None of the elderly got lost
The device needs to be robust and reliable	Y	All elderly were able to success fulfill the navigation task with this system.
If a special device, small, light and long power supply	P	Mobile phone are accepted by elderly
Display has to be readable under all lighting conditions	P	Dependent of the used mobile phone
The system should contain a GSM unit in order to call for help in an emergency	Y	Mobile can be used
One can decide who should be called and who should be able to determine the whereabouts	N	*
<i>User requirements, elderly users (mobile devices)</i>		
Mobile devices should be compatible with hearing aids	N	No elderly with hearing aids participated in this user-test
Mobile devices should have a wide range of volume levels	Y	-
Several input modalities should be included (audio hints can help for reduced vision)	N	*
Slide-out keyboards should be avoided	Y	-
Program and command naming should be carefully considered and in accordance with the users' mental models	Y	*
Provide large, clear and bright screens	Y	-
Provide large buttons	Y	-
Eliminate buttons on the sides and rear of devices	Y	-
Provide the possibility to zoom in on small text	Y	-
Provide clear confirmation of target capture (i.e. button press, visited link). The user should not be expected to detect small changes	Y	-
Older users should not be expected to double click because of slower hand movements	Y	-
A single, consistently placed button for returning to the home state should be included	Y	Not necessary only one screen
Graphics should be relevant and not for decoration.	Y	-
Images should have alt tags	?	?
Icons should be simple and meaningful and also labeled (with a large enough font)	N	No icons are used
Clear navigation should be provided	Y	All elderly were able to success fulfill the navigation task with this system.

Tapping often preferred to drag and drop	Y	-
Provide current location in the interface	N	Only a compass was provided
Clearly show which tasks are active	Y	-
Important features should be available directly via a labeled button and not via menu navigation	Y	Only one button
Avoid pull down menus	Y	-
Do not have very deep hierarchy and group information into meaningful categories	Y	-
Important information should be highlighted	Y	-
Information should be concentrated mainly in the centre	Y	-
Provide ample time to read information	Y	-
Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choice to the user	N	*
Main navigation always the same and critical functions should not disappear	N	*
Colours should be used conservatively	Y	-
Blue green tones should be avoided	Y	-
Background screens should not be pure white or change rapidly in brightness between screens. Also, a high contrast between the foreground should exist.	Y	-
Avoid moving text	Y	-
Avoid fancy font types	Y	-
An online help should be provided	N	No help button available
Error message should be simple and easy to follow	N	No error message appeared during the user-tests

5.4.1 WELL FULFILLED REQUIREMENTS:

- The system should be easy to use: By filling out the SUS (question 3) all elderly stated that the system was easy to use
- The system should be easy to learn: By filling out the SUS (question 10) none of the elderly stated that they need to learn a lot of thing before they could get going with this system.
- The system should be reliable: All elderly were able to success fulfill the navigation task with this system.
- Minimize numbers of steps: Only one step is necessary to start the Home Compass

5.5 REFERENCES:

1. Kempen GI, Brilman EI, Ormel J. [The Mini Mental Status Examination. Normative data and a comparison of a 12-item and 20-item version in a sample survey of community-based elderly]. Tijdschr Gerontol Geriatr. 1995;26(4):163-72.
2. Brooke J. SUS - a quick and dirty usability scale. In: Jordan PW, Thoma B, Weerdmeester BA, editors. Usability Evaluation in Industry. Lodon: Taylor & Francis; 1995. p. 189-94.

6 TESTS REPORT SIEMENS AG

Seven elderly participated in this NavMem user test in Germany..

Characteristic	Value
Age (years)	66 (Range: 57 - 79)
Gender	4 male 3 female
Hearing	4 full hearing, 3 very minor problems
Vision	3 full vision 4 minor vision problems
- color blind?	None
Motor abilities	6 fully mobile, 1 minor problems
Dominant hand	7 right
Mini-Mental State Examination (MMSE)* (1)	

Table 1: Demographic characteristics of the included elderly

All elderly owned a mobile phone. Three elderly used a smartphone (1 x Apple, 1 x Nokia, 1 x Samsung) and four elderly used a classic mobile phone (3 x Nokia, 1 x Siemens). Three of the participants had no experience with GPS applications or devices at all and two of the remaining four were used to car navigation systems and the other two had used one very rarely. One of the users rated his sense of direction excellent and the other six rated their sense of direction good.

the elderly needed only a few seconds to understand the service. Especially the vibration, when the walking direction was correct, was appreciated by almost all elderly. Some of them suggested increasing the vibration, so they could put the mobile phone in the pocket and still feel the vibration. Another suggestion was to add a sound next to the vibration. Most elderly felt secure during the use of this navigation app and had full attention for the traffic around them.

6.1 REQUIREMENT CHECK FOR NAVMEM NAVIGATOR:

*These requirements were not a subject in the user-test / functionality not yet incorporated

<i>User requirements, dementia</i>		
The system should support an active lifestyle	N	*
The system should support in doing daily activities outside	N	*
The system might provide navigation support inside	N	*
The system should support in doing social activities (e.g. visit to friends/family)	N	*
The system should automatically recognize a disorientation event	N	*
The system should provide support in case of disorientation	P	Only when elderly understand how to interpret the arrow / map
The system should only provide navigation support when needed	P	-
The system should support the user in navigation and orientation in an unobtrusive manner	P	To navigate elderly have to hold and look at the mobile phone
The system should facilitate help provided by (a informal) caregiver automatically when needed	N	*
The user can contact an informal caregiver in times of need	P	By using the phone but not out of the app

The (informal) carer could also contact the user (two-way communication)	P	By calling the phone but not inside the app or via a backend solution
The device should also be used by bystanders to call for help when necessary	P	Bystanders could use the mobile phone to call for help when necessary
The system must contain “tracking at a distance”	N	The tracking only visible for the user, not “at a distance”
The system could monitor the activities performed by the user	N	*
The system should be easy to use	Y	None of the users had any problems
The system should be easy to learn	P	They only used the dedicated applications with nearly no interaction
The system should be reliable	P	GPS signal accuracy and coverage in narrow streets
The interface should be very simple	Y	General comment was to simply follow the arrow
The interface could include information about the surroundings to support memory	P	POIs were included but not used by the users
The system should also be suitable for wheelchair use	N	No wheelchair users participated in this user-test
The system could be compatible with other memory aid systems (e.g. digital calendar)	N	*
<i>User requirements, stroke</i>		
The system should provide simple memory aid	N	*
The system should provide a lifeline	N	*
The system should provide accessible routing	P	What does accessible mean and for whom (target user group)?
The system should allow both for simple and more advanced information	P	The system provides an arrow (simple informative) and a map (advanced information) but people have to know that and be able to use it
Safe and secure	P	Like all other visual based navigation applications – one has to take notice of the environment
Flexible and adaptable	N	-
Possible to manipulate with one hand only	P	One person had extremely small hands and needed occasionally two
Easy to manipulate	P	Partially too easy – accidental clicking of buttons
Easy to bring	Y	The mobile phone is easy to bring
Easy to remember	P	So far limited functionality and therefore quite easy
Keep texts short	Y	-

Minimize numbers of steps	P	Quite a number of steps were needed to start the navigation
Limit the amount of information	Y	Amount of information was limited to the navigation task
Provide appropriate reminders	N	*
Consider using images	P	The system had images but did not display them
Information available multimodally	N	Only visual information provision
Clear information on directions and avoid coded information or mental rotations	Y	Simply follow the arrow (could be a bit more stable)
<i>User requirements, elderly users (navigation devices)</i>		
Easy to use	Y	
Keys and screen needs to be large enough	N	Elderly stated that the screen was too small
Clear and easy to understand information	Y	Follow the arrow (list of POIs did not make sense (click to view image not clear)
Important not to get lost	Y	None of the elderly got lost
The device needs to be robust and reliable	P	Too easy to accidentally close the application
If a special device, small, light and long power supply	N	Facilitated a regular smartphone
Display has to be readable under all lighting conditions	P	Depends on the used mobile device
The system should contain a GSM unit in order to call for help in an emergency	Y	Smartphones normally do
One can decide who should be called and who should be able to determine the whereabouts	N	*
<i>User requirements, elderly users (mobile devices)</i>		
Mobile devices should be compatible with hearing aids	N	No elderly with hearing aids participated in this user-test
Mobile devices should have a wide range of volume levels	Y	-
Several input modalities should be included (audio hints can help for reduced vision)	N	*
Slide-out keyboards should be avoided	Y	
Program and command naming should be carefully considered and in accordance with the users' mental models	Y	*
Provide large, clear and bright screens	P	Elderly stated that the screen was too small
Provide large buttons	Y	-
Eliminate buttons on the sides and rear of devices	Y	-
Provide the possibility to zoom in on small text	P	Can be done with Android features but not tested or asked for
Provide clear confirmation of target capture (i.e. button press, visited link). The user should not be expected to detect small changes	Y	-
Older users should not be expected to double click because of	Y	-

slower hand movements		
A single, consistently placed button for returning to the home state should be included	N	Not working correctly
Graphics should be relevant and not for decoration.	Y	-
Images should have alt tags	?	?
Icons should be simple and meaningful and also labeled (with a large enough font)	N	Icons are hardly used
Clear navigation should be provided	P	Usual accuracy issues with GPS signals in narrow streets
Tapping often preferred to drag and drop	Y	-
Provide current location in the interface	Y	On the map with a arrow
Clearly show which tasks are active	Y	-
Important features should be available directly via a labeled button and not via menu navigation	P	Features such as “direction”, “map”, “home” and “help” are directly available
Avoid pull down menus	Y	-
Do not have very deep hierarchy and group information into meaningful categories	Y	-
Important information should be highlighted	P	Are separate buttons
Information should be concentrated mainly in the centre	Y	-
Provide ample time to read information	Y	-
Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choice to the user	N	*
Main navigation always the same and critical functions should not disappear	N	*
Colours should be used conservatively	Y	-
Blue green tones should be avoided	Y	-
Background screens should not be pure white or change rapidly in brightness between screens. Also, a high contrast between the foreground should exist.	Y	-
Avoid moving text	Y	-
Avoid fancy font types	Y	-
An online help should be provided	N	Help button did not yet work
Error message should be simple and easy to follow	N	No error message appeared during the user-tests

6.1.1 WELL FULFILLED REQUIREMENTS:

- Easy to bring:
 - A regular smartphone was used for the NavMem navigator app and a smartphone is accepted and easy to bring and most people carry one anyway.
- Limit the amount of information:
 - the amount of information was limited to the navigation task and the displaying of POI images did not yet work automatically and thus did not distract or support the participants.
- Important not to get lost:
 - During the user test none of the elderly people got lost

6.2 REQUIREMENT CHECK FOR HOME COMPASS:

*These requirements were not a subject in the user-test / functionality not yet incorporated

<i>User requirements, dementia</i>		
The system should support an active lifestyle	N	*
The system should support in doing daily activities outside	N	*
The system might provide navigation support inside	N	No indoor navigation included
The system should support in doing social activities (e.g. visit to friends/family)	N	*
The system should automatically recognize a disorientation event	N	*
The system should provide support in case of disorientation	Y	-
The system should only provide navigation support when needed	P	-
The system should support the user in navigation and orientation in an unobtrusive manner	P	One has to carry the device in the hand
The system should facilitate help provided by (a informal) caregiver automatically when needed	N	*
The user can contact an informal caregiver in times of need	P	Use smartphone capability but not from the application
The (informal) carer could also contact the user (two-way communication)	P	Regular phone capability but not inside the application
The device should also be used by bystanders to call for help when necessary	P	Bystanders could use the mobile phone to call for help if necessary in case they know how to operate it
The system must contain "tracking at a distance"	N	Not yet implemented
The system could monitor the activities performed by the user	N	*
The system should be easy to use	Y	None of the users had any problems
The system should be easy to learn	y	None of the users had any problems to learn how to use the application (but not yet all functionality available)
The system should be reliable	Y	With the usual accuracy issues of the GPS signal
The interface should be very simple	Y	None of the users had problems
The interface could include information about the surroundings to support memory	P	POI images were available but not displayed
The system should also be suitable for wheelchair use	N	No wheelchair users participated in this user-test
The system could be compatible with other memory aid systems (e.g. digital calendar)	N	*
<i>User requirements, stroke</i>		
The system should provide simple memory aid	N	*
The system should provide a lifeline	N	*

The system should provide accessible routing	N	How could the system do this if not providing any route at all?
The system should allow both for simple and more advanced information	N	Only a simple information is available
Safe and secure	P	People have to watch the screen as for all regular navigation applications
Flexible and adaptable	N	Nothing to adapt or be flexible in
Possible to manipulate with one hand only	Y	
Easy to manipulate	Y	Only one screen and one button
Easy to bring	Y	Smartphones are normally carried around
Easy to remember	Y	Just shows where home is
Keep texts short	Y	minimal texts
Minimize numbers of steps	Y	Only one step is necessary to start the Home Compass
Limit the amount of information	Y	
Provide appropriate reminders	N	*
Consider using images	N	No images are used
Information available multimodally	YN	Visual / haptic / acoustic
Clear information on directions and avoid coded information or mental rotations	Y	-
<i>User requirements, elderly users (navigation devices)</i>		
Easy to use	P	Application was easy to use / smartphone in general was not tested
Keys and screen needs to be large enough	P	Screen could be larger but user choice
Clear and easy to understand information	Y	Simple to use (applications)
Important not to get lost	Y	None of the participants got lost
The device needs to be robust and reliable	P	Depends on the chosen device (outdoor phone)
If a special device, small, light and long power supply	N	*
Display has to be readable under all lighting conditions	P	Depends on the chosen phone
The system should contain a GSM unit in order to call for help in an emergency	Y	Smartphones normally do
One can decide who should be called and who should be able to determine the whereabouts	N	*
<i>User requirements, elderly users (mobile devices)</i>		
Mobile devices should be compatible with hearing aids	N	No elderly with hearing aids participated in this user-test
Mobile devices should have a wide range of volume levels	Y	-
Several input modalities should be included (audio hints can help for reduced vision)	N	*
Slide-out keyboards should be avoided	Y	-
Program and command naming should be carefully considered	Y	*

and in accordance with the users' mental models		
Provide large, clear and bright screens	Y	-
Provide large buttons	Y	-
Eliminate buttons on the sides and rear of devices	Y	-
Provide the possibility to zoom in on small text	Y	-
Provide clear confirmation of target capture (i.e. button press, visited link). The user should not be expected to detect small changes	Y	-
Older users should not be expected to double click because of slower hand movements	Y	-
A single, consistently placed button for returning to the home state should be included	Y	Not necessary only one screen
Graphics should be relevant and not for decoration.	Y	-
Images should have alt tags	?	?
Icons should be simple and meaningful and also labeled (with a large enough font)	N	No icons are used
Clear navigation should be provided	Y	Simply follow the arrow
Tapping often preferred to drag and drop	Y	-
Provide current location in the interface	N	Only a compass was provided
Clearly show which tasks are active	Y	-
Important features should be available directly via a labeled button and not via menu navigation	Y	Only one button
Avoid pull down menus	Y	-
Do not have very deep hierarchy and group information into meaningful categories	Y	-
Important information should be highlighted	Y	-
Information should be concentrated mainly in the centre	Y	-
Provide ample time to read information	Y	-
Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choice to the user	N	*
Main navigation always the same and critical functions should not disappear	N	*
Colours should be used conservatively	Y	-
Blue green tones should be avoided	Y	-
Background screens should not be pure white or change rapidly in brightness between screens. Also, a high contrast between the foreground should exist.	Y	-
Avoid moving text	Y	-
Avoid fancy font types	Y	-
An online help should be provided	N	No help button available
Error message should be simple and easy to follow	N	No error message appeared during the user tests

6.2.1 WELL FULFILLED REQUIREMENTS:

- The system should be easy to use:

- None of the users had any problems to use the application and process the provided navigation instructions
- The system should be easy to learn:
 - None of the users needed more than a very short introduction in order to use the application
- The system should be reliable:
 - All users reached their destination and had just to cope with the usual GPS signal accuracy insufficiencies e.g. no or limited GPS coverage in narrow streets.
- Minimize numbers of steps:
 - Only one step is necessary in order to start the Home Compass

7 REVISION PROCESS

This chapter briefly describes the refinement process of the requirements list.

7.1 PRE-CLUSTERING AND WORKSHOP

The refinement of recommendations was carried out in two steps. The first step was to cluster the original requirements. The clustering was made by putting together requirements which were the same but originated in different, and furthermore grouped in different categories not directly tied to the different user groups that originally informed the initial design. The clustering resulted in 4 high-level categories, in which one had sub-categories.

- Activity requirements
- Function list
- Hardware and system high-level requirements
- Usability requirements (with subcategories)



Figure 2 Clustering of requirements: post-it method

The Usability category was the largest, and was divided into sub-categories that were informed by the 10 Usability Heuristics of Jakob Nielsen [1], and adapted to the project.

All requirements in the categories were then prioritized using a subset of “functional analysis” requirements engineering [2], making each issue either a:

- **necessary** requirement (the system must fulfill this)
- **consider** requirement (this issues must be considered carefully)
- **avoid** requirement (some recommendations include guidelines that state things that should be avoided based on the targeted user group)

This merging and re-structuring of the requirements was then proposed to the 12 developers and testers who met at the “Developer Workshop” that was planned for exchange of results of user tests in March 2014.



Figure 3 Developer workshop

First, the workshop was dedicated to transferring the test results of the developer participants. This was done by presenting the results published in this report in chapters 8-10, and by showing examples of problematic use situations on video.

In the revision discussion all participants were divided in three groups. The groups discussed the rearrangements of the requirements and proposed changes according to test results and the goal of the project. Note that the original requirements list also contained a “wish-list” from user organizations, which not all fitted the project goal. This resulted in that some requirements and functions from the original lists were removed altogether, some were added, some were modified and some were kept as they originally were. The resulting list with the clustering is presented in chapter 12.

7.2 REFERENCES

1. Nielsen, Jakob. *Usability Engineering*. Morgan-Kaufmann 1993. See also: <http://www.nngroup.com/articles/ten-usability-heuristics/>
2. Magnusson, C. et al. *User Study Guidelines*. HaptiMap project. See also: http://www.english.certec.lth.se/haptics/papers/HaptiMap_d12.pdf

8 REVISED REQUIREMENTS LIST

This chapter lists the requirements after refining. The process and the tests that are the background for this list are presented in chapters 7-10. Each requirement can be connected back to the original requirements in chapter 6 by the letter-number combination in the parentheses. New requirements are also marked, and some items have a clarification or explanation written in *italics*.

8.1 ACTIVITY REQUIREMENTS

These requirements are on a high level, and are reminders of what the high level goals of the project are and the ultimate goal of using a navigation help is all about.

8.1.1 NECESSARY:

- i. Support an active lifestyle (A1)
- ii. Support daily activities outside (A2)
- iii. Support wayfinding and getting help if needed (rephrased from “Not getting lost (C4)”)

8.1.2 CONSIDER:

- i. Support social activities (A4) *Note: This is seen as an implicit goal rather than explicit. If you are able to go out independently, it is easier to maintain the social connections you have.*

8.2 ESTABLISHMENT OF SERVICE AND FUNCTION RANGE BASED ON ORIGINAL REQUIREMENTS

Several of the “requirements” expressed in the original document are about diverse and disperse services and functions that may or may not be the primary goal of the project. These are, in most cases wishes from the user organizations and may not fit the goal of the project. This is a list to try to sort out what is a necessary function and what is on the “wish-list”.

8.2.1 NECESSARY

- i. Call for help (C8, C9, B2, A9, C8, B2, A10) – *merged with “call for caregiver”*
- ii. Provide current location (D18) *Where am I-function*
- iii. Geofence / time fence / distance fence checking (**new**)
- iv. (Automatic) tracking of user (A13) / sending of user position (**new**) *The privacy of the user needs to be considered carefully*
- v. Provide information about the route: waypoints, landmarks, distances, times (**new**)
- vi. Manage contact details for help / care givers (**new**)

8.2.2 CONSIDER

- i. The system should provide accessible routing (B3)
- ii. Appropriate reminders (connected to the task, e.g. “where was I going?”, “remember to bring device”, “remember to charge device”) (B14)
- iii. Provide possibilities to create tailor made routes (**new**)
- iv. Automatic disorientation recognition (A5)
- v. Bystander should be able to use the device (A12)
- vi. Information about surroundings (A19) – *could be a map*
- vii. Compatible with other systems (A21)
- viii. Add custom landmarks (**new**)

- ix. Monitor activities (A14) – *in the aspect: remember routes automatically*

8.3 HARDWARE AND HIGHLEVEL SYSTEM REQUIREMENTS

These are necessary to take into account when designing new hardware and the general behavior of the system or app. They may also important for app design, since it is possible to influence e.g. battery life depending on how the software solution is made. Use these always as a checklist and note which are important for your app or solution.

8.3.1 NECESSARY

- i. Possibility to manipulate with 1 hand (B7)
- ii. Easy to bring (B9)
- iii. Bright screen (**new**, adapted from D6)
- iv. High-quality touch screen (**new**) – *note that persons who are older often have more dry skin, thus making some capacitive touch screens hard to use. Consider pens and/or gloves for help*
- v. Safety notice (**new**)

8.3.2 CONSIDER

- i. Robustness (C5)
- ii. Battery life (C6) – *should be longtime (GPS drains battery) and the device needs to monitor battery level in respect to the activity and also warn if a walk is too long for the battery to manage*
- iii. Weight and size of device (C6) – *not too large, but still big enough to see well*
- iv. Large screen for good visibility (adapted from D6, C2, C7)
- v. Size of buttons (may be larger than normal) (C2,D7)
- vi. Spacing of buttons (**new**)
- vii. Hardware button placement (**new**)
- viii. Compatibility with hearing aids (D1)
- ix. Sound volume range (D2)
- x. Vibration intensity (**new**)
- xi. Ease of manipulation for persons with limited dexterity (B8)
- xii. Wheelchair use (A20) - *attachment and EMC*
- xiii. High-resolution screen (**new**, adapted from D6)

8.4 NAVIGATION / WAYFINDING REQUIREMENTS (**NEW**)

8.4.1 NECESSARY

- i. Clear visual presentation of heading (e.g. arrow)
- ii. Multimodal heading information
- iii. Clear multimodal arrival notification

8.4.2 CONSIDER

- i. Notifications at turn points in a route (multimodal)
- ii. Distance to goal-information, possibly in several modalities

8.5 NOTE ON USABILITY REQUIREMENTS

These are the software usability requirements that were identified. They are grouped by taking inspiration from 10 usability heuristics by Jakob Nielsen (see reference [1], chapter 11), and adapted to the project. Some of them also have implications on hardware choice (like good contrast, which needs support in both hardware and software).

8.6 VISUAL DESIGN

8.6.1 NECESSARY

- i. No abrupt changing contrast & brightness between screens (D30)
- ii. Good contrast (D30)
- iii. Appropriate size of icons and text (larger than you think) (D15)
- iv. Sufficient space between buttons / icons to prevent accidental invoking (**new**)
- v. Possible to enlarge text (D9)
 - i. Simple interface/ Minimalist design (A18)
 - ii. Provide predefined color schemes (**new**)

8.6.2 CONSIDER

- iii. Use images/relevant graphics (B15, D13)
- iv. Don't code information on color only – use grayscale and add color (**new**) - *Note particularly that blue/green tones are not necessarily perceived as intended due to the lens getting more yellow with age (D29)*
- v. Put important information in center (D24)
- vi. Conservative color use (D28)
- vii. Be careful with pure white / bright design (adapted from D30) *Stark white may blur / cause glare because of cataract changes in the lens, but also note that devices being used outside need to be bright to be seen at all in sunlight*
- viii. Prevent accidental interaction (by requiring confirmation, for example) (**new**)

8.7 CONSISTENCY

8.7.1 NECESSARY

- i. Recognition rather than recall (D26)
- ii. Design for first use:
 - a. Easy to remember (B10)
 - b. Easy to learn (A16)
 - c. Easy to use (C1, A15)
- iii. Interface navigation should be the same – consistent interface (D27)

8.7.2 AVOID

- i. Moving text (D31)
- ii. Drag- and drop interface (D17)
- iii. Double click (D11)
- iv. Menus (D20, D21, D22)
- v. Fancy fonts (S32)
- vi. Longclick (**new**)

8.8 VISIBILITY OF SYSTEM STATUS

8.8.1 NECESSARY

- i. Highlight important information (D23)
- ii. Show active task (D19)
- iii. Provide information of target capture (e.g. button press animation/click/vibration) (A10)
- iv. Provide feedback on position accuracy (**new**)
- v. Battery information tailored to activity (**new**)

8.9 MATCH BETWEEN SYSTEM AND REAL WORLD

8.9.1 NECESSARY

- i. Speak the user's language (D5)
- ii. Clear information (C5)
- iii. Short texts, limit amount of information (B11, B13)
- iv. Minimize the number of steps in sequences (B12)

8.9.2 CONSIDER

- i. Be careful with coded information (adapted from B17)
- ii. Don't force the user to make mental rotations (adapted from B17) – *when providing maps, for example, make it possible to choose a north-up or heading-up orientation*

8.10 SAFETY, RELIABILITY AND ERROR

8.10.1 NECESSARY

- i. Robustness (C5) – in the software sense
- ii. Provide feedback on position (in)accuracy (**new**)
- iii. "Take me home" button (**new**)
- iv. Safe, secure, reliable (i.e. well tested) (A17, B5)
- v. Simple error messages (D34)
See also revised list of functions that have to do with contacting care personnel and/or position tracking

8.10.2 CONSIDER

- i. Home button (to start of app) (D12)

8.11 FLEXIBILITY OF INTERFACE

8.11.1 NECESSARY

- i. Provide alt tags for images (A14)
- ii. Multiple modes (simple -> expert) (B4)
- iii. Multimodal information (B16)
- iv. Allow sufficient time to read (no toast messages, for example) (D25)
- v. Personalized color schemes, sounds, vibration patterns/strengths (**new**)

8.11.1.1 CONSIDER

- i. Flexible and adaptable (B6)
- ii. Unobtrusive / multimodal navigation (A8)
- iii. Multiple input modalities (D3)

8.12 HELP AND DOCUMENTATION

8.12.1 NECESSARY

- i. Provide help function (**new**)
- ii. Provide manual (**new**)
- iii. Provide tutorials (**new**)

8.12.2 CONSIDER

- i. Provide help in a flexible way – images, easy to read, expert... (**new**)
- ii. Online help (A33)

9 APPENDICES

Appendix 1: Test manuscript, ULUND version translated into English, to serve as template

Appendix 2: Walking interview and NASA RTLX protocol, ULUND version translated into English, to serve as template

Appendix 3: Test protocol with demographic questionnaire and semi-structured post-interview questions, ULUND version translated into English, to serve as template