MOBISERV – FP7 248434

An Integrated Intelligent Home Environment for the Provision of Health, Nutrition and Mobility Services to the Elderly

Deliverable

D2.6: Final Evaluation Report

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Glossary

Term	Explanation
ANNA	Ananz, Stichting Anna Care Group (NL)
AUTH	Aristotle University of Technology (Greece)
CSEM	Centre Suisse d'Electronique et de Microtechnique (Switzerland)
DoW	Description of Work – The initial plan for the Mobiserv project
HRI	Human-robot interaction
LUT	Lappeenranta University of Technology (Finland)
MOBISERV	An Integrated Intelligent Home Environment for the Provision of Health, Nutrition and Mobility Services to the Elderly
PRU	Physical Robotic Unit
ROBS	Robosoft (France)
SHACU	Smart Home Automation and Communication Unit
SMARTEX	Smartex (Italy)
SMH	Stichting Smart Homes (Eindhoven, NL)
UWE	University of the West of England (Bristol, UK)
WHSU	Wearable Health Support Unit

Executive Summary

This document, *D2.6: MOBISERV Final Evaluation Report*, identifies the outcomes of the extensive usability and user experience evaluations conducted on the second and final MOBISERV prototype. A range of issues have been identified and reported, using both expert review and user-based evaluations. The findings include aspects relating to the user interaction and experience of primary and secondary stakeholders with the MOBISERV prototype.

User evaluations have been conducted using the MOBISERV prototype at the *Robotic Ambient Assisted Living Studio* and *UWE student flat* in the UK and at the *Smartest Home of the Netherlands*, *Ananz care homes*, and people's own homes in the Netherlands.

The details of the methodology used to conduct the evaluations are available in D2.4 MOBISERV Evaluation Plan – Issue 2.

Figure 1 The MOBISERV robot that makes people smile

We would like to thank all the participants in our evaluations for the generous contribution of their time and thoughts.

1 Introduction

1.1 Scope of the study

This report *D2.6: MOBISERV Final Evaluation Report* includes the findings of the final phase of evaluation studies conducted on the MOBISERV prototypes and Kompaï robots that were delivered to the Netherlands in the 3rd week of March and to the UK in the 2nd week of April and the software released on the 24th of May 2013 in the UK (with remedial changes by UWE as described in Appendix 2) and on the 8th of July 2013 in the Netherlands. There was an intermediate release of the software on the 7th of August 2013, however this was found to have numerous problems (Appendix 7) and the changes made by UWE could not be integrated to this version. The evaluation strategy, which was modified to reflect the state of the MOBISERV prototype as reported on the 20th of June 2013 (Appendix 1), has been reported in deliverable D2.4 issue 2.

1.2 Aims and Objectives

The purpose of the evaluation is to ensure that all MOBISERV components are appropriate, usable and acceptable for the target users, both primary and secondary, for whom they are designed, and address all aspects relating to achieving the desired functionality and usability as specified in the requirements deliverables D2.3 issues I, II and III.

The evaluation structure, as well as theoretical and pragmatic details relating to the evaluation study, have been defined in D2.4 issues I and II and D2.2 issues I, II and III. These specifications underpin the evaluations carried out. Given the complexity of the MOBISERV system and the components, there are a vast number of evaluation criteria, these have been defined in depth in D2.4 issues, as well as, in D2.2 issues, and the reader is referred to these for details.

1.3 Intended Audience

This report provides the outcomes of numerous evaluations of the MOBISERV system to enable future research and development to build upon findings and perspectives from a range of primary and secondary stakeholders. As such, the findings in this report have a broad impact, which is to provide invaluable insights for all future development of similar technologies for older adults, and thereby enabling the design and development of technology to support independent living to be conducted in a more focussed manner. The findings also help to inform debates on ethical issues related to the use of assistive technology of this nature in future implementations.

2 Description of the MOBISERV system

MOBISERV has aimed to design and develop a proactive personal service robot, integrated with innovative wireless (bio-) sensors, localisation and communication technologies, smart home utilities, and wearable monitoring equipment to support independent living of older persons, giving them ability to make informed lifestyle choices, covering health and wellness, nutrition and mobility but also, social interaction, safety, security and privacy.

Following a user requirements gathering and analysis phase that was carried out simultaneously in two countries, the MOBISERV consortium identified a set of scenarios; these comprise the people, tasks, and contexts that help define what might be expected from an application in a given situation. Scenarios have helped the team to explore in more depth, the non-functional aspects of the individuals' context, which – in addition to ensuring that the functional components are technically viable – have also increased the probability of user acceptance by considering enhanced flexibility for adaptability and customization.

2.1 Basic functionalities

The following functionalities have been found to be fundamental requirements to enable all other functionalities and services of the complete MOBISERV system:

1. The robot should be able to locate and go to the user
2. The robot should be able to face the user in all interactions
3. The robot should be able to charge autonomously

- *In the MOBISERV prototype system used for the user evaluations, requirements 1, 2 and 3 of the list above were not fully implemented.*
- *In the final MOBISERV prototype system, requirements 1 and 2 of the list above have not been fully reached.*

2.2 Primary User Services

The main feature of the MOBISERV system is to activate, stimulate and motivate the primary user – on a physical, cognitive, and social level. This is done by a smart system collecting a lot of context information and a social robot that interacts with the user. Most interactions between the social robot and the primary user are either suggestions/encouragements – which are context-based – or reminders – which are time-based.

System-initiated functionalities

The following functions would be initiated by passive (implicit) input – so based on a set of rules that are applied on the context data gathered by the system in combination with the user model:

1. Encouragements to drink – dehydration prevention
2. Encouragements to eat – nutrition coach
3. Encouragements to exercise – exercise coach
4. Social / companion suggestions (based on emotion recognition)
5. Reminders for medication
6. Fall detection
7. Vital signs monitoring
8. Agenda reminders

- *In the MOBISERV prototype system used for the user evaluations, functions 1, 2, 3, 4, 6, and 7 of the list above were not fully implemented.*
- *In the final MOBISERV prototype system, functions 4 and 7 of the list above were not fully reached.*

User-initiated functionalities

The following functions would be initiated by active (explicit) input – so based on input from the user, either by touch or by voice:

1. Doing exercises
2. Video communication with friends and relatives
3. Reporting to health professionals
4. Home control
5. Games
6. Photo album
7. Robot control

- *In the MOBISERV prototype system used for the user evaluations, function 4 of the list above was not implemented.*
- *In the final MOBISERV prototype system, function 4 of the list above has not been fully reached.*

Third-party-initiated functionalities

The following functions are initiated by external events – so based on input from other parties outside the home environment of the primary user.

1. Incoming video calls
2. Notification of a visitor at the front door

- *In the MOBISERV prototype system used for the user evaluations and in the final MOBISERV prototype system, function 2 was not implemented.*

More detailed information about these primary user functionalities and services offered is available in deliverable D7.3.

2.3 Secondary User Services

In addition to what has been described above with regard to services that are available to primary users, the system provides customisation features – for instance of the context rules, parameters of these rules, and the user model. These customisation features are accessible to secondary users, like partners, family and (informal) carers:

1. User settings
2. Robot settings
3. Function settings

- *In the MOBISERV prototype system used for the user evaluations, all these requirements were not implemented.*
- *In the final MOBISERV prototype system, these requirements were only partially implemented.*

In addition to this, secondary users are able to set, customize and update messages like suggestions and reminders given to primary user, photos shown, contacts available, etc.:

1. Agenda
2. Social suggestions
3. Food suggestions (message, photo, timeslots)
4. Drink suggestions (message, photo, timeslots)
5. Exercise suggestions (message, photo, video, timing)
6. Photos
7. Contacts

- *In the MOBISERV prototype system used for the user evaluations and in the final MOBISERV prototype system, all these functionalities were available.*

A third group of functionalities for secondary users is the overview of the data gathered by the system. A lot of data is being monitored and collected by the MOBISERV system. It is important that this data is used and visualised in an easy and efficient manner, so that the (informal) carer understands what is going on at a glance, and is able to act on this. The following list of data and corresponding trends/tendencies would be available:

1. Eating pattern
2. Drinking pattern
3. Physical activity
4. Social activity (visitors, incoming calls, outgoing calls)
5. Sleeping pattern
6. Emotional pattern
7. Amount of suggestions given
8. Robot usage
9. Game performance

- *In the MOBISERV prototype system used for the user evaluations and in the final MOBISERV prototype system, the actual logging and visualisation of these data was not implemented.*

More detailed information about the secondary user interface is available in deliverable D7.3.

3 Evaluation Strategy

3.1 Initial strategy

The original approach for the MOBISERV user trials and evaluations and addressing the MOBISEV research aims has been thoroughly described in D2.4 issue 2. These plans included sessions of multiple days in people's homes with free usages and no researchers present. Secondary users would setup and use the system through the secondary user interface, and primary users would use the system freely through the robot, smart clothes and eating/drinking cameras.

3.2 Delays and state of the prototype system

The delivery of the final MOBISERV system prototype has seen significant delays. Despite a through and realistic implementation plan that was agreed among all partners in January 2013, it took until the 16th of August 2013 for the final version of the prototype to be released. The pilot site and evaluations partners SMH and UWE did receive preliminary versions of the system in March, April, May and July but could not start evaluations due to lack of essential functionality and usability.

In April, May and June, both UWE and SMH did a lot of testing of the system received, to guide further adjustments of the system, and estimate what could be used in user evaluations, and to adjust these evaluation plans accordingly. It was found that the prototypes delivered until the beginning of July to conduct the trials lacked the reliability and robustness to enable the implementation of the evaluations trials as planned (for details, see Appendix 1 – MOBISERV system status report 20th June 2013). Most of the specifications for the final prototype have not been implemented, and parts that do work are very unstable. Therefore, it would have been irresponsible to leave the system in people's homes without being present as a researcher so it was impossible to test the system over longer periods of time. In addition, UWE had to make software modifications to enable the integrated system to be used in trials as planned (see Appendix 2).

Subsequent to this, Robosoft released new versions on July 4th and August 7th 2013, but stated that the modifications that UWE had made could not be merged with this version as the software had been completely recoded with a new software architecture.

3.3 Contingency strategy: Plan B

Looking at the original evaluation strategies and the prototype systems received until beginning of July, the following has been observed:

Usability Tests – Stage 1 & 2

- This would be a repetition of the early-2012 user trials but with updated functions. However, these functions are not available.
- No data logging is available in the robot software so quantitative analysis of data logs will not be possible.

Field Trials – Stage 1 & 2 & 3

- Since there is no integration of the ORU + WHSU + Smart Home, none of the high level functions can be trialled – so we cannot show that the system responds to eating/drinking activities, or physical activity, or a fall, or a visitor, or enables the user to control the smart home.
- Since the overall GUI software + basic navigation software + person finding software is unreliable, pro-active delivering reminders and suggestions is unpredictable and buggy (even when using the Wizard)
- Since the secondary UI is not finished, many settings are not available (setting up eating/drinking times, setting up thresholds for eating/drinking/activity, interaction settings, emergency contacts, etc.
- No data logging is available in the robot software so analysis of user model data as will not be possible.

Field Trials – Stage 2 & 3

- Not possible at all due to lack of functionality and robustness of robot software.

In collaboration with the other project partners, UWE and SMH decided to take an alternative approach for conducting evaluation, which will be summarized in the following sections.

3.3.1 Aims

We would like to let primary and secondary users experience the MOBISERV system as realistically as possible. However, it will not be real usage, as there will always need to be a researcher present. Main aims are therefore usability testing (primary + secondary UI) and discussing ideas on the overall experience that users could have, on the functionalities, on their interaction with this robot, etc. Also risks will be assessed when installing MOBISERV in real homes.

3.3.2 Scope

Because of the state of integration, eating/drinking observation, emotion detection, smart clothes, and fall detection will not be evaluated. We will focus on the basic social robot functionalities only:

- delivering suggestions (eating, drinking, physical activity, social)
- delivering reminders (agenda, medicines)
- programming the system through the secondary UI
- video communication
- games & photos

3.3.3 Methods & Procedures

Because of the state of the system prototype, long-term user experience trials will not be possible, and we will use focus groups, interactive demonstrations, Wizard-of-Oz trials, discussions, and questionnaires as methods. Some examples of our evaluation sessions are given here:

Focus groups with professional carers, family, and informal carers

- Demo of robot (live & video)
- Discussion
    - About the services
    - About the robot interaction
- Demo + interaction with secondary UI (live)
- Discussion
    - About the secondary user interface
    - What is useful, what is not
    - What are other requirements
    - What are problem areas that could be solved

Home trials with individual users

- Demo of robot (live & video)
- Demo of secondary UI
- Interaction with robot (primary user)
- Interaction with secondary UI (partner)
- Wizard-of-Oz trial
- Discussion
    - About the services
    - About the robot interaction
    - About the secondary user interface

Home trials at dementia department

- Wizard-of-Oz trial
- Observation of responses
- Discussion with care professionals
    - About the services
    - About the robot interaction
    - What is useful, what is not
    - What are other requirements
    - What are problem areas that could be solved

3.4 Modifications to the robot embodiment (UK)

Following the embodiment workshops in UWE (reported in D2.7), which investigated the acceptance of a robot, it was decided to explore some changes to the physical appearance of the robot and address some of the additional functionality identified by users.

Dressing the robot

The issues that were addressed were that people mostly preferred softer shapes and forms and did not like to see the metal parts and cables and wires exposed. For this reason a cape and "skirt" were custom made to cover up the metal back and the front where there is cabling connecting the speakers and USB hub. The clothes have resulted in a softening of the metallic form and based on the feedback of the users in response to the appearance have been more positive than previously noted. The robot is now more clearly a female embodiment and presents a certain vulnerability that is less threatening and therefore more approachable. We have also been referring to the robot as "Molly" which is easier for people to remember and relate to than the generic Robosoft's name for the robot "Kompaï". The "clothes" also provide a visible feature where the user can see how they can customise the robot and in the evaluations they speak of having "clothes" for the robot that will match their décor. All the studies at UWE apart from the Stage 1 Pilot were conducted with the robot wearing the "clothes".

For a dissemination event in Bristol we also tried enhancing her look by adding a flower next to her head. This made for a good conversation and engagement point, as it was the weekend of a music festival in the region – Glastonbury. We joked that Molly was dressing up for the music festival. We have found that presenting the robot in this way generally helps to make people to feel more comfortable and adds a certain character to the robot that they can associate with.

Figure 2 Clothes for Molly

Enhancing functionality

A number of users in the previous studies have noted the lack of an arm to assist with picking things up and carrying. So we experimented with attaching a "reaching grabber" which is a hand-held device, which enables older adults to pick up things from the floor. With this attached to the robot, it is always at hand for the user to use themselves, rather than being left in another room or misplaced.

Figure 3 Small basket of fruit attached to the robot base

We placed a small basket with a couple of fresh fruit on the base held by Velcro and also attached a closed thermos flask. This provides the robot with an added feature that exploits the use of the fact that it is a mobile platform. For older users that need a walking support, getting the robot to transport things for them from one room to another provides an added benefit. We built this feature into a scenario for our stage 2 trials to evaluate its utility.

3.5 Evaluations overview

In total, the final phase comprised 11 evaluation points. Table 1 shows these points at which evaluation studies were conducted. Results will be described in the next chapters, which include a description of the evaluation context and summary of the key issues identified at each evaluation point.

Evaluation Point	Evaluation Type	Place	Month
1	Initial system integration, installation, and heuristic evaluations	NL + UK	April - June
	Usability Testing		
2	Stage 1 Pilot Studies	UK	May
3	Stage 1 User Orientation Workshops	UK	June - July
4	Stage 2 Individual Trials	UK	July - August
	Field Trials		
5	Dementia Unit User Experience Trial	NL	July
6	Day Care Centre User Experience Trial	UK	May
7	Residential Care Home User Experience Trial	UK	June
8	Home Apartment User Experience Trial	NL	July
	Other Evaluations		
9	Hazard Analysis Study with overnight experience	UK	August
10	Show and Tell Sessions in Care Centres	NL	July
11	Consultation Session with Secondary and Tertiary Users	NL	July

Table 1: Evaluation history

4 Evaluation Findings

This chapter summarises the key findings over all of the evaluation points.

4.1 Overall findings

Taking a whole-system perspective, a number of the key aspects have been highlighted for further discussion in the sections below.

4.1.1 Learnability and Adaptation

Learning and adaptation should take place, not only on the side of the system, but also to a certain degree on the side of the user as well. We have found that people start to adapt the volume and pace of their voice, as well as their articulation to improve the voice recognition of the robot. They do so automatically, and with some trial and error after a while they will develop the ability to communicate quite effectively given the constraints of the speech recognition system. However a problem can arise if a person gets accustomed to using their voice with the robot in a certain way. Changes in an older person's voice as they age are common and this will affect the recognition accuracy, even if the person does try to adapt as well. Therefore a person's speech signals should be monitored for any changes over a period of time and there should be protocols defined for the necessary action that might be required. If this is accompanied by cognitive decline, then reduced voice recognition accuracy, particularly after a long period of good performance, can be a very deleterious experience for the user.

4.1.2 Companionship

This has been found to be a fundamental value-added outcome of having a robot to support independent living. Social isolation and loneliness are uncomfortable realities of living alone and having an entity that is responsive, both to physical needs as well as emotion needs, will go a long way in making independent living a welcome option. There is a need however to consider that the companion that one chooses to live with is actually compatible with an individual's temperament and environment. Therefore a flexible and customisable solution, in terms of physical characteristics, as well as behaviour and responsiveness, is vital.

4.1.3 Secondary and Tertiary User Perspectives

Our secondary and tertiary partners in the project have noticed that through the MOBISERV project, (robot) technology and smart clothes have come closer to employees and clients. Literally, because the MOBISERV prototypes have been shown and evaluated by many secondary and tertiary stakeholders, but also in the minds of all of the people working and

living at residential care homes or other stakeholders related to care of older adults. This has led to fact that many people talk and think about technology in general and social robotics in particular in the care sector.

From a very sceptical point of view, where many people said that “care is and will be a human task, so please do not bring technology”, we have come to a much clearer view, where technology can be supporting these human tasks. Just by interviewing employees, talking about the possibilities, brainstorming about applications like services and products, we have enlarged the accessibility of technology – unknown is unloved. It was found that by talking about it, about experiences, and by showing and letting people experience what it is, acceptation is coming quickly.

One of the final focus groups in MOBISERV showed that employees at Ananz are getting used to providing telecare more and more. Services for (informal) carers enabling them to give personal reminders and suggestions over a distance to people living at home were very much appreciated. It is clear that trust in technology among employees and clients is increasing, especially in the past 3,5 years of the MOBISERV project. The idea that technology can help to make carers’ work more enjoyable, without taking over the job has been accepted with much enthusiasm.

4.1.4 Utility in Dementia

While people with mild cognitive impairment might experience some problems in managing to consolidate the skills needed to interact with a supportive robot, the utility is high in terms of cognitive stimulation. By having games and photos, as well as music and videos, the robot can provide a pro-active intervention in terms of stimulation. In an environment which is short on staff, the MOBISERV system and robot have the ability to provide entertainment to people who otherwise might spend long hours just sitting on their own in an armchair. The ability to programme the robot to encourage engagement is very promising in improving the general quality of life and wellbeing.

During the tests with MOBISERV on a closed department for people with severe dementia, it became clear that technology can be deployed much broader and easier in care than we thought. Especially for this target group, technology can increase well-being. For traditionally trained care takers, this almost seems a contradiction. But also these people were convinced more and more by these tests about the added value of technology for clients’ well-being. In progressive conditions, where memory of actions and recognition of new things introduced into the environment, there is a potential danger that the robot could cause anxiety or result in a user interacting with it in an un-safe manner. However with good supervision, such as in a residential home setting, and early introduction to the system, the potential benefits could outweigh the risks, which can be carefully managed.

4.1.5 Representations of health data that older people can understand

There is potentially a lot of health and general activity data that is collected by the sub-systems of the MOBISERV system, such as from the nutrition support system, as well as the wearable health support unit. These, together with the other data that has been defined in the user model (T7.2), can provide a rich picture of a person's overall cognitive state and wellbeing. Over a period of time, this data can provide information of changes in the person's medical and physical state, which could be used as part of preventative health care system. If this data is made available to the older person as well, in a format that they can easily understand and interpret, then this gives them the ability to take responsibility of their own health and wellbeing. Being empowered in this way is a core aspect of promoting and facilitating independent living.

4.1.6 Standalone system – Health and Safety

By conducting the trials in the field, we have identified a number of health and safety issues. These have been analysed as part of a risk assessment protocol and will provide invaluable support for the technical team in realising practical deployment of the technology. By focussing on safety processes and procedures and getting the robot to behave in a more collaborative manner with the user, there is much that can be achieved in working towards a safer system which can make more realistic field trials possible. It should be noted that the more feedback the robot provides to the user of each aspect of its status, the better informed the user is of what is going on, and so can pre-empt possible mishaps and be more responsible and alert during an interaction. We are still a few years away from a fully safe and autonomous system, and the more the technology works in partnership with the user, the more hope there is of real deployment.

4.1.7 Integration & Installation Process

Our trials have provided valuable guidelines for preparation of the robot and the environment in order to ensure successful integration and installation. Careful management and planning, and a thorough understanding of the shortcomings of the technology ensure a full-functioning system is deployed.

It is important that the introduction of a system such as MOBISERV into a person's life is conducted as part of a phased process. Just as friends take time to get to know one another and understand each other's attributes and shortcomings, before they are truly comfortable and accepting of each other's company, so should a robot and an individual be given the opportunity to get to know one another.

Learning and adapting to routines, habits and nuances of personality lie at the heart of any successful and fulfilling relationship. Therefore the assessment performed as part of an installation process needs to be holistic and should involve understanding not only the person's functional and medical problems, but also their likes and dislikes, how they like to

be spoken to, their interests and hobbies, types of exercises suitable for them, activities they enjoy, types of food and drink, etc. This information can then be used to customise the content of the robot and also change the "personality" of the robot in line with what they desire – an authoritative system, or a social companion or a carer.

4.2 Initial system integration, installation, and heuristic evaluation findings in the UK and NL

Following the delivery of the new version of the software to the Netherlands on the 3rd week of March 2013 and the delivery of the robot to the UK in the 2nd week of April 2013, over a period of 3 months, a series of observations on the usability of the system were noted during the partially unsuccessful process of integrating and installing the complete MOBISERV prototype on the test sites in the UK and the Netherlands. The main issues found included:

Hardware

- For some unknown reason a pan/tilt unit has been added between the robot body and head in the robot that was delivered to SMH. This is useless, as the robot can turn by itself. This has not been used. The robot at UWE does not have this, but the head on the robot delivered to UWE was very poorly attached by an inadequately secured metal bracket, where the screws would work themselves loose, causing the head to fall off. UWE Robotics Lab engineered a new bracket to secure the head safely.
- For an unknown reason, the tilting of the touch screen has been removed. This was there to facilitate users that are standing instead of sitting. Also the fact that the screen cannot tilt forward means that when the user is seated, overhead lighting can cause a reflective glare on the screen. Detaching the touch screen from its lock position and moving it forward can help to overcome this but this means that it is not rigid when the user taps it, which can make the touch ineffective at times.
- An external speaker has been added to the robot – which is good – but in the NL it runs on batteries that run out of power very quickly. The robot at UWE does not have this problem and the sound from this was found to be reasonably loud.
- The yellow SOS button does not do anything.
- The Kinect sensor is mounted insecurely on a bracket that rattles when it moves which can be disconcerting.

Software

- Many issues reported in D2.5 Issues I and II were not solved and/or not implemented.
- The robot does not find the user before issuing a suggestion or reminder.
- The robot does not return to the charger after x amount of minutes of idle time.
- The robot does not say when it starts to move when issuing a reminder or suggestion. No stop button when moving.
- Robot speaks many unexpected things and responds to all kinds of sounds.

- Lots of functionalities missing. The secondary user interface is far from finished.
- No “intelligence” has been implemented.
- The software is unreliable and there are intermittent crashes that require a reboot of the whole system.

This set of issues led to the decision of adapting the evaluation strategy. There is more information detailed in Appendix 1 – Overall system integration and installation.

4.3 Stage 1 Pilot Studies UK

4.3.1 Participants and Context

Prior to carry out the full stage 1 trials it was necessary to conduct some pilot studies to clarify and validate the protocol and assess the range and scope of functionality that was available. The pilot study was conducted in the Living Lab area in the Bristol Robotics Laboratory, which replicates a studio flat. The participants are given a demonstration of how to interact with the robot using voice and touch and then guided through using the available features themselves. This study generated a lot of information about improvements needed and what issues needed to be addressed when conduction the proper Stage 1 trial.

The participants were a male and female couple in their mid-70’s and a male psychologist in his late 50’s. All three participants were of reasonably sound physical and good cognitive ability.

4.3.2 Findings to guide Stage 1 Study

Robot Movement and Navigation
Collision sensing is not activated when the robot moved using the turn commands. We should be sure to advise users to be careful of their feet when they use this facility. This could have health and safety implications for people with short-term memory problems.

If the robot is moved too close to an object using the turn command, then when asked to move to a mapped position is hindered as the collision sensors are activated that can prevent it from moving.

It is unclear what the benefit of the user being able to send the robot to a different location is. A carrying feature would be useful and we will explore how some carrying facility can be attached to the robot. Also the robot could be requested to take a photo of another room and bring it back to the user who might have mobility difficulties. If the robot camera was linked to the tablet that the user had, then the robot could be used in a tele-presence mode.

The older participants don't seem very confident that the robot will avoid them or come to a stop and seem to physically flinch. It would be useful if the robot could let them know that it had "seen/detected" them or an obstacle and that it would be stopping. Even if it said something like " I detect an obstacle in my path" that would be good feedback to the user.
The instruction on the screen "Move the robot" which is in the third person seemed incongruous to one participant who had been engaging with the robot in the first person for all other commands. This has interesting implications for the notion of identity that the robot possesses or is seen to possess.

Screen Positioning

From a seated position the screen of the laptop can be difficult to see due to overhead glare. As no tilting is available, it needs to be pulled forward from the laptop locked position. This however results in too much movement when the user touches it, so something needs to be placed behind it to prevent it from moving backwards. Also note the poor fitting that is holding the head, which causes it to wobble and rattle in a disconcerting manner when the robot moves. Sometimes the poorly attached screw comes loose and the head rolls off. This will need to be fixed before the stage 1 trials.

Figure 4 Positioning of the laptop screen

Games

The games currently available, such as Chess and Blackjack have screen elements that are too tiny for touching with a finger, we need to encourage the user to stick to using the Simon game. The games on the system should be ones that would be more accessible to older adults with reduced dexterity. There is a bug with the game Zookeeper which continues to play even when the user leaves the game. One of the participants requested a crossword. The unresponsive fixed expression of the robot is not very conducive to playing a game with a "companion" even if it interacts via voice like a "real" entity possessing a personality and knowledge.

Figure 5 Unresponsive face of the robot is not very amenable to the role of a companion

Touch screen Interaction

The older male participant was used to using an iPad and tried to use a drag motion when playing chess, however the touch-screen on the robot does not support this, which was confusing to him. We will need to find out what the users' previous experience of technology and explain any differences that they need to be aware of. The touch screen responsiveness is not consistent and this can be very confusing to the user to know how hard or gently to press. Sometimes a delay in the system processing can result in them thinking that their touch has not been acknowledged, resulting in them pressing harder or repeatedly, which causes more responsiveness issues. One of the participants had not brought their reading glasses with them so it made reading the screen difficult. There is no functionality for magnification of the screen available.

Voice Interaction

All the participants speak in long sentences, sometimes using the robot's name that often results in a lot of confusion for the speech recognition engine. When using voice, suggest to user they speak single words because sometimes difficult for robot to pick a word out of a stream. For example one participant said "*Can you go to the entrance please*" which was not recognised by the robot.

Also remind users frequently about short delay in robot going from "not listening" to "listening" mode and the delay in receiving command and acting. There should be some visual feedback of selected option when using voice also as it was not always clear to the user what was happening – had the command be heard, interpreted correctly, or being responded to or not.

We need to get users accustomed to using the touch screen when the robot does not respond to speech as it can be a very frustrating experience. The Talk in red and green are very confusing and it is not clear whether this instruction is for the user or the status of the robot. Need to develop an alternative interaction strategy such as Listening or Not Listening.

Exercises

There should be instructions that make clear the purpose of every exercise set. Also health warnings should be added. It will be important to screen users for conditions and abilities so that they don't overstretch or overexert themselves during the trials. Also consideration needs to be given to how much stretching room is required for the different exercises. The robot could make sure whether the person had enough space and that it was not in the way, or move back if it was. In doing the exercises, if the robot is by the side of the chair then the user needs to turn they head towards it to follow the exercise. If the robot is in front of them then there is not enough room to stretch legs, if the robot is too far back then they cannot view the screen easily and it might not be within reaching distance.

Figure 6 User having to look to the side, which could cause strain during exercise

Exercises/games/photos should be customised to the user so their abilities and preferences should be noted beforehand in consultation with carers as appropriate. To offer a diversity of options we need to extend suggestions to exercise through activities such as gardening and cooking.

Photos

There is a synchronisation problem with viewing the photos when returning to them in slideshow mode, as the text "This is your GP doctor Harrison" appears with a previous photo of Kompaï's head. The photos are only accessible in a linear manner by next or previous which can get very tedious for the user. It will be useful to associate more meaningful text with the photos such as prompts or questions for cognitive stimulation. At present the robot keeps hearing itself read the text associate with an image and says "I am sorry but could you repeat what you said please" in a loop.

Reminders

Regular medication reminders have been requested as being very helpful. These could be set-up using the Agenda, however this does not currently allow a photo to be associated with an agenda reminder that is useful for people who take a whole variety of medication. We will have to trigger this via the Wizard in the trial.

Control the Home

No screens have been included for this function, so we cannot demonstrate this to the user, even if it doesn't work, it would have been nice to be able to show the user the potential and discuss this with them.

Participant details for customisation of content

In order to make the trials more meaningful and safe for the participants it would be important to capture key aspects relating to their physical, cognitive, emotion and social aspects. Based on the findings from these Pilot Stage 1 trials a participant information form has been designed, (see Appendix 3).

4.4 Stage 1 User Orientation Workshops UK

4.4.1 Participants and Context

The aim of the orientation workshops was to get participants familiar with the project and robot (via live demos – play acting and some minimal interaction). We also wanted to get their initial views and perspectives on issues regarding features and contextual use. At this stage we were also hoping to screen participants to select suitable candidates for the individual trials (stage 2) and further home trials. The trials were conducted in the BRL Robotic Ambient Assisted Living Studio - a closed room set up as a studio apartment where there was access to Wi-Fi.

Figure 7 Robotic Ambient Assisted Living Studio

There were eight participants in total for this phase, 4 male (60 – 79 years) and 4 female (60-79 years). One of the male participants was a retired medical doctor and one of the female participants was a retired nursing lecturer, so these participants were also able to provide a secondary stakeholder perspective. All the sessions were recorded with a video camera placed behind the participant.

Overall the participants were fairly relaxed with the robot and seemed to get quite comfortable with using it in the session. The sessions were kept light-heart and all the participants enjoyed themselves with comments such as "*I love this*". Interestingly, the robot's mistakes were interpreted as amusing by the participants and an opportunity for a good laugh. As a follow-up they were asked about their willingness to participate in the Stage 2 trials to which they all agreed.

4.4.2 Findings from study

Overall Concept and Acceptance of the Robot

A questionnaire with quantitative and qualitative information was used at the end of the session to collate feedback.

Following their orientation session with the robot the participants completed a questionnaire. See one of the filled-in questionnaires presented as a sample in Appendix 4.

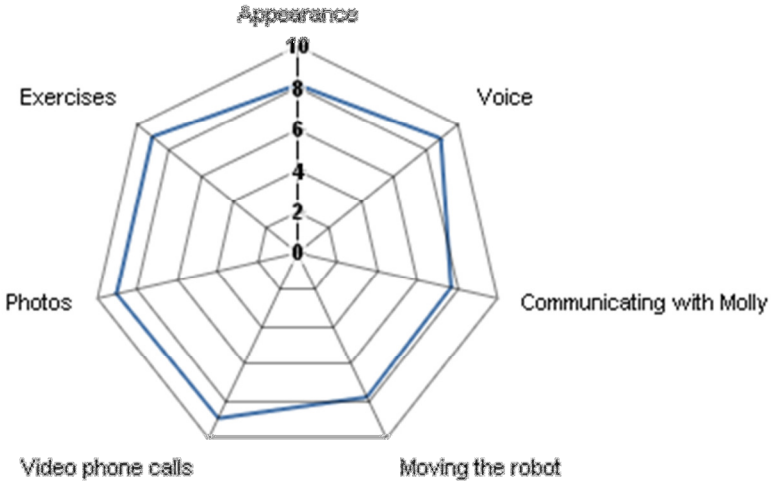


Figure 8 Questionnaire responses, Average Scores. 1 = Unsatisfactory: 10 = Very Good

For the question regarding whether the participant would mind having a robot like this in their house supporting them if needed, 5 out of the eight participants replied that they wouldn't mind, Figure 15.

Would you mind having a robot like this in your house supporting you, if needed?		Response	%
No		5	63%
Yes, please state why		1 (+2 Ambivalent)	38%
Total		8	100%

Figure 9 Acceptance of the robot in the home

Figure 16 shows some of the reasons that were given by the three participants for minding to have the robot in their home. It was interesting that one of the participants expressed their assumed view of others. As these were ambivalent responses, they have been counted as minding.

Reason for minding
I am ambivalent! Currently I value my independence and find it hard to visualise tolerating a robot in the house. However, if it was an option of being able to stay at home, supported by the robot or going into a care home, I'm sure I would try it.
If I have money.
I wouldn't mind having one - others may need to be persuaded.

Figure 10 Reasons given

Participants were also asked to give qualitative feedback on each of the features. This is shown in Figure 17.

Appearance	Voice	Communicating with Molly	Moving the robot	Video phone calls	Photos	Exercises
I don't see the need for 'clothin' and that is unnecessary	Clear and comprehensible	From listening delay in replying to commands	Formal	Video problem in receiving and sending. Find	Easy to view	A little speedy and everything for older people could cope
Prefer the current face to a more humanoid one	Clearly robotic but not alienating	There are some issues to be resolved. I found key pad easier than voice commands. Problem of knowing whether delay means Molly has not heard or is responding slowly			Useful for reminiscence work	Customisation needed; in current video the presenter talks too quickly.
Very cute and non-threatening.	Not irritating. Again non-threatening.	Very easy	A bit difficult at first but easy to pick up afterwards	Really good as easy to do and good for lonely people	Really good for all people, especially with dementia	I really liked this one as a most useful programme for elderly.
Easy on the eye	Very clear	Was it my clarity of speech that made the problem	Confused me at the start with left/right, but I could learn.	Very good and versatile	Very worthwhile! Could a video be incorporated?	Brilliant concept
Customisation options, facial - dress	Need to vary phrases	Voice recognition poor at the moment	As above but good set of commands	Some may want privacy options	Customise	Must do some myself
If cover used may be matching decor	Very clear	Very good just to keep voice be clear	Good again. I think you should think direction out.	IST will be better	Wonderful for everyone.	Wonderful asset
Very good	Very good	Wonderful	Very good	Wonderful	Very good	Very good
It is a new concept	Getting used to talking to a computer and giving instructions verbally					

Figure 11 Qualitative Responses, Each row is response from an individual participant

The size of the robot is also of significance, as determined in the previous user acceptance studies, when considering acceptance and this was also explored.

Do you think this robot is too big for your house		Response	%
Yes. If yes, then please state what would be the ideal size and shape for such a robot		3	38%
No		5	63%
Total		8	100%

Figure 12 Responses in regards to size of the current Kompaï Robot

The qualitative responses from the three participants that thought the size was too big are shown in Figure 19.

Yes. If yes, then please state what would be the ideal size and shape for such a robot
About half the size!
Shape is fine, just a bit smaller on the base, due to lack of space in normal house.
Smaller size if possible for cramped surroundings.

Figure 13 Ideal size of the robot

It should be noted that while the height of the robot as it is currently, is important for comfortably seated interaction, the footprint could be reduced. This would also help in general navigation around cluttered environments and the overall small houses in the UK.

Even though the average score on the appearance was high, when asked about alternatives, four of the participants responded as shown in Figure 14

If Yes, then which of these would you prefer for the appearance of the robot	Response	Comments
For the robot to look more human	0	None
For the robot to look like a pet (dog, cat)	0	None
For the robot to look like a piece of furniture	1	No additional comments
Other - Please state	3	I think more functionalities and less commands could be perfect. Customise - some people might like different things. Too human might upset - possibly cartoon like. It would need more inputs from different people. Change hands.

Figure 14 Other appearance issues

In relation to behaviour of the robot, the views were mixed as shown in Figure 15. This question was only answered by 7 of the 8 participants.

How would you like the robot to behave?	Response	Other Comments	%
As a social companion	3	None	43%
Non-interactive - like a machine (e.g. vacuum cleaner)	2	None	29%
Other - Please state	2	As she is. Both – would like human links easily available for periods of loneliness.	29%

Figure 15 Robot Behaviour

In regards to the robot's functionality, there were 6 responses regarding what the participants would not like the robot to do.

What would you NOT like the robot to do and why?
Exercises reminders, Cut out video and telephone calls
This is a very individual matter - it needs to be customised.
Wake me up early!
Wake me up when not ready to wake. Criticise my mistakes - diplomatic robot needed.
Programme for individual users.
N/A on what I've learnt today.

Figure 16 Functionality preferences

In relation to interacting with the robot, there is a strong preference for voice-based interaction, note that some participants selected both options.

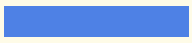
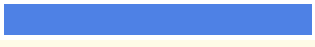
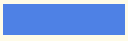
How would you prefer to communicate with the robot?		Response	Comments
Via the interactive touch screen		3	None
Talking to it		5	None
Other - Please state		2	Both as now. Talking if voice recognition improved.

Figure 17 Preferences for Interacting with the Robot

Moving of the robot in a person's own home was also explored. The participants raised some useful pragmatic issues in considering this as shown in Figure 18.

Text Response
Possible problem with furniture, on 3 plans so start a problem
Concerned about safety ensues - frail older people can lose balance easily if jogged/ pushed.
Absolutely fine.
Could learn to live with Molly.
Fine but might have problems with simple things like carpet grips.
Good
Good
No problem if it could cope with my muddles.

Figure 18 Responses to How would you feel about the robot moving around in your home?

Smart Garments

Only one participant in the study was a size that was suitable for the garments available. It further studies it will be important to supply the garments in medium, large and extra-large to match the general demographic. It was suggested that the garment could be used to detect stoppage of breathing in sleep apnoea.

One of the participants was interested in the weight of the belt and it was found that it was quite light which is good. However there were mixed responses to wearing the garments, which were deemed acceptable if they were needed due to a medical condition with one participant saying "*Imagine if you were in the hospital, how quickly would you want to get out?"* implying that using this would enable earlier discharge.

Figure 19 The weight of the smart belt was found to be acceptable.

Reminders

Medication and food reminders would need to be triggered artificially as setting them up in the agenda would cause problems due to the unreliability of the robot software which crashed often, meaning that it was not possible to stick to a strict time agenda when conducting the evaluation studies. At present when a reminder is issued, there is a screen with an OK button, however when the user presses this, the software goes to the games screen and asks which game the user would like to play. One participant recommended that the medication could be kept on the robot in a special box so that the user could access them easily when reminded.

Use of the Wizard

Due to the lack of autonomy of the robot, it was determined that for the Stage 2 trials all the interaction involving initiation by the robot would need to be triggered by someone outside the room controlling the robot. This meant that from a logistic point of view, a number of additional cameras would need to be used when it came to Stage 2 trials.

Fall detection

It was not possible to demonstrate fall detection due to lack of integration, so it had to be explained to the participants. All participants considered this a very useful feature for those living on their own.

Figure 20 Explanation of Smart Garments to the user

Video conferencing

The reliability of the Wi-Fi connectivity had a major impact on the smoothness of the video conferencing function, with a marked deterioration in the quality when the connection was slow or the signal strength was weak. In addition the Lync software provided a very limited interface with poor control over the camera. In addition, using the camera on the laptop is limiting as it depends on the height of the person and cannot be adjusted. It is not possible for the user to select which camera to use, as in some cases it would be better to use the camera on the head of the robot or in the base (for emergencies if the user has fallen). It should be

possible for the user and the caller to select which camera to use. As can be seen in the Figure 21, only the top of the head of the user can be seen and it is not possible to adjust this view as no tilting or camera control is available.

Figure 21 Only the top of the user's head is visible to the caller (see frame in lower right hand side of screen)

The utility of video conferencing was very much appreciated with one participant saying "*If you are an old age pensioner, sat in a chair all on your own it is absolutely horrendous, but for us to have a machine like this, it is absolutely amazing*." When there is an incoming call the robot says "Name_of_person" is calling, answer" there is no ringing or repetition, this means that if the user misses this the first time then they might not realise that there is a call. Also the robot does not find the user in this instance.

Find the user

This feature does not work reliably enough to be used – the recognition rate is extremely poor and the number of false positives is too high. When it thinks it has found the person, it turns to an angle and does not face the user. Also it is not able to detect a person if they are seated or fallen down. To overcome the high false positive rate it has been decided that the robot will ask "are you there?" and then when it does not get a reply or acknowledgement, it will go to the next location on the map and repeat, until the user given an affirmative response. Following this the message will be delivered.

4.5 Stage 2 Individual Trials UK

4.5.1 Participants and Context

The aim of this phase of the trials was to gather quantitative and qualitative assessments of users' responses to the MOBISERV system as well as information on users' performance, usability errors and interaction problems. We also wanted to continue to gather qualitative information on users' priorities for alterations and additions to the future concepts.

The 8 participants for this study were the same people from the Stage 1 orientation workshops; this meant that they were familiar and more comfortable at interacting with the robot after their first experience. They knew what to expect and were aware that the system was still in its development stage. By using the same participants we were able to assess how they really felt about the robot, and not being influenced by the awe of meeting it for the first time. The trials were conducted in the same place as the Stage 1 orientation workshops, which were in the Robotic Ambient Assisted Living Studio in the BRL, UWE. We were interested in studying how easy the users found the system to learn and whether they would be quicker to correct mistakes and adjust to the robot's and their errors in interaction.

For this trial, the participants were left alone with the robot after a safety briefing and a reminder of the voice and touch interaction process. They were also given a safety sheet to refer to if needed. The facilitators stayed outside the room and observed the interaction via the cameras and glass door. The wizard was used to make the robot's behaviour appear autonomous as the user worked through each of the tasks.
An example of the task sheet that was given to participants is included in Appendix 5 which shows each of the tasks, described as Scenarios, given to the participant to perform. Figure 22 shows the view from two cameras of the user performing Scenario 2.

Figure 22 Participant performing Scenario 2. There are two camera recording the scene.

Following the completion of the scenarios, a post-task interview was conducted. Each session was recorded using a set of 5 cameras. MORAE usability recording software was used to capture the screen as the user interacted with the robot as well as their face from the camera on the top of the robot's head. This gave information regarding the facial expression and body language of the user. Sound was also captured together with the video. There were another two cameras set up to record the different areas of the studio apartment, one for the kitchen and one for the bedroom. There was an additional video camera recording the interaction from behind the user. The cameras were discretely placed so the participant was not really aware of them during the session.

The data from the MORAE software, Figure 23, can be tagged to identify aspects such as time taken to complete the tasks, number of errors made, process for correction adopted, types of errors, feelings of frustration, feelings of anger, feelings of happiness/fun, feelings of accomplishment, number of times command repeated, response time of the robot/system, response time of the user. Facial expressions and body language will also be analysed from the captured videos, Figure 24. The tags can be collated based on type of tag. This detailed analysis is currently underway and will be published in a research journal paper.

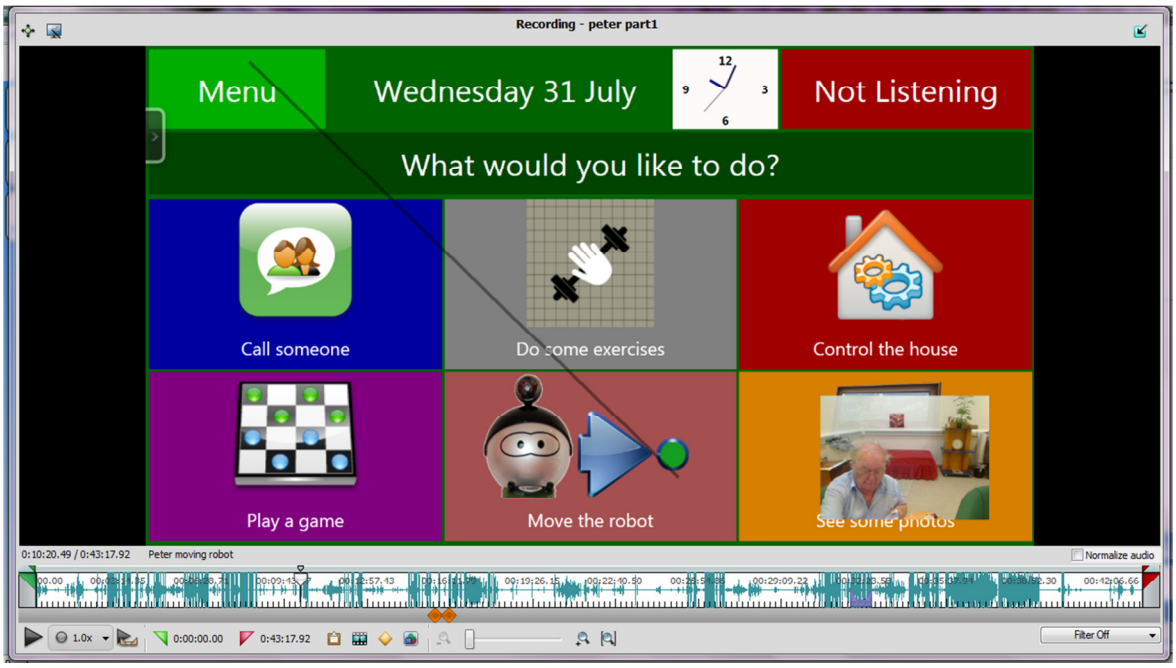


Figure 23 MORAE Manager Screen showing the Robot GUI indicating where the participant clicks and an inset image of the participant. The data can be tagged and then the tags can be collated based on type of tag. This detailed analysis is underway.

Figure 24 Participant's facial expressions and body language can be analysed.

To prepare for the session, specific photos which matched the interests of the participant (as filled out on their form in stage 1) were uploaded onto the robot. The suggestions were also customised with the name of the participant to have a more personalised experience.

Additional participant with early dementia

We also conducted a modified Stage 2 trial with a participant of the residential care home we had visited earlier. We left the robot in the room with this participant for an hour and instructed them to do what they liked. We were just outside the room and were able to use the robot to give the participants voice messages when they got confused about what to do.

4.5.2 Findings from study

Interaction with the robot

It was clear from assessing the interactions of all the users that they were more comfortable and natural in using the robot. As stated by one of the participants "*I'm getting quite used to her, and am able to correct my mistakes with her, a good sign of growing confidence*". It is also interesting to note that the users started to refer to the robot as "her" or "Molly", which was the name we gave the robot, rather than call it " the robot". One of the users noted that it was "*good fun*" trying the scenarios. It was also noted that the commands need to be "*structured so that they do not have to be accurate e.g. " move the robot" or "move robot" or "move" should all be acceptable*".

One participant thought that over a period of time one would "*project a personality*" on to the robot. This is interesting and it would be useful to explore this more from a psychological perspective.

The voice interaction has problems with coordination, which affects the accuracy of recognition, this happens when the users starts to speak before the robot goes into listening mode, which can happen in particular when they are not in direct view of the screen. Poor speech recognition does result in frustration, so the touch screen was found to provide a good alternative, which the users soon resorted to.

For the one participant in the residential care home who had early dementia, we made an interesting observation where he picked up his television remote control and tried to control the robot, Figure 25. This is not surprising as he was regressing to his old memories of controlling a screen, but it has implications for how people with dementia will get used to new technology like this and remember the "new" concept of controlling the system with their voice or touch.

Figure 25 Participant with early dementia tries to control the robot with his TV remote

Sound

The volume was not always loud enough, even at full volume, one of the participants that used hearing aids found that he sometimes had difficulty. The robot could be configured to broadcast to an installed loop system so a hearing aid user could switch their hearing aids to loop. Also it would be good if the pitch of the speech matched the user's hearing capability. With any background noise the robot fails to operate as it responds to all sounds in the environment when in listening mode.

Moving the robot

All the participants got confused about remembering that to make the robot go to a different room you have to go to the "Move the robot" screen first. This seemed counterintuitive to

them, particularly as the commands to turn the robot left, right or around are available at the top level. There needs to be commands available to make the robot go backwards as well. The "Come Here" command does not work which some participants try to use instinctively. Some participants also try to use more common actions which should be logically possible but have not been programmed, such as "move back" or "Go to the …[name of place]", which is not understood by the robot. Also there is inconsistency in the commands where one participant said "Move Right" rather than "Turn Right". However it was observed that most participants soon realised these shortcomings and were able to revert to a correct command. The vocal "Stop" command does not always work, particularly if the user is some distance away from the robot. There is also a lag in responding to the command which means that fine positional control cannot be achieved. The user is confused whether the stop aborts the current action (e.g. going to a particular room) or not.

There was also frustration experience due to the long-winded process of getting the robot to move using the voice commands and it was found that after a few attempts, people resorted to using the touch screen.

Reminders

While the facility for giving the users reminders was found to be useful, it was noted that it would be good if the user could make a request for a reminder to be repeated at a certain time. As it currently stands, this can only be configured by a carer or someone with access to the secondary user interface, which means that the user themselves have no control over the system to get it to assist with memory-related tasks. One participant noted that the reminders for medication would be "*Great, because it would save me from setting alarms to take medicines etc.*". Additional reminders that participants said they would like to receive included "*Appointments - more around - take a drink - meal times., Tablets, Birthdays and special dates, Have you had a properly balanced meal / Have a good breakfast / Have you turned off the gas and cooker, Daily diary with some repeat during the day.".* A carer or relative to set-up reminders was found acceptable. Regarding exercise reminders participants noted that it would be "*Fine, very helpful*", but also "*A reminder is OK but not repeated too often!"*

Smart garments

Considerable improvements have been made in the design of the garments following the points noted in the last evaluation report. The pyjama top has been found to be comfortable with soft material. The new designs can be further improved by taking note of the following points:

Instructions on the pyjamas

It is good that clear instructions are available on the garment itself, however instruction 1 regarding wetting the electrodes created ambiguity regarding amount of wetness and process for wetting. This could be made easier by supplying the user with a small squeezable spray. The instructions could then be changed to "Spray a little water to dampen the inside of the

cuffs". The word "electrodes" will not be understood or remembered, or their location remembered by a number of users.

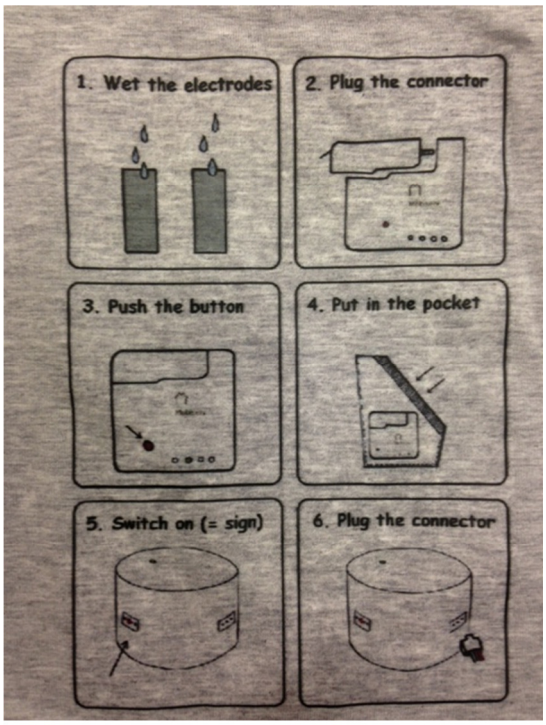


Figure 26 Instruction printed on the pyjama top

Instructions on Belt

The "Wet the electrode" instruction could be modified as discussed for the pyjamas. Here the electrodes are more easily recognisable as the image in the instructions, however the word "electrodes: could be printed under them for both the L and R. The Pocket shown in this instruction does not match the actual pocket on the belt. Also there could be a Velcro fastener on the belt pocket to avoid the data logger from slipping out.

Figure 27 Instructions on belt

Size and end of the belt

Overall, people liked the idea of wearing a belt. Only one of our participants in this study was slim enough to wear the belt. He found it comfortable. The end of the belt sticks out from under a shirt and is "visible" as wearing something under clothes, so this could be secured better to hide it.

Figure 28 Pocket on Belt

Connecting the data loggers

While the connector slides in well, its correct placement is crucial and requires a steady horizontal push. For removing, the user might forget that a sliding action is required and could bend the pin by pulling the wire connector upwards to detach, as was observed in one case.

Figure 29 Connecting the data logger

Securing the Pyjama Datalogger Pocket

At present the pocket on the sleeveless pyjama top does not have Velcro like the other pyjama top pockets resulting in the data logger slipping out in a sideways lying position.

Figure 30 Pocket on the sleeveless pyjama

Wrist tabs (spring-loaded clasps) on the pyjama top

Putting on the garments with a carer's help presents no problems, however there are numerous challenges for securing the wrist tabs securely by an older person on their own.

In the first instance, as shown in Figure 31, users were found to accidently put their hand through the wrong side of the tab. This also made it difficult to retract their hand in order to correct the mistake. This movement can present problems for older adults with mobility difficulties, stiff joints and arthritis.

Figure 31 Confusion with the wrist tabs (right hand picture shows correct position)

Tightening the wrist tabs requires one hand (thumb and forefinger) to press the release catch and the other hand to pull the string. As a result the string cannot to fully retracted to tighten the wrist cuff fully

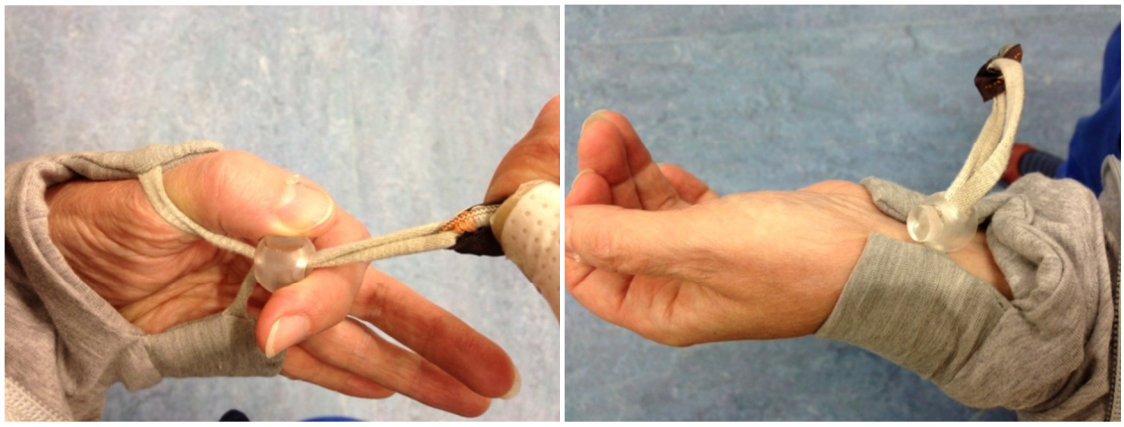


Figure 32 Tightening the wrist tabs

Side tightening tab on pyjama top

It was found that adequately tightening or loosening the side tab on their own involved the older person reaching behind with the arm. This can be difficult for older adults with mobility difficulties, shoulder and back problems, stiff joints and arthritis.

Figure 33 Side tightening

Temperature data logger and sensor

The on-off switch on the temperature logger was found to be too small to read for people with visual difficulties. The connector is also too small and difficult to see which way round it must be inserted.

Figure 34 Temperature data logger

Temperature sensor

The temperature sensor has sharp edges that were easily exposed. Older people have fragile skin. It is recommended that a larger metal plate is used with all the edges securely covered.

Figure 35 Temperature sensor

Video Chat

On the whole, while people appreciated this feature, the limitation of Lync regarding the video control and responsiveness leave much to be desired. It is recommended that Lync is not used and some other alternative is sought. For the user's family to install this is quite cumbersome as it is a non-standard application.

Social Interaction and Companionship

There is only a limited vocabulary that has been hard-coded into the robot. More could be done to make the robot more responsive and friendly. This could have been done by using information about the context to create "spontaneous" comments, such as using the time of day or a recently completed event or use of a feature to prompt a comment by the robot. The wizard was used to some extent for this, and when it was used it proved to be very helpful.

One participant commented that "*I felt that I wanted to chat to Molly - doing a running commentary! However she responds when you just want to chat to yourself - wants to be given a command. / I felt I could see her more as a 'person' this time. This surprised me. / I hadn't learn to pause after 'move the robot' before saying where to. / I felt that familiarity will make use easier.*" With another saying "*I'm getting quite used to her*".

Games

On the whole the selection of games was found to require more choice and customization. The text was too small to read for some participants and the buttons shown on the screen were too small for some participants to successfully locate. The help screens didn't always work, the chess program didn't move the pieces in a visually clear manner so sometimes this was missed. So overall if a game is loaded, it needs to be configured for the user, for their

physical and mental capabilities. E.g. games the user knows how to play or games with a learning mode so users can learn at their leisure that could be extremely useful in stimulating mental activity. A number of suggestions for games were given by the users on the form such as Patience, Cribbage, Rummikub and Shut the Box.

Viewing Photos

As in the previous stage 1 session we had collected information about the participant's interests we were able to customize the collection of photos to each individual participant. This was very much appreciated by the participants and they noted that the ones they found most interesting were related to them – *"The picture of us on holiday. Very clever, and a great surprise.", "Turkish quilt. An interesting concept in quilt design!", "The photo of myself and colleagues planting a tree. The photo of the harbour because I enjoy taking my grandchildren on the boats there"*. The photos that they said they would like to store on the robot would be of their "*holidays and grandchildren, mostly people rather than just landscapes. Also well-known places that I've never visited, personal memories"*.

The photo viewing feature could be made more interesting by including randomization of presentation, more user control over the selection and a larger database of photos and keeping updated with new photos.

Additional features

Some users recommended that it would be good to be able to access the internet, which could also be voice controlled. Music and accessing the news was also recommended. Being able to access special interest chat rooms via the voice conferencing link was also suggested.

Other recommendations included "*Mechanical extensions and associated equipment e.g. Molly compatible fridge or microwave. Screen to be able to magnify photos or games. Patient care scenario tailored to individuals.*".

4.6 Dementia Unit User Experience Trial NL

4.6.1 Participants and Context

The MOBISERV robot and its services are primarily designed to keep people independent and enable them to stay in their own home as long as possible. As a result of a brainstorm between the people of Ananz and Smart Homes that are involved in MOBISERV, the idea originated to run a field trial in a psycho-geriatric section of a care home, to see what such a social robot could do for (a group of) people with severe dementia.

The direct reason for the execution of this field trial is the expectation of the medical staff and management of Ananz about the fact that a robot like MOBISERV could have a positive effect on the quality of life, well-being, and the health of residents. Initiative and liveliness are some of the aspects that disappear when dementia progresses. During the day, many residents fall asleep, among others because of the lack of stimuli, resulting in a bad sleeping pattern during the night. Therefore, many clients use sleeping medication. When people would be more active and would sleep less during the day, this could reduce or remove the need for sleeping medication. Also the assumption that the mood and peace of mind of residents could be improved by a social robot has been a motivation for this field trial.

For this specific field trial, we have named the MOBISERV robot MAX (as an acronym for the MOBISERV Ananz eXperience). The field trial has been conducted at the 'Zwaan' department of care centre 'Akert' in Geldrop – a small scale housing centre for clients with diagnosed dementia. To be more precise, we have chosen for living room 'Oever', in which 12 residents are living.

4.6.2 Aims

Main aim of this field trial was to observe the overall interaction between people (in particular clients, but also their family, care professionals, and volunteers) and social robot MAX. Next to this, we wanted to observe the following:

- (How) do people respond to MAX? Does MAX cause a surprise effect? Is MAX able to get people out of their normal routine and to excite them?
- Is MAX able to break certain patterns? Get people out of their passive rhythm?
- What are appropriate initiatives / responses for this group of people?
- Is MAX able to offer added value to a group, or is this only possible in one-on-one situations?
- Is MAX able to help wandering clients? What will happen when the robot walks along with these people?
- What are long-term effects?

Some of our research questions:

- When people are more active during the day, will they have a better night with more sleep? Would they need fewer sleeping medication? Could MAX play a role in this?
- Will the presence of MAX cause less or more unrest in the living room?

MAX is not meant to replace an employee. The aim is to find out how technology can support employees and clients in enlarging their well-being and health.

4.6.3 Setup

During the first week, MAX has been silent and passive, like a piece of furniture. This period was used by the residents (and employees, family and volunteers) to become accustomed to the fact that there is a new object in their living environment. After this period of familiarization, robot MAX has been active between 10:00 and 16:00, always controlled remotely by the researchers of Smart Homes and Ananz – who were close enough to see what was going on. MAX offered a couple of concepts of the MOBISERV services to the residents. MAX has provided the following functionality:

- Regularly, MAX drove around in the living room, passing by the tables of the residents, and addressed people.
- MAX played music, music videos, or showed photos.
- MAX gave personal attention by providing a customized response to individual clients, like:
    - Approaching people, looking at them, and initiating something;
    - Having a chat;
    - Showing general photos (nature, animals, people, etc.);
    - Showing personal photos (family, buildings from their hometown, etc.);
    - Offering a game (point at the right picture, memory);
    - Playing music;
    - Showing animal videos (Animal Crackers);
    - Showing a video of a laughing baby;
    - Showing music videos (André Rieu, Ave Maria);
    - Giving a specific alert in case of silence or when people have fallen asleep.

Researchers of Ananz and Smart Homes observed and analysed these interactions between MAX and the clients, care personnel, and family.

4.6.4 Observations – during the field trial

By researchers

- Lady, when seeing personal photos: “How can this be possible, haha!” She really likes it: “This is the most beautiful thing I have ever seen.”
- Especially personnel is sceptical at the start of the trial: “I am very curious to see what it does, that Max thing.” Or: “When will they start with that joker?”

- Lady: “Our Max.”
- Max: “Should I play another song?” Lady: “Yeeeeeaaaaaaah.” And later on: “Can it play even more songs? Super!”
- Photos work out great and elicit responses: “Oh yes, very nice. And this little house, and those flowers, and those colours, beautiful.”
- People tend to touch the photos and videos they like.
- A lady recognizes a photo from a distance, and responds to it. She starts a whole conversation with the robot about the village she used to live in, etc.
- Max asks another lady where she is from. The lady tells about her hometown: “I am from Oldenbergen.” Max: “Oh, I think I have never been there.” The lady: “You should really go there once.”
- A man dozed off, but when hearing the music from Max who is driving by, he wakes up, and starts to whistle along right away. A bit later, he also starts to clap.
- Music brightens up multiple people at the same time, and can evokes emotions and interactions between people.
- Several people talk about Max. A lady tells another lady: “He played a song specially for me.” Also people from other sections in the care home come over to see Max.
- One of the residents explains to some children how Max works and what it does, and strokes Max’s head, and says: “Yes, he is a good one.”

Figure 36 Max in a group setting at a care home

By personnel

- Max asks people what they like, and after an interaction, ask whether he can move on. People respond to this. People are alert, also the ones that are not directly involved. Very nice.
- When Max played music videos, people got enthusiastic. Very interesting.
- It is cosy to have Max around, for the residents and for me. People get attention and this makes the feel happy.
- One lady told Max that she did not like to play a game and did not do it. This was okay, she was not upset, but at ease.
- One man played a game with Max and really livened up. Afterwards, he still looked happy.

- There was a nice and positive energy in the living room. Residents got stimulated, and responded very well. Some cannot read, but with some help of us, it works well.
- I was trying to comfort a lady that was very sad and crying, but this was hard. When Max came along, she became a bit more at ease, she showed me some things on the robot, and her tears slowly disappeared.

4.6.5 Observations – after the field trial

By researchers

- Max did not create extra unrest.
- During the first two days, the presence of two extra people (the researchers) draws some attention from a couple of residents, but during the following days, they are used to us.
- Conversations are sometimes hard, but not impossible. Max has to use short sentences, and closed questions, and should repeat these questions a couple of times.
- The initiative should always come from Max, for this group of target users.
- Photos of animals and familiar things work well, and elicit responses from the users, like stroking the screen, verbally describing the picture, or talking to the picture.
- Several people respond to what the robot says and talk back. Other ignore the robot, but this also depends on the moment in time.
- Residents that are deeply absorbed in themselves, do almost not notice MAX. Residents with a more open view, can be 'caught' by MAX.
- A couple of residents played a memory game, where they had to touch certain pictures on the screen of Max, and this worked very nicely.
- In general, residents responded positively on Max and its possibilities. We did notice a difference between the morning (before lunch) and afternoon (after lunch). In the morning, people are more alert, but there is also more tranquillity.
- Max could become the right hand of an activity leader, and also be a trigger for creativity.
- There are a couple of things to improve, including the voice (volume and speed) and the touch screen.
- It is great, impressive, and promising to see how residents, care professionals, family and volunteers respond to their new companion, and how residents smiled, whistled and sang along.

By personnel

A.H. – primary responsible care giver

- In general, I am very enthusiastic about MAX in our living room.
- Residents are being motivated to participate in activities like playing a game or watching photos. Most of them enjoyed this.
- Also music videos were appreciated, people sang along and whistled, and some of them got a bit emotional.

- Some residents had a chat with MAX and enjoyed this, but others did not really understand who was talking.
- After interacting with the robot, people seemed calm and satisfied.
- Things that should be improved are the very long time it takes to setup and start MAX, and the very low volume of the voice of the robot.
- Also be careful with the level of the games – if should not be too high.
- As a conclusion: I liked to have MAX in our living room during the past days. Almost every resident liked it and participated. Some people seemed more alert, and after MAX left, there was no unrest.

Figure 37 One of the residents interacting with Max

I.D. – activity leader

- During the first day, I was really surprised by the incentives that MAX gave to the people. Residents seemed alert, watched MAX, and were okay with it.
- What struck me was that they seemed to find it normal that there was a robot driving around.
- It were mostly people from outside (family and volunteers) that said it was special.
- Together with me, MAX tried some games with the residents. Some people have trouble reading, or do not understand what is written, so it is good that the robot also talks. When using the robot together with me, people seemed to get more confidence and touched the screen more easily.
- One of the ladies did not like the robot at all, and did not want to play with it. She was not afraid of it, but said it was for young people, not for her.
- Things to improve: pictures should stay on the screen when people touch them, because it means they like it; the volume of the robot's voice should be higher; and the voice should be more human.
- I have become very enthusiastic, and a follow-up trial will be very welcome. It was a pity that this trail was so short, I would have liked to try out more things.
- Nevertheless, people need a human hug every now and then, and this is something MAX will never be able to give.

N.L. – primary responsible care giver

- When Max came to our living room, there were different responses. Some people liked it, others did not.
- During the first week, Max was silent and just stood in the corner. People did not give it any attention then.
- In the second week, when Max was active, I had the feeling that the residents liked it.
- When Max took a break, people that were actively involved also calmed down. They did not talk about Max then. But when Max was back, most people had full attention again.
- A successful test in my opinion.

A.M. – team manager

- We started with a one-week familiarization phase, but from this experience, we can state that this was not necessary. People did not pay any extra attention to it, did not talk about it, and were not afraid.
- After that, Max was active for a week and I have received positive responses from the staff.
- There were residents that paid attention to the robot and residents that did not respond.
- The large majority was triggered to give a response to Max and sometimes to other residents.
- Sceptical employees have seen the added value during and after Max was there.
- I think this trial has shown what a robot could do with our people. We have discovered several necessary improvements to make this really work. Think about face recognition, emotion recognition and full autonomous behaviour.
- Next to this, good information and guidance is necessary to receive acceptance from non-residents (staff, family, volunteers)

4.6.6 Suggestions for improvements

During these 5 days, we have learned many lessons. We have gained a good idea of what such a robot companion should be able to do for this target group. Here is a list of things that might be interesting and should be taken into account when starting a follow-up project.

Usability

- The voice needs to be adaptable (intonation, voice, speed).
- The volume of the voice needs to be higher.
- People tend to touch the screen quite long or stroke certain pictures. This causes the system to detect multiple ‘clicks’ or a ‘double click’ (sometimes showing the context menu). This needs to be solved.
- Face detection and recognition is needed (to get personal settings / show personal content).

- Emotion recognition could be useful to adjust content.
- We found quite some challenges for or navigation; stools, chairs, walkers).

Content

- The content is most important. It should be very diverse and extensive.
- There should be more music from the 40s / 50s / 60s that people heard in their past and excites them.
- We need to find out the hobbies, favourite music and past regions/cities that people lived in should feature.
- Possible link with home automation; streaming sound and video to TV and speakers, etc.
- The robot could do a little dance, on some slow music.
- We should try out skype with live conversations.

Process of running the trial

- Communication and "showing" is of major importance during the introduction and the execution of these kinds of trials and projects; this raises awareness so people will not think it is weird and personnel sees how and that it works. Well-being is not provided by just technology, but it can be a very valuable addition.
- In the future, a follow up study should include a scientific study with a control group and validated observations (see Dementia Care Mapping – www.bradford.ac.uk/health/dementia/dcm)

4.6.7 Conclusion

The aim of this field trial was to find out whether and how a companion robot like MOBISERV could stimulate and activate residents of a psycho-geriatric department. In case of success, this could have positive effects on the quality of life of these residents, it could lower the burden on the care professionals, and it might make their job more interesting and more fun.

It can be stated that we look back at a successful trial, both from the perspective of the care professionals and the residents. Care personnel reported numerous events of a positive vibe in the living room, residents being excited and looking happy. The general feeling in the living room was cosy and MAX contributed to this by addressing the people that were open to him, and giving them some attention every now and then.

Based on this field trial, the expectation is that MAX can activate, stimulate, and entertain people on an individual basis, but also on a group level its possibilities are promising, not only as a mobile multimedia solution – carrying around music for instance – but also to facilitate interaction and contact in between residents.

It seems realistic that MAX will function as some kind of “toolbox” from which the care professional can draw from, to provide care to their clients. Because MAX offers many options (music, memory games, photos, videos, interaction and autonomous navigation) the care professional will have more and richer choices in the activities he or she can offer to the residents. MAX could learn residents’ preferences of photos, music, stories, videos, and could then offer these on important occasions, and in an appropriate manner.

The fear or assumption that robots are not appropriate or acceptable for our “older” fellowmen, let alone people with dementia, seems false. The residents responded to MAX very enthusiastically and seemed to get used to him very quickly. In fact, there seemed to grow a bond between several residents and MAX.

The power of MAX will increase when more personalisation will be applied; so when family, informal carers and personnel are able to offer the right content to the right person. It is expected that MAX will cooperate with the care professional to get the best from both the human and the technology.

The main goal was to find out whether MAX could excite, stimulate and activate people. MAX has succeeded in this. Therefore, it would be great to give this field trial a follow up using improved technology and including more controlled and longer-term tests.

4.7 Day Care Centre User Experience Trial UK

4.7.1 Participants and Context

The Day Centre provides educational and leisure facilities for the local community and is a focal point for social activities for older people living in their own homes but wanting to participate in community activities. Six adults between the ages of 70 and 90 years of age volunteered to participate; there were three women and three men. There was one wheelchair user and two participants who used walking frames. One male participant was recovering from a stroke and had left-sided weakness and some communication difficulties.

A room of approximately 6 x 12 metres was made available for the group to interact with the Robot. A Bluetooth microphone was used so the robot would not be affected by the general noise and conversation in the room and could also pick up the voice of those participants who had very quiet voices and wanted to call the robot when it was on the other side of the room. The room was mapped out, with some room locations, living room, bedroom and kitchen defined, as well as a location next to each pair of participants' chair designated with a name.
Participants sat in a semi-circle and interacted with the robot for a period of approximately one hour where the robot was sent to a pair of individuals at a time.
Three researchers were on hand to facilitate the evaluation and three carers form the centre observed and asked questions.

The aim of this session was to introduce the robot to the participants, let them have a brief interaction with it and get their feedback on the appearance, functionality and how they would feel about having a robot such as this in their own homes.

4.7.2 General MOBISERV Concept

Participants had a wide variety of attitudes to the robot ranging from enthusiastic and amazed to sceptical and suspicious. However they all scored the various aspects highly in the feedback form at the end of the session, Figure 38, despite having a number of issues with interacting with it. Half of the participants said that they would like to know the robot better in another session. Aspects of the appearance that people highlighted as positive were the colour of the robot, noting that it was "*calming*" and found it "*restful, not intrusive*."

It was recognised that the communication with the robot would improve after repeated use. When asked to imagine having the robot in their own home, the responses from the two who replied were not so positive, saying that they were not sure as they would be nervous being alone with the robot and that it would suit better someone who was disabled better. The other four participants refrained from answering this question.

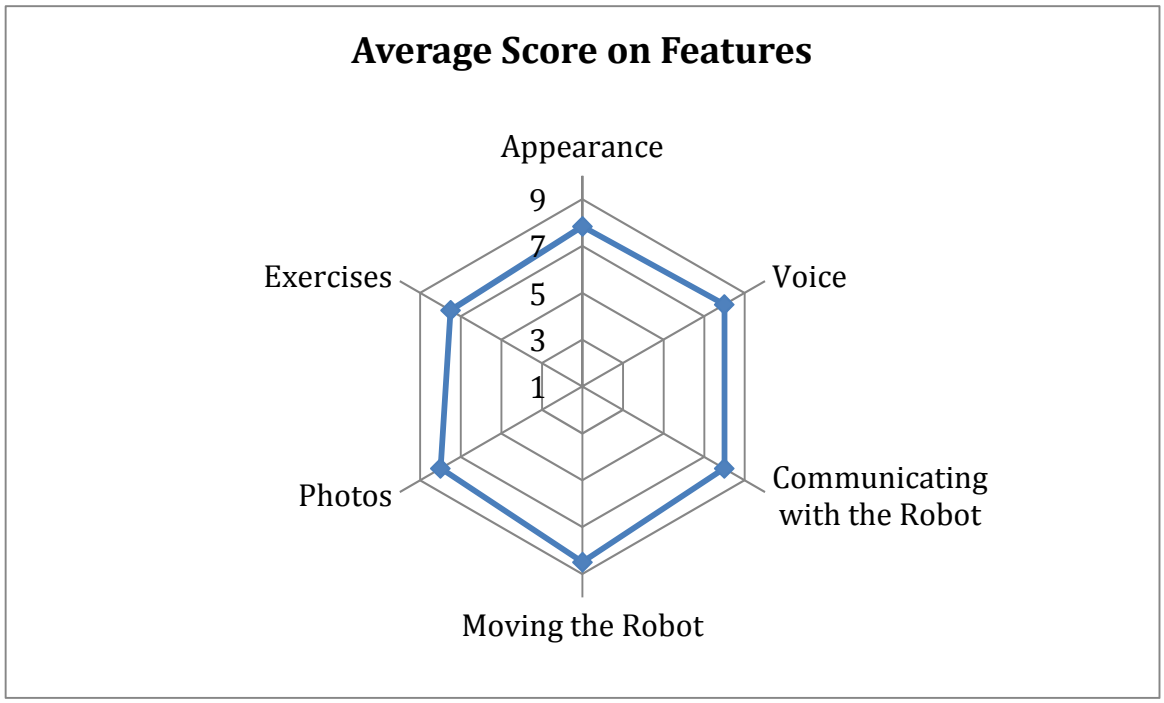


Figure 38 Questionnaire responses, Average Scores. 1 = Unsatisfactory: 10 = Very Good

The robot evoked a lot of curiosity with one participant saying that "although he didn't have a degree he would have liked to take it apart to see how it worked".

One of the carers recognised that it was "*still work in progress*". The issue of not being able to go upstairs was also raised. One of the male participants was insistent that it does not have a "*practical use*" despite being explained the different functionality. This participant also said on his feedback form that the appearance was not impressive and communicating with the robot was "*not very easy, needs improving*" Personality and attitude of participants seems to be more predictive of good human-robot responsiveness, than functional abilities and their disabilities. Two participants who had mobility support and some communication difficulties were more responsive to the potential.

4.7.3 Specific Findings and Discussion

Interaction with the robot

It was found that a couple of the participants who had very soft and weak voices found it very difficult to use the voice interaction facility. Even with the Bluetooth microphone, their inability to enunciate in a clear voice resulted in non-recognition of voice commands or misrecognition. We also found that an individual with a hoarse voice had particular difficulty in communicating with the robot. It should be noted that voice disorders are often a natural part of aging and so while people might be able to communicate in this way and get used to it, as they age their voice will change and this will mean that the speech recognition system will need to be responsive and adaptable to this change. Intelligent signal analysis could be used to detect changes and this could be combined with the number of errors in recognition that were occurring when compare with an average over a period of time.

When in listening mode, the robot responds to all sounds which it thinks are words with the statement “Sorry, I did not understand you, what did you say?” “I’m sorry could you repeat that please”. This can be in response to coughing, laughing, clearing the throat or other sounds that it picks up from the environment. This can cause further confusion for the user trying to issue a command if there is an overlap with what they are saying. The natural reaction is to repeat the command, however if the robot is facing away from the user, they obviously can’t see the screen to know whether it is in listening mode or not, resulting in a problem with synchronisation, due to the robot “hearing” only half of the command.

UWE made an important change to the screen design to better indicate to the user when they should speak and when not, i.e. when the robot was in Listening Mode or Not Listening, by just using the words Listening on a Green background and Not Listening on a Red background – this made an enormous difference in helping users with understanding when to speak, over the original design of the microphone which was found to be highly ambiguous and difficult for people to remember. We found that the new design was even understandable to a participant with communication difficulties.

Figure 39 New screen design to improve interaction: listening and not-listening buttons

The new Turn Left and Turn Right functionality was found to serve as a good feature to enable the robot be adjusted by the user to face them during interaction, however there are no commands to get it to come closer a little or move back to ensure an ergonomically comfortable operating position.

Figure 40 The ‘turn around’ command is useful, but the microphone is facing the wrong way

The angle of the touch screen is currently fixed and can’t be changed. This results in a glare on the screen from overhead lights affecting visibility. The screen of the laptop can be brought forward, however this makes it unstable.

The responsiveness of the touch screen can be erratic. The user having long nails can affect this response adversely as the finger does not adequately make contact with the screen. Also sometimes a user tried to touch the screen from an angle and as such the side of their hand

made contact with the screen, which was confusing for them as they did not realise that this had happened and as far as they knew they were touching their intended target on the screen with their finger. This can be an issue for older adults with shaky hands, however effort has been made to keep the on-screen areas large to prevent problems.

Some users felt the need to introduce themselves to the robot – saying "*Molly, this is Brenda talking*" . This is interesting as they realise that the robot cannot see or recognise them – as it has fixed painted eyes, and also it suggests that the robot should have a response for this introduction in the spirit of good etiquette.

Functionality – Photo Album

The size of the photos can be too small for some users with visual impairments. This is compounded if the photo is too dark. Making the interface functionally simple can result in a poor experience for the user due to lack of functions to make adjustments. Simple controls could be provided and more efficient use should be made of the screen real estate.

We added descriptions to the photos which were "spoken" by the robot when the user selected the photos. This was found to enhance the functionality of the photo album feature considerably as it provided an added dimensionality of the robot "socialising" with the person by telling them some interesting information about the photo, and also by including questions in the description, such as – "This is a picture of the Bristol Harbour. Don't the houses look pretty painted in different colours. Have you been on a boat ride in the harbour?" made for a good prompt in evoking and stimulating memories.

Functionality – Exercises

For the exercises we incorporated a number of exercise videos with music and instructions designed for older adults to be done in a seated position. Putting in simple descriptions about the exercise video, which the robot said at the start provided a useful guidance for the user. Also we found that providing instructions on which button the user had to press as part of the spoken information helped the users to know what to do next – such as "Press the start button when you are ready". The music based exercise videos were very much appreciated by the users, with comments such as "lovely!"

Functionality – Control the House

It was unfortunate that Robosoft has not made available the screens for the "Control the House" function, which while even though not linked to a smart home infrastructure, would have been useful to demonstrate and get feedback on in regards to usability. People, did however appreciate the utility of this for someone with a mobility disability.

Functionality – Games

Participant expressed a wish to have games that they knew such as Bingo. Unfortunately, the games provided at present have not been customised for use by older adults, in terms of

suitability as well as usability of the interface. This was particularly noted for those who participated in this study who were inexperienced in the use of computers.

Functionality – Moving the robot

It was found that for the participants who were not mobile, when the robot was sent to a location on the far side of the room, it could be very difficult to get it to come back as they would be unable to see the screen and thus know when to speak, or even know if the robot had the right screen activated. The facilitator provided the instructions to support them in getting the robot back. The Bluetooth microphone helped them to use speech without having to exert their voice, however there needs to be some other mechanism developed to enable commanding the robot to come back as remembering to have a Bluetooth microphone at all times will not be practical. As the room was large and spacious without any obstacles, the robot was able to navigate effectively in this space. One of the carers was interested in the robot being able to carry trays of food which they said would be a useful feature given that it could move from one location to another.

4.8 Residential Care Home User Experience Trial UK

4.8.1 Participants and Context

This study was conducted in a private residential care home, which has a range of residents ranging from those with early mild dementia to those needing nursing care. A group of 9 older adults, age ranges 67 to 94, four women and four men, with very mild to moderate dementia, participated in an hour-long session. The session involved a demonstration to the group of the available functionality with each participant having an opportunity to try out a few of the functions each, including sending the robot to another person. We had mapped the room and created locations near the participants' chair designate with their names. The Bluetooth microphone was used to ensure reliability of the voice recognition as there was background noise in the environment.

The aim of the session was to assess how people with mild dementia would respond to the robot, how they interpreted the functionality and consider what support such a system could offer in residential care homes. The session was followed up with a discussion with the home's manager, deputy manager and a formal carer, where a demonstration of the smart garments was also conducted.

4.8.2 General MOBISERV Concept

There was a usual mix of responses from the participants, ranging from very enthusiastic to scepticism about the usefulness of such a system. Some of the participants remained quite detached and carried on with sleeping and reading when it was not their turn to react. Others remained engaged throughout, making jokes while observing others interacting.

One of the aspects that emerged was that people in such an environment rely on their formal carers who are very well trained to recognise and respond to their needs. The residents are there because they need and appreciate this high level of personal care. As such, a system such as this seemed unnecessary to some of them.

On the other hand, the overworked staff can easily appreciate the advantages that such a system could offer in support and complement their work. Keeping residents entertained, particularly those with dementia, remains a challenge while attending to everyday care needs of the residents. The three members of staff could clearly identify what such a system would offer in terms of cognitive stimulation and notifying them of emergency health status, as well as delivering more personal messages to the residents in their rooms when they couldn't get to them immediately - " Trisha told me to tell you that she will be with you in a moment". This would be particularly useful in the morning hours when all the residents were waking up and ringing their call buttons. The robot could also assist with planning triage in these busy circumstances.

From the hour of interaction with the robot it was clear that the robot provided a useful vehicle for mental stimulation, whereby residents who were earlier dozing in their armchairs became quite animated when the robot came to them.

Figure 41 Resident enjoying interacting with the robot

4.8.3 Specific Findings and Discussion

Interaction with the robot

At the start of the session, when the robot spoke in a loud and clear voice, one of the participants claimed "*I can't understand a word of that*". It turned out that he had left his hearing aid in his room, which was then brought up to him. For people with hearing impairment, it is sometimes usual for them not to always wear their hearing aid or turn it on. In the future, when the functionality of finding a user worked reliably, this could provide a crucial level of assistance for safe independent living where the robot could approach a person and remind them of this, particularly if the hearing aid was a Bluetooth device whereby it would be possible to know whether it was worn and operating correctly.

When the robot makes an error in recognition or does something unexpected, some users are quick to blame themselves, one user was apologising "*Sorry about that*" when it did something unexpected. It was difficult to communicate to him that it was the robot at fault. One must be careful about the impact of such systems on people's self-efficacy, particularly when trialling a system that has numerous faults.

One participant with mild dementia had problems in understanding the concept of having to give voice commands to the robot. This can be understandable for someone who is not experienced with voice interactions and the fact that the robot has a limited vocabulary makes it even harder. The contrary logic of this that can confound people is that if the robot can understand speech, then why can't it respond to all speech commands. The fact that it needs to be in a "Listening" mode to "hear" you, was found to be quite hard to grasp for some older

people with early dementia. There needs to be some alternative modalities with more intelligent processing by the robot, of using mouth movements to interpret when the user is talking and process these synchronously, as humans do, in order to make speech interaction a viable mode of communication for someone with dementia.

Potential for entertainment, cognitive and physical stimulation
The robot provided a cause for a lot of amusement amongst some of the participants. Such as when the Simon game makes a strange noise when the user makes a mistake, one of the participants interjected "*is that a rude comment, or not*?" which resulted in a lot of laughs.

One participant who had been asleep was very enthusiastic to wake up and interact with the robot, particularly in doing the exercises. For her age of 94, she was very energetic and chose one of the longer exercise routines to do under the watchful eyes of the carers and facilitators. However, this does highlight a potential safety issues. It is important to note that in an environment such as this there will be people of a wide range of physical and cognitive abilities. If things are overly simple for some, they might be boring for others. As such there might be a range of exercises to suit all user needs. The robot would therefore need to have face recognition or other means of reliable identification, to ensure that the system functionality and contents is changed and personalised for each user so that no user is out of their limits.

4.9 Home Apartment User Experience Trial NL

4.9.1 Participants and Context

The participants are a couple – husband and wife, aged between 80 and 90 –and living in their own apartment, in a building that offers some care services for people that need or like this. We have met the participants a couple of days earlier in one of the care homes where we were demonstrating MOBISERV. They are enthusiastic and eager to participate. They have lived in their own home for long, but had to move to this new place quite recently because of a broken hip of the man, due to a fall. The husband has fallen, completely unexpected, while working as a volunteer in care for older people, and broke some bones. He had to rehabilitate for 3 months in a hospital and care home, but then had to go home. However, they lived on the first floor, reachable by stairs only. So they had to move to a new location very quickly. They did not like this at all, but are getting used to it now. The lady loves to travel. She visits her sons and daughters living throughout the country quite often. The man does not like to travel, and now even less because he needs a taxi or bus because of his hip, so the lady often travels alone. Both of them do not suffer from dementia, although the lady thinks that her husband is mentally declining. The man gives the impression that because of her, he can live on his own, but that without her, he would not manage.

Their apartment
The man uses a rolling walker, so this has the advantage that there is enough space for the robot to drive around inside. The whole apartment has carpeting. This is okay for the robot, except when charging. Then the robot sinks a bit, while the charger stays on top of the carpet, and they do not fit well anymore. There is no internet available. They do not have a computer. And they do not feel the need to start using a pc.

4.9.2 First impression & general MOBISERV concept

Their first impression is positive and critical. They like the idea and state the robot is "quite funny". The lady immediately says that she would like to call the root Dora. The man thinks that the robot is not complete yet, because it lacks arms. But apart from that, it is a nice thing. But it cannot pick up or bring things. But for people that start forgetting things, it can remind them, which is good.

When asking about the added value for them, the lady says "Well, I am not sure. For us, I do not think so, not yet, because I am still fine. And I am only out in the morning. And he does not suffer from dementia, luckily. But I do like it." Also she thinks that it is most valuable for people that live alone, more than for people living together. Especially the reminders of things to do: "Here, I will say such things. Do this, do that. Or, when I go out, I will write it down. You do not have this when you are alone."

4.9.3 Specific Findings and Discussion

Voice & behaviour
Both participants are quite positive about the robot's voice. The lady thinks it is very clear. The man states that the voice is quite warm, and says "It is warmer than a computer, which is monotone. This is better."

When the robot says "sorry, I did not understand" for the 10th time, the lady states "Why does it say this now? It has to go to the doctor haha."

When asked how the robot can be more like a companion, the lady says: "Haha! I would say that is should sing a song. We love music, so it should play music."

Both participants like the looks of the robot and from a practical point of view think that the screen is big enough and very clear. About driving around, they first think that the bathroom is private. But when thinking about it, they state that it should be able to go there, when they would need support there.

Functions: exercises

Both the lady and the man are a bit sceptical about the robot telling them to do exercises. "Oh, I would never do those exercises." The lady is doubts whether people will listen to the robot when it says they have to do something. She agrees that people need some intrinsic motivation, they have to want it themselves, or they will not do it. This is an overall observation for many of the MOBISERV functionalities.

Functions: eating/drinking suggestions

The eating and drinking suggestions based on their behaviour are welcomed by the participants: "Yes, very good, because everybody forgets these things every now and then." The man worries a bit about the need to adjust their home "with all those sensors" and also for video calling, he thinks that they would need other devices to make it work.

Robot with arms

The man indicates that he somehow misses arms on the robot and states "I think that soon they will be more complete" and "now it is a brain on wheels, no more than that". He is focussed on the word 'robot' instead of thinking about what it should do, and states that he has "American movies in mind, where robots do the dishes", but when asked whether he would you like this, he says no, and states that he can do everything by himself.

Carer interface: general idea

Both participants have no experience with computers at all, so it is not easy to get the idea of a tablet and online interface for partners and carers to configure the robot. The man has a vague idea ("so this is some kind of note book?") but the lady understands it better. She thinks it is very good to have access everywhere, for instance "when you have forgotten something yourself". She thinks that this could work well for family and partners.

About the naming, she indicates that 'online interface' is completely incomprehensible for her, and also she states that 'informal care' is something you do for others, not for your family: "I do not see caring for my husband as informal care. This is just what you are used to do."

Carer interface: usability

As stated, the couple has never used a pc or tablet before, so when shown the carer interface on an iPad, and asked whether the lady has any idea how to put something in the agenda, her answer is "No, no! No idea." So rather than a usability test, this is more of an introduction and learning test. It is clear that the lady does not get the concept of a form and how to write in it – how to touch a field so the keyboard will appear. But she learns very quickly, and after one example, she gets the idea. So with a clear first instruction and walk-through, or an on-screen instruction, this might work. She states "when you do this more often, you exactly now where to be and what to do".

Overall, there are many usability flaws and bugs. Text size is too small, checkboxes are too small to use, checkboxes are too close to each other, it is not clear which ones are selected and which are not, and sometimes it is not possible to choose a new photo for a suggestion.

Interesting observation: the lady pushes very long on the touch screen and gets the context menu (select, cut, copy, paste) – this is not specific for our user interface, but is something to keep in mind. Another observation is that when the keyboard appears, the name of the text field disappears, so it is not clear what to type. Also it is not clear how to proceed to the next field, especially when the on-screen keyboard is visible

4.9.4 Conclusion

One of the main conclusions – also stated by one of the participants – is that there are many bugs in the system. Therefore, a serious experience cannot be given. The participants like and appreciate the general idea, and think it is very interesting, but they see many things that do not work, that go wrong, and tend to focus on this. (This is a pity, especially because several of these issues were already discovered a long time ago, but have not been fixed in later prototypes.) So their opinion is that the things MOBISERV does are all good – but for people that need it. “Everything it does is useful, there is nothing wrong with it, but we have not seen it really in practice yet” the lady says, indicating that she would like to experience it – really using it over a longer period of time.

Also, together they can cope very well at the moment, so they do not see an added value for them at this moment, but they do think it is valuable for people that live alone. As a final comment, they ask us to use the language of the target group more. For instance: informal carer interface or online interface should describe what it does: “What is it? It is a setup-screen!”

Other observations
While going to their building, outside and in the building, Kompaï gets a lot of attention. Cars stop, people are enthusiastic and ask what its name is and what it can do. When telling them what MOBISERV has to offer, all people – young and old – respond very positively and like it.

4.10 Hazard Analysis Study with overnight experience UK

4.10.1 Participants and Context

A two storey flat was hired for the purpose of this study. The flat was rigged with cameras so the evaluator could observe the user's interaction with the robot in the living room and kitchen and control the robot using the wizard.

The participants were an Occupational Therapist and an Engineer. Due to current safety and liability and reliability issues with the robot older people could not be used for this study.

The participants were instructed to carry on as they normally would in their own home and interact with the robot as frequently as they wished. The wizard also was able to control and simulate social and intelligent responsive behaviour.

Post-it notes and pens were left in all locations were the participant was expected to spend time. The participant was instructed to write any thoughts that occurred to them as they were "in the moment" with interacting with the robot. A sample of the post-its can be found in Appendix 6.

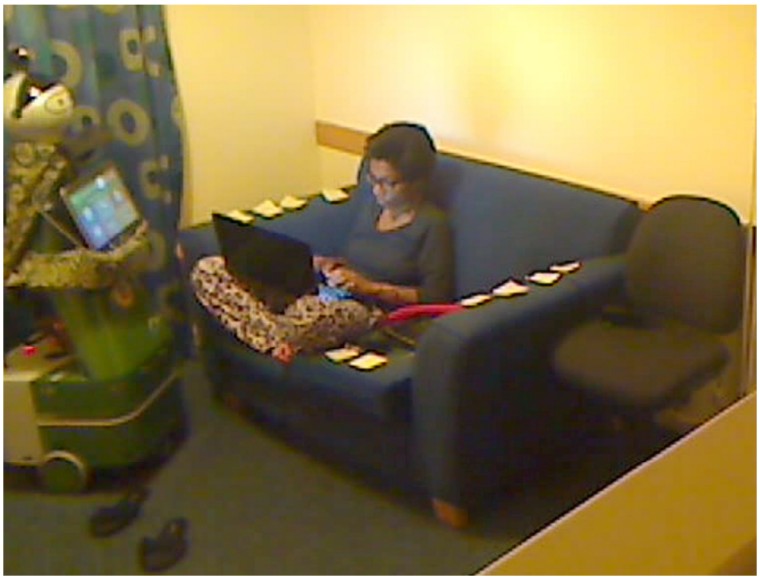


Figure 42 Participant recorded thoughts on post-its and placed them in-situ

In addition to noting problems with usability and social interaction, the major focus of this study was to determine safety related issues. The content on the robot, such as photos and reminders and suggestions were customised to give the participants a personalised experience.

4.10.2 Findings from study

Social Companionship
Both the participant noted that they felt that the robot was indeed like a social companion which they appreciated having around. Also they felt that being told or instructed to do something by the robot made them feel that they were compelled to carry out the instruction. One participant said that they wanted the robot to follow them around.

Error Correction
It was found that if the user was getting something wrong then the Wizard could get the robot to communicate to the user what action they could take. Such as " I think that something is blocking my way" or " You have to wait till I am in listening mode before speaking to me". This was found to greatly improve the smoothness of the interaction, with the users soon remembering this for themselves.

More detailed analysis of the collected video data and post-it notes is currently underway.

4.10.3 Risk and Hazard Considerations for Deployment

An occupational therapist assessed the activity and movement of the robot in the flat and identified a set of risk and hazards to be considered, particularly in relation to when the user is an older person.

4.10.4 Laser and Ultrasound Sensor Operation during navigation

Sensors do not seem to have repeatability of responsiveness in certain situations when the robot is approaching user.

Risk: If the participant moves their chair **forward** just a little (easy to do unintentionally) the robot can collide with the user's feet or knees. The robot informs the user to be careful when it is moving but does not inform the user when it has reached its destination. Sometimes it stops just before the location due to detecting a blockage, so the user assumes that it has reached its destination, however when the user shifts, their legs for instance then it moves again – to achieve its position. This can cause it to brush across the user's knees; this could hurt someone with sensitive skin/joints and also be alarming.

Risk Management: When there is a participant who has long legs/ obese/difficulty bending at knee, they will need to keep their feet out of the way when seated. Warn user not to approach robot on bare feet/open sandals as the robot cannot sense objects that are low and could possibly run over their toes. Ask them not to stretch their legs as robot is approaching.

4.10.5 Laser and Ultrasound Sensor Operation during fine adjustments of position of the robot

The sensors are inactive when the user says TURN RIGHT, TURN LEFT and TURN AROUND.

Risk: Usually this is not a problem because the robot is light and the edges on the base unit are rounded, but the user, particularly someone with poor eyesight or cognitive impairment, could misjudge the space that the needs to turn, resulting in an accident (robot knocks a table with hot drink, or causes injury).

Risk Management: Encourage and train the user to be more aware of space requirements when using these commands.

4.10.6 Management of obstruction during navigation and user response

Usually the robot avoids people/objects in its path but sometimes when it is trying to get to a specific location it will continue straight ahead even if someone is standing in front of it and come within a few centimetres.

Risk: If there is no room to the side, then a usual user reaction is to step back, which causes the robot to move forward. This can mean that the user can get “trapped” by the robot blocking their path. A MOVE BACK command would be very useful. The robot is light enough to be physically pushed back if the wheels are not locked, however older adults with physical difficulties would still find this hard. It can be a frightening situation for a user, and the panic response could make them forget what they can do.

Risk Management: Remind the user to make use of the STOP voice command and if necessary the emergency stop button. A button on the screen is hard to press if the robot is moving towards the user, particularly in a state of physical fragility.

4.10.7 Robot navigation through narrow doorways

Sometimes when approaching a narrow doorway from a sharp angle the robot can get stuck in a recursive loop of trying to move away from one side of the door frame to just encounter the other.

Risk: When this happens, the robot just keeps turning on the spot from left to right. This behaviour can make the robot appear “angry” or “mad” to the user. Another risk is of the user getting trapped in a room unable to go through the doorway if the robot is blocking it.

Risk Management: Discuss this potential risk with the user to explain and demonstrate that this is an engineering fault and the robot can be dislodged from this state by giving a little physical push. However, this is not a practical solution for older adults who are physically and/or mentally frail.

4.10.8 Emergency button on the front of the robot not activated and the red STOP button behind the robot is not always easily accessible

The red Emergency button on the front of the robot is not connected to any emergency assistance service and the red Stop button at the back is not easily accessible to someone with mobility difficulties – it is positioned low and behind the robot.

Risk: The user could forget that the button has not been activated and press it when wanting to call for help. The user could mistake it for the stop button. The user might not be able to access the Stop button if there is no space for them to move alongside the robot.

Risk Management: The emergency button should be masked with tape when a person is interacting with the robot independently until it is actually functional.
It should be made to look quite different from the stop button – perhaps have a shape of a medical cross. The stop button should be made available at the front as well.

4.10.9 Risks relating to users' undeclared health conditions

Many participants in robot sessions are more frail than would appear from the data that they self-reported on their health forms. Also many health conditions have come to light just before sessions that have not been declared on health forms e.g. fainting due to diabetes, sleep apnoea, shortness of breath on exertion.

Risk: There is a risk that the user could suffer a medical emergency when interacting with the robot and the presence of the robot might aggravate the situation.

Risk Management: Make sure that there is a first aider present. When leaving the robot alone with the person, there should always be remote observation through a separate camera to ensure safety of the person at all times. Should a situation arise, there should be a mobile phone with a quick dial to emergency services available.

4.10.10 Risk relating to system failure

At the moment, the robot's operating system frequently crashes and it is not straightforward to restart the system. Whereas younger participants could be trained to restart the system,

older adults could not be expected to do this. The robot also sometimes exhibits a strange behaviour before an eminent crash of moving side to side which could knock something over or make the user panic.

Risk: There is a system crash when the participant in a physically compromised position, which prevents them from moving.

Risk Management: Inform the user that crashes are possible and demonstrate to them how the robot might respond in a crash. The user and the robot should be observed and perhaps some remote controlling software such as VNC should be installed on the robot so that it can be controlled remotely by an expert to restart the system in case of a crash.

4.11 Show and Tell Sessions with Secondary and Tertiary Users NL

4.11.1 Participants and Context

About 50 people living in and visiting two care homes of Ananz in Geldrop – many older people living there, or visiting, or working as volunteers (all aged between 60 and 95), but also some employees of Ananz, and two people from different local governments (a social worker from the city of Helmond, and a policy maker form the village of Mierlo).

4.11.2 General MOBISERV concept

It is quite wonderful to see that all the people we have shown the project, the robot, and the services during these couple of days are all positive about the general idea of a smart system and companion robot. There was nobody that had expressed negative thoughts about the general idea. Of course they see many things that should be improved or changed, but nobody rejects the idea of technology keeping an eye on them and supporting them in the near future. It is nice to see that when the robot drives around, inside care homes, or even outside on the street, people start talking to it immediately.

Many responses included quotes like "*very interesting*", "*looks promising*", "*amazing*", "*very nice, what a nice thing*" and "*this is done very nicely*". Also a general idea is that it should offer added value to the user, so for all individual services, people only want it when they need it. Often people that have a partner state that it is more valuable for people living alone, but others also indicate that it could be useful when their partner is out for a while: "*Oh yes, when you are home alone all day, this is a very nice distraction and stimulation*." Some final quotes:

An older lady: "*I really feel that it is my birthday, because I have a robot visiting me*."
An older man: "*Thank you for sharing your success with us*."

4.11.3 Specific Findings and Discussion

Looks & behaviour

Of course, everyone has an opinion about the looks of the robot. Many people say they like it, and that it looks nice, some even think it is kind of human. But it is no surprise that most people like to change something and make it more personal, "*add personal elements to its looks, like clothing*", more friendly, and more sociable. One of the participants wondered whether the head could be more human, and whether it could change, so that when you are in a call with John, the head would show John's face. Some quotes:

"*Very well done.*"

"*What is that? Oh, it is a robot.*"
"*Looks like a 50's robot*"

About certain details, somebody asked why the robot has no mouth. Another person observed that there are still quite some loose components – it is not one whole thing. About the robot driving, opinions differ. Some say "*very ingenious*" and "*quite fluid*", while others think that it could be smoother; "*a bit more Brazilian – more relaxed*". One of the participants stated that the system should detect intonations in the user's voice, and adjust its behaviour to this:

"*When a person is in a certain mood, change the robot's behaviour accordingly.*"

The robot's voice

Opinions about the robot's voice differ a bit, but we noticed a tendency among the older participants that they think the voice is not bad, while some even state that it is friendly. Nevertheless, several people think that it is still metal-like and halting, and should be improved. Most people do think that the volume is a bit low.

Usability of the GUI of the robot

The opinions about the GUI and touch interaction are mostly positive, but with some concerns about learnability. A couple of participants wonder whether "older people could use *such a thing*" and whether "*older people want to start learning this, or not*". This is something many participants think about, but the general idea is quite positive, although some think that it "w*ill take some time to get used to*". Some people come up with solutions for this, like; "*give instructions for every step, or let people just start and find out*" and; "*show only functions that are available and available people to call*" and also; "*let the robot give concrete instructions like 'just touch my screen' or 'say yes or no with your voice*'". Another comment to make it more usable and easier, is to indicate the next step, what to do, after a suggestion has been given. This is something many people miss in the current system. Several participants also indicated that the screens should have less distracting info during interactions – so only he suggestion/question and the reply options, and no other info like the time, date, menu button, etc.

Functions: eating /drinking

Most participants think these are very good and smart functions. Most comments are on the interaction style. "*The language should be more personal*" and "*I will not get hungry from this*" because it is not very friendly and inviting at this moment. Many people think that it should be more friendly and enthusiastic; "*It should shout something like 'Dinner! To the table!' like people are used to from their past. Mother would shout something like this.*" As already indicated, several people would like to see that there is guidance after the suggestion has been given. It would be good if Kompaï would join or guide the person to the kitchen. A final comment is that in the current system, these suggestions are only triggered by the system, but some people would like to get inspiration form the robot on their request. Something like "*what shall we eat today?*" and the robot would then give a suggestion.

Function: social contact

This is one of the most popular functions among the many participants; "*Ideal that you can call people and see them*." Some comments were made related to usability, keep it as simple as possible and give clear instructions, and related to the internet connection; "*will you need internet for this?*" and "*a good function, when the connection is good*". For people with lowered initiative, it was suggested that instead of proposing to call someone, MOBISERV should make it even more concrete and let the robot propose a specific contact, like 'Shall we call Lisa?'. This makes it even simpler, because the user only needs to say yes or no.

Function: reminders & suggestions

Also with these functions, many people like it ("*This way you do not have to forget anything anymore*.") but several people state that they do not need it, because they do not forget things, or because they live with their partner. Also suggestions should be personal, and adjusted per user. And there are some concerns about the system being too decisive; "*it should be an addition to your life and to normal care, not a replacement*". One participant was very enthusiastic about companion suggestions, and thought that it could be a very active 'partner'. He said: "*When people are alone and dependent, and have the chance to get depressed, the robot should feel this, and try to help or cheer them up, like 'Hey, look in the mirror, what is wrong?'*"

Fall detection

Fall detection is very much appreciated, and several people wonder how this is possible. Several people ask us whether it could go one step further: "Also think about preventive *warnings*." This is something for future research.

Function: photo album

People appreciate the photos very much, and many participants state that it is great that others can also add items.

Carer interface

The idea of a carer interface is found to be very good. It can give peace of mind, and is essential to keep things up to date. This is what makes it possible to include the necessary personal elements. For many participants it is clear that the informal carers know best what is right for their clients, what to say and what not. "*So give room for these personal elements in the secondary user interface.*"

Deployment & Exploitation

Many people wonder about practical things that are needed to make MOBISERV work. Some examples are; "*Does your house need adjustments?*" and; "*How long does it need to charge?*" or; "*How long will such a robot last?*" Some people already asked us whether it is on the market, whether they could buy it, or when it will be on the market. Of course, many people talk or ask about the costs. How much will it costs, who is paying for this, and will it

be reimbursed by their health insurance or municipality. One older man stated: "*It will not be a cheap thing, but if people need to go to a care home or hospital, it is even more expensive. So you can earn it back very quickly.*" An interesting finding is that when we mentioned a price of € 5000 to see people's response, most people did not think that this is too much.

4.11.4 Necessary improvements

During these days, we clearly noticed that we should work on the robot's voice. We could replace the voice of the robot with a real female voice, or maybe we could to use the voice of devices such as TomTom navigation. Also, another word for 'online interface' needs to be found, since nobody understands what this means.

4.12 Consultation Session with secondary and tertiary users NL

4.12.1 Participants

In this session, 5 professional carers (all female) participated together with 1 professional care manager (male).

4.12.2 General MOBISERV concept

The opinions about the general idea of MOBISERV are critical but positive. The participants see the added value but have questions like "*does this work for people with real dementia?*". Also some of them tend to think for their clients, and state things like; "*Many people will not like it, don't you think? Or do they? How did people respond?*" This is a clear carer-bias that we see more often. Carers tend to be critical, while al very large amount of end users tends to be very positive about the MOBISERV concepts. Also, carers seem to be afraid for losing their job sometimes, while we always state that MOBISERV will be an addition bringing added value, and is not meant to replace human carers. Examples:

"But we should not forget the human care."
"In a care home, you will have carers and the robot, but who does what?"
"It should not be a replacement but an addition to the care."

But overall, carers see benefits of using MOBISERV. They see the added value for the client and for them. They do point at critical things that should be taken into account, like the progressing state of a person's dementia ("*You have to adjust very quickly to the process of decline. This is sometimes hard – things that work on one day, can be impossible on the next day. Partners see it, but for children or informal carers that live further away it is hard to notice.*") and the fact that there has to be an intrinsic motivation to use something like this. Some think that the partner or informal carer could and should transfer this motivation to the end user. Also they state that it should not be patronizing too much, which depends on the text and ways suggestions are given. Some quotes:

"It moves, so it has a big effect."
"The robot is easier than a fixed screen on the wall, where people have to go to by themselves."
"I think people that are lonely will really like this. The fact that there is something."

4.12.3 Specific Findings and Discussion

Looks of the robot

The consensus about the robot's look is that it looks very accessible, nice and friendly, but that a little bit more human would be nice – less formal, and a bit more personal. But it

should always be clear that it is a machine. Some people think that it looks a bit 'retro', also because of the green colour. So some state that another colour would be better, to make it a bit more modern.

The way the robot moves

The way the robot moves is found to be quite static, and most participants think that it should be a bit more smoothly. Some think that the robot could move a bit faster, but this should always be adjusted to the user. A couple of participants warn us that in most of the homes they visit, they see much more carpets, thresholds, little tables, and chairs than shown in our demo video. This is indeed something to keep in mind.

Voice of the robot

The general opinion about the current voice is that it is a bit dull, static, and should be less formal and more human. This is nothing new, but for Dutch it is hard to find good voices at this moment in time. Carers commented that to make it really work, it should probably speak and understand dialect languages. Some suggest that they would like to add their own voice to it, or the voice of someone's partner: "*What about the voice and/or dialect of the informal carer?*"

Usability of the GUI of the robot

The GUI on the robot looks good, clear, compact and with clear icons. One of the carers is concerned about reflections of light, but that is a general problem with screens, and can easily be fixed because the robot turn around.

Function: eating/drinking

Overall, carers see the added value of this function, but only when people need it. It looks good, but could be refined a bit, made more personal. They have two remarks: using cameras is something people might reject, so it depends on how far in the process of dementia a person is, and what they choose for. Two: we need to keep in mind the learning capabilities of people with dementia, "*so use voice as much as possible, instead or in addition to the on-screen messages."*

Functions: exercising

Carers see the added value of this function. They like it and think it is good that the robot stimulates this. Some already state that the current exercises look like personally adjusted exercises, which is great. The way the robot introduces the exercises seems a bit forced, and could be refined a bit, made more personal, and some carers state that the function should focus on 'fun', making it less serious.

A general comment is that exercises should not only be triggered based on the user's behaviour, but should also be set on a time in the agenda: "*It would be great if this could be set in the agenda*". A concern of some carers is that for some people it might be too much trouble to use the smart clothes. This is something to find out in follow-up studies.

Function: other suggestions
The fact that the robot could give other suggestions (besides eating/drinking/exercising) is very welcome. Carers think that it is a nice addition, convenient, and that it "*gives it a spontaneous character*". They state that this should be the focus, and that it promotes trust and safety

Function: (medicine) reminders
This is a very welcome function, there is no doubt about that. Some carers state that the function already exists in phones and watches, and that it is good that the robot has this functionality as well. There are some ideas to make the service more complete though. First of all, the robot should point at the medicines, explain where they are, or even drive there when the user asks this. Also, the combination could be made with a smart pill box, so users will not be reminded when they did take their pills.

Function: fall detection
This is very clear for all participants, it is most valuable. They state that falls occurs often, and that they stay unnoticed for some time in many cases.

Functions: games
Carers like the fact that there are games. It is entertaining and interactive, both are very good. But there is a general concern about the level of the games. Most carers think that it should automatically adjust to the right level for the user. "*This should be adjusted to the right level.*" "*Careful with the level of the games.*"

Functions: social contact
According to all carers a very good function, among other things to prevent loneliness. They especially like the idea of the robot actively suggesting to make a call. One important thing to improve and to keep it very clear and usable is to show only those contacts that can be called, and not the ones that are not available or are not allowed. This has several reasons; for instance when it is in the middle of the night, it should be prevented that people are called to, this might be set in rules, but could also be set by the contacts. In general, it would be great if the informal carer could set when he/she is available. If a contact is not available, it should not be shown to the user, to prevent disappointment and to improve simplicity.

Functions: basics
Two concerns arise about the basic functioning of the robot. Firstly; can the robot be switched off? Carers wonder what will happen, and whether someone gets a warning. Also they wonder whether the robot can be switched on remotely. Secondly; what happens when the robot breaks down? The see the importance of these events, because users and their carers might start to trust on the system quite a lot, and things might go wrong when the robot cannot function and/or speak anymore.

Function: home control

The discussion and opinions about home control go in two directions. First of all, sensing the status of the home, and warning about things, is good. The focus here is on safety, which is very welcome. An addition to the connection to the front door is to recognize people at the front door, and act upon this: "*it should say that you should not let strangers in, or suggest to use a call centre for assistance, when the visitor is not recognized*".

The other direction is about controlling devices in the home, like closing curtains, witching lights, etc. Most carers are not so enthusiastic about this and indicate that it conflicts with the intention to activate people. They agree that it completely depends on the target group. So when needed, it is very handy, but when the user can do it him/herself, let them get up and do it.

Function: photo album

Carers think this is a nice function, focussing on fun. It is agreed on that it would be even better when the photos are personal. One of the carers asks when the robot will show these photos, which is a good question – for people with (early) dementia, the initiative should always come from the robot. Carers think it should be made very simple for family and friends to add photos. For instance via e-mail or Whatsapp. "*Say I am on a holiday, and I want to send a message with a photo to my parents. Could that be done, maybe via Whatsapp?*"

Carer interface: the idea

The carer interface is seen as a good way to give the informal carer some peace of mind. Some carers say they are not sure whether this will work. In any case, it should be super simple to use by family, since partners are often also quite old themselves.

When asked, what they would like to see in the overview, carers indicate activity/passivity of the primary user, whether someone has been outside or not, and what has been suggested by the robot and what was the response of the user. About these data, cares wonder whether it should record everything it monitors. They agree that it would be great to have a nice list of how much someone has eaten, drunken, etc. but not every detail is necessary. "*How far do you want to go? How much privacy? People might lose own control…*" The general opinion is that it should not just record everything. It should be necessary and useful. Regarding what is useful, cares state: "*The system should help <u>us</u>, by monitoring and signalling.*" Regarding privacy, the idea arises that there should be different roles of users of the carer interface, defining who sees what. "*Yes, a psychologist would like to see when someone has been down, but others do not need to see this.*"

Carer interface: usability

Some comments after working with the carer interface are that it is quite okay. Some state that we should keep it clear, easy and simple, and that adjustments should be easy and quick.

Other interesting directions

Seeing what is possible with the MOBISERV system, carers start thinking about many other things that they would like to see. A couple of them are listed here:

- It could detect the first signs of wandering; when someone leaves the home, it should give a signal. Or when someone goes out to a shop, and has not returned after 2 hours. Wandering is one of the biggest problems at a certain moment. Also, when someone gets too far off the track he or she is supposed to take, outside the home, the (informal) carer should get a message. This could be done with GPS maybe. It would be great of someone else could see on a screen where the person is. Carers state that this is also interesting for care homes; keeping an eye out on people wandering away, but for this, the robot is not necessary.
- Some carers see that the MOBISERV concept can be extended to other fields; young people that live in sheltered living homes for instance. "*I think you can apply it very broadly.*"
- Some carers think that face recognition should be included, especially to make it work in care homes or places were multiple users are present.
- Another idea of one of the carers is an interactive table top (for people in care homes that sit at a table most of the time) to activate people. There they could use the same services, suggestions, games, photos, but without the robot.

Answers to the question: In your opinion, what does MOBISERV offer?

- **For clients:**
  - Forgetfulness
  - Malnutrition
  - Dehydration
  - Structure
  - Time and day; what time is it?
  - Staying longer in your own home
- **For informal carers and family:**
  - Peace of mind.
  - Signalling.
  - Safety.
  - Some room, not being overloaded. Being able to do a little less, so doing other things better, more rest, less anger.
  - Do the right things (so there is more time for nicer things for family).
- **For professionals:**
  - Peace of mind.
  - Some extra time.
  - Recording eating, drinking, medicine intake.
  - Detecting falls.
  - Extra eyes and some assistance.
  - More time for clients.

Answers to the question: In your opinion, what should be added?

- **For clients:**
  - Add sound to the photos, recorded voices, etc.
  - It should remind to take your keys, when going out.
  - It has to be super practical. You should not have to learn or study.
  - It should know which items are where in your home, when looking for them.
  - It should go along when going outside, somehow.
  - What about tasks like washing windows, vacuum cleaning, lawn mowing?
- **For informal carers and family:**
  - Should be easy to setup.
- **For professionals:**
  - Again, should be very easy and simple.
  - If we have to set this up by ourselves, there will be quite some carers that find it hard and that will not like it.
  - It should be very clear what is the goal.
  - Resistance can be lowered by showing it in the most practical way possible.
  - Maybe, there should be a small team of carers that will set it up.

4.12.4 Conclusion

The general opinion is positive, with many little user-interaction details to be improved. Carers see that the biggest advantages lie in the fields of safety and monitoring; detecting falls, gas, fire, wandering – these things are the major reason that people have to move from their own home to a care home – and monitoring eating, drinking, medicines, and steering this when necessary. The carers hope and see that MOBISERV could take away the task to monitor 'technical' things, like eating, drinking, activity, temperature, etcetera, so there will be more time for human care.

5 Practical Deployment Findings

5.1 In individual homes

5.1.1 Preconditions – things to prepare before installation

From practical experience, we have found that the following steps are necessary to enable proper installation of the MOBISERV system:

- Arrange an internet connection.
- Arrange transportation of the robot (it has to stand up straight, not lay down).
- Know the size for the smart clothes.
- Charge the batteries for the data logger.

Other preconditions that should be met to facilitate MOBISERV system:

- There should be no stairs in the home, or the robot is only able to work on 1 floor.
- There should be no clutter on the floor, which includes wires, books etc.
- The minimum distance of the doorways that the robot is currently able to navigate needs to be met.
- The flooring should be a single colour and no patterns that have edges with a high colour contrast – e.g. white patterns with long edges on dark blue, as it causes the robot to do a sudden stop and lock wheels.
- All doors have to be put in a fixed open position as closed doors will affect the navigation and the robot just comes to a stop in front of the closed door and does not respond or inform the user of blockage. It is illegal to leave a fire door in an open position so this will be a safety issue.

5.1.2 Observations & findings during installation

From our practical experience, we have found that the following steps are necessary to enable proper functioning of the MOBISERV system:

- Install a wireless LAN router or setup a 3G phone connection.
- Put tape or foil on windows or reflective objects at the height of the robot's laser.
- Connect charger to the power grid.
- Connect the robot to the wifi network.
- Map the rooms with the robot.
- Adjust and refine the map created by the laser scanner.
- Connect the eating/drinking pc to the wifi.
- Install the eating/drinking camera.
- Connect the tablet / pc for the secondary UI to the wifi.
- Connect the robot to the eating/drinking pc (IP address).
- Connect the robot to the smart home interface (IP address).

- Open de secondary UI on the dedicated tablet / pc (IP address).
- Connect the robot to the data logger (Bluetooth).

5.1.3 Observations & findings during usage

The following findings have come to light during our evaluation sessions and field trials.

Hardware

- The user has to think about charging the smart clothes data logger's batteries.
- Every now and then, the screen of the robot goes a bit darker or lighter, like a power saving mode, while it is not on batteries and power saving is off.
- The robot sometimes got stuck in the doorway when it approached from a sharp angle as the door frame was seen to be an obstacle – at this time it would get stuck in a recursive state of turning left and then right – which is very alarming for the user. Also it is a safety hazard if the wheels lock while in the doorway as it can block the user in the room.

Software

- The robot says "sorry I did not understand" many times a day. This gets very, very annoying.
- The online carer tool is only available on the local (wifi) network.
- The robot stops listening without a cause, it still talks but does not listen, after an agenda reminder.

Practical findings – Private house 1

Regarding the robot's navigation, the following issues / challenges have been found:

- Very low windows (the robot's laser looks through it, so does not see the window)
- Reflecting objects like the garbage bin and flower pots (the robot's laser is reflected in a very specific direction and therefore not detected, so it does not see these objects)
- Thin metal legs of chairs (same as reflecting objects)

Figure 43 very low windows


Figure 44 a temporary solution to low windows and reflections: white tape

Practical findings – Private house 2

This was a big one-floor house, which was ideal. However, there were many challenges regarding the robot's navigation:

- Very thick carpets, which are impossible for the robot.
- Chairs with thin metal (reflecting) legs.
- Tables made of glass.
- Windows all the way to the floor.
- Doors of glass.
- One-legged chairs and tables (because of the 2D vision of the robot, it sees the legs, but not the much larger seat or table top)

Figure 45 high carpets, 1-leg tables, chairs with reflective legs, etc.

Practical findings – Private house 3

This was a small one-floor apartment. The man living here used a wheeled walker, so there was enough space for the robot. The whole apartment has a thin carpet, which is not a problem, except when charging: although the robot has no problems driving, it does sink a little bit. The charger does not sink, so they are not on the same level anymore. As a result, the robot cannot charge, as it bumps into the charger's extension, instead of hovering above them.

Figure 46 the robot sinks a bit and bumps into the white part of the charger instead of going over it

Practical findings – Private house 4

This is was a flat on the UWE campus where the overnight trials were carried out. There is mixed flooring with some rooms carpeted and some having vinyl flooring such as the kitchen area. Between each room there is a metal strip between the join of the two rooms' flooring – this is very common in the UK. Sometimes the robot was found to get stuck on these and going from the lower lever to the higher level. This seemed to be a random issue, with the robot being able to make it over sometimes, while getting stuck at others.

Figure 47 a doorstep

For doorways that were located next to a wall, the robot would sometimes do a sharp turn and then stop as it would have got too close to the doorway

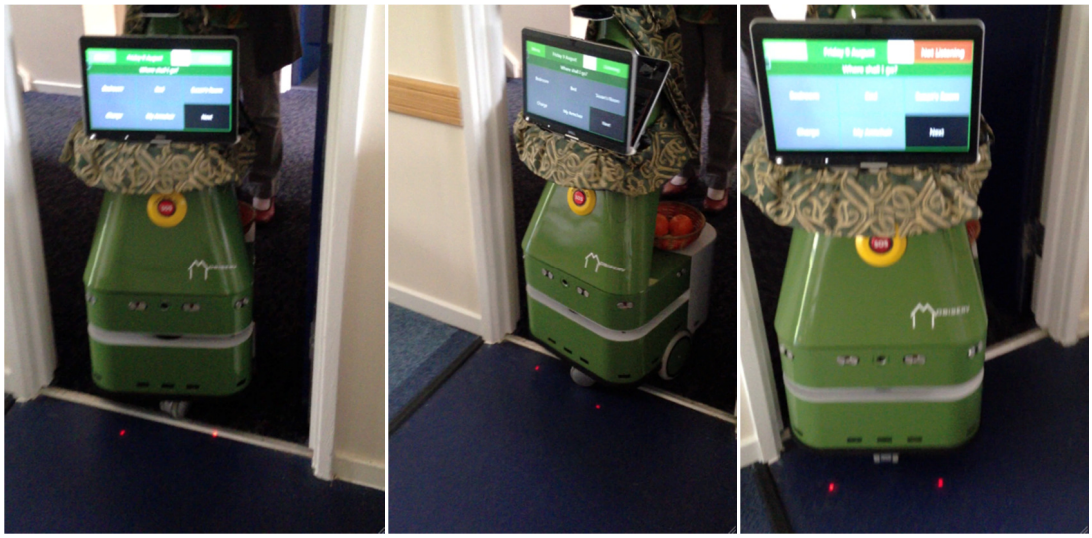


Figure 48 the robot on the doorstep

In some instances the robot was not able to dock as it seemed that doing a turn in an attempt to get into the charger resulted in the back wheel being parallel to the docking station, rather than perpendicular to it.

Figure 49 Even good alignment does not enable docking as back wheel is stuck in wrong position

A floor with a pattern of light lines on a dark background, Figure 50, resulted in the robot doing an emergency stop after moving a couple of centimetres, with its wheels locking.

Figure 50 Dark floor with light lines

5.2 In care homes

5.2.1 Observations & findings during usage

From practical experience in care homes, we have acquired the following findings.

Hardware

- The led lights on the robot's back, showing the battery level is always green and full. And then suddenly it is dead. When the battery is dead, it gives out a very high-pitched noise, which is very frightening to the user.
- The robot does not automatically go the charger when it is running low on battery and also does not inform the user of low battery so that they do not know that the battery is finishing.

Practical findings

The main things that comes to attention are:

- In a care home setting, there are many small obstacles that make navigation for the robot very hard. There are obstacles everywhere: chairs, tables, wheelchairs, rolling walkers, mobile IV units, stools, etc. Many have thin legs, which are hard to detect with only a 2D laser scanner.
- There are multiple users, so face recognition is a requirement for any follow-up trials or projects.
- We have to think about hygiene issues with multiple people touching the screen.

6 Discussion and Conclusions

Enhancing understanding of user requirements and usage scenarios, refining functionality concepts, and understanding the nuances of human-robot interactions are only achieved through facilitating extensive user usage of the technology.

Our large range of studies involved end-users with a range of physical and cognitive disability, formal and informal carers, as well as management staff involved in the care and wellbeing of older adults. Over the lifetime of the project we had multiple evaluations in different contexts and using a range of methods. These user studies have provided rich knowledge about the context of use and potential barriers, constraints, and criteria for acceptability of a social companion system such as MOBISERV. The evaluations have revealed invaluable knowledge that will help future design, development and deployment of this technology. People prefer to grow old in their own homes, where they are amongst familiar things and still part of their communities and neighbourhoods, rather than being marginalised in a care institution away from their mainstream society.

Usability
From the many observations and findings in evaluation studies with the MOBISERV system, it is clear that most users with adequate guidance are able to use the system, to interact with the robot, and to have a good user experience. However, to enable high level of reliable and repeatable usability requires a careful design process involving industrial product design, interaction design and graphical design. Only then, users will be able to use the system with confidence, and will have a great experience.

Added value
The team has learned that older adults are receptive to a system like MOBISERV, its robot and its services whenever they do not interfere with their daily routine too much and if the user can customize the robot's character, behaviour and appearance. They want to be in control of the system's behaviour; it should act in accordance to their preferences. Most valued aspects of the MOBISERV concepts by end-users and carers are 1) companionship; 2) stimulating, motivating and reminding; 3) keeping an eye out and calling for help, for instance in case of a fall; and 4) the friendly embodiment and natural interaction with the robot.

Acceptability
To ensure user acceptance, a training period of at least a few months is necessary, starting with a short introduction and building up slowly from a few hours to a couple of weeks, at a pace that suits the individual. The person's mental attitude regarding acceptance of technology of this nature has been found to be a good indicator of the level of ease with which they are able to learn to interact with the system. The determinants of successful training are:

- The user not feeling anxious or intimidated if the robot does not respond as expected, being able to recover from unintended states,
- Less than 1% error in execution of functions
- Completing all tasks with clear feedback from the system
- Being able to respond appropriately to reminders and suggestions
- Remembering how to control the movement of the robot
- Correctly remembering how to stop the robot

Practical deployment

Our evaluation studies have highlighted pragmatic issues to consider during deployment. We have found that there need to be several phases for the introduction and deployment of a personal robotic system. These include initial assessment of individual care needs and the suitability of their living environment for incorporating a mobile robot. The assessment needs to be holistic and involves understanding not only the person's functional and medical problems, but also their likes and dislikes, how they like to be spoken to, their interests and hobbies, types of exercises suitable for them, activities they enjoy, types of food and drink etc. This information can then be used to customise the content of the robot and also change the "personality" of the robot in line with what they desire – an authoritative system, or a social companion or a carer.

Future work

During the 3.5 years of the MOBISERV project, we have gained many interesting and useful findings and insights. In this period, we also found many new or extra research directions. For the near future, the most important directions include; 1) research on services like MOBISERV during long-term experience by users – what are the effects; 2) research on the usefulness of logged data for carers – will they use this data and in what way; and 3) research on the usage of the secondary user interface – are family members and carers the right persons to setup, customize and maintain a system like MOBISERV.

Conclusion

A project such as MOBISERV offers tremendous hope and promise in people being able to realise their aspirations of continuing to lead their lives with dignity and freedom in their own homes. During the time that our demonstration videos have been online, we received several calls and e-mails of people that would like to buy MOBISERV. Although we are almost there, and we found that many users are ready for it, there are still many things to improve. Our evaluations have shown that while there is much to be achieved in terms of developing the safety and intelligence of the technology, more consideration has to be given to the cognitive and physical aspects of the people interacting with them in designing the technology. Trying to mould pre-existing systems and expecting people to work around the limitations of the technology is not an option. The systems need to be custom designed to function in an efficient and effective manner.

Appendix 1 – Overall system integration and installation

Status Report – June 20th 2013

1. The Thessaloniki system (nutrition monitoring - Optical Recognition Unit - ORU) is not usable as an integrated component of MOBISERV because:

- The times to start and stop monitoring of eating and drinking cannot be specified – as there is no secondary user interface. It is unclear how they can be hardcoded either – there is no configuration file.
- The nutrition monitoring system (ORU) cannot be started by the MOBISERV system (robot) – as there is no evidence of a call to the nutrition monitoring API to do this – need to check SMH version.
- The MOBISERV system (robot) cannot receive any input from the nutrition monitoring system – there is not function call set up in MOBISERV (robot) to do this – need to check SMH version
- If a meal was missed – and there was functionality to pass this information to the MOBISERV system (robot) – there is no function to handle the event – so no process of finding the user and giving them a reminder or encouragement for a meal/drink is triggered – need to check SMH version
- If a meal is eaten – there is no function call in the MOBISERV system (robot) to a) receive or request this information and b) log this event – need to check SMH version
- We can't even trigger a "missed meal" event from the wizard to show how this could work.

2. The WHSU is not usable as an integrated component of the MOBISERV system because:

- While there is a function where the MOBISERV system (robot) tries to connect to the data logger every time it is polled, it is not able to auto detect datalogger and pairing with it, so setting up the data logger has to be done manually by someone with technical expertise and the status of the connectivity is not clearly evident.
- There is no facility to enable the setting of a threshold value for energy (activity level) - this should have been possible to do via the secondary user interface, which would be used to trigger an activity/exercise reminder/suggestion.
- It is not clear how/where a threshold value for the energy can be specified in the MOBISERV system code in any case.
- There is a function stub to request data (energy value and fall (Yes/No) from a paired datalogger – however in this function no proper response has been defined.

3. "Find the User" function is not usable as the algorithms are not reliable.

- The robot (MOBISERV system) is able to **sometimes** find the user (the code is unreliable and has not been tested by Robosoft) – a protocol has been defined to go

from one set location to another, use the Kinect to scan for a Person shape, put a message on the screen if it thinks it has found the person and ask – are you there? If the user is there they can say "Yes" or touch the button on the screen – after which it issues the reminder/suggestion (triggered by the Wizard). If the user is not there, and no one responds to the question "Are you there?" then the robot goes to the next location after a fixed time.

4. The secondary user interface can be used to add exercises, suggestions, photos and contacts which can be read by the robot. However now when the suggestions/reminders are triggered from the wizard – which is the only way to give a suggestion – the robot always tries to find the user first – even if the person is sitting right in front of the robot. Reminders are just text (set in agenda/calendar) - no images can be included.

5. The robot is able to receive and make calls but only **two** contacts (accounts) have been set up for this project – one is for the robot and there is one other for the researcher. It cannot be expected that relatives of the participants or others will be able to download and setting up the Lync software and user account.

6. The robot is not able to reliably dock in the charger. So when the user sends the robot to the charger it does not get charged as it fails to connect. So old people will need to be asked to physically push it in if left alone with it for over 5 or 6 hours.

7. The robot is not able to go autonomously to the charger when it is running low and not being used or ask the user to send it to the charger if they are not using it.

8. The robot is not able to inform the user if the battery is running low. There is no indicator in the primary user interface warning of low battery. When the battery runs out the robot base cannot be moved via the Xbox controller and has to be physically pushed. It emits a high-pitched sound until it is plugged in.

9. There does not seem to be logging of user interactions and events so this system interaction data will not be available for our analysis. So there is no user model. D7.2 has not been addressed.

Appendix 2 – Fixes to prototype used in the evaluations by UWE

Fixes made by UWE to make the prototype in a fit state for evaluations.

The MOBISERV final prototype application delivered (24th May 2013) by Robosoft had a number of issues that had to be addressed by the UWE team in order for Stage 1 evaluations to take place. Additional time was spent by the UWE team in analysing the structure of the uncommented MOBISERV application code in order to undertake the remedial work.
The changes are described below.

Wizard Mode

While performing "Wizard of Oz" tests on users, the application would remain in listening mode (green "Talk" button, waiting for a user to speak). Since we needed to simulate the platforms ability to respond, we needed to disable listening so the application would not constantly respond to the user with "I'm sorry I did not understand, could you repeat that, please?."

A switch was implemented on the secondary user interface, which allowed us to switch between "Wizard Mode" and "Normal Mode". Switching the application to Wizard Mode disabled speech recognition, but continued to display the "Talk" button as green (listening). Switching back to Normal Mode re-enabled speech recognition.

Static Suggestions

The secondary user interface allowed us to trigger suggestions to the user, but problems arose with issuing the command due to the Kinect sensor – it was not reliably able to find a user in the home, often mistaking everyday objects such as plants, and other furniture for a user. The specification notes that when a suggestion is to be issued, the robot should seek the user out, then display/read out the suggestion to them.

During user evaluations, the robot could be sent to specific locations, or controlled manually with the controller. The solution was to implement a "Static Suggestion" button on the secondary user interface for each type of suggestion. These buttons duplicated the suggestion features, but disabled seeking the user. This enabled us to manually move the robot in place, then display a suggestion to them.

Common Phrases

During testing, we found that we would use a large number of phrases that the robot would say to the user repeatedly. Unfortunately these had to be manually typed into a text box, in order to get the robot to read it aloud which can cause a delay.

A number of buttons were added to the evaluation interface to allow us to simply press them in order for the robot to read them out.

Application Crashes

The application would crash without warning in many places. This happened a lot, and for no real apparent reason.

In a multithreaded application, a number of user interface elements were being accessed by multiple threads. Since the interface elements were locked to the thread that created them, the application hung when another thread attempted to update the elements. Procedures were put in place to invoke the control correctly, allowing a delegate to execute on the thread that owns the controls window handle.

Blinking Talk Button

The talk button would blink, which users found distracting. It would often not blink at all, or blink very fast or slowly. We removed the blinking feature, reverting back to the static red/green colour scheme.

Talk Button

During our testing, we were made aware that at least one of our user evaluation participants suffered from red-green colour blindness, which affects up to 8% of men and 0.5% of women with Northern European ancestry (Wong, B. (2011, 06). Colour blindness. Nature Methods, 8(6), 411). We were also told that the word “Talk” was confusing – We were often asked what exactly it was referring to.

To clarify the confusion with the talk button, we modified the size of the button, and changed its text to “Listening” and “Not Listening” depending on the state of the robot. We retained the colour scheme for non-colour-blind users.

Slideshow

When reading back photograph descriptions to the user during a slideshow, the description would often get cut short, the next image would get shown and the description of that would be read instead.

The timer on the slideshow was made to be dynamic - reading the full description, and waiting a short time before displaying the next image. This enabled us to add more useful and interesting description and questions related to the images with a view to enhancing user engagement.

Additional Issues

In addition to the issues and fixes outlined above, there were a number of problems that we were not able to resolve due to the way they were implemented, the technologies used, or the little time we had available.

Multi-threading

A poorly executed application structure resulted in many problems within the MOBISERV application. Some of the symptoms of this were readily apparent after a few review sessions with the robot. Some examples of which are outlined below.

1. Flash games are not correctly destroyed. Games continue to play in the background, making noises and causing the application to suffer memory leakage.
2. Lync calls continue to run in the background if not properly exited. For example, if a suggestion were to come through during a call, there would be no way of returning to the call to end it.
3. Users are unable to return where they left off (resume) on any given screen if interrupted by another action. For example, if while playing a game you received a call, you could not return to the game in the same position. This is the case for all screens, when an action takes place the previous screen is destroyed.

Lync Integration

When a user's password expires, a number of steps have to be taken in order to get the MOBISERV application to run with the ability to make/receive Lync calls.

1. Close the MOBISERV application, and ensure Communicator.exe (Lync) is not running.
2. Change the Lync password online.
3. Edit the registry settings of the system to enable Lync to run with UI suppression mode switched off.
4. Launch Lync independently, and sign in.
5. Exit Lync.
6. Edit the registry settings of the system to enable UI suppression mode.
7. Re-launch the MOBISERV application

Getting Lync to work reliably is problematic and sometimes it does show the robot as being online even though it is running. In this case steps 1, 3 to 7 have to be repeated. This has a

very negative impact on user experience when it is sometimes needed to be done during a trail.

Localization, Mapping and Docking

The navigation application that acts as a core part of the MOBISERV framework has been problematic since it arrived. There are numerous issues with the application – Its inability to recover from errors is the biggest issue. The mapping technology selected isn't dynamic, meaning that if anything in a room changes, the robot will not be able to localize correctly, will not update its map to reflect the changes, and (depending on the location of objects and their new positions) fail to navigate to a point if it detects an obstacle.

The robot should dock in its charger, but has extreme difficulty doing so. The mechanisms in place for moving to specific places fail to account for minor changes in localization. The robot has to be aligned almost perfectly (Directly facing, and in front of the docking station) in order to dock correctly. A variation of a few degrees or a centimetre either side results in a failed dock, even if the docking station is clearly visible to the robots laser range finding device.

In situations where obstacles are presented, the robot should find an alternative route. In its current state, the robot does not seem to do this. Due to the shape of the base, if the robot ventures too close to an object and rotates, it will knock into the object.

Appendix 3 – Participant Information Form

<table>
<tr><td colspan="3">ROBOT WORKSHOPS</td></tr>
<tr><td>First Name</td><td>Surname</td><td>Date of Birth</td></tr>
<tr><td>Address</td><td>Tel numbers</td><td>email</td></tr>
<tr><td>Occupation/ Retired</td><td>Mobility e.g. Wheelchair user</td><td>Transport needs</td></tr>
<tr><td colspan="3">Preferred pastimes, hobbies, interests.</td></tr>
<tr><td colspan="2">Would you need to attend with a spouse/carer ?</td><td>Any additional information you would like to include ?</td></tr>
<tr><td colspan="3">Any medical condition or have you had any surgery that might affect your participation in the workshop ?

<table><tr><td>Hearing (hearing aid ?)</td><td></td></tr><tr><td>Sight (glasses ?)</td><td></td></tr><tr><td>Speech (e.g. Difficulty with pronunciation or volume ?)</td><td></td></tr><tr><td>Dexterity (e.g. Do you have some difficulty manipulating a TV remote control ?)</td><td></td></tr><tr><td>Memory</td><td></td></tr><tr><td>Other challenges to health ?</td><td></td></tr></table></td></tr>
</table>

Appendix 4 – Example Stage 1 Questionnaire

GB

An Integrated Intelligent Home Environment for the Provision of Health, Nutrition and Mobility Services to Older Adults

QUESTIONNAIRE

On a scale of 1(unsatisfactory) to 10 (very good) how would you rate:

Feature	Score	Comment
Appearance	7	Prefer the current face to a more humanoid one.
Voice	7	Clearly robotic but not alienating.
Communicating with Molly	5	There are some issues to be resolved. I found they pad easier than voice commands. Problem of knowing whether delay means Molly has not heard or is responding slowly.
Moving the robot	7	
Video phone calls	8	
Photos	8	Useful for reminisence work.
Exercises	8	Customisation needed; in current video the presenter talks too quickly.

Q1. Would you mind having a robot like this in your house supporting you, if needed?

- ❑ Yes
- ❑ No, please state why

I am ambivalent! Currently I value my independance and find it hard to visualise tolerating a robot in the house. However, if it was an option of being able to stay at home, supported by the robot or going into a care home, I'm sure I would try it.

1

An Integrated Intelligent Home Environment for the Provision of Health, Nutrition and Mobility Services to Older Adults

Q2. Do you think this robot is too big for your house?

☑ Yes. If yes, then please state what would be the ideal size and shape for such a robot

About half the size!

☐ No

Q3. How would you feel about the robot moving around in your home?

Concerned about safety issues - frail older people can lose balance easily if jogged/pushed.

Q4. Would you prefer the robot to have a different appearance?

☐ Yes ☑ No

Q5. If Yes, then which of these would you prefer for the appearance of the robot

☐ For the robot to look more human
☐ For the robot to look like a pet (dog, cat)
☐ For the robot to look like a piece of furniture
☐ Other - Please state

Q6. How would you like the robot to behave?

☑ As a social companion
☐ Non-interactive - like a machine (e.g. vacuum cleaner)
☐ Other - Please state

Please turn over ...

2

An Integrated Intelligent Home Environment for the Provision of Health, Nutrition and Mobility Services to Older Adults

Q7. What would you NOT like the robot to do and why?

This is a very individual matter - it needs to be customised

Q8. How would you prefer to communicate with the robot?

- ☑ Via the interactive touch screen
- ☑ Talking to it – if reliable
- ☐ Other - Please state

.....

Q9. How old are you?

- ☐ Below 50
- ☐ 50 - 59
- ☑ 60 - 69
- ☐ 70 - 79
- ☐ 80 - 90
- ☐ Above 90

Q10. What is your gender?

- ☐ Male
- ☑ Female

Q11. Where and with whom do you live?

- ☐ In my own house
- ☐ In a residential care home
- ☐ Other accommodation – Please state
- ☐ With a relative / friend
- ☑ On my own

.....

Q12. In the future, would you consider having the robot perform care-related tasks for you?

- ☐ Yes – Please state what tasks..... Reminders, but I wouldn't wish to be 'nagged' about things & 'showed' be doing
- ☐ No – Please state what tasks.....

Q13. Do you use any of the following on a regular basis?

- ☑ Email
- ☑ Internet shopping
- ☐ Skype
- ☑ Web browsers for news or searching for information
- ☑ Word processing
- ☑ Facebook or Twitter
- ☑ Computer games
- ☐ Keep fit videos

3

Thank you for taking the time to complete this questionnaire.

Appendix 5 – Example Stage 2 Task form completed by participants

SH

Scenario 1

- **Imagine that you are feeling nostalgic and want to see some of the photos stored on Molly.**
- Start by getting the robot to come to your armchair.
- You can put it into a comfortable viewing position by using the "TURN LEFT or TURN RIGHT" commands. You can also adjust the screen to a comfortable viewing angle for yourself.
- After you have viewed all the photos stored on Molly describe the one you found most interesting and tell us why

The picture of us on Holiday. Very clever, and a great surprise.

- What photos you would like to store on Molly if you were using Molly at home

As many of the older photos of holidays and grandchildren, and children. Mostly people, rather than just landscapes. Also well-known places that I've never visited.

Scenario 2

- Imagine that you would like a drink, some fruit and a plate of biscuits which are all in the kitchen. You can get Molly to carry the drink and fruit for you from the Kitchen to your armchair. You can carry the plate of biscuits yourself.
- So try and do the following:
- Send her to the kitchen, put the thermos flask in the holder on Molly and then send her back to your armchair. Don't forget to bring the plate of biscuits yourself.
- When you are settled back down in your armchair again, please tell us:

	Please circle your choice
How easy it was to interact with Molly for this scenario? 1 = Very Hard 5 = Very Easy	1 2 3 4 (5)
Did you feel that you were able to control Molly safely? 1 = Very Unsafe 5= Very Safe	1 2 3 4 (5)
In the future, if you needed to, would you want a robot like Molly to help you transport items around the house? 1 = No, never 5 = Yes, definitely	1 2 3 4 (5)

Scenario 3

- Imagine that you are feeling bored and would like to play a game.
- Select a game of your choice and play it for a few minutes.
- Select another game and play that for a few minutes as well.

- After you have played the games please tell us whether you can see yourself playing these or other games if you were using Molly at home

☑ Yes ☐ No ☐ Maybe

- What games would you like to see added on Molly, and would you play them on your own, with a visitor or both?

Patience
Cribbage
Rummy Kub

Both

Scenario 4

- Imagine that you have just woken up and are sitting up in bed. Molly is going is to come and give you two reminders for the day.
- Please go and sit at the edge of the bed and wait for Molly.
- After Molly has given you the reminders, please send her to the dining room.

- How did you feel about receiving the reminders from Molly?

Absolutely fine

- If you were using Molly at home, what reminders would you like her to give you?

Tablets
Appointments
Birthdays & special dates

- Would you allow a relative or a carer to set-up reminders for you on Molly? Would you feel it was bossy or helpful?

Yes. Very helpful.

Scenario 5

- Imagine that you have been sitting for a long while watching the television. Movement is important to keep your circulation going so Molly is programmed to encourage you to do a physical activity to keep you fit and well.

- Please go and sit on the marked CHAIR in the Dining Room and wait for Molly to come to you and suggest you choose an exercise. Choose an exercise you would like to do and copy the movements if you are happy to do so.
- If you were using Molly at home, how would you feel about receiving exercise reminders and suggestions from Molly?

Fine - Very helpful

- Do you think that you would exercise more often if you were given these video guides?

Yes -

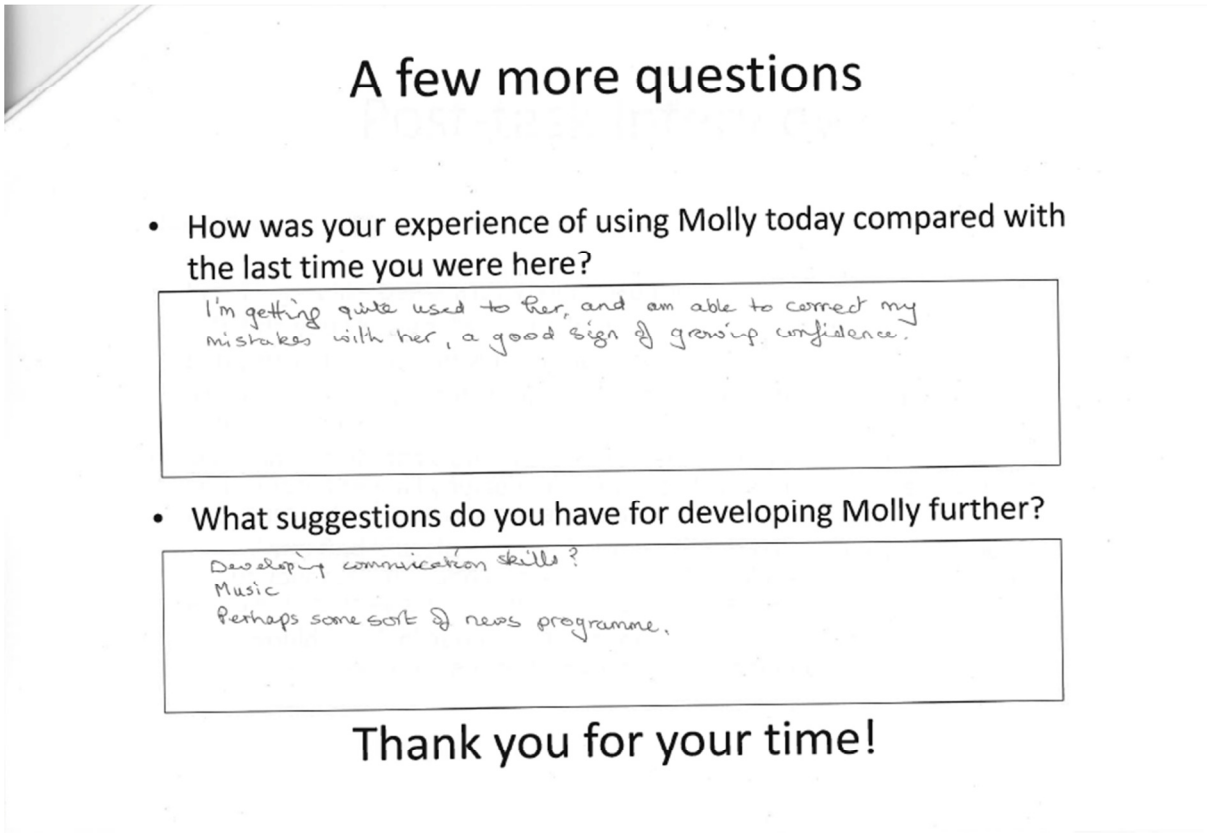
- Can you imagine Molly as a guide to other physical activities? What would these be?

Anything really.

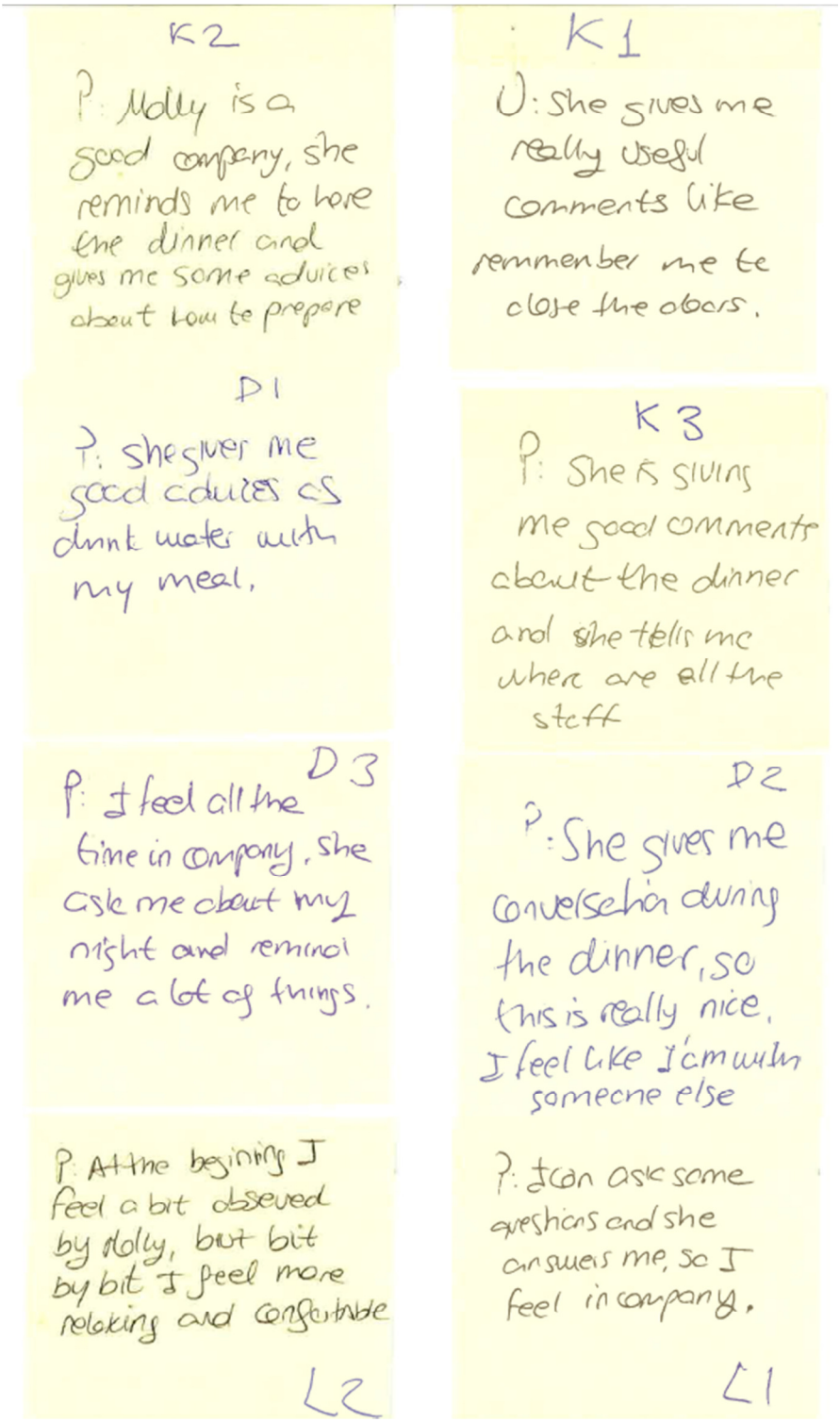
Scenario 6

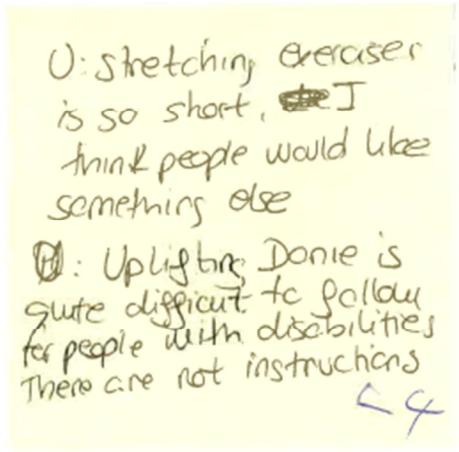
- Imagine that you are having lunch and your friend calls you via Molly's video link.
- Please go and sit at the dining table on the marked chair and wait for Molly to come to you when the call is received. As you are in the middle of lunch, please answer the call and tell your friend that you will call them back after you have finished lunch.
- After you have hung up, have a drink of water, wait a few minutes and then call them back.

	Please circle your choice
How easy it was to interact with Molly for this scenario? 1 = Very Hard 5 = Very Easy	1 2 3 4 (5)
Would you like to use the video link while talking to your friends and relatives?	Yes No (Maybe)
Do you use use a phone frequently at the moment? Landline/Mobile/~~Skype~~/~~Other~~ (_____) (Delete ones you don't use)	Yes ✓ No


A few more questions
• How was your experience of using Molly today compared with the last time you were here?
I'm getting quite used to her, and am able to correct my mistakes with her, a good sign of growing confidence.
• What suggestions do you have for developing Molly further?
Developing communication skills?
Music
Perhaps some sort of news programme.
Thank you for your time!

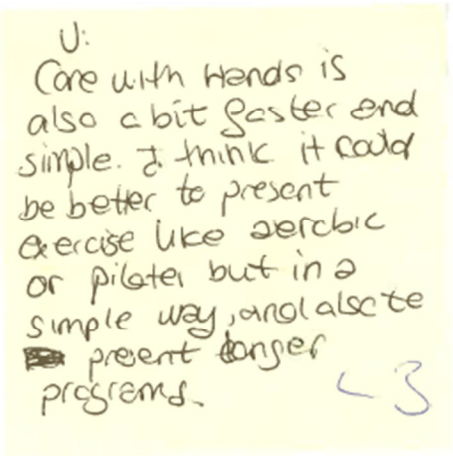
Appendix 6 – A sample of the post-it notes left by participants in the house



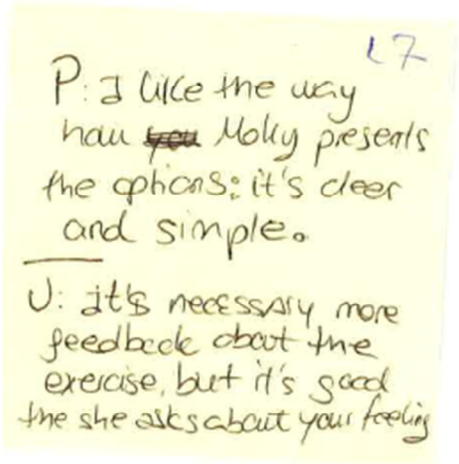

U: Stretching exercises is so short, I think people would like something else

P: Uplifting Donie is quite difficult to follow for people with disabilities There are not instructions

L4

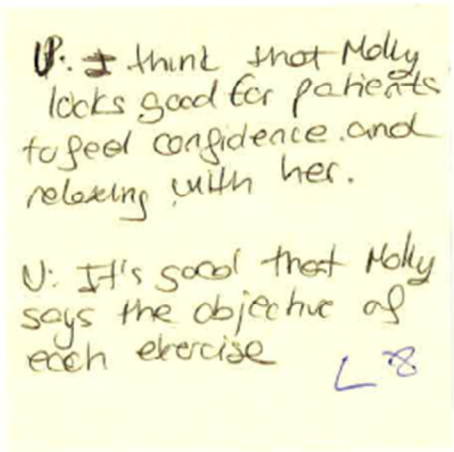

U:
Care with Hands is also a bit faster and simple. I think it could be better to present exercise like aerobic or pilates but in a simple way, and also to present longer programs.

L3


P: I like the way how Molly presents the options: it's clear and simple.

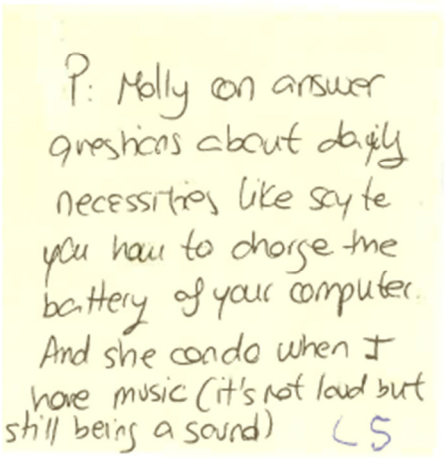
L7

U: It's necessary more feedback about the exercise, but it's good the she asks about your feeling

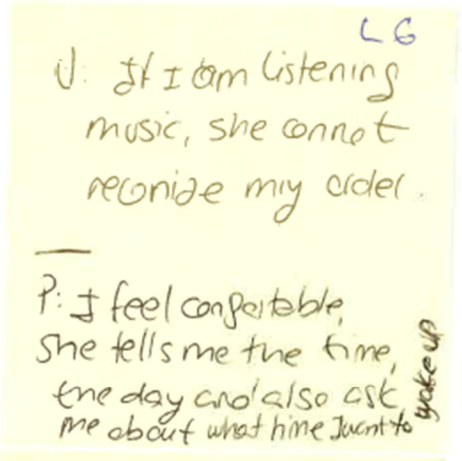

P: I think that Molly looks good for patients to feel confidence and relaxing with her.

U: It's good that Molly says the objective of each exercise

L8

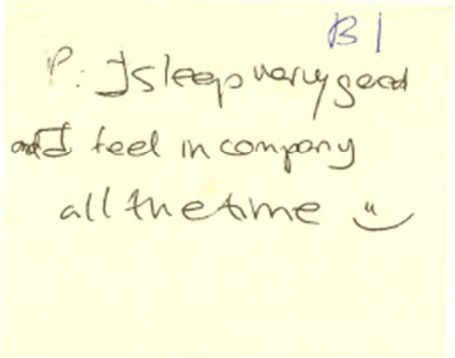

P: Molly can answer questions about daily necessities like say to you how to charge the battery of your computer. And she can do when I have music (it's not loud but still being a sound)

L5

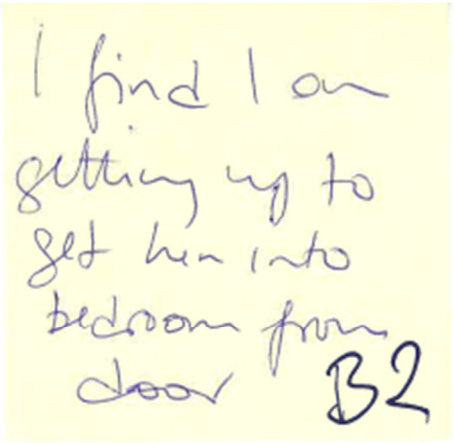

U: If I am listening music, she cannot reconize my order.

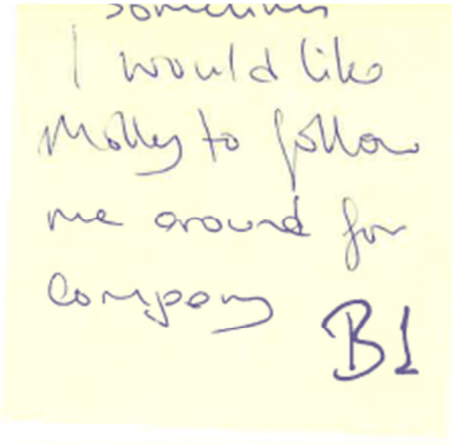
L6

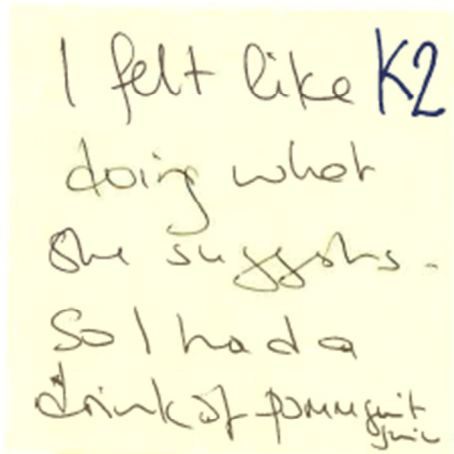
P: I feel confortable, She tells me the time, the day and also ask me about what time I want to wake up


P: I sleep very good and I feel in company all the time

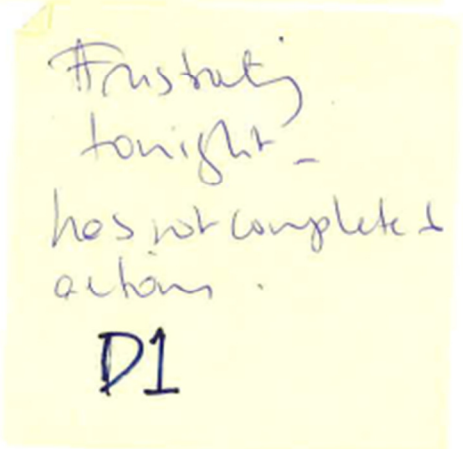
B1

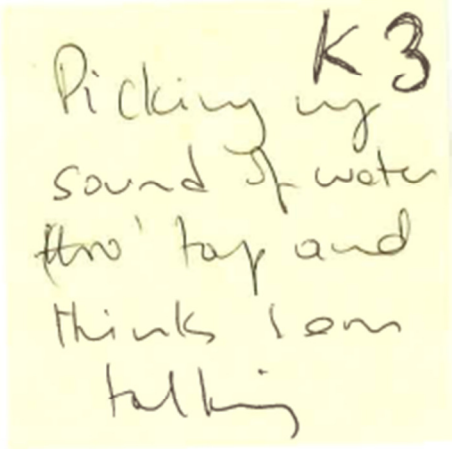

I find I am getting up to get him into bedroom from door
B2

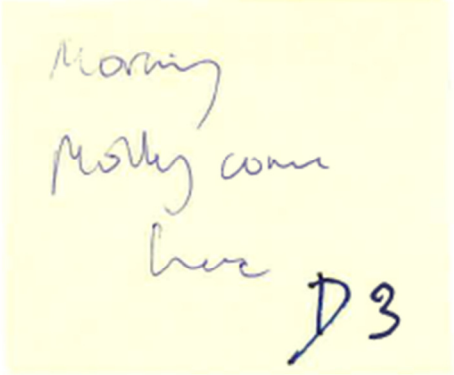

I would like Molly to follow me around for company
B1

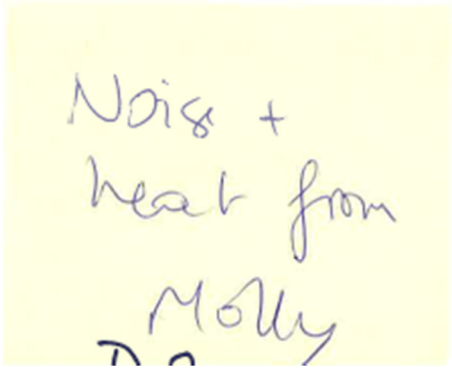

I felt like doing what she suggests. So I had a drink of pomegranit
K2


Doing me up the wall
crashed eh kitchen door
K1


Frustrating tonight - has not completed action.
D1


Picking up sound of water thro' tap and thinks I am talking
K3


Morning
Molly come here
D3


Noise + heat from Molly

Appendix 7 – Issues reported for Version released 7th August 2013

Despite some improvements, this version still has issues as can be seen in the video which makes it unusable in trials with users:
www.dropbox.com/s/wqcpwkczkud381j/Version_7thAug13.wmv
This final released version has a completely different set of icons to the previous versions that were used for final phase of trials, so will be completely new to existing participants.

Interruption from automatic reminders during other activities
There is no provision to configure the frequency or logical triggering of the suggestions. Also these suggestions should be triggered by some intelligence afforded by the incorporation of the user model parameters.

Microphone icon representation
Red/green colour blindness (http://en.wikipedia.org/wiki/Color_blindness) is an accessibility issue (experienced by one of the UK Stage 1 and 2 participants) – Therefore showing a microphone icon on a red or green background to indicate coordination of speech will be indecipherable to someone with Red/Green colour blindness. Our solution, which was to use the words "Listening" and Not Listening" together with colour which was found to be much easier to understand and remember by older people. We would like to revert to this.

Speech during photos and exercise videos is incorrectly linked to status of the microphone
The status of the microphone now affects the speech synthesis causing problems in communicating descriptions to the user. The trials found that having descriptions that were read by the robot was an important feature to evoke social communication and it is important to retain this.

Video control during Lync call is problematic, with the video getting started automatically.
Due to privacy issues, this was a fundamental requirement, the user should be able to choose whether or not to accept a call with video and select how to control it.

Description text does not display correctly on the screen
We do not need to show all the text to the user – just conversational information that is conveyed by the robot in regards to the images shown on the screen – it is an important aspect in conveying a sense of companionship with the person. The robot tells them interesting stories about the pictures – this is something that we have found as being an important aspect through our research with real older users. If it is important to have text

shown on the screen then a solution could be to have two fields defined in the setup – text_on_screen and description_spoken_by_robot.

The robot still does not inform the user of where it is going and that it has arrived – this is an issue because it sometimes gets stuck near the target location – the user might assume it has reached successfully and then do another action, which results in crashing the system

When the user sends the robot to another place where they can't see the screen and there is an issue with the navigation system, then it helps for the robot to have some response to communicate this situation – it needs to inform the user – this is the only way the system will work in a useful, pragmatic manner. The robot will not always stay in a "robot-friendly" environment and we have to be creative about the strategies to make a system that will never be completely error proof behave in a robust and safe way.