iStoppFalls

Deliverable 1.5

End-User Requirements Analysis

Editor:	Rainer Wieching, USI
Deliverable nature:	Report (R)
Dissemination level: (Confidentiality)	Public (PU)
Contractual delivery date:	M5
Actual delivery date:	M5
Suggested readers:	All project members, Public
Version:	3
Total number of pages:	55
Keywords:	End-User Demands, Usability, Accessibility, Elderly, Independent Living, ICT

Abstract

End-user needs assessments were performed by USI and IBV: participatory design sessions with end-users for discussion and idea generation by using market available input/output devices in order to develop user settings and scenarios for primary (exercising older adults at home) and secondary (care givers and relatives) end users. Implications based on empirical interviews and workshops were retrieved from 17 users from Germany and Spain so far. Selection of end users for the living labs and main evaluation trial was started, and is still on-going. Future results from living-lab assessments with real *iStoppFalls* technology will provide more detailed data and insights.

Disclaimer

[Full project title] **ISTOPPFALLS**– **I**CT-based **S**ystem **toP**redict & **P**revent **Falls**

[Short project title] ISTOPPFALLS

[Number and title of work-package] WP1 – Requirements Analysis

[Document title] End-User Requirements Analysis

[Editors] Rainer Wieching, Johanna Meurer, Martin Stein, Sima Schöning, all from USI;
          Helios de Rosario, Juanma Belda, both from IBV; Hannah Marston from DSHS

[Work-package leader] Rainer Wieching, USI

[Estimation of PM spent on the Deliverable] 3

Copyright notice

Executive summary

This deliverable provides a first requirement analysis focusing on general perceptions and ideas of end-users about interactive television (iTV) systems which facilitate fall-preventive exergames at home. In addition, the feed-back of the end-users on continuous tracking of their daily life activities by the senior mobility monitor (SMM) was assessed.

Older adults are often reluctant to use information and communication (ICT) systems in their homes, but fall preventive exercises need to be performed at least 3 times a week over a longer period of time to be effective. Thus, motivation and compliance plays a crucial role in this setting and ICT systems can provide very good support, if they are adjusted to the needs of the elderly end-users.

In order to assess the requirements of the end-users, we have conducted an empirical study with 17 community-dwelling older adults living in Germany and Spain. Structured interviews were implemented with 6 older adults in Siegen (Germany) and 6 from Valencia (Spain). Furthermore two workshops with 5 participants in total were carried out in Siegen, where the end-users were able to test already existing exergames, originally designed for younger users, and were also introduced to tablets and different iTV interface configurations.

Results from empirical interviews, which were conducted with 12 community-dwelling older adults from Germany and Spain, confirmed that there is a need and willingness for using such an exergame. Furthermore, the interviews helped to gain a better understanding of the social situation of these older adults, and their special demands when using an ICT-based fall prevention application.

During the workshops in Germany it became apparent that the older adults participating in the tests were considerably effective in using the (high-end) exergame, and that using a tablet together with gesture and voice control was highly appreciated by them.

Different implications for the planned *iStoppFalls* solutions (iTV, exergame and SMM) were derived from first user tests as described above. User interaction with these different system components should be based on gesture and voice control. Other input/output (I/O) sources (mini-keyboard, etc.) might be used if more intuitive control is not available in the respective home setting.

First end-user testing results on exergaming at home with a gesture and voice controlled iTV solution provide initial evidence that ICT-based fall preventive exercises, promoted for community-dwelling older adults, were well received and accepted by the end-users. Further research with first "real *iStoppFalls* technology" is needed to provide more detailed information and applied feed-back by the end-users. This will implemented in several update packs in WP 6 together with the missing end-user surveys from Finland and Australia.

List of authors

Company	Author
USI	Rainer Wieching
USI	Johanna Meurer
USI	Martin Stein
USI	Sima Schöning
IBV	Helios de Rosario
IBV	Juanma Belda
DSHS	Hannah Marston

Table of Contents

Abbreviations

AAL	Ambient Assisted Living
ADL	Activities of Daily Living
HCI	Human Computer Interaction
ICT	Information and Communication
I/O	Input/Output
iTV	Interactive Television
MS	Microsoft
SMM	Senior Mobility Monitor
TV	Television

1   Introduction

Naturally, older adults are different from younger people and children in their abilities and experiences as related to ICT and ambient assisted living (AAL) settings including iTV, exergames and continuous measurements of daily activities [1].

Physiological changes in sensory perception, motor and cognitive abilities that are generally attributed to a high age are well documented. The majority of the current senior generation does not have the same level of experience in computer technology as younger generations have, what can be ascribed to the still relatively young history of this technology [1]. These age related changes and differences influence older adults while using human computer interfaces (HCI) [2].

Visual difficulties
The loss of visual acuity is the most often cited reason for the deterioration of vision in old age. Older adults do not adjust as fast to darkness and are more prone to being blinded by light. They are not as sensitive towards contrasts, what can be traced back to their diminished sensitivity to colours [1]. The naturally increasing yellow coloration of the cornea that occurs in older age, disturbs the passage of blue light, which can lead to confusing the colours blue, green and purple [3]. The perception of colour and depth isn't that developed anymore and the field of vision is also reduced more and more with age [4].

Acoustic differences
Older adults have problems hearing high frequencies and localizing sound. It is also difficult for them to understand synthetic language, as it often sounds distorted [1].

Motoric difficulties
The motoric skills of seniors strongly depend on their individual abilities. In general one can say that with increasing age, response time and movements are slower and the ability to sustain constant movements decreases. Additionally, older adults have increasing problems with their coordination and balance; they are less flexible and display a higher variability in their movements. Dexterity and precision in movements also deteriorates in old age [1].

Cognitive problems
Apart from the physical conditions, cognitive abilities diminish with increasing age, just as the capacity of short-term memory, the ability to understand discourse, to solve and discuss problems, and the skills necessary to code and recall memory [1]. People with cognitive impairments need longer to acquire new skills; they also experience problems when having to understand complex processes that need to be performed [4].

Difficulties to understand technology
People over the age of 65 watch more television than other age groups, but they barely use the internet. This is mainly due to the fact that many of today's retirees and pensioners did not need or use a computer or the internet in their professional career. People born before 1960 are said to belong to the 'electro-mechanical generation', whereas those born after 1960 are part of the 'software generation'. Today's seniors did not grow up with computer technology and thus often do not have an accurate mental representation of it, they often cannot imagine how a computer works or what possibilities it offers [1]. They are thus confronted with new ways of thinking and problem solving, and they often find it difficult to quickly familiarize themselves with a new computer program due to their lack of experience [2].

Implications for *iStoppFalls*
During the requirements analysis of *iStoppFalls* it was necessary to focus on these issues in order to refine them more project specific and to consider their implications whilst designing the iTV and exergame applications. Therefore, this deliverable (end-user requirement analysis) will describe specific human computer interaction (HCI) solutions for older adults to facilitate fall-preventive and ICT-based exercising at home.

2   State of the Art & Objectives

2.1   State of the Art

Older adults have a multitude of preferences, interests, tastes, abilities and experiences that differ from those of younger adults and children as well. This makes them just as diverse as any other group. But not much empiric data exists on what a typology of an older user would look like in terms of interacting with ICT– what this means for user-friendliness and accessibility of ambient assisted living solutions motivating for exercises at home.

A couple of studies though have been done on these issues, whose results target the majority of older adults as a group. In the following they are split up into researches concerning usability and accessibility for older adults in general and those dealing with the use of digital TV and iTV linked videogames for older adults. The latter put a stronger focus on the *iStoppFalls* project. These studies should be kept in mind during the requirements analysis to use relevance as reference and to apply their results in a more project-specific manner.

General studies on usability and accessibility of ICT solutions for older adults

Docampo Ramafor example, showed in his study that regardless of the physical and cognitive effects of ageing, the user interface that was dominant during the defining stages of life has an effect for generations. He confronted people from different age groups with an interface consisting of several levels and found a considerable difference in the amount of mistakes made by the 'electromechanical generation' and the 'software generation'. He also showed that older users used a different strategy when dealing with new interfaces. They used a more reflective approach, while younger generations approached it with a 'trial-and-error-strategy' [5].

Jakob Nielsen revealed that older adults experienced usability problems twice as often and twice as severely as younger users. He also proved that seniors show a strong preference for websites that are easy to use. This demonstrates that older adults are more affected by an inappropriate design, but that an increasing usability can considerably increase their satisfaction/content [6].

Melenhorst though has demonstrated that not necessarily the effort to learn how to use a new interface is keeping older users away, but more the lack of perceived advantages. If a user-friendly interface only offers content that isn't of interest to a senior user, than he most likely won't engage himself with it [7].

Zajicek has shown in her experiments that interfaces with *voice help* are useful for older adults, if memory impairments hinder strategy building and experimental learning of the interface. The length of the spoken instructions is crucial though, voice instructions for older adults should be of the shortest possible duration, but still provide enough information for a successful interaction [2].

Besides the user-friendliness of software systems, their accessibility plays an important role. A survey conducted in 2006 by Yardley et al. showed that applications which could be used in the home environment, were the most attractive for older users – especially for those who were socially more isolated and thus had the biggest need for preventive measures to diminish the dangers of possible falls. The availability of an application in their own homes is important for them, because many do not want to participate in a group activity or cannot participate anymore due to their decreased mobility [8].

Specific usability studies on the usage of digital TV and iTV linked videogames by older adults

There are some works of research that are of notable importance for the *iStoppFalls* project. They focus on digital TV and iTV linked videogames usage of older people. Kurniawan for example, conducted a case study with female older adults to identify the deeper issues that made digital television unattractive for senior users. He revealed critical problems such as high costs, inadequate content, the complexity of operation or not available help, as reasons [9].

Rice and Alm examined a series of methods and interactive approaches that were developed to better assist older people when using current digital television. The results were unexpected, revealing problems in understanding the terminology and the interactive concepts that are used in typical digital television design. Promising for an easier utilization of digital television for senior users are experimental layouts and navigation-metaphors that are better equipped at directing the user [10].

Rodriguez et al. suggest the integration of iTV technologies, agent-based intelligent offers and innovative and 'active' interfaces to reduce the aversion of older adults towards information and communications technology in their home environment [11].

Obrist et al. presented the findings of a usability evaluation study in combination with eye-tracking conducted for an information oriented interactive TV application. The study focused on how older adults perceive and interpret a navigation oriented iTV application. Apart from the standard usability data the eye-tracking data was also used to gain more insight on why iTV usage seemed to be more difficult for the group of older adults [12].

In her research, Marston discovered that participants who played with a Wii console had a more positive experience than those who played with a PlayStation 2 console. The older participants found it easier to interact with the Wii as it allows a manipulation through natural movements, while playing with the PS2 means it is necessary to remember several sequences of buttons to push. Marston also discovered that content for older adults should relate to the real world [13].

Recent studies have identified the idea of implementing body movements (hand and facial gestures) into a game environment, what has proved to be a significant factor for player's engagement [14].

Exergame

An exergame facilitates video gaming as a way of delivering home-based exercises that offer a lot of positive aspects related to compliance/adherence of the exercise participants [1,15]:

1) Exergames may be used to engage older adults in exercises that are useful for reducing fall risk,
2) they can ensure higher compliance with exercise interventions than standard exercise interventions do,
3) because they can be done at home, there is the possibility that older adults may engage in higher doses of exercise than with standard gym class or community based exercise programs,
4) they provide a way of tracking exercise compliance over time, and
5) if compliance starts to fail, provide ways of encouraging continued participation.

Exergames can also be used to build up social connectivity of older adults by using different components for e-inclusion (e.g. multiplayer features) [16].

It's known that exergames (sensors used to transduce body movements into control of video game play) can promote adherence and exercise induced feeling-states [15]. Because such exergames can promote compliance with the exercise plans for fall prevention, *iStoppFalls* will develop a novel and innovative exergame solution which will use adapted HCI concepts for older adults and thus assure optimized compliance of our elderly users.

The *iStoppFalls* exergame as a software solution will be based on the Unity[1] platform, which is widely used in the gaming industry. This gives the project a higher flexibility for possible changes of technology throughout the project and the later dissemination. However at the current state, Kinect from Microsoft is the only available system that will give the feedback needed to create an appropriate software solution for our elderly users.

---

[1]http://unity3d.com/

Kinect is a "controller-free gaming and entertainment experience" created by Microsoft for the Xbox 360 video game platform and is already supported on the PC for development under Windows 7[2]. It enables users to control and interact with the Xbox 360 without the need to touch a game controller, through a user interface using gestures and spoken commands. According to the information supplied to retailers, Kinect is able to simultaneously track up to four people, including two active players for biomechanical motion analysis with a feature extraction of up to 20 joints per player.

Full-body tracking and the natural interface of Kinect which will be used in *iStoppFalls* plays a crucial role in providing new HCI concepts for older adults (user interfaces) and respective exercise data sets [13, 14].

Senior Mobility Monitor

The Senior Mobility Monitor as a component of the *iStoppFalls* system will unobtrusively and regularly monitor mobility in daily life. It will evaluate quantitative information on frequency, duration and type of mobility activities and qualitative information on balance function and muscle power. The device is an inertial sensor system which can be worn as a necklace without restrictions. This way, the SMM provides continuous fall risk monitoring and trend analysis of balance capabilities. It provides information on the effect of the training exercises for daily life of the user, and gives feedback to the training system to tailor exercises according to the needs of the user.

2.2   Objectives

Introducing new ICT technologies to the user group of older adults is in general a challenge. TV, as the most familiar and widely accepted appliance in home environments, gives us a good entry point to introduce new technologies. A successful iTV solution for older adults should at least fulfill the following requirements:

1. The **user interface** should be designed considering the specific needs/problems of older adults. The application should integrate several functions to lower the technical threshold. The interaction should be simple and requires only simple mechanisms to control it. The visualization should take the reduced eyesight of this user group into consideration (i.e. bigger fonts, zooming function). Aural feedback should consider the weakened hearing abilities of older adults.

2. Simple **input possibilities**. Unlike TV technology, which has evolved much in the past years, the remote control has not undergone any major changes since it first appeared. Standard remote controls nowadays are low in usability. There are often too many buttons on the remote control, which can confuse the users, resulting in only some buttons being used. Entering text using a standard remote control is arduous, which could be a big problem for future iTV applications.

3. The **cost of deployment** should be reasonable and cheap. The best practice should be: to reuse the devices (TV sets) that users already use in their homes if possible. If new devices are needed, they should better be designed as an incremental, but not as a substitute for the currently used ones.

In this deliverable we will take a deeper look into the context of iTV, exergaming and continuous measurements of daily activity of older adults living independently at home.

Detailed and attested user requirements will be gathered through a programmatic qualitative research process. On the technical side, gesture and voice control will be used for the iTV application, and in addition, exergaming and continuous monitoring of daily activities at home are implemented with older adults in this setting. These multifold demands have to be reflected in this end-user requirements analysis.

---

[2]http://www.microsoft.com/en-us/kinectforwindows/

Exergame & SMM:

1) Application of new ICT technology in community-dwelling older adults

2) Exergaming at home as an extended use-case of ICT in independent daily living of older adults

3) Appropriate visualization of short- and long-term results of continuous measurements of daily activities of older adults (SMM data representation to users)

HCI solutions of iStoppFalls:

1) Gesture and voice control (Exergame and iTV solutions)

2) Tablet as I/O interface (iTV solution)

3) Other I/O sources (iTV solution)

3   Methods

In order to be able to design solutions that will be usable and useful for the end-users and can also be integrated into the market and disseminated across several platforms, we need to clearly understand the specific situation of older adults. First, we need to understand their daily practices, how they live, what their actual interactions and communication modes are like and determine in which areas of their lives digital technology could be a meaningful contribution. Then, we need to focus on their needs in terms of information and communication, taking their abilities to interact with specific devices and technologies into account. The establishment of an integrated design approach that considers the needs of older adults and explores the social dimension of TV, would allow to determinate how smart television technology and ICT can become a resource for designing a fall prevention solution for older adults.

3.1   Interviews

Since the research goal of this requirement analysis is to elicit practices, attitudes and reflections of the elderly in relation to a fall prevention technology at home, it was decided to start with a qualitative empirical interview study in two countries, Spain and Germany. The interviews were conducted in a semi-standardized procedure, i.e. structured by an interview grid which has been developed according to the common and before mentioned core research themes (see appendix I). To understand the needs and expectations of the future end-users, all interviews in Spain and Germany focused on the following set of themes:

1) **General Information:** Questions were asked about the interviewee's age, marital status, education, etc. If and how often they receive assistance during the day. If they participate in community events or if they had regular family visits/meetings. Furthermore, we asked information about their home (rent or property, size in square meter, etc.), their regular activities during a day /week and if they perceive problems fulfilling these tasks on their own.

2) **Mobility and health:** Interviewees were asked about disabilities caused by health issues, their physical state, sportive activities, sport clubs, regular training (if any), their medication and possible implications caused by the medication. Additionally we asked them about their access to information on health related subjects and what kind of media (newspapers, magazines, Internet etc.) they prefer to get the information from.

3) **Fall related information:** This section entails questions about former fall experiences and their assumed causes. If they were scared of the possibility of falling and if there were any circumstances that increase their fear of falling (again). What kind of high risk falling spots were known in general and if they would be interested in preventive information and activities?

4) **Media Consumption**: We also asked the interviewees about their media consumption behavior and their technical affinity, e.g. we asked them for the frequency and setting of media usage, what kind of media they use, and what kind of problems they experienced during usage, in regards to their reduced audio-visual capability or missing technological experience. We questioned possibilities to ease their use of multimedia systems and enhanced remote controls for older adults, like tablets, smartphones, or other remote controls.

5) **Exergame and SMM**: The exergame and the Senior Mobility Monitor were on of our main research focus. We asked the interviewees if they already had some previous experiences with this technology and if they would engage in such games? We were also interested in scenarios that could be a motivation to perform exercises at home, as playing them together with their grandchildren, and if the design of the Senior Mobility Monitor (SMM) as a necklace is suitable for them to wear it all the day.

6) **Privacy and Security**: Other points of interest were privacy and security issues. Therefore we asked the interviewees if they would accept a continuously tracking of their movements (SMM necklace all

the day, but Kinect camera only during exercise sessions), if they have any concerns disclosing personal information into a health-related computer system and why not. Furthermore, we asked if there were any concerns about creating a profile of their activities and if they would be interested to receive personal feed-backs via the TV concerning their individual fall-risk, physical fitness, and possibilities to decrease the risk of falling. At least we wanted to know if the interviewees would like to share this information with others (family, physician, etc.)

7) **Miscellaneous**: In the end we asked miscellaneous (study related) questions such as: Would you be willing to use such a system? Do you have Internet access? What kind of TV do you own? Would you like to participate in this project? What motivates them to exercise? Motivation to be part of the long term study? Do they want to be supported to exercise to improve their health or are they satisfied with their current health state and do not see the need of an intervention?

In Spain and in Germany, we conducted 12 interviews - 6 interviews in each country. For the interviews the following selection criteria were used:

- Living in their own home
- Age between 60 and 80 years
- No cognitive disabilities
- Mixture of participants (frail, normal and active)

The contact to the German interviewees was established by a good relationship form University Siegen to a senior meeting place in the closer area of the University that is called "*Alter-Aktiv*". Elderly people can meet at this place, e.g. for taking computer courses. Therefore, most interviewed persons have some basic knowledge about new media and computer usage.

Each interview lasted between one to two hours and was audiotaped, and the audio material was transcribed thereafter. For the interviews we went to the homes of the participants. It was an opportunity to observe the environment in which the participants lived, and allowed us as well to locate them socially in their environment. We first explained the objective of the project and the topics we wanted to discuss with them. We then asked permission to record the interview in order to be able to be more attentive, and to create a trustful atmosphere. Before the end of the interview we made sure that no questions remained. We explained the next steps of the project and our expectations for next appointments. All participants were interested in participating in future studies of the project.

3.2   Workshops

Within the subsequent workshops, preliminary scenarios of *iStoppFalls* were presented to the participants. The main goal of these workshops was to refine and extend these preliminary scenarios based on the needs and interests of the participants.

The two workshops took place in Germany at the University of Siegen. In total we invited five possible users, who were divided into two groups with either two or three participants. Both groups participated in both workshops, which took place simultaneously. Workshop (A) was a session focusing on the user experience of playing exercise games using MS Kinect for 90 minutes and was followed by a group discussion of about 15 minutes. In workshop (B), "Participatory Design", we introduced tablet PCs to the participants. We showed them some functionalities and different applications. Afterwards we let the participants use the tablets without giving further instructions, and asked them to write some sentences in order to get feedback about the usability. Additionally, we presented the participants in this workshop (B) with interface mockups of a possible main menu of the iTV application, and tried out the 'card sorting' method (see figures 1-4). The menu points included:

- *Game* (start game here)
- *My Profile* (to view one's data)
- *Friends* (what are my friends doing?)
- *Learn* (pointers for healthy living)

Within the workshop the participants were shown four different paper prototypes to receive opinions regarding the possible look of the menu.

Figure 1: Paper prototype Nr.1   Figure 2: Paper prototype Nr.2
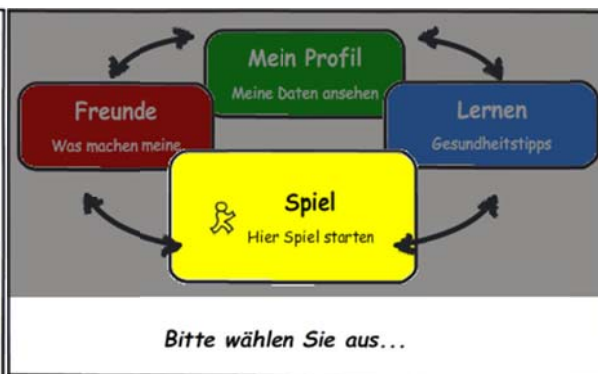
Figure 3: Paper prototype Nr.3   Figure 4: Paper prototype Nr.4

By applying these usability techniques we wanted to find out more about the mental constructs of older adults and thus how such a menu could be designed to fit their ideas. By presenting them our concepts of an interface we started a discussion, and especially during the card sorting the participants started to think about design implications and articulated their agreement with some concepts, criticized others, and made suggestions by their own.

4   Results

This section will discuss and present the results from the conducted interviews and workshops. In the presentation of the interview results we followed the segmentation of the interview guidelines. The analysis of the interviews is presented in more detail in appendix II and III.

4.1   Results from Empirical Analysis in Germany & Spain

We used the guideline as a framework for selecting main categories. All interviews were analysed with the help of Mayring's content analyses which allows data to be grouped in categories identified beforehand [17].

General information

We found out that none of the interviewees in Germany or in Spain required personal assistance or supervision for the performance of ADLs. They mainly do their household by their own, cook, bake, and socialize with friends. The interviews showed that the participants lived alone or together with a partner. There was no person from a younger generation living with them and they made very little or no use of a senior nursing services or domestic aid. In addition, most participants lived in large houses with several floors that offer many architectural obstacles and possible dangers of falling. Most interviewees also had a garden and especially in Siegen, where most houses are located on a sloping hill, which increase the risk of falling. The seniors feel very comfortable in their homes and would like to stay there until the end of their lives. Most of the participants reported that they visited a public facility, such as an internet cafe or a senior centre, at least once a week, to interact with other older adults. They also regularly participated in different group activities or went hiking with friends. Furthermore, they were all in close contact with their families.

Mobility and health

Most participants were in an overall good health condition. Some of them had some impairment such as arthritis, bypasses, problems with the hip, back or knee and most of them took medication. Beside these problems the interviewees were still quite mobile and feel fit. Most do not complain about their illness and have a quite positive attitude. However, some could not anymore perform activities they used to do in the past, like playing football or volleyball. Concerning the physical activities of the users, we observed huge differences: While some users were afraid of getting harmed by physical activities and see garden work or going for a walk as alternative sportive activities, others were much more active. Through the interviews, the favourite pastimes of the participants became apparent: hiking, gymnastics, bike riding, Yoga, Pilates, running on a treadmill, skiing, ballroom dancing and swimming. In general, slow exercises should be offered, this also became apparent based on the opinions of the participants of the Kinect games workshop. The majority of the users were most comfortable with doing activities that did not require quick or sudden movements, such as Tai Chi or playing darts, and described these as age-appropriate. Fast exercises such as stepping, were perceived as being too exhausting. Most users did not have a particular source from which they received information on health and healthy living. If such information was desired, they used the television, information supplied by their pharmacy or read health science magazines.

Fall related concerns

Concerning the topic of fall experiences, the interviewees had quite different experiences. While some of the users never had suffered any fall in their adulthood, others have suffered several falls during their life, even serious ones that harmed their joints. Although most interviewees only had fall experiences, which were caused by dangerous activities, they stated that fall prevention in general is an important topic for them. Furthermore, we observed quite different fall prevention practices. For example most of all interviewees avoided walking on rough pavement, most replaced their bath with a shower, or use a small ladder or climbing stairs to assist them. Others were not afraid of falling yet because of their overall good physical situation, but feared that this could change when becoming older. Most users are interested in fall prevention information. This makes it important for the application to call attention to the many dangerous situations in their everyday surroundings and to give them pointers on how they can better manage and handle their everyday life and to avoid falling in their home. Many seniors themselves expressed great interest in

information on how to avoid falls. One woman asked e.g. if there are special devices for help in the case of ice and snow, another was interested in how to quickly and safely get up again after a fall. Therefore, besides the physical training, educational information is regarded as a necessary part of fall prevention.

Consumption of media and digital devices

All users watched TV, read books or magazines and listened to the radio. None of them stated any problems regarding their media consumption. Some of the users even used the internet and a mobile phone. But most mobile phone users used their devices only for cases of emergency or to receive calls. Some had problems to use it in a proper way because of a lack of experience with this kind of devices. Regarding the internet the interviewees stated a very selective way of use. For example they used it for internet banking or looking things up as in an encyclopedia. Nearly all stated that their problems in using the internet were due to the multitude of features and that they had to learn how to use it step by step. Other interviewees saw no advantage in using the internet or any other type of new media and consequently did not know how to use the devices, arguing that an internet connection would be too expensive for them.

Assessment of digital games and the SMM device

Most interviewees were not familiar with computer games or with the Wii gaming console. Only very few had played Wii or Nintendo DS together with their grandchildren. The users who had some previous experience with playing videogames did not find them very entertaining. They thought that they are more suitable for children and that the games did not provide anything of interest for them.

When asked about suggestions for the game, the interviewees stated that the application should be diverse and should include gymnastics like exercises but also sports such as golf or darts and these should be offered in turns. One interview participant suggested that the game should be a combination of body and mind training. Another suggested ball games to enhance balance. Many of the elderly people could also imagine the application to incorporate virtual environments modelled after existing cities, parks and museums, where people could learn something about their surroundings, combining this with going for a walk that included exercises such as climbing stairs. Again others preferred to not do their exercises in an "enchanted forest", but to just be able to do their exercises. Thus, it should be possible to choose between these two possibilities. For some interview participants, it was also very interesting to do sports virtually that they had enjoyed when they were young, but weren't in the bodily constitution to still engage in them, or other sports, that they would have liked to do, but couldn't because of the circumstances during and after the war. As an example, skiing or surfing were often named. The interviews showed that almost all those questioned, liked to look at (family) photographs and to reminisce. Based on this, the integration of personal pictures could be something to consider. To take pictures during a game and then share them with other people was strictly rejected by a female workshop participant. The other participants were also not too thrilled with the idea. These sports would have to be offered in "mild", age appropriate version, and would definitely need to be executed in a slower manner. Furthermore, the interviewees agreed that controlling the game via gestures would be the easiest possibility. They liked the idea to play without an additional controller.

Regarding the assessment of the SMM, the users were positively minded to wear such a necklace. They would have no problems with the recording of their movement data or wearing it throughout the whole day. Few users thought that the necklace might be uncomfortable to wear and saw no use of it because they felt quite fit. But they agreed that it might be an interesting device for more fragile older adults.

Concerns of privacy and data security

None of the users refused to provide information about their health for the computer system. Furthermore, they did not see any problem if the information given at hand is used for medical purposes. All users accepted that their movements would be continuously monitored and would not mind to wear the necklace at home and possibly outside. In addition they like the idea of customizing their activities and movements and some would like to share this information with family members and health professionals.

Miscellaneous

This means that they prefer direct personal contact over connecting in the virtual world. This coincides with the statements of the workshop participants regarding the menu item *Friends*, which most participants thought was unnecessary. The majority of the users did not want an integration of social networks into the iTV/Exergame application. But, in another context they could imagine an integration of a social component

as a possibility. Many participants, both from the interviews and also from the workshops, said that they would like to be able to play with their grandchildren in order to share a common interest with them.

4.2   Results from Usability Workshops in Germany

The results from the Usability Workshops focus on the interviewee's reports and our observations. In particular we gained results concerning the design of the main menu and navigation, the acceptance of being notified to do exercises, the usage of technical terms, integration of social contacts, the acquaintance of handicaps, and the acceptance of the SMM. Furthermore, participants played a MS Kinect based exergame for the first time (Your Shape Fitness Evolved 2012), and gave us feed-back on the appropriateness of the included games, their problems with exercises and requested postures, as well as on gestures and voice control. See figure 5 as an example of participants playing the exergame.

Main Menu

During the workshop, the following suggestions were reported by the participants as related to the structure and contents of the main menu[3]: The majority of the participants were immediately sceptical towards the menu item *Friends*. "Why do I see my friends", one participant asked. "Except if they're also connected to the game", he added. A female participant complained, that she did not want other to see, if she did her exercises.

The expression *My Profile* did not mean anything to the participants at first. "What's my profile? I hope it shows that I did something correctly", said a participant. The participants agreed that they only wanted to see their personal performance data under that particular menu item. Other participants of the workshop viewed the conducted card-sorting method under this menu item, as the place where functions for social contacts were located, even though there is already an option for Friends. They assigned sub items such as *Activities of Others*, *Challenge*, *Social Network* or *Invite Friends* to the menu item *My Profile*.

To place *Learn* as a separate menu item, was regarded as unnecessary. They opted to incorporate health tips into a trailer at the beginning. They believed that the contents were not that informative to make it necessary to recall them over and over again, one participant said. Another added that it wasn't very useful to read health tips on the television screen: a resulting suggestion for design could be to transform the health tips into video clips, instead of text.

In general, the participants expressed a desire for a simpler and less ambiguous menu. "It's not that simple", a participant said. The participants agreed that they wanted a menu without lots of accessories and other extras, but one that was simple and easy to get to know and use. "You just want to play and see what you've accomplished. Why do you still need to have *Friends* and *Learn* in there", one participant clearly said. Another added: "The exercises are what's important". An interviewee stated that she only wanted to see the necessary information in the menu – without even having seen the paper prototype.

Menu and Navigation

The participants agreed that Prototype No. 1 was the best, one female participant described it as neat and simple. The prototype with the rotating menu (Prototype No. 2) was described by one participant as "nonsense" and "not necessary".

The third and fourth prototypes with the horizontal and vertical display in the form of tabs, was hardly considered. This is most likely due to their relatively meagre computer knowledge, based on their old age, thus they weren't as comfortable with the tabbed view. The smaller display of the menu items could also have discouraged them, just as the picture might have also created some confusion.

---

[3]   Please note that the names of menus are presented and discussed in English in this report, although the participants evaluated these items in German. It remains questionable to what extent German results can be extrapolated to other languages. It is highly likely that the issues about the meaning of menu names differ between languages, so the recommendations reported in this deliverable should be taken with caution. This will be clarified and explored further during the Living Lab phase in WP6.

Notifications when watching television

An interviewee said that she would not perceive reminders for exercise, that would just pop up when watching television, as annoying. She would however not interrupt the current television program to do the exercises. These reminders need to be very subtle and should disappear automatically after a short time. When a user opens the iTV/Exergame application, it should be possible to look at them again. If and how often such a notification should appear when watching television, still has to be decided.

Technical terms

There was only one female interview participant who said that she did not own a computer or have an internet connection at home. Since she has no experience at all with computer technology, technical terms such as virtual, controller or email did not mean anything to her.

Integration of social contacts

Most of the questioned older adults, said in interviews, that they visited a public facility, such as an internet cafe or a senior centre, at least once a week, to interact with other seniors. They also participated regularly in different group activities or met up with friends to go hiking. This means that they prefer direct personal contact over connecting with others in the virtual world. This coincides with the statements of the workshop participants regarding the menu item *Friends* that most participants thought was unnecessary. The majority of the users don't want an integration of social networks into the iTV/Exergame application.

The seniors are all in close contact with their families, and in this context they could imagine an integration of a social component as possible. Many participants, both from the interviews and also from the workshops, said, that they would like to be able to play with their grandchildren in order to share a common interest with them. In general, most participants could only imagine playing together with other people, if they are being in the same room and not to play together via a network.

Take handicaps into consideration

A female participant with hip problems stated that for her it would be important that exercises will be offered which she could also do seated. It might happen one day that she wasn't able to stand up anymore, or won't be physically able to do any exercise because of blockade or pains in her hip. Such, or similar handicaps concerning the lower limbs, affect many older people as became apparent in the interviews.

Give exact feedback on how to correct posture/position

The participants sometimes did not know what they were doing wrong with their posture. This means that, for example when playing golf, the avatar did not react, even if the user believed to be standing in the correct posture. If the posture is wrong when doing the gymnastics exercises, the avatar's body parts will be shown in red, but many participants did not know what they needed to do, to improve their posture. In one rhythm based exercise, the participants found it very difficult, to copy the exact rhythm of the avatar demonstrating the exercise. These examples show that it is essentially necessary to correct the wrong posture or position of the user, and to explain how exactly the exercise is done correctly, and what effects the wrong posture can have.

Figure 5: Exergaming seniors during the workshops

Demonstrating the correct body position

The participants from the workshops regarded it as very important, that the correct posture is first demonstrated, and then done by the user himself. For this, the participants would like to see a real person showing how the movements are done correctly in a short video clip. For this, the person should be wearing tightfitting clothing, so that the exercise is recognizable.

SMM

Most participants agreed to have SMM data recorded, if they themselves benefited from this, for example through an indicator that would show how leg strength had changed. Just as described earlier, the workshop participants regarded the display of their own performance data over time as important and interesting.

5   Implications

5.1   Scenarios: iTV, Exergame & SMM

In the following chapter, user driven implications for the *iStoppFalls* solution will be provided, based on the analysis of the interviews and workshops that were done.
The presented approaches do not concern results of a representative study of quantitative data, which intend to prescribe fixed guidelines, but is merely intended to provide awareness and implications for the design of *iStoppFalls* solutions arising from qualitative empirical research methods.

5.1.1   iTV

Based on the interviews and workshops, different suggestions and conditions from the viewpoint of the older adults can be extracted, that can be applied to the iTV application in general.

General Aspects

Main Menu

A suggestion for design would be, to not call one menu item *My Profile*, since this name caused confusion, but to use instead *My Performance*.
A design suggestion for the structure of the menu would be to show only the items *Game* and *My Performance* in the main menu. The item *Learn* should be integrated into the application, in the form of short informative movies that would be embedded deeper in the structure of the application.
Functions regarding the item *Friends* should be, if at all, incorporated into the system at different points. Where exactly these topics (*Learn* and *Friends*) should be embedded in the system, needs to be further elaborated.

Menus & Navigation

As described in chapter 2.1, Docampo Rama also demonstrated in his study that older people aren't very familiar with a layer structure [5]. Thus, the design suggestion here is that the menu should be displayed as in Prototype No.1. If taking the previous suggestion into consideration – to only show the menu items *Game* and *My Performance* in the main menu – the menu would be even more concise, which is generally an important factor of such a menu. The buttons would need to be large enough and displayed in a way suitable for older people.

Notifications when watching television

If and how often such a notification on the iTV/Exergame application should appear when watching television, still has to be decided. The user though, needs to have the possibility to completely turn off this function, if he does not want to use it.

Technical terms

Because many members of the current older generation are not familiar with technical software terms (see chapter 2.1, Rice and Alm [10]), it is important to avoid technical terms as much as possible within the entire application or to describe them accordingly.

Social networking & e-inclusion

Integration of social contacts

In general, most participants could only imagine playing together with other people, if all of them are in the same room and do not like to play with others via a network. One older participant however said that she like to keep in touch with other older adults while staying at home. Here, the integration of a social network

would be an advantage. A precise suggestion for the integration of social contacts is not possible at this stage. As mentioned above, this topic might still need to be further discussed.

Fall preventive educational contents

Environmental hazard warnings

The workshop participants, as described before, preferred information about fall prevention issues to be presented in the form of short video clips. At this point, in terms of research, it is necessary to think by which means this information should be presented, and if alternatives should also be made available. All interviewed older adults regularly read magazines or watched television shows to inform themselves on health related issues, so it can be expected that such an offer would be received very well as part of the iTV application.

5.1.2   Exergame

Take handicaps into consideration

A participant with hip problems stated that for her it would be important that exercises would be offered that she could do seated. Such, or similar handicaps concerning the legs, apply to many older people as became apparent in the interviews. For the design of the exergame this means that it is necessary to provide alternative possibilities of being able to do the exercises seated and standing.

Give exact feedback on how to correct posture/position

The results show that it is necessary to correct the wrong posture or movements of the users and to explain, how exactly the exercise is done correctly and what effects the wrong posture/movements can have. In order to fulfil the aim of the overall application, i.e. to prevent older people from falling, it is especially important that they train the correct posture and movements. A participant with hip problems added, that it was very important to get into the right posture, because even the slightest mal-positioning of the hip when doing exercises, for example, could cause great bodily harm.

Demonstrating the correct body position

The participants from the workshops regarded it as very important, that the correct posture is first demonstrated and then done by the user himself. For this, the participants would like to see a real person showing how the movements are done correctly, preferably in a short video clip. The person should wear tight-fitting clothing, so that the exercise is recognizable in detail. Just as described in the previous chapter, it is important that the users receive tips on how to correct their posture and movements as soon as they do anything wrong. Apart from that, the users should be able to watch the movie again at any time.

5.1.3   SMM

Most participants agreed to have SMM data recorded, if they themselves benefited from this through an indicator that would show how leg strength had changed, for example. Just as described earlier, the workshop participants regarded the display of their own performance data as important and interesting. This needs to be displayed in an intuitively accessible way in the iTV/Exergame application and cannot just be a list of numbers.

The participants pointed out that there must be meaningful and tangible expressions like "Your leg strength has already been improved by 20 percent" or "Yesterday, you have been active for a total of 4 hours". Additional visual representations in the form of graphical plots over time or bar diagrams would also support the clarity of data representation.

5.2   Usability & Accessibility

The following chapter concerns specific design guidelines for special I/O concepts in *iStoppFalls* which are mainly related to the usability and accessibility of such systems (iTV, exergame, SMM) for older adults.

5.2.1   Gesture & Voice Control

Introduction

Gesture and voice control will be the television input concepts of the future, next to tablets and smartphones. Gesture control itself, was first introduced by Nintendo with invention of the Wii. But a controller is here still necessary. With the Kinect in connection with the game console Xbox, Microsoft finally made it possible to control such applications exclusively with gestures and/or voice – completely without another input device. Movies can now be browsed by hand or can be paused by calling out "Xbox stop".
Operating via gesture and voice control has many advantages. It is easy and intuitive, fast and it's a lot of fun. However, this technology may be disturbed, and not function properly, if another person speaks, or walks through the scene [18].

Implications for iStoppFalls

Most participants were initially enthusiastic about being able to control the application through gestures and voice. After some participants had tried playing games with the Kinect, they reported it as mostly been funny and interesting. In the workshops and interviews however some restrictions came to light, that need to be considered when implementing the gesture and voice control for older people.
Encompassing body movement as one of the design guidelines would engage users/players into the gaming environment. This particular aspect of gaming/interactive entertainment as described by Bianchi-Berthouze, Kim, Patel [14] (see chapter 2.1) would potentially enhance the gaming experience and engagement of older adults by conducting game play mechanics through natural body movements.
Also Rodriguez et al. [11] suggest the integration of 'active' interfaces in order to reduce older adult's reluctance against ICT in the home environment, and Zajicek [2] showed that interfaces with voice help are useful for older people, because they suffer more from memory impairments.

Gesture control

Do not demand for unnecessary and/or dangerous movements
The interviews showed that most of the interviewees had age related problems with their hips, back, knees and joints. This needs to be kept in mind when designing the gesture control, and thus fast and expressive movements should not be demanded.
This became obvious in the workshop, when one participant complained of being overwhelmed with the fast movements that were asked of her. The feedback from other participants confirmed this. As said before, most participants described Tai Chi or darts as being suitable for their age, while the quicker exercises, such as tennis, were perceived as having been too fast.

Appropriate size of buttons and timing of feed-back
Many participants had difficulties keeping their hands firmly on the sometimes rather small buttons. They slid off before the action could be performed, so that they again had to move their hand onto the button. This confirms that people lose much of their motoric precision with old age. Therefore, the buttons of the gesture control of the iTV/Exergame application need to be large enough, so that the seniors do not have difficulties keeping their hand there for a certain period of time.

No unnecessary functions and visual stimulation

In the second part of the workshop, where the users tried out different games with the Kinect, it again became apparent that they did not want fancy accessories or unnecessary extra functions. This was very obvious in the comments made by a user, such as "But I don't want to celebrate", if he was asked to celebrate, or "I don't want fans", if virtual people were cheering him on. Another workshop participant showed to be annoyed by the background movements of a Kinect application: "Those things flying around are irritating".

Give precise and simple instructions

All questioned seniors did not have any prior experience with gesture or voice control. Even if they claimed not to have any problems, it is important that their inexperience is taken into consideration, to be able to give them an understandable and concise instruction manual.

The workshop part, where participants could try out games with the Kinect, again confirmed that it is necessary to always give the older users hints and instructions on what to do or to explain what is happening. In many situations during the workshop, it was noticiable that the participants were insecure or not sure of how they were supposed to react or if they were supposed to change something. This leads to the important conclusion that in a senior appropriate application there is a general need for notifications and to give as much feedback as possible. One participant remarked on this subject: "Later, if you're going to have this at home, you really have to try hard and there won't be anyone telling you what to do". This emphasizes critical problems of older adults using digital TV services as revealed by Kurniawan, such as the complexity of conduct or not available aid [9].

Clear labelling of loading processes

All user often had the problem that they couldn't clearly identify what was happening on the screen – if it was a part of the demo, where only instructions are given or if the last turn in a game was being repeated, or if the game was just loading or if their own gesture or voice directions were required. This became clear, for example, when the users unsuccessfully tried to use gesture or voice input during one of the demo film clips. This means it is necessary to make sure that in the design of the application, it is possible to clearly distinguish between what is happening on screen and to know when an input is expected from the user. These notifications though, need to be understandable for older people. One workshop participant asked during the loading process, which was only marked as 'loading process': "Loading process. Do I need to do something here"? Here it might be necessary to add that the user needs to simply wait, e.g. by displaying a clock.

Voice Control

Concise feedback for voice control

There were some problems in the workshop with the voice control, possibly based on such critical problems of not available aid as described by Kurniawan [9]. When some users tested it, the system did not react, even if the user had said the right thing. This also happened if the user did not say exactly or entirely what was displayed on the screen, for example if he only said the beginning of the name of an application. In such cases, the seniors futilely waited for the system to react, not knowing why nothing was happening. Therefore it is important in regards to the design, that the user receives exact feedback when using voice control, so that he knows why the voice control is not reacting and what he needs to do to make it work. Acoustic feedbacks would be useful, as seniors are used to verbal communication. Feedback could be: "You have chosen...", "I do not understand. Please try again", or "Please repeat the complete sentence"! In addition to that, users should be told when they can make a voice input and what they should say or what input alternatives there are. Even an initial hint how the voice control should be executed, such as: "Please speak loud and clear", would be useful for the partly uncertain seniors. One participant noticed after a successful voice input during the workshop: "You need to try and speak like a robot".

Voice-to-text messenger function

An older user said in an interview, that he had problems with typing quickly and therefore does not like chatting. Since many older people went through their working life without a computer (as described in chapter 1) this typing difficulty will apply to the majority of users. So, if any kind of chat will be incorporated into the application, a voice-to-text-messenger should be taken into consideration.

5.2.2 Tablet as I/O interface

Introduction

The tablet PC as an intelligent remote control will be another important television control interface of the future. With the possibility to surf the web by using the television set, an input device like the tablet PC, will become indispensable. If people were required to enter a web address via a usual remote control, they would soon lose interest due to the arduous nature of this task.

Using the internet on an iTV device is more interactive than just watching television. This is why input options and functions such as browsing, text input, start, pause, and search options are necessary, which can be made available much easier on a tablet PC than with a normal remote control.

By using the touchscreen of a tablet PC, it is possible to control objects on the television screen and comfortably browse through online content. Another advantage is that it is possible to watch these contents on the tablet while moving around freely in the home. A tablet PC can also be used as a conventional remote control, with the advantage that buttons could be displayed very largely, which would make its usage comfortable especially for older people [18].

Implications for iStoppFalls

Problem solving approaches for the navigation with a tablet

All in all, the seniors were very curious about the technology of the tablet PC, for example, they found the automatic vertical and horizontal alignment interesting, and the large buttons were seen positively.

Font size

Many older users find it difficult to read a small font size. This was confirmed by an older user in an interview, who regularly gives computer classes to other seniors. The question, if it was possible to change the font size, immediately came up in the workshop, when the users were introduced to the tablet PC. This means that it is important, that the font is displayed large enough, or that there is the possibility to adjust the font size according to personal needs.

Simple navigation/control

One workshop participant complained that it was necessary to have a solid knowledge of using a computer, before you could use such a tablet PC. It is important to make sure that the navigation of the tablet is self-explanatory for older users, so that they lose their fear of computers and aren't intimidated by a complicated technology and navigation. In this context it is necessary that unnecessary functions be avoided, and clear and concise menus are offered including sufficient pointers and feedback. This confirms once again that the critical problems of the complexity of conduct and not available aid should be taken into account, as described by Kurniawan [9].

Avoid distractions

The older adults all agreed that offering only the necessary information and functions was a very important aspect. One workshop participant complained that an overload of information would confuse people, distract and overwhelm them – especially because the ability to concentrate decreases with age. It would be necessary to have a slimmed down version of the tablet PC, that really only offers the project applications.

One-to-one rendering of the television screen
With regards to the control menu of the iTV interface, the workshop participants could imagine a one-to-one rendition of the menu from the TV screen on the tablet PC. This makes it necessary to keep in mind, that the display should be created in a way that would make it possible to be easily placed on a television screen and the tablet PC, so that the buttons and menu items would still be large enough on both devices.

5.2.3   Other I/O solutions

Introduction
Ever since its invention 60 years ago, the remote control has been the standard input device for television. This is extraordinary, because it is not very user-friendly.
One issue is that it has too many buttons – some remote controls have up to 60, even if only some buttons are needed to change the program and control the volume. Some buttons are even assigned to multiple functions, and the often not identifiable symbols on the buttons cause additional confusion.
Many buttons are very small, so that it is only possible to push them with one's fingertips. This is difficult, especially for older adults, who often have an impaired vision and problems with their motoric precision. The missing light is another reason why, especially in the dim television glow, it is difficult to actually make out different buttons.
Another disadvantage is that the remote control gives the signal to the television set via infrared rays. These are often vectored too strongly or the receiver in the TV is too weak. This means that it is necessary to aim very precisely, something that older people often find difficult. The signals can be easily disturbed by furniture standing in the way of the signal or by other people interrupting it by walking by [18, 19].

Implications for iStoppFalls

Navigation with a special keyboard and/or TV standard controller
Participants in the workshops were not explicitly asked what their opinions or suggestions were for the navigation via a standard input device like a keyboard or a normal remote control, but it became apparent that the participants did prefer a remote specially made for the application.

Clear labelling of the fields of the iTV navigation interface
Workshop participants agreed that the number or the symbol of the button on the input device that needs to be activated should also be shown on the screen.

6   Conclusions

Overall, there is sufficient data that an iTV/exergaming solution for older adults living at home (including SMM) seems to be a suitable approach for promoting an active lifestyle and thus independent living.

The participants of our empirical studies accepted the proposed solutions with their I/O channels and contents (in part). This is consistent with a study from Australia, which showed that older adults do play fitness games at home [20].

One limitation of our approach is that there were not enough really frail participants included in the requirements analysis, whom will be studied in more detail during the living lab phase of the project. Furthermore, it is apparent that within such an early requirement analysis, without prototyped technology in use (*iStoppFalls* system components), there is a lack of tailored suggestions for the final design. This applies as well for country specific differences which were not apparent between Germany and Spain, but might exist as compared to other countries like Finland and Australia.

These limitations will be tackled by updated data (e.g. by surveys from Finland and Australia, and by real *iStoppFalls* technology in use) which will be included into the next update packs within WP6. Furthermore, this updated version will include secondary end-user aspects (health professionals, insurances and other stakeholders).

These update packs, which will be prepared inWP6, will be based on more information from different countries (Finland and Australia), and on real *iStoppFalls* technology developed by respective consortium partners.

References

[1]
IJsselsteijn, W., Kort, Y. de, Nap, H.H., Poels, K.: *Digital Game Design for Elderly Users*, in FuturePlay 2007, November 15-17, ACM, Inc., New York, 2007.

[2]
Zajicek, M.: *Special Interface Requirements for Older Adults*, Oxford Brookes University, Oxford, 2006.

[3]
European Telecommunications Standards Institute: *Human Factors (HF); Guidelines for ICT products and services; "Design for All"*, ETSI EG 202 116 V1.2.1, ETSI, Sophia AntipolisCedex, 09/2002.

[4]
ISO/IEC: DRAFT ISO/IEC GUIDE 71 - Guidelines for standardization to address the needs of older persons and people with disabilities, ISO/IEC, Genf, 2000.

[5]
Docampo Rama, M.: *Technology Generations Handling Complex User Interfaces*, PhD Dissertation, Eindhoven University of Technology, 2001.

[6]
Nielsen, J.: *Usability for senior citizens*, http://www.useit.com/alertbox/seniors.html, Alertbox, 28.04.2002, Accessed: 17.01.2012.

[7]
Melenhorst, A.-S.: *Adopting communication technology in later life. The decisive role of benefits*. PhD Dissertation, Eindhoven University of Technology, 2002.

[8]
Yardley, L., et al.: *How likely are older people to take up different falls prevention activities?*, in Preventive Medicine, 47(5), p. 554-558, Elsevier B.V., Amsterdam, 2008.

[9]
Kurniawan, S.: *Older women and digital TV*, ACM Press, New York, 2007.

[10]
Rice, M., Alm, N.: *Designing new interfaces for digital interactive television usable by older adults*, in Computers in Entertainment (CIE) - Social television and user interaction, Volume 6 Issue 1, ACM, New York, 2008.

[11]
Rodriguez, T., Fischer, K., Kingston, J.: *Intelligent Services for the Elderly Over the TV*, in Journal of Intelligent Information Systems, Volume 25 Issue 2, p. 159-180, Kluwer Academic Publishers, Hingham (MA), 2005.

[12]
Obrist, M., Bernhaupt, R., Beck, E., and Tscheligi, M.: *Focusing on elderly: an iTV usability evaluation study with eye-tracking*, in Proceedings of the 5th European conference on Interactive TV: a shared experience, p. 66-75, Springer-Verlag Berlin, Heidelberg, 2007.

[13]
Marston, H. R.: *Wii Like to Play Too: Computer Gaming Habits of Older Adults.*PhD Dissertation, Teesside University, Middlesbrough, 2009.

[14]
Bianchi-Berthouze, N., Kim. W. W., Patel. D.: *Does body movement engage you more in digital game play? And Why?* in Affective computing and intelligent interaction, p. 102-113, Springer-Verlag Berlin, Heidelberg, 2007.

[15]
Bronikowska, M., Bronikowski, M., Schott, N.: "*You Think You Are Too Old to Play" Playing Games and Aging*, in *Human Movement* 2011, vol. 12(1), p. 24-30, 2011.

[16]
Mueller, F., et al.: *Sports over a distance*. DOI 10.1007/s00779-006-0133-0. Springer Verlag London 2007.

[17]
Mayring, P. [2007]: Qualitative Inhaltsanalyse. Grundlagen und Techniken (9. Auflage, erste Auflage 1983). Weinheim: Deutscher Studien Verlag, 2007.

[18]
Spiegel Online, *Ende der Fernbedienung – Wie Sie übermorgen fernsehen werden*, http://www.spiegel.de/netzwelt/gadgets/0,1518,808503,00.html, 11.01.2012, Accessed: 18.01.2012.

[19]
Spiegel Online, *Technikärgernis Fernbedienung – Viele kleine Tasten, wenig Bedienung*, http://www.spiegel.de/netzwelt/tech/0,1518,595526,00.html, 10.12.2008, Accessed: 18.01.2012.

[20]
Brand J. et al.: *Interactive Australia 2009.National survey of 1614 households*.The Centre for New Media Research, Bond University, Gold Coast, Australia, 2009.

Appendix

Appendix I: Interview Script

Part I: Preparations, target group, sample size

- Interview Sample iStoppFalls:
    1) Germany (12 Participants)
    2) Spain (6 Participants)
    3) Finland (6 Participants)
    4) Australia (6 Participants)

- Target Group iStoppFallsInterview (priority as follows):
    1) All participants should live (more or less) independently in their own home
    2) If possible, every country should provide 2 participants from the following groups:
        - Frail (but without cognitive impairments)
        - Normal (inactive) older adults
        - More active older adults
    3) If possible, each of the 3 groups should consist of 1 male & 1 female participant
    4) Diseases: no diseased persons, as defined in the inclusion/exclusion criteria of our main evaluation trial (see DoW)
    5) Age: between 60-80 years (other inclusion criteria, see DoW)

- Preparation:
    1) Audio recorder, notes, LabTop with media (images, movies) on Xbox/Kinect & SMM
    2) Explain the further usage of the acquired material and create a relaxed atmosphere
        - Provide information about yourself and your research
        - Provide information about the process of the interview (duration, etc.)
        - Usage of the data (anonymization, non-commercial)
        - Ask for permission of audio recording
    3) Usage of the interview guideline
        - Follow the guideline, but do not stick to it if interviewee mentions other interesting aspects
        - Add important aspects to the guidelines for further interviews. Upload the updated document to the BSCW
    4) Create Post-Interview notes!
        - Usually a lot of important aspects will be mentioned when audio recording is turned off. Please take notes!
        - Prepare a description of the whole interview setting. Describe who was additionally participating (e.g. wife / husband). What impressions did you get from the interview?

Part II: Interview Schedule

- Interview Guideline iStoppFalls
  In the following one can find a set of questions as guidance for the interview. "Sub-Questions" serve as an indicator to hint at interesting aspects when the interviewee does not address relevant issues. Nevertheless these questions are not mandatory and may not be asked directly.

  1) **General Information**
     - Please introduce yourself!
       - Age, marital status, education, etc.
     - Do you receive assistance during the day?
       - Do relatives provide you with help? (Shopping, etc.)
       - What kind and frequency of assistance do you receive?
       - Do you receive any professional support? (Medical, caregivers, etc.)
     - Do you participate in community events resp. do you have regular family visits / meetings?
       - What kind of events do you take part in?
     - Can you describe your flat / house?
       - Rent or property, size in square meter, etc.
     - Please describe a usual day / week?
       - What regular activities are you engaged in?
       - Do you perceive problems fulfilling these tasks on your own?
       - Do you anticipate problems in the future which needs for assistance?

  2) **Mobility / Health**
     - Behavior / Adaptations caused by health issues
       - Are there activities you used to engage in, but must be stopped because of decreasing capabilities (vision, hearing, mobility issues)
     - How would you describe your physical state?
       - Handicaps, sportive activities (if any)
     - Do you have to take medication?
       - Implications of the medication? (Inability to drive, sleepy, vertigo, etc.)
       - How long have you been taken medications?
     - Do you or did you engage in any physical activities (during your life)?
       - Sport clubs, regular training, etc.
     - If you think about the activities you engage in, where do these activities take place? And how do you get there?
       - Compared to the past?
     - Which kind of sources do you use to provide yourself with information about health related information?
       - Persons (physician, family/relatives, friends), type of media (newspapers, magazines, Internet etc.), preferred access to media information, etc.

3) Fall related aspects

- Did you ever fall?
  - Because of what did you fall? Please specify:
    physical fitness (strength, balance, etc.), the normal ageing process (vision, reaction time, peripheral sensation, etc.), diseases/medication (hypotension, tremor, vertigo, dizziness, mental disorders, etc.), or other reasons (environment, etc.)?
  - How often did you fall?
  - Have you been injured?
- Do you fear falling (again)?
  - Do you fear falling because of the reasons as stated above, or other reasons (environment, etc.)?
- Are there certain circumstances that increase your fear of falling (again)?
  - Dangers of falling inside the house compared to dangers outside?
  - High risk falling spots in general? Rooms, areas, different day times?
- Would you been interested in preventive information and activities as related to falls?
  - Would simple information provided via the TV be enough for you?
  - Or would you be motivated in regular fall preventive physical activities (exercises)?

4) Media usage / technical affinity

- Frequency and setting of media use:
  - How often do you use the media?
  - Where do you use the media?
  - Any other people with you while using the media?
- Which kind of media do you use?
  - Do you try to use new devices / services? (Smartphones, Tablets, Social networks, etc.)
- Which kind of media do you use to get different kind of information?
  - E.g. news -> TV; recipe -> magazine; health information -> internet; etc.
- What kind of problems do you experience during use?
  - Sensory incapability (vision / hearing / cognitive impairment)
  - Missing technological experience / knowledge (terms, new connectors, etc.)
- What do you think could ease your use of such multimedia systems?
  - Enhanced remote controls for elderly, like tablet, iPad?
  - Gesture and voice control?

5) Exergame / Senior Mobility Monitor

- Have you heard about Kinect or Wii exercise games?
    - (Provide information about Kinect and Wii sport games, like photos, videos and game examples)
- Do you think elderly could engage in such games?
    - Yes, why and in which of these games in particular?
    - No, what should be changed to address elderly?
- Do you have any suggestion how to enhance such an exercise system (exergame) to make it easy to use for elderly users?
    - User Interface, scenarios, training contents, etc.
- Which scenarios could be motivating for you to perform exercises at home?
    - Would you use it by your own, or would you appreciate to play together with your family, relatives and/or friends.
    - What could be the best setting in your daily living behaviors to work with such a system (living room, TV, etc.)?
- Would you appreciate to use such an eHealth system (with virtual consultants/trainers) in addition to your regular activities with health carers (physiotherapists, etc.)?
- Have you heard about fall-related emergency systems like the Senior Mobility Monitor (SMM)?
    - (Provide information about the SMM, like photos, etc.)
- Is the design of the Senior Mobility Monitor (SMM) as necklace suitable for you to wear it all the day when you stay at home?
    - Handling, etc. What are advantages, what could be problems in your daily living attitudes?

6) Privacy/Security

- Do you have any concerns to disclose personal information into a health-related computer system?
    - What information do you want to keep to yourself?
    - What are you afraid of that could happen with the data?
- Do you have any concerns to provide information for the purpose of medical analysis?
    - What type of information do you want to keep to yourself?
- Would you accept a continuously tracking of your movements (SMM necklace all the day, but Kinect camera only during exercise sessions)?
    - Why not?
    - Even if it would automatically call emergency if needed?
- How do think about creating a profile of your activities?
    - Help vs. control/observation
- Would you be interested to receive personal feed-backs via the TV concerning your individual fall-risk, physical fitness, and possibilities to decrease your risk of falling, and to improve your overall health?
    - Would you like to share this with others (family, physician, etc.)

7) **Miscellaneous (study related)**
- Would you be willing to use such a system?
  - Rather alone to exercise? Or as joint activity with family / friends?
- Do you have Internet access?
- What kind of TV do you own?
- Would you like to participate in the project?
  - Motivation to exercise? (3 times a week)
  - Motivation to be part of the long term study? (6 months duration, continuously)
  - Motivation to participate in the Living Lab (1 year, regular feedback and visits)
- Ethical question of research goals
  - Do you want to be supported to exercise to improve your health or are you satisfied with your current health state and do not see the need of an intervention?

Appendix II: Empirical data from Spain

GENERAL INFORMATION

This section presents the information provided by the users interviewed about their personal and family data, dwelling, current health status and activities performed in their daily life.

Table 2 shows the general information of the "active elderly". Both users are people with a high level of activity that practice exercise every day and participate in cultural and social activities. These two users denoted his desire to remain active and engage in activities that keep them active both physically and mentally.

GENERAL INFORMATION (SPAIN)	
ACTIVE elderly	**Health condition** ✓ None of them required personal assistance or supervision for their activities of daily living (ADLs). **Social situation** ✓ User 1 goes to a social center for retired persons, a few times per week. There he socializes with friends and peers. Additionally, he travels on an occasional basis with IMSERSO (Spanish institution for elderly people), especially to the Canary and Balearic Islands. He brings and picks up his grandchildren from school every day. ✓ User 2 goes to a social center for seniors several times per week, where she performs activities related to theatre and play games. Additionally, she goes for a walk with friends every day. **Dwelling** ✓ Both users own a house with elevator and no architectural barriers. User 1 has a 70 m^2 flat and user 2 a 90 m^2 flat. Moreover, both users changed their bath for a shower. **Activities performed in daily living** ✓ Both users practice exercise every day. ✓ User 1 goes cycling 1,5-2 hours every day. In addition, he goes for a walk with his wife in the evening every day. ✓ User 2 walks during 1 or 2 hours every day maintaining a constant velocity.

Table 2. General information of "active elderly"

Table3 presents the general information of "normal elderly". Both users are in good health condition although they take some medication. They are aware that as time passes by their physical condition changes and consequently they will need help to perform specific activities in the future, especially those that require the use of ladders.

GENERAL INFORMATION (SPAIN)	
NORMAL elderly	**Health condition** ✓ None of them required personal assistance or supervision for the performance of ADLs. ✓ Both feel that their body does not function the same way during some activities such as climbing stairs, walking for a long journey... but, in general, they are in good health condition. **Social situation** ✓ User 3 goes to a social center for retired persons, a few

GENERAL INFORMATION (SPAIN)
times per week, where she socializes with friends and peers. She also travels on an occasional basis with IMSERSO. Furthermore, she brings and picks up her grandchildren from school every day and meted her sons and grandchildren every weekend to have lunch.   ✓ User 4 enjoys meeting new people and participating in research tests and other activities. He also travels regularly and meets his friends every day.   **Dwelling**   ✓ Both users own a house with lift and no architectural barriers. User 3 has a 70 m^2 flat and user 2 a 150 m^2 flat. In both cases, they changed the bath for a shower.   **Activities performed in daily living**   ✓ User3 does the housework, brings her grandchildren to school and then goes for a walk during 1hour every morning. Then she cooks the meal and picks up her grandchildren from school. In the evening, she performs sedentary activities such as watching television or reading.   ✓ User 4 owns a house in the countryside with an orchard where he cuts the grass, prunes the trees… When he does not go to the countryside he meets his friends. Additionally he performs sedentary activities such as watching TV, reading or listening to the radio.

Table 3. General information of "normal elderly"

Table 4 shows the general information of "frail elderly". It can be appreciated that both users have some severe pathology that hampers the practice of physical activity regularly; however, they do not need personal assistance. Both have an active social life.

GENERAL INFORMATION (SPAIN)	
FRAIL elderly	**Health condition** ✓ None of them need personal assistance to perform the ADL's. ✓ Both have some severe pathology that hampers the performance of some activities they used to do. **Social situation** ✓ User 5 does not have many social events but he meets sons and grandchildren every weekend to have lunch. ✓ User 6 goes to a social center for retired every day, where she plays games. Additionally she goes shopping with a friend every Tuesday morning. **Dwelling** ✓ Both users own a house with lift and no architectural barriers. User 5 has a 100 m^2 flat and user 6 a 90 m^2 flat. In both cases they changed the bath for a shower. **Activities performed in daily living** ✓ User5 used to do the housework regularly, but lately he does it less often. He usually goes to the swimming-pool in summer and also goes for a walk. He loves plants and spends much time taking care of them. ✓ User6 does the housework regularly. She usually goes to the market in the morning, watches TV in the afternoon and then goes to a social center for retired.

Table 4. General information of "frail elderly"

ASPECTS RELATED TO MOBILITY AND HEALTH

In this section the aspects related to mobility and health are presented. These aspects refer to the subjective perception of health status and objective physical condition (diseases, taking medications, sports practice...) Table 5 shows information related to mobility and health in "active elderly". We can observe that both users present good health and physical conditions. Moreover, both users practice physical exercise every day.

MOBILITY AND HEALTH (SPAIN)	
ACTIVE elderly	**Objective health condition (diseases, medication …)** ✓ User 1 has mild pain in the cervical region but it does not hamper the practice of physical activities or performance of ADL's. In general he does not take any drug but he occasionally takes some anti-inflammatory. ✓ User 2 has a mild visual loss (she wears glasses). She also has a mild hearing loss that does not hamper maintaining conversations or listening to the TV or radio. She takes medication for hypertension since 3 years. **Physical activity** ✓ Both users have practiced some sport since they were young and still do but less frequently than they used to. ✓ User 1 used to go to the gym but now he practices physical exercise at home. He has a bike at home that he uses 2hours a day. Additionally, he goes for a walk in the afternoon with his wife for one hour. ✓ User 2 walks for 1-2 hours every day maintaining a constant velocity. She also goes to the market every day with friends or husband. **Subjective health condition (health perception)** ✓ Both users consider they have a good health condition. They think that they will not be able to perform the physical activities they normally do in the same level or frequency; however, they do not feel worried about that at the present and they try to maintain their current level of physical activity to preserve their health condition as much as possible. **Sources of information on health care** ✓ User 1 is not very interested on health care issues; however, he is very interested in sports. ✓ User 2 is not very interested on health care issues as well because she thinks that it is something irrelevant for him at present.

Table 5. Mobility and health in "active elderly"

Table 6 shows information related to mobility and health in "normal elderly". Both users do physical activity but they do not practice any sport. In both cases, they try to maintain an active lifestyle and get informed on health issues.

MOBILITY AND HEALTH (SPAIN)	
NORMAL elderly	**Objective health condition (diseases, medication …)** ✓ User 3 does not practice much physical exercise because she has got pain in the joints of both the upper and lower limbs and consequently she is progressively loosing muscle strength. She used to practice fitness but gave up because she had shoulder pain. She takes medication for osteoarthritis since one year.

	MOBILITY AND HEALTH (SPAIN)
	✓ User 4 does not present any important pathology. He takes medications for cholesterol and hypertension. **Physical activity** ✓ User 3 does not practice any physical activity because she is afraid of getting harmed any joint or augmenting her pain. She only walks for an hour every day. Additionally, she does the housework and goes to the market. ✓ User 4 has played "pelota" since he was young, but he has recently given up because of family issues and does not go to neither the trainings nor the championships. For this reason, he walks for 2 hours with a constant velocity every day to keep doing some physical activity. **Subjective health condition (health perception)** ✓ User 3 is afraid of practicing any physical exercise due to her joint pain and considers that she will not practice fitness any more. ✓ User 4 thinks that he may lose weight (about 15kg) to be fit. He does not like following diets but he tries to eat adequately (amount, balanced diet…). Anyway, he considers he has a good health condition. **Sources of information on health care** ✓ User 3 usually watches a program on TV about health care and reads magazines about it. ✓ User 4 enjoys reading science magazines and usually asks his GP for health care information.

Table 6. Mobility and health in "normal elderly"

Table 6 shows information related to mobility and health in "frail elderly". Both users have a pathology that provokes them pain that hampers them practicing any physical activity. However, they consider they are independent to carry out ADL's.

	MOBILITY AND HEALTH (SPAIN)
FRAIL elderly	**Objective health condition (diseases, medication …)** ✓ User 5 has back injury that provokes constant pain. ✓ User 6 has a heart valve since 3years ago. She feels better after the heart surgery but cannot make great efforts. ✓ Both users take medication every day. **Physical activity** ✓ None of the "frail elderly" practices any physical activity due to their health problems. In fact, user 6 does not do any social activity since her husband died. ✓ Both users were recommended by their doctors to stop doing physical exercise but go walking regularly and keep active **Subjective health condition (health perception)** ✓ Despite their pathologies, they consider they are in good health condition. However, they cannot perform some activities they used to do. **Sources of information on health care** ✓ User 5 is very interested in health care issues, especially nutrition. He keeps informed by watching TV and reading magazines. ✓ User 6 is not very interested in receiving information about health care.

Table 7. Mobility and health in "frail elderly"

ASPECTS RELATED TO FALLS

In this section, the aspects related with falls and the circumstances that can increase the fear to fall are presented.

Table 8 shows information related to falls in "active elderly". It can be seen that none of the users have never had a significant fall, although they both insist on the importance of having information about falls and how to avoid them.

FALLS (SPAIN)	
ACTIVE elderly	**Falls** ✓ None of the users has ever suffered any fall in their adulthood. Both had some accidents due to wet floor or ice on the pavements when they were young. **Risk factors** ✓ Both users think they will not suffer falls because they avoid all risks that may cause them. For example, they avoid walking on rough pavements and they have changed their bath for a shower at home. **Interest in receiving information on falls prevention** ✓ In both cases they are interested in receiving information on falls prevention, especially that related on how to manage to get up from the ground if they fall and the way they fall.

Table 8. Falls in "active elderly"

Table 9 shows information related to falls in "normal elderly". None of the users experienced falls due to age; however, user3 has had several major falls during her life that makes her be more cautious and sometimes feel fear to fall. In both cases they would like to receive information about falls prevention.

FALLS (SPAIN)	
NORMAL elderly	**Falls** ✓ User3 has suffered several falls during her life, even serious ones that harmed her some joints. Nevertheless, she has never suffered any fall in their elderly life, but she is afraid of suffering one. ✓ User 4 has never had a significant fall. **Risk factors** ✓ User 3 avoids performing activities that imply more probabilities of falling down, such as climbing stairs, practicing sport or walking on rough pavements. Additionally she has changed the bath for a shower at home. ✓ User 4 performs activities in the house he owns in the countryside that involve a higher risk of fall, such as pruning the trees. **Interest in receiving information on falls prevention** ✓ In both cases they are interested in receiving information on falls prevention.

Table 9. Falls in "normal adults"

Table 10 shows information related to falls in "frail elderly". Both users are very afraid of suffering falls due to the pathologies they have. Consequently, they avoid all the risk factor they can, such as climbing stairs, walking on rough pavements.

FALLS (SPAIN)	

FRAIL elderly	**Falls**
	  ✓ User 5 has many difficulties to maintain balance during walking due to a spinal injury; however, he has never fallen down. He avoids performing activities with increased risk of fall and is always accompanied by some relative when he has to walk for a long time.
	  ✓ User 6 suffered many falls due to dizziness until the heart surgery. Since she was operated she has never fallen down but is afraid of suffering falls.
	Risk factors
	  ✓ Both users are very afraid of suffering falls but they avoid risky situations outdoors and they changed the bath for a shower at home to prevent falls.
	Interest in receiving information on falls prevention
	  ✓ Both users are interested in receiving information on falls prevention.

Table 10. Falls in "frail elderly"

ASPECTS RELATED TO THE USE OF MEDIA.

In this section the aspects related to the use of media are presented, especially TV, radio, press and more complex media, such as smart phones, computers, internet, tablets
Table 11 shows information related to the use of media by "active elderly". Both users keep informed by both traditional media such as TV, radio and press and more modern media such as the internet.

USE OF MEDIA (SPAIN)	

ACTIVE elderly	**Frequency and use of media**
	  ✓ Both users watch TV, read books and magazines and listen to the radio.
	  ✓ Both users have a mobile phone and use it regularly.
	  ✓ Both users can use a computer and surf the internet.
	  ✓ User 1 does not have a computer at home because he finds the connection rates very expensive and prefers to do other activities. He usually listens to music when she practices sport.
	  ✓ User 2 has a computer at home and internet connection. She enjoys solving crosswords.
	Problems with the use of media
	  ✓ None of the users has any problem using the media.
	  ✓ User 1 does not use the internet because he thinks the rate is too expensive because he receives a retirement pension, and cannot afford it.
	Circumstances that would facilitate the use of media
	  ✓ User 1 could afford the internet connection at home if there were special rates for retired people.

Table 11. Use of media by "active elderly"

Table 12 shows information related to the use of media by "normal elderly". Both users keep informed by traditional media such as TV, radio and press but they do not use more modern media such as the internet.

USE OF MEDIA (SPAIN)	

NORMAL elderly	**Frequency and use of media**
	  ✓ Both users watch TV, read books and magazines and listen to the radio.
	  ✓ User 3 cannot use a computer and has no interest in learning to use it. She has a mobile phone that she only

USE OF MEDIA (SPAIN)	
	uses for receiving calls.
	✓ User 4 has a computer at home without internet connection. He uses the computer to see educational and cultural CDs. He uses his mobile phone with no problems.
	Problems with the use of media
	✓ User 3 has some problems using computers and mobile phones because of the lack of experience with these kind of technologies.
	✓ User 4 has problems using the internet due to the lack of experience; additionally, he is not interested in learning to use it because he thinks he does not need it.
	Circumstances that would facilitate the use of media
	✓ They do not see any advantage or do not have the need to use the internet or another modern media; consequently, they do not know how they would use it easier.

Table 12. Use of media by "normal elderly"

Table 13 shows information related to the use of media by "frail elderly". Both users keep informed by traditional media such as TV, radio and press, but they do not use more modern media such as the internet because they cannot use a computer. Both users are reluctant to use new technologies.

USE OF MEDIA (SPAIN)	
FRAIL elderly	**Frequency and use of media**
	✓ Both users watch TV, read books and magazines and listen to the radio.
	✓ User 5 has not neither mobile phone nor computer.
	✓ User 6 has a mobile phone but not a computer.
	Problems with the use of media
	✓ None of these users employs modern media such as the computer because they have no experience with it.
	✓ Both users are reluctant to use new technologies because they do not like them.
	Circumstances that would facilitate the use of media
	✓ They do not see any advantage or do not have the need to use the internet or another modern media; consequently, they do not know how they would use it easier.

Tabea 13. Use of media by "frail elderly"

ASSESSMENT OF THE USE OF THE EXERGAME & MOBILITY MONITOR.

In this section, the results obtained from the assessment of use of the mobility monitor are presented; particularly those related to the use of consoles and the SMM.

Table 14 shows information related to the use of the mobility monitor by the "active elderly". Both users know about consoles, in fact one of them has a Nintendo DS. However, none of them feel attracted by the idea of playing with a video game because they think consoles are not adapted to the needs of the elderly people. If video games were better suited to the needs of this collective they are sure they would use them.

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR (SPAIN)	
ACTIVE elderly	**Previous knowledge**
	✓ User 1 knows about these games because his grandchildren have a Wii.
	✓ User 2has a Nintendo DS and knows about other consoles through her grandchildren.
	Use of video games
	✓ Both users have played a video game but they did not

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR (SPAIN)	
	amuse very much, they think it is more suitable for children. They think that these video games do not provide anything new for them(remember we are talking about games for children, including Formula 1, war games ...)
	Suggestions ✓ Both users think that video games should be adapted to adults and have an objective. ✓ They also think that the controls for the consoles are complicated and consider that they should be easier to use. ✓ They suggest games with an objective that are familiar to older people such as cards games, petanque...
	Context of use ✓ User 1prefers to play alone, but he would not mind to play with his wife, children and / or grandchildren ✓ User 2prefers to play with her family. ✓ The ideal context is to use the console at home, where they have the TV. They say they would perform the exercises in the living room.
	Assessment of the SMM ✓ Both users think that everything that aims at improving the health of the elderly is important and they are willing to collaborate to achieve it. ✓ They have not heard about the SMM before but they find it very interesting. ✓ Both users think that the necklace-shaped SMM would not be uncomfortable.

Table 14. Assessment of the mobility monitor by "active elderly"

Table 15 shows information related to the use of the mobility monitor by the "normal elderly". Both users know about consoles, in fact one of them says his wife has a Nintendo DS. However, none of them feel attracted by the idea of playing video games because they think consoles are not adapted to the needs of the elderly people. If video games were better suited to the needs of this collective they are sure they would use them.

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR (SPAIN)	
NORMAL elderly	**Previous knowledge** ✓ Both users know about these types of consoles through their relatives.
	Use of video games ✓ User 3 has never played video games because the idea does not attract her and does not feel motivated to do it. ✓ User 4 has played with the Nintendo DS because his wife has one. He has played games such as Brain training but he does not feel very motivated to use console.
	Suggestions ✓ Both users think that video games should be adapted to elderly people. ✓ They suggest consoles and video games easier to use because they consider the majority of people of their age has only primary education and cannot use this kind of technology. ✓ They suggest games that are familiar to older people such as cards games.
	Context of use ✓ Both users prefer playing with their relatives.

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR (SPAIN)	
	✓ The ideal context is to use the console at home, where they have the TV. They say they would perform the exercises in the living room. **Assessment of the SMM** ✓ They have not heard about the SMM before but they find it very interesting. ✓ Both users think that the necklace-shaped SMM would not be uncomfortable.

Table 15. Assessment of the mobility monitor by "normal elderly"

Table 16 shows information related to the use of the mobility monitor by the "frail elderly". One of the users knows about consoles through his relatives, but user 6 has never seen a console. If video games were better suited to the needs of this collective and easier they think they would maybe use them.

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR (SPAIN)	
FRAIL elderly	**Previous knowledge** ✓ User 5 knows about these games through his grandchildren. ✓ User 6 does not know how a console works. **Use of video games** ✓ User 5 has seen his grandchildren playing with the console, but has no interest to know how it works because it does not attract his attention. ✓ User 6 has never played a video game because it does not attract her attention and she does not feel motivated to do it. **Suggestions** ✓ Both users think that video games should be amusing. ✓ They suggest the controls should be easy to use like the TV remote that they are used to employ. **Context of use** ✓ Both users prefer playing with their relatives. ✓ The ideal context is to use the console at home, where they have the TV. They say they would perform the exercises in the living room. **Assessment of the SMM** ✓ They have not heard about the SMM before but they find it very interesting. ✓ User 6 has a telecare device. She wears it at home every day and says that it does not bother her to perform activities of daily living. ✓ Both users think that the necklace-shaped SMM would not be uncomfortable.

Table 16. Assessment of the mobility monitor in "frail elderly"

ASPECTS RELATED TO PRIVACY AND DATA SECURITY.

This section presents the aspects related to privacy and data security.
All users are willing to provide information about their health condition but only for medical purposes.

PRIVACY AND DATA SECURITY (SPAIN)	
ACTIVE elderly NORMAL elderly FRAIL elderly	✓ None of the users refuses to provide information about their health condition for the computer system. ✓ They do not see any problem if the information given is used for medical purposes. ✓ All users would accept that their movements were continuously

PRIVACY AND DATA SECURITY (SPAIN)	
	monitored and would not mind carrying the necklace at home.
	✓ They like the idea of customizing their activities and movements.
	✓ They would like to share this information with family and health professionals.

Table 17. Privacy and data security

OTHER ASPECTS

In this section we present results on the willingness of users to participating in future trials and its feasibility.

OTHER ASPECTS (SPAIN)	

ACTIVE elderly
NORMAL elderly
FRAIL elderly
	✓ All the users interviewed would be willing to use the system and most of them prefer to use it accompanied.
	✓ Only one of the users interviewed has access to the Internet access.
	✓ All users have a flat screen TV in their living room.
	✓ All users would like to participate in the project.
	✓ The requirements to participate in the project would be:
	   ○ Active and normal elderly: Being motivated to practice physical exercise every day.
	   ○ Frail elderly: Being motivated to practice physical exercise 3 days a week.
	   ○ All the users would be willing to participate during 6 months in the study (more than 6 months is excessive).
	   ○ They think that 1 year of Living Lab is excessive and it would decrease their motivation along the study.
	✓ All users think that the system is very useful and that it can improve the quality of life of elderly people as well as prevent falls in the future.

Table 18. Other aspects

Appendix III: Empirical data from Germany

GENERAL INFORMATION

This section presents the information provided by the users interviewed about their personal and family data, dwelling, current health status and activities performed in their daily life.

Table 19 shows the general information of the "active elderly". Both users are people with a high level of activity that practice exercise every day and participate in cultural and social activities. These two users denoted his desire to remain active and engage in activities that keep them active both physically and mentally.

GENERAL INFORMATION (GERMANY)	
ACTIVE elderly	**Health condition** ✓ None of them required personal assistance or supervision for their activities of daily living (ADLs). ✓ For his age, User 4 has an above average fitness. He does not feel any pain when getting up in the morning and manages all tasks in the household on his own. ✓ User 2 and user 3 are very active. However, both have age-related health problems, but they do not restrict them very much. **Social situation** ✓ User 4 goes to an internet café in a senior citizen centre to meet other elderly people once a week. Additionally he attends courses about topics like art, science, economy etc. of the adult education centre and does excursions with them. Furthermore his adopted daughter and her two sons visit him from time to time. ✓ User 2 takes part in a foreign language course and goes to a social center for elderlies. **Dwelling** ✓ User 4 lives in a house with an area of 130 square metres. ✓ User 2 and 3 live in a house with a garden which they maintain themselves. **Activities performed in daily living** ✓ Because User 4 lives alone, he manages the whole household and completes all tasks like cleaning, cooking, washing etc. by himself. ✓ User 2 and 3 do the household together, cook and bake, meet up with friends.

Table 19. General information of "active elderly"

Table 20 presents the general information of "normal elderly". Both users are in good health condition, although they take some medication. They are aware that as time passes by their physical condition changes and consequently they will need help to perform specific activities in the future, especially those that require the use of ladders.

GENERAL INFORMATION (GERMANY)	
NORMAL elderly	**Health condition** ✓ None of them required personal assistance or supervision for the performance of ADLs. ✓ User 1 feels that his body does not function the same way during some activities such as climbing stairs, walking for a long journey but, in general, they are in good health condition. ✓ User 6 has age-related health problems and feels otherwise relatively fit and mobile. **Social situation** ✓ User 1 goes to a social center for elderlies a few times per week. There he socializes with friends and peers. There he gives computer courses to work with digital photos. Additionally, he hikes with friends and is mainly responsible for the household while his wife is still working. ✓ User 6 meets regularly with friends to walk and talk and to maintain social contact. She occasionally travels with a friend, but less frequently than years ago. **Dwelling** ✓ User 1 owns a house with no architectural barriers. While building the house twenty years earlier he anticipated possible mobility problems his future and prevents stairs even in his garden. ✓ User 6 inhabits a medium sized apartment with balcony in an apartment building, located on the slope of a steep hill. Accordingly, there are long stairs in the hallway, but there can also be used an elevator. **Activities performed in daily living** ✓ User 1 likes to take photos and to make them over with special computer programs. Further does the household and makes the garden, the cooking, the washing, etc. ✓ User 6 has no particular hobbies. She enjoys walking and meeting up with friends.

Table 20. General information of "normal elderly"

Table 21 shows the general information of "frail elderly". It can be appreciated that both users have some severe pathology that hampers the practice of physical activity regularly; however, they do not need personal assistance. Both have an active social life.

GENERAL INFORMATION (GERMANY)	
FRAIL elderly	**Health condition** ✓ User 5 had a hip surgery, but feels better than before the surgery. She feels that she is in a good health condition. When she goes out of the house, she takes a walking-stick umbrella with her to preserve her hips. Inside the house she holds on to the banister rail to walk safely.

GENERAL INFORMATION (GERMANY)

| | **Social situation**
✓ User 5 does not participate in a weekly or monthly activity or meeting. Before her hip surgery she went weekly to a gymnastics course. Sometimes she does bus tours with other seniors. Once in two years she goes for a medical cure. She is in close contact to her family, but she does not get on well with her neighbours, because in her opinion they are jealous of her big estate. She maintains old contacts, but she doesn't like to travel a lot. User 5 has got two young friends (two brothers), who help her frequently with heavy work in the house or garden like paperhanging.

Dwelling
✓ User 5 owns a 630 m² big estate with a 125 m² living space, which extends over three floors. Additionally the house is located on a slope. So User 5 lives with a lot of architectural barriers like stairs or steep paths. She lives there alone, but she feels very comfortable in here house.

Activities performed in daily living
✓ User 5 does the household and the garden, but not everything in the garden like risky work at the slope. She goes shopping on foot. She walks at least one hour per day. She makes gymnastics every day for 20 minutes on her own. |

Table 21. General information of "frail elderly"

ASPECTS RELATED TO MOBILITY AND HEALTH

In this section the aspects related to mobility and health are presented. These aspects refer to the subjective perception of health status and objective physical condition (diseases, taking medications, sports practice...) Table 22 shows information related to mobility and health in "active elderly". We can observe that both users present good health and physical conditions. Moreover, both users practice physical exercise every day.

MOBILITY AND HEALTH (GERMANY)	
ACTIVE elderly	**Objective health condition (diseases, medication …)** ✓ User 4 does not have any acute diseases. He only takes one medicament per day against prostate ailments and goes to the eye specialist for post examinations because of his former eye cataract from time to time. ✓ User 2 and 3 take medication regularly, but feel no limiting side effects. ✓ User 2 has a spinal cord disease and painful arthritis in the joints. ✓ User 3 has several bypasses and a pacemaker. **Physical activity** ✓ User 4 is highly physical active. So he goes biking in hilly environment one hour a day and also hiking with his friends for holidays in the mountains once a year. ✓ User 2 and 3 both go to a gym regularly. ✓ User 2 practicing yoga and Pilates. ✓ User 3 trains on the treadmill and does gymnastics. ✓ Both dance standard dances together.

MOBILITY AND HEALTH (GERMANY)	
	Subjective health condition (health perception) ✓ User 4 feels very good for his age and says that he is able to do all tasks in daily life like when he was younger. ✓ According to the circumstances user 2 and 3 feel fit. They do not complain about their illnesses and have a very positive attitude. **Sources of information on health care** ✓ User 4 reads up on health care topics just from time to time. Sometimes he watches TV programmes about certain topics that he is interested in or he directly asks his doctor. ✓ User 2 and 3 use magazines and television to inform themselves about health issues.

Table 22. Mobility and health in"active elderly"

Table 23 shows information related to mobility and health in "normal elderly". Both users do physical activity but they do not practice any sport. In both cases, they try to maintain an active lifestyle and get informed on health issues.

MOBILITY AND HEALTH (GERMANY)	
NORMAL elderly	**Objective health condition (diseases, medication …)** ✓ User 1 presents no important pathology except the problems with his hip and back. He takes medication to regulate a hypothyroidism and a depression. He has a Tremor but does not take any medication. ✓ User 6 had a knee operation, and therefore some movements, such as jogging, cannot run without pain. She also has chronic neck pain and makes appropriate daily relaxation exercises. She also has age-related symptoms such as arthritis in the hands and joints. She regularly takes metabolic drugs, which she can assign no side effects. **Physical activity** ✓ Except working in the garden and the hiking User 1 does no regular sport. In his former years he played volleyball, indiaca and cycle training but had to give it up because auf pains in his back and problems with his hip. Therefore he does not practice any physical activity because she is afraid of getting harmed any joint or augmenting her pain. ✓ During the last time user 6 makes sports less time than it used to be. She goes for a walk at least half an hour daily because she cannot jog any longer. In addition, she occasionally swims, but not as frequently as before. She has tried several gyms and concepts, of which she was disappointed. **Subjective health condition (health perception)** ✓ User 1 is feeling good for his age but he also states that his agility is ebbing with his age: for example there is a pain in his legs after hiking. He is also afraid that his physical abilities abate in the future. ✓ User 6 feels good according to her age. However, she notes increasing restrictions, which she attributes largely to her age. **Sources of information on health care** ✓ User 1 has no particular source of health information. Sometimes he watches something on TV or read in a magazine. For example there was a report on back pain in

MOBILITY AND HEALTH (GERMANY)	
	which he was interested. ✓ User 6 occasionally informs herself about health issues, but she has no particular source.

Table 23. Mobility and health in "normal elderly"

Table 24 shows information related to mobility and health in "frail elderly". Both users have a pathology that provokes them pain that hampers them practicing any physical activity. However, they consider they are independent to carry out ADL's.

MOBILITY AND HEALTH (GERMANY)	
FRAIL elderly	**Objective health condition (diseases, medication …)** ✓ User 5 takes pills and ointment for her hip pain, but not regularly. Furthermore she takes hormone pills because of an anomaly, since otherwise she would get a headache and nervousness. These pills have no side effects. **Physical activity** ✓ Except working in the house and garden, User 5 regularly makes her gymnastics, which were shown to her in the cure. Before her hip surgery she went weekly to a gymnastics course. She goes for a walk every day for at least one hour. **Subjective health condition (health perception)** ✓ User 5 feels after her hip surgery much better than before ("I'm back again one hundred percent."). She sees the garden work at the slope as a risk factor for her. She wants to boost her mobility of herself, which was particularly strongly needed after her surgery. She was afraid of her surgery, but she almost reached her old health condition. She feels that she is in a good health condition, but she is aware that this is getting worse with increasing age. She wants to provide for herself as long as possible. **Sources of information on health care** ✓ User 5 has no particular source of health information. Sometimes she reads different magazines or watches something on TV. She doesn't catch up on something specific.

Table 24. Mobility and health in "frail elderly"

ASPECTS RELATED TO FALLS

In this section, the aspects related with falls and the circumstances that can increase the fear to fall are presented.
Table 25 shows information related to falls in "active elderly". It can be seen that none of the users have never had a significant fall, although they both insist on the importance of having information about falls and how to avoid them.

FALLS (GERMANY)	
ACTIVE elderly	**Falls** ✓ User 4 does not have any age-related problems regarding falls. ✓ User 2 once fell off the bike because it was stuck. Another time she slipped on a slippery floor. But she does not think the falls happened because of her age. ✓ User 3 cannot remember a fall. **Risk factors** ✓ User 4 says that he is not afraid to fall with his current physical situation but thinks that it can change by becoming older. ✓ User 2 and 3 think that they counteract falling already through their dance training and certain balance exercises. Accordingly, they have no fear of falling because of their age. In their house they have not taken any special safety precautions. **Interest in receiving information on falls prevention** ✓ User 4 is interested in information about falls prevention regarding the future (when he possibly will not have the same fitness than before). So now, he already wants to do something for his fall prevention and is quite interested in the next steps of the project. ✓ User 2 and 3 are interested in such information.

Table 25. Falls in "active elderly"

Table 26 shows information related to falls in "normal elderly". None of the users experienced falls due to age; however, user 3 has had several major falls during her life that makes her be more cautious and sometimes feel fear to fall. In both cases they would like to receive information about falls prevention.

FALLS (GERMANY)	
NORMAL elderly	**Falls** ✓ User 1 has never had a significant fall. But he is sure, that the risk to fall rises with the higher status of age. ✓ In younger years user 6 has fallen down the stairs and got a muscle transverse crack. Lately she did not fall. **Risk factors** ✓ User 1 avoids performing activities that imply more probabilities of falling down like working on a ladder. Information about risk factors of falling down are addressed as highly relevant and the most important to avoid accidents is to prevent falls like having no booby traps on stairs and the floor. He mentions that while the risk to fall rises with becoming older, one has to compensate that with being more careful or avoiding risky activities. ✓ User 6 thinks that through certain exercises, such as improving the balance, she can counteract the danger of falling. Because of her heavy fall she is usually moving cautiously, but has taken no special precautions in her

FALLS (GERMANY)	
	home.
	Interest in receiving information on falls prevention
	✓ In both cases they are interested in receiving information on falls prevention.
	✓ User 6 is quite interested in information on fall prevention. She even informed herself by an insurance company over a fall insurance.

Table 26. Falls in "normal adults"

Table 27 shows information related to falls in "frail elderly". Both users are very afraid of suffering falls due to the pathologies they have. Consequently, they avoid all the risk factor they can, such as climbing stairs, walking on rough pavements.

FALLS (GERMANY)	
FRAIL elderly	**Falls**
	✓ User 5 fell once as she was a child and has got a crooked arm since then. She has not done yet any fall experiences in her higher age.
	Risk factors
	✓ User 5 avoids performing activities that imply more probabilities of falling down like working on a slope. When she goes out of the house, she takes a walking-stick umbrella with her to preserve her hips. As she is a little bit afraid of falling, she holds on to the railing inside the house and outside at the slope paths to walk safely.
	Interest in receiving information on falls prevention
	✓ She would be grateful for tips and information how to better behave to avoid falls, for example if there are special help devices for ice and snow. She could imagine such information in the form of quizzes because these are her passion.

Table 27. Falls in "frail elderly"

ASPECTS RELATED TO THE USE OF MEDIA.

In this section the aspects related to the use of media are presented, especially TV, radio, press and more complex media, such as smart phones, computers, internet, tablets.
Table 28 shows information related to the use of media by "active elderly". Both users keep informed by both traditional media such as TV, radio and press and more modern media such as the internet.

USE OF MEDIA (GERMANY)	
ACTIVE elderly	**Frequency and use of media**
	✓ User 4 daily watches TV but just in the evening hours. Furthermore he uses the internet to check his e-mails from time to time.
	✓ User 2 and 3 use the Internet, TV, their MP3 players, magazines and radio regularly.

USE OF MEDIA (GERMANY)	
	Problems with the use of media ✓ User 4 does not have any Problems with visual or audio skills. He says that he is able to deal with keyboard and mouse well. Despite he has not had any experience with gesture and speech control yet, he is not afraid to try it. ✓ User 2 and 3 do not have problems. They use the Internet to clarify difficulties. **Circumstances that would facilitate the use of media** ✓ Nothing to mention here.

Table 28. Use of media by "active elderly"

Table 29 shows information related to the use of media by "normal elderly". Both users keep informed by traditional media such as TV, radio and press but they do not use more modern media such as the internet.

USE OF MEDIA (GERMANY)	
NORMAL elderly	**Frequency and use of media** ✓ User 1 uses the Internet watches TV, read books and magazines and listen to the radio. He uses the internet in a selective way for information and internet banking. He uses the internet, the computer and his mobile phone with no problems. ✓ User 6 generally has a rather low media consumption. Mostly she uses the internet and her TV, for example, to obtain information or to watch a movie. She has canceled all her magazines subscriptions and often listens to the radio. **Problems with the use of media** ✓ User 1 has problems with the writhing on computers - he is not so fast. Therefore he likes to writhe emails but do not like to chat. ✓ User 6 has no particular problems. **Circumstances that would facilitate the use of media** ✓ User 1 mentions his experience that the older people in his computer course can often not read the small letters. ✓ User 6 has no specific concerns.

Table 29. Use of media by "normal elderly"

Table 30 shows information related to the use of media by "frail elderly". Both users keep informed by traditional media such as TV, radio and press, but they do not use more modern media such as the internet because they cannot use a computer. Both users are reluctant to use new technologies.

USE OF MEDIA (GERMANY)	
FRAIL elderly	**Frequency and use of media** ✓ User 5 watches TV in the morning and the evening for the weather information, news and crime thrillers. Furthermore she reads magazines. **Problems with the use of media** ✓ User 5 does not have a computer and an internet access, because she doesn't see any advantage in it. At the end of her career, she made some experiences with the computer, but she didn't feel any joy in its use. She still can see almost everything without glasses and she still can also hear well. She cannot do much with technical terms like virtual, controller, e-mail, teletext, etc. **Circumstances that would facilitate the use of media** ✓ User 5 would find a gesture control great. She wants to have only a few menu items. She has not much imagination how one might design such a game for seniors. Easier technical terms would facilitate the use of media for seniors.

Table 30. Use of media by "frail elderly"

ASSESSMENT OF THE USE OF THE EXERGAME & MOBILITY MONITOR.

In this section, the results obtained from the assessment of use of the mobility monitor are presented; particularly those related to the use of consoles and the SMM.

Table 31 shows information related to the use of the mobility monitor by the "active elderly". Both users know about consoles, in fact one of them has a Nintendo DS. However, none of them feel attracted by the idea of playing with a video game because they think consoles are not adapted to the needs of the elderly people. If video games were better suited to the needs of this collective they are sure they would use them.

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR (GERMANY)	
ACTIVE elderly	**Previous knowledge** ✓ User 2 and 3 have no knowledge on the field. **Use of video games** ✓ User 2 and 3 have no experience on the field. **Suggestions** ✓ User 4 suggests that the game should be a combination of physical and memory training. ✓ User 2 suggests ball games to improve the balance. She wants to do the exercises alone in any case. **Context of use** ✓ User 4 imagines to play the game in team with other people via network or at home, e.g. with his grandsons. **Assessment of the SMM** ✓ User 4 thinks that parts of the record of the SMM data would be very interesting for him, e.g. to monitor the changes of the power of legs. So he has no problems with the recording or to wear the necklace during the game. ✓ User 2 and 3 would not wear the SMM. They think that the

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR (GERMANY)	
	shape of the SMM is uncomfortable and do not see a great use for themselves to wear the device.

Table 31. Assessment of the mobility monitor by "active elderly"

Table 32 shows information related to the use of the mobility monitor by the "normal elderly". Both users know about consoles, in fact one of them says his wife has a Nintendo DS. However, none of them feel attracted by the idea of playing video games because they think consoles are not adapted to the needs of the elderly people. If video games were better suited to the needs of this collective they are sure they would use them.

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR (GERMANY)	
NORMAL elderly	**Previous knowledge** ✓ User one knows about these types of consoles through his relatives but has no experience in playing them. ✓ User 6 has heard of the Wii console. **Use of video games** ✓ User 1 has never played video games because the idea does not attract her and does not feel motivated to do it. ✓ User 6 has never played a video game herself. **Suggestions** ✓ User 1 thinks that video games should be adapted to elderly people. ✓ He suggests consoles and video games easier to use because he considers the majority of people of his age cannot use this kind of technology. ✓ He suggests games that are familiar to older people and to build virtual surroundings like cities, parks and museums where people can learn something about their environment and can go for a walk with some exercises. ✓ User 6 suggests that the exercises should not be connected to a plot. She does not want to do the exercises in a "fairytale forest". She suggests 20 minutes for the duration of a workout. **Context of use** ✓ User 1 prefers to play alone but thinks that playing with relatives could be fun, too. The ideal context for him is to use the console at home, where they have the TV in the living room. ✓ User 6 would prefer to exercise alone. But she mentions that group exercises, however, could increase the motivation. **Assessment of the SMM** ✓ User one has not heard about the SMM before. He thinks that it might be very interesting for older people but sees no use for himself. ✓ Further he does not think that the necklace-shaped SMM is comfortable. ✓ User 6 considers that the use of the SMM could be useful for old people. She can imagine to use a SMM.

Table 32. Assessment of the mobility monitor by "normal elderly"

Table 33 shows information related to the use of the mobility monitor by the "frail elderly". One of the users knows about consoles through his relatives, but user 6 has never seen a console. If video games were better suited to the needs of this collective and easier they think they would maybe use them.

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR (GERMANY)	
FRAIL elderly	**Previous knowledge** ✓ User 5 knows about these types of consoles through his grandchildren but has no experience in playing them. **Use of video games** ✓ User 5 has never played video games. **Suggestions** ✓ User 5 would play gymnastics games any time. She can very well imagine virtual walks in different cities like Düsseldorf or Frankfurt. Sports such as skiing or surfing would have been very interesting for her in the past (she likes water sports), but there was no possibility to practice them during or after the war. She doesn't believe that she would still learn such sports today, but maybe in a virtual and easier manner. She can also imagine to integrate hiking and stairs climbing in such games. She wouldn't see small text information as bothersome, when they would appear during a crime thriller. But when it is an exercise reminder, she first would finish her crime thriller. A chat function would be too complicated for her. **Context of use** ✓ User 5 prefers to play in the winter, when she cannot work in the garden and spends much time in the house. The ideal context for her is to use the console at home, in the living room or bedroom, where she has TV devices.

Table 33. Assessment of the mobility monitor in "frail elderly"

ASPECTS RELATED TO PRIVACY AND DATA SECURITY.

This section presents the aspects related to privacy and data security.
All users are willing to provide information about their health condition but only for medical purposes.

PRIVACY AND DATA SECURITY (GERMANY)	
ACTIVE elderly **NORMAL elderly** **FRAIL elderly**	✓ None of the users refuses to provide information about their health condition for the computer system. ✓ They do not see any problem if the information given is used for medical purposes. ✓ All users would accept that their movements were continuously monitored and would not mind carrying the necklace at home. ✓ They like the idea of customizing their activities and movements. ✓ They would like to share this information with family and health professionals.

Table 34. Privacy and data security

OTHER ASPECTS

In this section we present results on the willingness of users to participating in future trials and its feasibility.

OTHER ASPECTS (GERMANY)	
ACTIVE elderly **NORMAL elderly** **FRAIL elderly**	✓ All the users interviewed would be willing to use the system and most of them prefer to use it alone with the possibility to be accompanied. ✓ All of the interviewees except one have access to the Internet and the medial properties. ✓ All users have a flat screen TV in their living room. ✓ User 1 wants to participate in the project if it is not boring and interesting. ✓ User 1 wants to see the results of the exercising in his daily life. ✓ All users think that the system is very useful and that it can improve the quality of life of elderly people as well as prevent falls in the future. ✓ For user 1 it is important to see advantages of the exercise.

Table 35. Other aspects