Reassuring the Elderly Regarding the Use of Mobile Devices for Mobility

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Abstract. People facing threats of mobility loss have their self-confidence shaken and tend to reduce their physical activity. As is well-known, the decreased physical activity, particularly for the elderly, is one of the factors that contribute to accelerating the deterioration of their health with consequent loss of autonomy and quality of life. Today, GPS-based technologies available on mobile devices offer many solutions to help guide users around much of the world. However, there are several known factors that act as barriers to the use of these technologies, such as user unfamiliarity with these devices, the complexity of geographical information and the difficulty of typing the origin and destination locations. In this paper we propose a solution for mobile devices that seeks to promote user confidence in daily mobility, especially among the elderly. We present the main system functionalities and the interface design.

Keywords: Active aging, Mobile applications, daily mobility.

1 Introduction

It is an accepted fact that populations are aging in developed societies [1]. The decrease in mortality along with improvements in the quality of healthcare and better living and working conditions have led to greater longevity than in the past. A strategy which addresses population ageing should be organised in order to help create a cohesive and inclusive intergenerational society [2].

Information Communications Technology (ICT) is considered an important tool in helping to create this cohesive and inclusive society [3]. ICT can make key contributions to the independent living of the elderly, particularly in reducing expenses for health and care services, providing individual solutions and meeting individual needs, improving living standards and creating new business opportunities [4].

Usually the receptivity of the elderly to new technology is low, but in cases where its use entails obvious and relevant benefits to their lifestyle, they are very receptive [5].

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Within ICT, the adoption of mobile devices (tablets and smartphones) has seen huge growth, given their features, such as communication ability, internet and phone, intuitive touch interaction, big and high resolution displays, light weight, high resolution cameras, sensors (GPS, compass, among others) and advanced computation ability. These features make them appropriate for assisting the elderly in their daily activities and afford a promising tool for improving their quality of life (QoL). Imaculada Plaza at [3] presents a comparison of seven quality of life components identified by older people and the expectations and needs of the aged in relation to mobile applications found in the literature:

Table 1. Comparison of quality of life components identified by older people and expectations and needs of the aged in relation to mobile applications found in the literature. Source: [3].

QoL component	Needs of older person
Family and other relationships/contact with others	Maintain social contact / communication device
Emotional well-being	Feeling safe and secure
Religion/spirituality	
Independence/ Mobility / Autonomy	Freedom of movement/ Memory and daily life activity aids/ Enjoyment/ Self-actualization
Social/ Leisure activities	Memory and daily life activity aids/ Enjoyment/ Self-actualization
Finances / standard of living	
Own health/health of other(s)	Healthier independent life

People facing threats of mobility loss, such as that related to the diagnosis of Parkinson's disease or the arrival of its first symptoms, have their self-confidence shaken and tend to reduce their physical activity (PA) in order to avoid hazardous situations. At such moments people start wondering: "... what if I become disoriented, how can I find my way back home?" or "... if I get lost, will my loved ones be able to find me?"

Physical activity is a well-known factor in healthy ageing and the lack of it has long been associated with chronic disease [6]. The decrease in PA in people, particularly the elderly, is one of the factors that contribute to an accelerating deterioration in their health, with consequent loss of autonomy and quality of life. Moderately frequent intense activity has significant cardiovascular and mental health benefits, and protects against osteoporosis, obesity and related disorders. Promoting physical activity in adults is a public health priority [7].

Today the technologies provided by personal mobile devices offer many solutions to help guide users, based on the Global Positioning System (GPS). These solutions can support and guide users over practically the whole planet, showing them the best route between two selected points.

However, there are several factors known to act as barriers to the use of these technologies, such as the fact that many people, and especially the elderly, are still not familiar with the use of these devices; geographical information as it is usually

presented in these applications - maps and abstract schemas - is complex and often requires the introduction of names of origin and destination locations.

In this paper we propose an application for mobile devices that seeks to promote people's confidence in daily mobility. This solution focuses on that section of the population which is aged, gets about on foot or by public, lives alone, and may have one or more carers (among family, neighbours or professionals). We seek to help elderly people on the QoL of emotional well-being and fulfil their needs to feel safe and to enjoy healthier more independent lives.

In order to do so, we are designing and implementing an App prototype, on mobile devices named Compass&Magnifier (C&M). At this first stage, the requirements are based on brainstorming, on interviews with elder care professionals, on known elderly- related limitations and on other relevant work.

This paper is organized as follows: Section 2 refers to related work and Section 3 explains the methodology adopted for the development of our App. Section 4 depicts the main C&M system functionalities and the interface design. Finally, Section 5 summarises the paper and presents a synopsis of future work.

2 Related Work

Two main GPS technology-based strategies were identified for reassuring the aged in their everyday routines: to increase their sense of safety through easy/swift contact with their loved ones or carers; and to provide them with relevant information about their routine(s).

2.1 Increase Old People's Sense of Security through Easy and Rapid Contact with Their Loved Ones or Carers

There are several solutions based on GPS technology that aim to increase older adults' autonomy by increasing their sense of security when outdoors, and which also ease carers' concerns by reassuring them that they will be alerted if their loved ones become disorientated and need help.

Some of these solutions focus on senior citizens suffering from dementia, Alzheimer's disease or other memory-related problems. They register and monitor the elderly's everyday routes, trigger alerts to carers if they are wandering off or lost, or notify carers if they are safe inside or around the home, or if they are making scheduled visits to the doctor.

Within these solutions, the dedicated systems, such as special GPS bracelets, GPS necklaces (e.g. see [8]) or shoes (e.g. see [9]), are professional solutions and incur associated costs – usually users buy the device and sign up to a service on a paid monthly basis. However, these systems can cause stigmas to the users because they are specific to these problems. Such dedicated solutions are beyond the scope of this paper.

There are other solutions based on Apps that run in mobile devices. They overcome the stigma inconvenience because the mobile devices do not specifically concern themselves with these problems; they can even be considered fashionable.

Moreover the Apps are usually cheap and the mobile device Apps permit the user to benefit from many other forms of support. The smartphone prices are still high, but every day sees their prices falling and their power and sensors improving. If the user doesn't have one yet, probably he/she will obtain one soon.

There follows a description of a branch of Apps related to reassuring the elderly in their daily comings and goings.

The Apps focus on older adults and people in the initial stages of dementia, such as Alzheimer's patients, e.g AlzNav [10] and Tweri: The Alzheimer Locator [11] enables us to pre-define a safe geographical limitation zone and generate an alert to the user and to the carers, if the person passes beyond the defined limits.

These Apps also implement other functionalities, such as: SOS buttons, buttons that when pressed make a direct call to one predefined carer; and System failures, e.g. "out of battery", "loss of GPS signal" or "loss of GSM signal", which inform carers about user device status.

AlzNav App also generates a simplified walking navigator that is always able to point the user in the right direction in order to get back home. Other Apps promote the user's sense of security based on simplicity, e.g. One Touch SOS App [12]. The App implements SOS buttons that send the user a pre-defined contact address.

Since elderly people tend to have sight difficulties, Apps such as The Big Lancher [13] equip smartphone interfaces with large buttons and texts, thus enhancing user usability and consequently their sense of security. The Big Lancher also includes an SOS Button functionality.

The authors of Protege [14] developed an App for enhancing communications between the old adult and their carer. This App has a very good interface adapted for the elderly, and implements a substantial set of functionalities, of which we highlight: the SOS Button, which alerts in the event of a fall, or of no activity or a low battery; and carer inquiry messages, e.g. "how are you?" or "where are you?".

2.2 Providing the Elderly with Relevant Information about Their Routine

One way of reassuring a senior citizen is to inform him/her about his/her routine progress, e.g. "everything is ok!" or "you are late". Daily Commute [15] is an App that aims to make a prediction in relation to the user's daily travel and help him/her arrive on time. The App compiles user travel data over time to predict commute time each morning. Despite it not being an App specifically adapted for the elderly, the functionality enabling it to forecast "leave time" and "arrival time" can be very reassuring.

Real-time geographical information is another very important way of reassuring the aged. It can be re-assuring for an elderly person to be able to review a route in order to remember it or to see his/her progress in real time. Maps Apps, such as the widely known Google maps [16], are web-based services that provide detailed information about geographical regions and sites around the world. They usually provide visual road maps and satellite views. In some towns and cities, Google Maps offers "street views" comprising photographs taken from vehicles (3D views). This kind of App usually has too many functionalities or choices available at the same time, which may serve as a drawback to elderly users.

3 Methodology

As a methodology for design and development, we choose the user-centered design (UCD), since it tries to optimize the product around how the users can, want or need to use it. UCD was introduced by Norman and Darper [17], and became a recognized methodology among researchers in Human-Computer Interaction (HCI). It is characterized as a multi-stage problem solving process that requires designers to analyse and foresee how users are likely to use a product and test the validity of their assumptions with regard to user behaviour in real world tests with actual users.

There are several tools in the analysis of UCD, but those primarily used are *persona*, scenarios, and use cases. The persona is a fictional and life-like character that represents archetypal users [18-19]. It is described following field research, and since it is almost impossible to apply all user characteristics, there may often be several personas.

Scenarios is a fictional story about the "about the persona´s daily life" or a sequence of events with the *persona* as the main character. There can be best case scenarios, average case scenarios, or worst case scenarios, where, according to the main character's experience, either everything works out for the best, or he has an ordinary day in which nothing exciting or depressing occurs, or everything around him or her goes wrong. Scenarios can help us discuss potential designs with other designers and potential users [20].

The use case captures a contract between the stakeholders of a system and describes the system's behavior. It collects together different scenarios (different sequences of behaviour) [21].

3.1 Requirements

Following our research, we made an enquiry dedicated to people of 50 or more years old, concerning people's interest in using some devices in their everyday life, and into their frequency of use. This enquiry included questions regarding their self-evaluation, about their autonomy in terms of everyday tasks, and also about their comparative confidence and sense of wellbeing, in relation to others of the same age.

Up to the time of publication of this paper, we had 57 respondents, 39 of whom were aged between 50 and 60. For the upper ages we only had 18 responses. Nevertheless, these results showed that the few older people above the age of 60 use mobile devices only rarely, and those that do use them only use basic functionalities. The authors Ferreira et al [14] reported as a fact that they could not ask senior citizens what they expect from an Android mobile application / device due to their relative level of ignorance regarding the full possibilities of this technology.

So at this first stage, we decided to design a prototype, based on an initial set of requirements that could be considered to meet with better acceptance and greater success among the targeted persons. These requirements were based on brainstorming, interviews with eldercare professionals, research on elderly- related limitations and on similar mobile Apps.

We identified three main groups of requirements, which are listed and detailed below:

1. General aspects to consider: The App should focus on a few relevant tasks, closely related to daily routine, and use simple or well-known metaphors;
2. Considering the interface and layout design, it should provide selective user-friendly contents – directly connected to the task. The layout must be consistent throughout the menu's sequence and redundant on essential information or commands. It is also important to guarantee clear and familiar information, using cultural or acquired stereotypes in terms of tasks and colours, as well as to provide flexible interaction and error tolerant design, e.g. taking into consideration hand tremors and reduced sight. Finally, it is essential to assure feedback control (audible or tactile forms) and allow user preferences – such as volume control, type size, or voice commands.
3. The visual interface would benefit from the choice of an accessible typography, with large and clear font, presented in white or yellow, on a dark blue or black screen; and it is important to avoid overlapping the text with background patterns or images.

With "Dewsbury" [22], we agree that "One of the most complex and time-consuming elements of designing for people is actually the requirements process. In order for the final design to be accessible to and actually used by the Target group it is critical that this group is fully engaged in the design process".

The next step (beyond the scope of this paper) will be the evaluation of the prototype and a participatory redesigning with a group of older people, following UCD methodology.

3.2 Personas and Use Cases

Based on the uniqueness of our social and geographical territory (inland northern Portugal) and on our previous experience and research, we decided to focus on people living in a rural environment, in receipt of poor services and for the most part living a long way from main services and care providers.

Most of the elderly population targeted have poor literacy skills and have lived in that region almost the whole of their lives. They remained in their village while their younger relatives moved to the big cities.

Presented with these problems, we decided to evolve this interface, taking into account two different types of cases and problems, and two *persona*: Elderly people who remain in their own homes in a small village, facing problems of isolation and difficulties of covering distances; People that move to another area which is unknown to them – facing fears of uncertainty about their new environment.

To represent those two types, we created Maria (persona 1) and Leandro (persona 2). Their descriptions are as follows:

Persona 1: Mary, retired marketer.
Maria's goal: Maintain her routines and feel secure.

Maria is an 83-year-old widow who has always lived in her small rural village in northern Portugal. Despite not having had the opportunity to go to school, she learned to read, write and to do some maths.

Although retired, Mary continues to manage her small village shop (grocer's) and walks daily between home and work. During the walk she usually takes the opportunity to chat with her neighbours.

She raised three children, who live close to her. The youngest daughter lives with her two grandchildren several metres from her home and visits her daily, providing her with the necessary support. Her oldest son lives a little further away, but even so, Mary goes to have lunch with him every Saturday. Whenever the weather permits, she goes on foot. The middle child lives outside the village, so in this case Mary uses the phone to keep in touch.

Every weekend she attends mass, on Saturday or Sunday, depending on which day is the more convenient.

Usually she sleeps between 22:00 and 06:00, and for relaxation her favourite companion is the television.

As the years have gone by, she has had more difficulty in following her routines – she suffers from hypertension and varicose veins. She has been taking more and more breaks and having longer rests.

Mary cooks her own food and brings her groceries home daily. In the main she uses her gas stove and microwave oven. Despite having recently acquired a mobile phone and a washing machine, she finds it difficult to use them without assistance. She has never used a computer.

Use Case

- Maria's new smartphone has a C&M Application. Her son installed it in order that she could be confident in maintaining her daily mobility.
- Even when she feels tired on her way to the shop, she is confident that if she falls or lingers longer than usual, one of her children will be alerted and will probably contact her or will even come to help her.
- On the other hand, she can also find the nearest safe place, in case she decides to choose a different route. That is why she uses the C&M - she uses the magnifier icon on the main screen and selects her neighbour, based on house and face picture – she hates to dial and write names to contact! In dangerous situations she can always call for help using the main screen S.O.S shortcut.
- Once she is very near, she decides to ring and announce her arrival for a small chat… and rest!

Persona 2: Leandro Silva, ex-farmer.
Leandro's goal: Walk about in the city that he doesn't know, and feel safe there.

Leandro is 78 years old, and because his wife recently died, he was left alone and went to live with his son Joel in the city. He used to work as a farmer, having studied only up to the end of the 4th year of schooling.

This is the first time he has left his home town. Although Joel has enrolled him in the day care facility, he likes to walk around, to look at the magazines at the kiosk and

to rest in a public garden in his locality. Once in a while there are some football games on the café's TV and he likes to go there and watch them. He would like to have a small pet – to keep him company during the day and to accompany him around the city. But Joel worries about his solitary wanderings tries to discourage him from doing so.

He performs his daily toilet on his own and manages to prepare tea or a simple meal – ever since Joel showed him how to use the main kitchenware.

In the evening he turns on the TV while waiting for the rest of the family to arrive home. Together they chat a little and eventually play some cards.

Use Case

- Every day, before going out, Leandro makes sure he doesn't forget his mobile phone. It has an app with a compass and a magnifier that reassure him about his way home…
- When he decides do walk around the corner he looks at the compass and con-firms that he is going in the right direction for the pharmacy – where he went two weeks ago to buy his medicine.
- He is sure about the way home, but in any case, he knows that if something happened his son or the institution to which he usually goes in the afternoon would be contacted.

4 Compass and Magnifier

In order to define C&M App, we describe the functional system specification and interface design.

4.1 Functional System Specification

In Fig. 1 a C&M Unified Modelling Language (UML) Use Case is presented, in which we highlight the carer and elderly actors' functionalities.

Carer. The carer is the person responsible for setting up the application. Access to this part of the system requires authentication in order to avoid accidental or unauthorized data changes. The management is composed of two different sets of functionalities.

On the one hand, the functionality "Manage System" allows the editing or validation of the safety area, automatically estimated by the system based on historic users' routes and mobility variables such as time, locations, distances and user speed. These variables are automatically collected by the system, which produces a commutation profile in order to monitor users' behaviour during daily mobility. The Carer can access the commutation profile and validate or rectify it in order to properly adapt the system's monitoring to user needs. In addition, the system management includes the configuration of contacts that should receive the system's warnings in case of an abnormal situation such as falls or long delays.

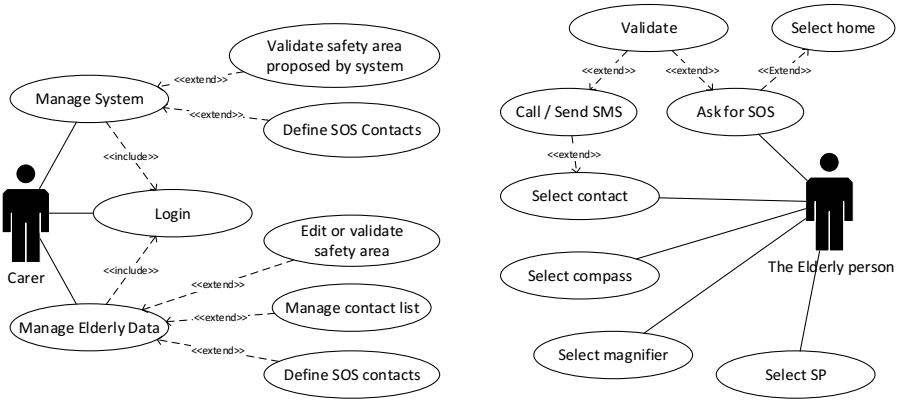


Fig. 1. C&M UML Use Case diagram

On the other hand, the functionality "Manage Elderly Data" concentrates the attention of the Carer on the elderly user. The definition of safety areas is one of its subtasks concerning the user's movement through exterior environments. If the user enters a zone outside the safe area, an SOS event is generated. The Carer can also manage the user contact list.

The Elderly Person. The elderly person is the central character in the system. On his/her needs everything hinges. He/she can select a safety point (SP) as destination from the available SP list on magnifier mode. Then he/she might follow the orientation provided by the compass mode, which indicates the path from the user location to the selected destination.

At any location, if the user selects the magnifier mode, the system sorts the SP according to distance in order to inform him/her about the current location and the nearest SPs. If the system detects that the user has strayed from the safety area, or that he/she has fallen or is not adhering to his/her scheduled or common routines, it will trigger an SOS event and suggest to the user an "Ask for SOS" action. If the user ignores the action and remains outside the safe zone, the system will send a message to the pre-selected contacts. Otherwise the user can cancel or confirm the action.

The "Ask for SOS" action can also be triggered by the user if he/she becomes frightened. In this case, the system automatically selects home as SP destination.

Finally, the user can contact any relatives on the contact list by voice or SMS.

4.2 Interface Design

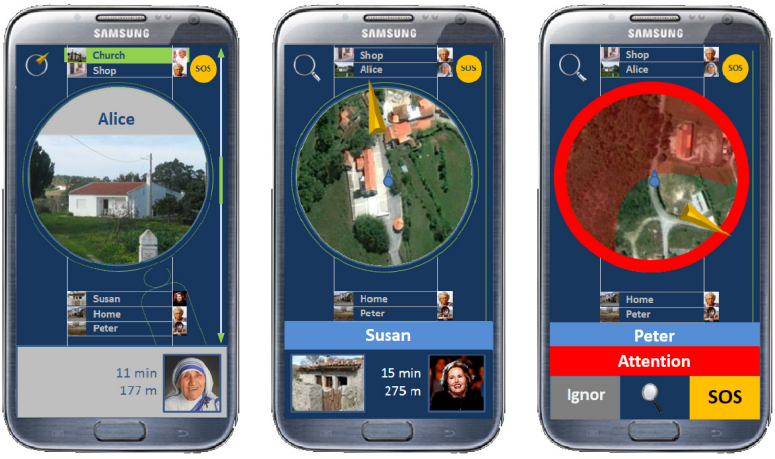
The main design concepts of this App are the two common physical tools used daily to assist people in doing some tasks: the magnifier is used to help see and read information, and the compass is used to find the way.

The App aims to summarise and show most relevant information at a certain moment, in a single and permanent circle that doesn't change when the screen is being turned round, Fig. 2. The user does not need to search for the information as it is always in the same place.

a) Portrait mode b) Lanscape mode

Fig. 2. C&M layouts modes

The main screen can be presented as a magnifier view or as a compass view, Fig. 3.



a)Magnifier view b)Compass view c) Out of safe zone Compass view

Fig. 3. C&M views

When the user stops, the App screen shows the magnifier view, Fig. 3 a), which allows the user to select a certain target. When the user is moving, the App screen shows the compass view, Fig. 3 b), which gives directions to the selected target. If no target is selected, the user's home will be the system's default. For both views, the same circle occupies the centre of the screen. Alternatively appears the "handle" of the Magnifier or the "pointer" of the Compass.

The user can switch between views, tapping the corresponding object icon, the compass or the magnifier, see Fig. 3, a), b) and c) upper left icon.

An arrow at the right hand side locates the position of each menu that accompanies a list of points of interest (also named as Safe Points), available targets.

These places are identified by their name, by the photograph of the main façade of the building / location, and if available, by a photograph of the main person connected to that building/location.

Although we intend to allow some other combinations or styles, this first prototype of the interface is presented in dark blue, with quite a large font size in white. This is considered a good compromise between contrast and readability.

5 Final Considerations and Future Work

ICT can make key contributions to the independent living of the elderly. In this paper we present a prototype of an application for mobile devices, such as androids or smartphones, called Compass and Magnifier. It seeks to promote people's confidence in maintaining daily mobility, realizing the importance of those daily activities for active ageing.

Considering the UCD methodology we have developed an initial prototype based on previous and related work. We have described it in this paper as well as the main system functionalities and some of the interface design criteria.

We are aware of the fact that this work is still in its early stages. However, the solution we have encountered already satisfies some of the main requirements identified. It is based on strong metaphors and allows us to progress with consistent interfaces and menus, among other important statements.

In the next stage we will evaluate this prototype and redesign some of its features, with the participation of an elderly target group. Some requirements relating to the carer's point of view will also be developed. In the end we will have designed an application that helps to achieve our main goal: contributing to the elderly's health and wellbeing based on the potential of ICT and mobile devices.

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