A Mobile Guardian Angel Supporting Urban Mobility for People with Dementia

An Errorless Learning based Approach

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Abstract: Dementia is one of the main causes of dependency for old people in the world, and, according to several studies, the number of people affected by such a problem is bound to grow significantly in future. This represents a high social cost. Memory loss and disorientation to space and time are among the most common problems in the early stages of dementia, causing worry in caregivers and consequently social isolation for the people involved. A mobile system in support of the autonomous mobility around town would offer a double advantage: allowing for more independence of the dementia affected people and reassuring caregivers. In this paper, we discuss the possibility of adapting an existing mobile system, developed for intellectually impaired young adults, to these specific target users. We identify in the errorless learning approach a possible method to support the learning of a new, technologically based system accessible to people with mild dementia, highlighting some potential issues that still need further investigation, in particular learning transfer and spontaneous use.

1 INTRODUCTION

According to several studies, the number of people in the world that have some sort of dementia is very large and will probably increase in the next years. Among the early symptom of dementia, the most frequently reported ones are loss of memory and disorientation to space and time. Therefore, people who have dementia in its early stages start having difficulty in finding their way, they wander with no apparent destination, they feel lost and sometimes actually lose their way.

Wandering and getting lost is one of the main concerns of families and caregivers. They have a lot of pressure and responsibilities, and often end up limiting the person's access to outdoors. Moreover, people with dementia themselves are aware of the issue and often feel insecure with the fact that they may not know where they are and what time of the day it is, therefore they limit themselves or accept the imposed limitations. Locked doors cause social exclusion and reduce the person's interests and activities, also causing the illness to get worse in a shorter time.

Having a system in support of the personal independence of people with mild dementia, by allowing and aiding their free movements around town would give them more freedom and the possibility to lead a more active life for a longer time. At the same time, such a system would offer families and caregivers a tool to keep in touch with their cared ones and always know where they are. People with dementia would find a support to tell them the time, guide them home, offer the possibility to get in touch with a friendly voice and ask for help when needed with a simple press of a button.

In this paper, after introducing the most common problems that characterize the early stages of dementia, we discuss how a platform supporting urban mobility could be adapted to maintain, as long as possible, the mobility of these new target users. Issues related to learning and being able to use the new technology from people with mild dementia are discussed, along with a feasible methodological approach to address them.

2 SETTING THE SCENE

Dementia is not a specific disease, but rather an overall term that describes a wide range of

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symptoms associated with a decline in memory, thinking and social abilities. In order to be classified as dementia, the decline has to be severe enough to reduce a person's ability to perform everyday activities (Committee for Medicinal Products for Human Use, 2008).

Although dementia mainly affects older people, it is not a normal part of ageing, but rather the consequence of some disease of the brain that influences its functionalities. Alzheimer's disease accounts for 60 to 70 percent of cases, vascular dementia, which occurs after a stroke, is the second most common dementia type, together they account for about 90% of the cases.

Dementia is one of the major causes of disability and dependency among older people worldwide: according to the World Health Organization (WHO) (World Health Organization, 2012), in 2012 35.6 million people had dementia. The total number of people with dementia was projected to almost double every 20 years, which means 65.7 million in 2030 and 115.4 million in 2050. About 150.000 new cases per year have been estimated in Italy only (Di Carlo et al., 2002).

Dementia has significant social and economic implications in terms of direct medical and social costs as well as the costs of informal care. The WHO estimated that in 2010, the total global societal costs of dementia was around 1.0% of the worldwide gross domestic product or 0.6% if only direct costs are considered.

Furthermore, dementia is devastating for the families of affected people and for their caregivers. Physical, emotional and economic pressures can cause great stress to families and caregivers, and support is required from the health, social, financial and legal systems.

Within this frame, loss of memory and orientation to space and time is a key issue in the early stages of dementia. When the illness is still in its mild or moderate stages, the person with dementia would still be capable of moving around town and leading an active life. Nevertheless, people with dementia report difficulties in living with the insecurity that you do not know where you are and what time it of the day it is (Harris, 2006). Unfortunately, the person's freedom is often drastically reduced, when not completely stopped, by caregivers, who do not feel at ease when letting their assisted ones free to move alone. People with dementia are frequently denied the basic rights and freedoms available to others, the limited or restricted access to outdoors also causes them to be socially isolated. These issues could be alleviated with the use of technology (Topo, 2008), which can be helpful in providing specific support and therefore allowing more freedom for the person with dementia to move around town in an autonomous manner.

Giving people with mild dementia a system that can offer them a guide and help, which is always present but not invasive, means giving them the chance of being socially active for a longer time, keeping up their interests and, therefore, slowing down the progression of the illness. Furthermore, the system would increase safety of the person and offer support and reassurance to caregivers.

3 TOWARDS INNOVATIVE AIDS

In a previously developed project, "Smart Angel", a cloud based mobile system has been developed with the aim of supporting urban mobility of people with intellectual disabilities, in particular young adults with the Down syndrome. Our position is that the system, after being specifically adapted to the different target population, could be effective also in supporting and enhancing the orientation abilities of people with mild dementia.

3.1 The Smart Angel Project

Smart Angel (Smart Angel, 2014), an Italian regional project co-funded by the Liguria Region, aims at favouring social inclusion of people with intellectual disabilities by offering them accessible tools supporting their daily activities and urban mobility. The name "Smart Angel" wants to recall a guardian angel, always at the person's side, providing help when needed in a non-invasive manner.

Supporting the urban mobility of intellectually impaired people is a key issue to promote and enhance their full autonomy. Thus, one of the main aims of the Smart Angel project was to enable them to move around in the urban context and reach relevant places (workplace, leisure, sports, home) by themselves. This was done by relying on last-generation existing technologies.

The project has been organized in a first training phase in which the users' orientation and mobility skills are stimulated and trained by means of ad hoc developed Serious Games, which make use of innovative virtual reality devices (Freina, Busi, Canessa, Caponetto, and Ott, 2014) (Freina and Ott, 2014). After this phase, the users start to move around in their town and to get confident with places and public transports. At the beginning, they are

closely supported and monitored by their educators. As the user's skills grow, the links with the educators get looser until they are allowed to move around in complete autonomy (at least along the established paths) by relying only on the help of mobile devices. Actually, this phase makes in-depth use of both cloud and mobile technologies (Costa, Freina, and Ott, 2015).

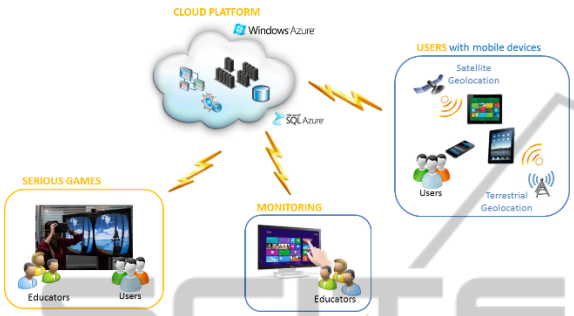

Figure 1: The Smart Angel System.

A central cloud based platform collects all the users' data and connects the other elements of the system. Each user has his own smartphone, equipped with specific apps, which allows him both to get appropriate support during daily standard activities and to move safely around town. A combination of satellite and ground localization systems is involved in tracing the users' movement.

3.2 Adaptation of Smart Angel to the New Target Population

The Smart Angel system has been developed for a target population of intellectually impaired young adults who have the abilities, either potential or real, to move in town autonomously. Therefore, attention has been focused on the development of basic abilities and specific support to mobility. The typical Smart Angel user is born in the digital era and is acquainted with technology; they usually have their own Smart Phone, which they used before entering the project and learning a new app is considered a fun activity.

People with dementia, on the other hand, are usually aged and often have very little know-how with respect to the new technologies. Furthermore, they do not need to learn new abilities for moving around, but rather to maintain already known skills as long as possible. The basic functionalities needed to support free mobility are the same, but the user interfaces, as well as the initial intervention needed to get the user acquainted with the new technologies differ deeply.

It has been demonstrated that old people with mild dementia symptoms can benefit from the use of user-friendly technologies, even though they need ongoing education and support (Hanson et al., 2007).

4 AN INSIGHT INTO A POSSIBLE METHODOLOGY

As reported in literature, the use of technologies, both new and known ones, is possible for people with dementia in its mild stages (Robinson, Brittain, Lindsay, Jackson, and Olivier, 2009).

Robinson et al. report the development of a technological system to support the independence of people with dementia. Interestingly, the final users have been closely involved in the definition of the system to be tested, and the key issues to be addressed were related to concerns about getting lost, loss of confidence, which caused to the reduction of daily activities and caregivers' anxiety. The use of some tracking technology and the constant possibility to get in touch with one another was considered as a good opportunity for caregivers to give virtual support and give the person with dementia more freedom.

Personalized solutions have been developed to address some important drawbacks: the size of the devices (the commercial ones were either too heavy and awkward to carry or too small and difficult to handle) and the fact that people with dementia may have weak vision, making the use of the commercial devices even more difficult. Today, these issues can be easily solved thanks to the new technologies, which, on the one hand offer tools that are small and light, while, on the other hand, thanks to special interfaces, can easily overcome the limitations due to sight impairments.

Robinson et al. focus also on the reported concern about social stigmatization: people participating in the project wanted a system to guarantee them a two-way communication and guide them home that had to be flexible and discreet. This issue is now automatically solved since the use of smart mobile phones, equipped with navigation systems and vocal interfaces has become widely spread. Nobody would regard as strange speaking on the phone, using a GPS navigation system or interrogating a smart phone while walking around town.

The reported experiments focused well on user requirements, design and prototyping, but did not

investigate on the solutions being actually used and being effective. It would be of great interest to explore which could be a possible methodology to teach the target population the use of the new technological tools in such a way that these tools would actually be used effectively in real life. It appears that the errorless learning approach could be the answer to this issue.

4.1 Errorless Learning

The concept of errorless learning has been introduced by Terrace (Terrace, 1963) who used it to train pigeons in discriminating red and green lights. In the errorless approach, the aim is that of significantly reducing the error rate. People learn by performing the same operation repeatedly, just like the trial and error approach, but in this case, specific attention is put on minimizing the number of errors.

Learning through trial and error requires the learner to recognize when and where the error occurred in order to resolve it. The explicit memory is responsible for the recognition and correction of the errors; this requires good skills of analysis, which may be compromised in people with dementia. If the error is not recognized as such, it could be encoded into memory, which would result in wrong responses later or conflicts between the correct and the erroneous information. The errorless approach, based on avoiding errors as much as possible, minimizes this problem (Clare et al., 2000).

Different methods can be employed to minimize errors during the learning phases, depending also on the type of skill that has to be learned. For non-procedural knowledge, spaced retrieval (in which the information is rehearsed repeatedly with increasing intervals between rehearsals) and vanishing cues (in which the amount of cues given is enough to be successful and is then reduced, keeping it always at the minimum number required for success) are the most used techniques. A stepwise approach is suggested for the procedural knowledge.

4.2 Errorless Learning and Dementia

According to de Werd (de Werd, Boelen, Olde Rikkert, and Kessels, 2013), people with dementia still have the ability to acquire meaningful skills. In particular, he reports the errorless approach to learning as being more effective than other approaches in teaching adults with dementia. He presents various works based on the errorless approach, reporting positive and long lasting effects in learning the use of technological devices from people with dementia: gains are generally maintained at follow-up. In most cases novel tasks were learned, in other cases familiar but forgotten tasks or information were relearned.

People with dementia usually need a continuous support in order to maintain their existing skills: reinforcement may be frequently needed. Therefore, caregivers would have to be involved in the learning process. Even if attention has to be paid in order not to overload them with responsibilities, they are fundamental to train and maintain the newly learned skills in the home environment.

In our case, we affirm that an errorless approach could be used to teach people with mild dementia how to use these new tools in order to have the best possible support in their movements around town. Such training has to be specifically studied keeping in mind the distinctive problems of the target population involved in the project, personalizing each training path to individual needs in order to stimulate and maintain, as much as possible, all the skills and knowledge that are still available to the user.

Furthermore, Nygård and Starkhammar (Nygård and Starkhammar, 2007) report that sometimes technology offers people with dementia a feeling of safety that actually proves to be false. For example, they may feel safe because they are carrying a mobile phone and they are aware that they have the possibility to ask for help if needed, but they have actually never used the phone and may not be able to do so. In our case, this phenomenon will also be analysed. Even if the person may not be able to use the tool in a real emergency, the increase in his personal confidence resulting from the availability of the system may lead to a better quality of life. Moreover, caregivers would have the possibility to trace the person at any moment, relieving their level of anxiety.

4.3 Issues for Further Investigation

Even though the errorless learning approach, enriched with specific training sessions tailored to individual needs seems to be a feasible way to get the most out of our system, some main issues are still open and require further investigation. In particular, we can foresee three critical issues: physical management of the smart phone, transfer of the learned skills to new situations and spontaneous use of the tools when actually needed.

As far as the management of the smart phone is concerned, the users need to learn some procedural knowledge: sequences of actions to be performed at

certain times to guarantee its usability. In particular, they have to remember to charge the smart phone and to take it with them when leaving the house, after checking that it is switched on. This issue can be addressed by specific and fixed routines: in the sequence of actions, the previous one triggers the following step. For example, every time that the user enters the house, he has to put the phone in charge in a visible place near the entrance. When leaving the house, he has to take the phone, check that it is on, and carry it with him.

Learning transfer refers to the ability to use past experiences to do a new task or the same task in a new context (Barnett and Ceci, 2002). As reported by Bier et al. (Bier et al., 2008), sometimes in dementia learning is very effective, but transfer of the learned skills to a new situation which may be different from the one in which the skill has been learned can be difficult. There are several techniques aimed at minimizing this problem. For example, learning can happen in locations that are as similar as possible to the contexts where the skills will then have to be applied, i.e. the users can practice the use of their new devices while actually walking in the real roads of their town. Furthermore, specific tasks can be designed to stimulate transfer by asking the person to use the new skills in different, but similar, contexts. Studies reported by Bier et al. show that transfer is possible in mild dementia when the target situation is similar enough to the learning one.

The last critical issue that we have identified is related to spontaneous use of the learned new skills in everyday living, which has not yet been extensively studied in literature. As reported by Bier et al. (Bier et al., 2008), it may happen that a new skill is learned, but then the person does not spontaneously use it in everyday life, even when prompted to do so. In our case, in order to use the newly learned tools, the user has to be able to recognize the situation (i.e. he is having problems with his orientation to space or time), remember the information (remember that he has a tool that can be helpful and how to use it) and have an intention to do it. It appears that stressing situations influence negatively the users' performance, therefore, an action that may not cause any problem in a normal situation, may be impossible when the context becomes stressful. According to Nygård and Starkhammar, using a technological tool in case of an emergency outside the home is stressful, and therefore unlikely to happen (Nygård and Starkhammar, 2007).

5 CONCLUSIONS

Dementia appears to be one of the major causes of dependency for old people in the whole world. Among the most common symptoms of dementia, there is memory loss and weak orientation to space and time, which impact on the individual freedom to move autonomously around town, causing social isolation and limiting the person's interests and activities. We propose to use a cloud-based system, which has been developed in support of the urban mobility of people with intellectual disabilities and that can be adapted to people affected by mild to medium dementia. The system, which uses a set of specific apps on a smart phone and a combination of geolocation systems to keep track of the user's movements, offers him the possibility to receive help when needed, to get in touch with a friendly voice or to have suggestions to find the way back home. At the same time, the system would be socially discrete and non-invasive, guaranteeing the person's privacy and independence. Furthermore, while increasing both independence and safety of the person, the system would also support and reassure families and caregivers.

Several issues have to be considered to make this goal feasible. First of all, a specific adaptation of the tool has to be done in order to respond to the different needs of the users, making interfaces as simple as possible and straightforward to use (Bocconi, Dini, Ferlino, and Ott, 2006). Special attention has then to be paid to the introduction of the system into the users' lives. The errorless learning approach is probably the best way to teach people with mild dementia how to take care and use their new device. Individual learning paths need to be studied with the direct and continuous support of the caregivers and specific fixed routines are needed in order to guarantee that the users remember to charge their smart phones and carry them when leaving the house.

Some issues still need further investigation. The training phase has to be integrated with specific actions to foster learning transfer, helping the people with dementia to recognize those situations when the tools could be helpful even when they differ from the learning ones. Furthermore, spontaneous use of the new system still has to be investigated, especially with respect to stressing situations as may be emergencies or, simply, realizing that we have lost our way home.

A specific experiment is needed in order to find an answer to these research questions, which would give the community further insight on the learning

possibilities still available to people with mild dementia, as well as an assessment on the real advantages of the use of a simple mobile based system in support of their mobility.

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