*Wearable Technology* (2022) Volume 3 Issue 1, *pp.* 63–71.
doi:10.54517/wt.v3i1.1665

ORIGINAL RESEARCH ARTICLE

# Mobile assistive technology with augmented reality for the elderly

***Rafael Saracchini[1*], Carlos Catalina[2], Luca Bordoni[3]***

[1] *Departamento de Simulación y Control del Instituto Tecnológico de Castilla y León, Burgos 09001, España, Spain. E-mail: rafael.saracchini@itcl.es*

[2] *Departamento de Simulación y Control del Instituto Tecnológico de Castilla y León, Burgos 09001, España, Spain. E-mail: carlos.catalina@itcl.es*

[3] *Cooss Marche, Ancona 60100, Italy. E-mail: l.bordoni@cooss.marche.it*

## ABSTRACT

Technology offers many possibilities, but older people often do not fully enjoy these opportunities and are frustrated or afraid of these new devices. This has led to their gradual isolation in a society where different forms of communication through the Internet and ICT are essential. In this article, we describe a study conducted during the anconeal project, which aims to provide technical solutions for the elderly to provide autonomy and better quality of life in their daily activities by integrating information and communication technologies. In order to achieve this goal, advanced augmented reality (RA) technology and Internet services and mobile device interfaces specially designed for the elderly have been developed. These technologies use the underlying structure of most home and geriatric care centers. We propose a prototype system composed of tablet computers and portable RA devices, and analyze the impact of society on user interaction, as well as the evaluation of acceptability and usability. The assessment was conducted through focus groups and individual pilot tests with 48 participants: The elderly, caregivers and experts. His comments concluded that older people have a strong interest and interest in RA based nursing information and communication technologies, especially those related to communication and autonomy.

***Keywords:*** assisted living; augmented reality; information and communication technology; media literacy; cognitive stimulation; the elderly; learning

## 1. Introduction

Today, everyone agrees that we live in a developing society and rely more and more on new technologies to promote this change. This continuous change affects members of society because it involves the cost of adapting to all these new habits and practices (time, effort, etc.). In many ways, the growth rate and the breadth of this change have led to the widening gap between social members, which is difficult to adapt. Citizens aged 65 or over, that is, the elderly, suffer because of the inherent limitations of the aging process. Stereotypes that link age

**ARTICLE INFO**
Received: February 15, 2022 | Accepted: March 28, 2022 | Available online: April 14, 2022

**CITATION**
Saracchini R, Catalina C, Bordoni L. Mobile assistive technology with augmented reality for the elderly. Wearable Technology 2022; 3(1): 63–71.

to resistance to change and inability to learn new strategies undermine their integration and quality of life in a growing digital society. This raises a serious social problem, exacerbated by the trend towards marketing to young audiences[1] or focusing on technically experienced users[2], and further exacerbated by increased social isolation due to age.

According to the 2014 report of Eurostat[3], the number of elderly people in the EU has accounted for 18.2% of the current population and is expected to increase to 31.3% within 20 years. In particular, Italy is the European country most affected by this problem: About 250,000 Italians are affected by Alzheimer's disease and a considerable number of dementia[4], which highlights the need for continuous assistance from nursing staff and ICT equipment to such patients.

Contrary to some common beliefs, older persons are aware of the importance and benefits of ICT, regardless of gender or level of learning, as shown by the studies of Agudo, Fombona and Pascual. It was noted that ICT was mainly used for social and entertainment, such as connecting with friends and family, or creating multimedia content. In particular, older people are easy to accept multimedia applications, such as video conferencing and online video, to supplement their daily activities.

A new method of providing multimedia and interactive assistive technology content is augmented reality (AR). This method includes superimposing animation or image on the image taken by digital camera. This technology is considered by educational researchers as a very powerful interactive tool[5] for visualizing complex structures[6], educational games[7] and design-based learning[8], thus improving students' learning motivation. Usually, these contents are provided through subscription stand-alone, tablet or mobile phone, and this function is integrated into some assistance systems[9]. However, these technologies are accepted, as shown by Hernández et al[10], this is not a simple usability or design issue: They should not be just tools to replace lost things, but tools for personal development.

An important observation in his work is that the conclusion is that the adaptation of ICT to older persons may be necessary, but this does not mean that it is a sufficient condition to ensure their use of technology. The device must be customizable, modular and scalable, especially for the elderly population with increasing individual differences.

Therefore, this flexibility to the personal needs of the elderly is an important part of the design of new technologies.

Computers and tablets require constant interaction and operation, which may not be enough to provide convenience for the elderly[11]. The six-sense project shows that using AR and a set of camcorders and picoprojectors, realistic visual tracks can be added to the user's environment, which is possible to interact with users. Advances in AR and simultaneous localization and mapping (SLAM) methods[12] eliminate the need to introduce AR markers and adapt the environment for their use.

The purpose of the Nacodeal project ((Natural Communication Device for Assisted Living) is to develop a new elderly care system aimed at promoting social integration through information and communication technologies. It provides a boot and communication service using two devices. The first is tablet computer, which contains a specially developed software to meet the needs and requirements of end users. It can be customized and accessed by different types of users. The second is a new type of Augmented Reality Technology[13]: A portable device with picoprojector and built-in camera, which uses the three-dimensional map of the environment to locate and locate users and truly project information (**Figure 1**).


**Figure 1.** Traditional AR (left) information is displayed on the

screen. In fact, on the website (right), information is projected and observed in the environment.

Using this technology, it is possible to create user-friendly guides, so that your users can perform their daily activities and access online services that are relevant to them. In order to meet these conditions, the following requirements are formulated:

• The system needs to determine the user location and equipment direction of AR in real time and automatically display the content.

• It must be suitable for care and rehabilitation centers without the need for complex infrastructure or expensive equipment.

• Users will interact with the system through a mobile interface (tablet) suitable for their cognitive level.

• It must be a bridge between ICT, end-users and their families and caregivers without changing their daily lives or reducing their mobility.

• You should change as few elements as possible.

These requirements cannot be achieved by WIFI or RFID triangulation because they cannot provide precise location and direction for portable devices, and the infrastructure required in this case is complex and expensive for most people.

• The visual slam/AR approach can meet these requirements by using components such as webcams and computers.

In order to assess the effectiveness of the proposed system, a study was conducted on voluntary older persons, caregivers and experts in Italian care centers to determine the benefits of social interaction and desirable features in terms of content, function and availability. The next section will outline the auxiliary system and its details in the verification process.

## 2. Design and verification methods

### 2.1. Auxiliary system

The system aims to take advantage of the resources available in most homes and public places: An open Internet access point. Its components are divided into two categories: Remote infrastructure, a web-based service used to manage the content of the display system; local infrastructure, a device installed in a medical center or home, and an interface device that interacts with end users (**Figure 2**).


**Figure 2.** Design the experiment assistant system.

The design of the system considers two main roles: Content creator and end user. The content creator is responsible for the creation and programming of multimedia content, which must be displayed by the auxiliary system. This person (or group of people) can be a caregiver, doctor, family member or behavioral specialist, and interacts with the system via a web interface accessible through a computer or smartphone. The end-user is the older person, who is provided with the content via the tablet and the portable AR device, called DC-PAR (device with a pico-projector for augmented reality) (**Figure 3**).

**Figure 3.** Interface devices: Tablet (left) and dcpar prototype (right).

A key concept of this design is that neither participant needs more knowledge than is required to use other common household appliances. Content creators must know how to navigate on ordinary websites, how to create or edit digital photos, presentations and movies, or at least how to play existing content. End-users only need to have a basic understanding of how to use the functions of

tablets, and they can receive content through AR without professional knowledge. In addition, due to the capability of wireless devices, users should not stay in a fixed place because of the requirements of desktop computers. This allows you to complete your daily life with minimal interference.

• Web interface and database. The main purpose of the web interface is to make it easier for authorized content creators to include multimedia content and to determine where and under what conditions AR content should be displayed. This information will be stored in a remote database that will be accessed by local infrastructure components. Possible services include: Personal agenda and timetable; SMS, telephone, IP voice and online chat; newspapers and magazines; memory practice and treatment information; educational videos related to topics of interest (cooking, handicrafts, etc.); maps, including potentially dangerous advertising spots; content generated by family members: Videos, photos, or music.

Content creators can customize services according to users' needs and habits. In addition, each field and its related services are designed according to the user needs collected in the specific content analysis[14,15].

• Personal computer. The augmented reality PC is a dedicated server connected to a wireless connection point. As the processing center of the system, it is not affected by the weight, power consumption or ergonomics of handheld devices. AR PC automatically distributes video and audio content transmitted to tablets and dcpar in real time, and monitors the database at specific time intervals to collect planned changes. It is also responsible for implementing augmented reality algorithms, environment recognition and determining the direction of dcpar by processing the data transmitted by the camera. Other services, such as facial recognition or behavioral analysis, can be included as software updates to avoid hardware changes. The component is designed to be highly automated and, like any other household appliance, displays content when the power is turned on. In an environment with multiple end users, such as a nursing center, the system must be managed by an operator (such as a nurse or geriatrician).

• Tablet PC. This is a commercial tablet with intuitive software and guidance assistance system, which is built according to the guidance and treatment standards in reality to help people with cognitive problems. Treatment allows users to stimulate them throughout the day through a continuous flow of information related to their personal data, time and space. It helps older people establish coherent cognitive representations to better understand their surroundings and their role in them[16]. The software interface is designed to simplify users' navigation in services and applications and constantly stimulate users' memory. Tablets contain four main applications: Calendar, conversation, games and entertainment. Each area represents a specialized service that promotes brain activity during use and helps remember daily appointments and to-do items.

• DCPAR. The prototype is a portable device, including an integrated camera, a pico-projector and a transmitter. It is contained in a 10 × 14 × 3 cm shell with a belt at the neck. Although this is a specialized hardware, low-cost components are used to make it affordable. As a video input and output device, it transmits the environment displayed by the camera, processes AR by PC, and preprocesses the generated image. This allows the automatic display of multimedia prompts related to the website. For example, when the user approaches the stove, he will issue a warning of potential risks. More practical content can be programmed, such as arrow guidance mode, which can be adjusted in real time according to the user's position.

• Installation. The wireless access point and the AR PC use the network available at the installation site, and are placed in a position with good wireless coverage. In order to make the recognition and location algorithm of augmented reality work correctly, the three-dimensional map of the environment must be prepared in advance. This step is

performed using specialized software[13], which runs on a laptop connected to a depth sensor (such as Microsoft Kinect), which scans the points of interest. The generated 3D map is stored in the database, and the content creator can configure the programming of RA according to the needs of users. According to the size of the scanning area, the scanning process shall not exceed two hours. Once completed, the attendance system can be used. Any significant changes in the environment, such as painting walls, moving or changing furniture, may require rescanning because the positioning system is based on visual reference.

## 2.2. User authentication

In order to correctly evaluate the proposed design, it is necessary to analyze its use in the elderly, identify defects and deficiencies according to the needs of the elderly, and determine its specific benefits to daily life. Most importantly, in this regard, one of the key contributions that needs to be analyzed is to reduce social isolation and improve socialization, integration and interaction with older persons affected by temporary memory loss. Taking these factors into account, the trial was conducted in group meetings and pilot individuals, nursing homes for the elderly and health centres in the province of Ancona, Italy.

The system verification phase with users is divided into two phases: A focus group composed of the elderly, nursing staff and experts (performance test phase 1) and a conversation with the pilot individual in the actual scene (performance test phase 2).

The first part of the test—A group meeting—attempts to understand the views of older people on the two components of the care system through a focus group at each facility. The purpose is to help older people access this new technology and help them understand the services and applications included. These meetings can explain the functions and characteristics of the equipment and collect preliminary opinions. An expert group was requested to assess these devices and their interaction with older persons. As a non-medical preventive measure, the system is not suitable for patients with serious cognitive problems. In addition, the clinical dementia score (CDR) scale[17] is used as a reference in the participant selection process. These tests were conducted for people with CDR 0 to CDR1 (**Table 1**).

**Table 1.** CDR scale and related cognitive status

| CDR scale | Cognitive state | Definition |
|---|---|---|
| CDR 0 | No cognitive impairment | Normal memory, no memory loss or slight and inconsistent forgetting. People are completely people-oriented and live independently. Able to maintain social relations, as well as intellectual interests and hobbies. |
| CDR 0.5 | Suspicious cognitive impairment | Mild forgetting, partial retention events, but with good guidance ability. Slight difficulties in solving problems and social relations. Slightly affected and in need of help in family activities and personal care. |
| CDR 1 | Mild cognitive impairment | Moderate memory loss, more sensitive to recent events and interfering with the development of daily activities. Moderate time orientation difficulties and certain geographical orientation obstacles. Unable to carry out daily activities independently. He needs help with dressing and personal hygiene. |

Together with the focus groups, the experts assessed the impact of the devices on social interaction, and how each of the individual applications of the system offered autonomy, well-being and happiness. They also assessed which apps end users liked best and how the use of social networks generated new interest among older people. Finally, other aspects are evaluated, such as tablet availability and the functions required in dcpar. The first coordination group was established in chiaravalle, located in La Ginestra nursing home, with 12 participants, including the elderly, caregivers and experts. Seven volunteers participated as pilots and two volunteers as observers. The expert group consists of asylum coordinators, Alzheimer's specialists and operators responsible for recreational activities.

The second group is in Jesus, in Victor Emanuel II sanatorium. The group consists of a larger

group of participants, most of whom are simple observers (4 pilots and 8 observers). The care coordinator, a member of the Alzheimer's Marche Association, a social health worker, two operators responsible for recreational activities and a family member of an elderly person assessed these devices and their use.

The third focus group is located in the Visintini care center in Falconara Marittima, which is dedicated to patients with Alzheimer's disease and Alzheimer's disease. The focus of this group was to assess the interaction of older people with more serious cognitive problems, which was significantly lower than that of the previous group. The team was supported by the day center coordinator, psychologists specializing in cognitive impairment and center volunteers.

The second test involved 13 pilots: 10 women and 3 men, with an average age of 80.3 years. Their physical and cognitive status varied: six of them were in wheelchairs due to physical pain or illness; There were 2 cases of mild cognitive impairment (CDR 0.5 and 1), and 5 cases of physical and mental health. All but three participants lived in the test facility: One lived in his own house, and two lived in the city center during the day, but returned to their families at night (**Tables 2 and 3**).

**Table 2.** Phase 1 performance test—Focus group sessions

| | **La ginestra** | **Emanuel** | **Visintini** | **Total** |
|---|---|---|---|---|
| Install | Nursing center | Nursing center | Health center | |
| Total number of participants | 12 | 18 | 5 | 35 |
| -The elderly in the second test | 7 | 4 | 2 | 13 |
| -Observers | 2 | 8 | 0 | 10 |
| -Expert | 3 | 5 | 2 | 10 |
| -Technician/Researcher | 0 | 1 | 1 | 2 |

**Table 3.** Phase 2 performance test—Pilot individuals and CDR status

| | **La ginestra** | **Emanuel** | **Visintini** | **Total** |
|---|---|---|---|---|
| Main users involved | 7 | 4 | 2 | 13 |
| CDR 0 | 2 | 2 | 0 | 4 |
| CDR 0.5 | 3 | 2 | 1 | 6 |
| CDR 1 | 2 | 0 | 1 | 3 |

# 3. Results

## 3.1. End user response

Among the elderly who participated in the individual pill test, 30.8% completely relaxed during the test and 30.8% fully relaxed, which means that 61.6% had a positive opinion. The rest (30.4%) felt uncomfortable, although no one completely rejected the device. This response is considered normal because this target group is unfamiliar and has a certain degree of resistance to its use (**Figure 4)**.

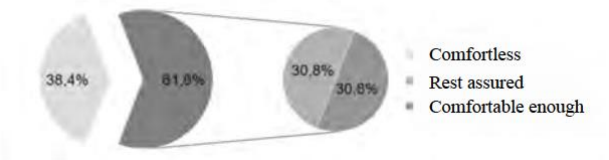


**Figure 4.** Focus group acceptance of equipment.

Most of the opinions collected after the tablet test were positive. Almost all the elderly interviewed felt ashamed and unsafe at first, followed by curiosity and enthusiasm. Older people believe that tablets are "a good tool to keep in touch with family and friends" and that having a "simple visit" can promote their "healthy and not lonely thoughts..." Many of them, after initial resistance and fear of novelty, learned to easily operate tablets and DCPAR. Once you understand its functions, you will show enthusiasm and willingness to learn more about the functions it contains. This gradual participation has led to positive cooperation, but it has also produced two key problems: The problem of equipment dependence and the treatment of negative reactions of the elderly, as well as the disappointment after the test. Experts believe that the problem of "addiction" is normal in this target

group. They are usually lonely, have few social opportunities, or live in a monotonous life with few cognitive stimuli, so they appreciate any form of hint to exercise their memory.

• Tablet PC. According to the survey results, the favorite service for the elderly is photo library (46.2%), followed by video and television (23.1%). The proportion of phones and Mensa Jeria and music players is similar (15.4%). Participants are not interested in other applications. In fact, they mainly focus on content related to family and friends. Specifically, participants with cognitive problems felt that the agenda was too difficult to use.

Participants wanted to improve photo albums and music applications, especially in terms of music volume (hearing problems) and image size (vision problems). Tam Bién said they wanted more multimedia content and a more intuitive interface in their era (**Figure 5**).

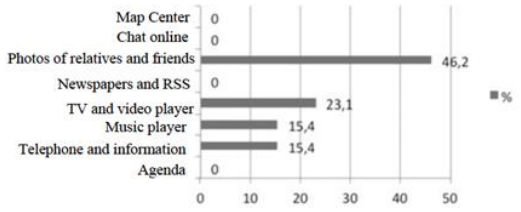


**Figure 5.** The preferred service among the services provided by tablets.

• DCPAR. In general, they find DCPAR bulky and sometimes difficult to correctly understand its purpose. Nevertheless, most of them can still use the functions of tablet and AR with a high degree of autonomy. In terms of its function, users are very satisfied with the ability to show pictures and films on topics of interest such as relatives or sports or religion. The responsiveness of the device is considered to be sufficient by properly adjusting the geometric environment of the projected image. Compared with the difficulties encountered on tablets, the most expected function of dcpar is that family members actively view the content they produce and use it as an agenda (**Figure 6**).

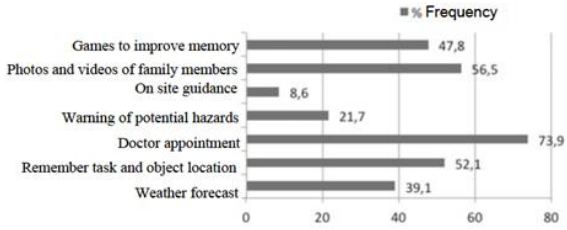


**Figure 6.** Function frequency requested by DCPAR user.

An important problem related to equipment ergonomics was found: The image quality was lower than expected due to the user's posture and the tilt of Pico projector. In addition, it is considered uncomfortable because it is worn around the neck and may increase the problems caused by osteoarthritis common in the elderly.

## 3.2. Caregiver response

Caregivers believe that the nursing system is a good support tool, but it is still too complex to be used independently by the elderly, especially if the elderly have any physical or cognitive problems. This view was supported by the subjects and their families, who suggested improving some user interface details, such as "keyboard size" and the full participation of caregivers, "they must play a central role in approaching the elderly and training in the use of new technologies". They also noted the addition of exercises to promote partnerships between places and images as a means of stimulating spatial perception in a facility or home environment, and introduced the possibility of video chat with friends and family.

Caregivers believe that the use of the proposed system may vary depending on the use environment. In the homes of the elderly, it helps to remember appointments and events, as a barrier warning system, as a reminder of the correct medication, as a television system with its own social network, and as a means of stimulating short-term memory and user interest. In a care center, the system is important to improve the relationship between users who use it as an entertainment device, remember daily plans and time and activities, and it can also help identify objects on the scene by associating the names of RA projections.

Nurses observed how users and nearby elderly people appreciated DCPAR images. It was also used as a tool to stimulate mobility in the elderly: Subjects were pushed to the room of the scene for investigation and often walked during the pilot test. Due to the perspective, it is difficult to be used for people with physical problems (such as the elderly in wheelchairs) and it is difficult to wear it for a long time. These are the weaknesses of the system. In addition, it is recommended to rearrange the help of caregivers or family members to manage appointments and user personal data in the online database.

Finally, caregivers have found that the best way to encourage the use of ICT equipment is to approach gradually at an early stage with the continuous help of "coaches" (such as caregivers or family members). This new technology approach requires the participation of people in the user's circle because they are more willing to cooperate with them than strangers. Another way to expose the elderly to the system may be through recreational activities, such as educational games. Experts involved in system validation believe that the elderly must participate from an early stage to avoid their tendency to isolate themselves. It may be an excellent tool for patients with Alzheimer's disease and contribute to non-drug treatment, although in this case, the user needs the support of the operator.

## 4. Conclusions

The analysis of users' needs and their acceptance of Pro technology solutions show how important it is for the elderly to keep in touch with others in order to actively stimulate their cognitive function and avoid social isolation. In the prototype verification phase, relational components have been carefully considered to understand the actual value of the technology under test and its ability to effectively affect the market. The results show that most elderly people want to participate in the digital process, but pay special attention to their prior knowledge and experience, which requires a deep understanding of their learning time. Most of the difficulties encountered are related to the level of internality and usability of the interface, rather than people's interest or understanding of ICT. This reinforces the view that "these older people need and desire to learn, and they see this moment in their lives, the moment when they are close to ICT.

Augmented reality technology provides automatic context detection and real environment information input, which plays an important role in the auxiliary system. Compared with tablet computers, the system can interact with users autonomously and provides the concept of "personal support" to help users complete tasks, rather than deviating from normal procedures when they want to enjoy the benefits of ICT. This feature may improve their mobility, and the information provided to the elderly who temporarily lose the memo will become an added value, or better "added" value, expressed in the most accessible channel for the target group: The link between experience and image. According to cognitive neuropsychologists, the matching of auditory or written images and information can promote and stimulate brain activity and help the elderly maintain good memory for as long as possible[16,18]. The analysis conducted in this study produced some valuable information, which is valuable for the design of AR devices for the elderly. Due to the participation of users and experts, the prototype is too large and cumbersome. The device should be designed in a more ergonomic way, and if it is expected to be used continuously and continuously in the user's life, it should have minimal difficulty in projecting the image into the field of view. In order to achieve this goal, the miniaturization and ergonomics of portable electronic devices should be further studied.

More tests are needed for older people living alone. Their needs and views may be very different from those of other people who often contact nursing staff, which is not included in our survey. At present, we are conducting research with volunteers in this situation to measure the possible impact of the proposed system.

It can be concluded that supportive technology solutions are a step towards the introduction of ICT to older persons and have a potentially beneficial impact on their lives. Tablets and depart have the potential to promote social interaction, virtually stimulate cognitive processes, and improve their self-sufficiency and quality of life. The system refuses to become a simple tool to compensate for the impact of information and communication technologies deemed unnecessary by older persons[10]. On the contrary, this technology has the potential to complement the current stage of personal growth, provide access to educational and entertainment content, and enable older persons to avoid the impact of social isolation by maintaining contact with family, friends and society. Future research will consider improving this technology to achieve the following objectives:

• Ensure that elderly people living alone can keep in touch with friends and family.
• Promote the autonomy of older persons through educational content and assistance.

• By implementing a special care center in the system to improve the sense of security and tranquility, the center can provide rapid care.

With the "increase" of the elderly, it is expected that the integration of AR technology into mobile devices will make their contact with ICT and digital tools more natural and pleasant.

## Conflict of interest

The authors declare no conflict of interest.

## References


1. Cutler, SJ. Ageism and technology. Generations. Journal of the American Society on Aging 2007; 29(3): 67–72.
2. Prensky, M. Digital natives, digital immigrants part 1. On the Horizon 2001; 9(5): 1–6.
3. European Commision. Eurostat. Population Structure and ageing [Internet]. Eurostat Web-page; [cited 2014 Oct 9]. Available from: http://goo.gl/4gyNuI.
4. Chiatti C. The UP-TECH project, an intervention to support caregivers of Alzheimer's disease patients in Italy: Study protocol for a randomized controlled trial. Trails 2013; 14(1): 155.
5. Wu H, Lee SW, Chang H, et al. Current status, opportunities and challenges of augmented reality in education. Computers & Education 2013; 62(0): 41–49.
6. Arvanitis T, Petrou A. Human factors and qualitative pedagogical evaluation of a mobile augmented reality system for science education used by learners with physical disabilities. Personal and Ubiquitous Computing 2009; 13(3): 243–250.
7. Rosenbaum E, Klopfer E, Perry J. On location learn ing: Authentic applied science with networked augmented realities. Journal of Science Education and Technology 2007; 16(1): 31–45.
8. Bower M, Howe C, McCredie N, et al. Augmented reality in education—Cases, places and potentials. Educational Media International 2014; 51(1): 1–15.
9. Avilés E, Villanueva I, García-Macías J, et al. (editors). Taking care of our elders through augmented spaces. Latin American Web Congress; 2009 Sep 11. NYC: IEEE; 2009. p. 16–21.
10. Hernández-Encuentra E, Pousada M, Gómez-Zuñiga B. ICT and older people: Beyond usability. Educational Gerontology 2009; 35(3): 226–245.
11. Kurz D, Fedosov A (editors). Towards mobile augmented reality for the elderly. IEEE International Symposium on Mixed and Augmented Reality. NYX; IEEE; 2014. p. 275–276.
12. Henry P, Krainin M. Rgb-D mapping: Using kinect style depth cameras for denser 3D modelling of indoor environments. The International Journal of Robotics Research 2012; 31(5): 647–663.
13. Saracchini R, Ortega CC. An easy to use mobile augmented reality platform for assisted living using pico-projectors. Computer Vision and Graphics—Lecture Notes in Computer Science 2014; 552–561.
14. De-Beni R. Psicologia dell'invecchiamento. Bologna: il Mulino, 2009.
15. De-Beni R, Carretti B. Come migliorare la memoria nell'invecchiamento. Padova (Italy): Psicologia Contemporanea; 2010.
16. The benefits of therapies activies such as reality orientation. Essay UK, 2014 Oct 9.
17. Herndon RM. Handbook of neurologic rating scales. New York: Demos Medical Publishing; 2006.
18. Mazzucchi A. La riabilitazione neuropsicologica. Premesse teoriche e applicazioni cliniche. Masson (Italy): Elsevier; 2008.