Towards Accessibility Guidelines of Interaction and User Interface Design for Alzheimer's Disease Patients

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Abstract—The number of people suffering from Alzheimer's disease is increasing. In a world which is more and more dependent on computing and Internet, this group of users is be-coming technologically isolated, due to the ill-suited design of user interfaces. Thus, in this paper, we propose a set of accessibility guidelines for designing user interfaces for adults diagnosed with Alzheimer's disease. These guidelines are identified after a comprehensive review of the literature. We identify 147 design guidelines that are grouped under 11 categories and 9 criterions. The aim of this work is to ensure that software applications and websites become accessible and easy to use to this demographic. The result of this work is a set of design guidelines, helpful for developers, designers, content producers, researchers and usability specialists. The proposed set of accessibility guidelines were applied for designing the user interfaces of a software application that target Alzheimer's patients (CAPTAIN MEMO memory prosthesis). Then, we evaluated the accessibility of the developed user interfaces. 24 Alzheimer's disease patients entered the study. The results confirmed that the developed user interfaces are accessible.

Keywords- Human-computer interaction; User interface; Accessibility guidelines; Design-for-all; Alzheimer's Disease

I. INTRODUCTION

The prevalence of Alzheimer's Disease (AD) is increasing rapidly [1]. The AD association reports that, in 2016, the worldwide prevalence of this disease is estimated at nearly 44 million cases. With aging of the population [1]-[4], this number will increase to more than 86.7 million cases by the year 2050 [1]. The annual incidence worldwide is estimated at 1.25 million cases, which is the equivalent of one new case every 25 seconds.

Individuals with AD present particular changes that differ from other user groups; parts of them are related to AD and the other parts are related to the expected effects of age. These changes impair individuals living with AD to use standard user interfaces. The difficulty in using user interfaces prevents individuals with AD from using software application and websites that can very well enhance their quality of life [5].

The design of user interfaces dedicated to AD patients should take into account their special needs to be accessible and easy to use [5].

A considerable amount of published works focused on designing user interfaces for older adults or people suffering from dementia. However, to the best of our knowledge, there is no work that defines a set of design guidelines for designing accessible user interfaces for AD patients.

The motivation for this paper arises from the growing number of AD patients and the number of technological advances that can enhance the lives of the AD patients [3], but are nearly unusable by them due to poor design.

In this paper, we propose a number of accessibility guidelines for designing user interfaces dedicated to people suffering from AD. The aim is to remove accessibility barriers. This work can be used as a starting point for designers, developers, content producers, researchers and usability specialists to set up application and websites projects for these particular users. Dementia is a degenerative brain condition which affects people at any age [5][6]. Its most common form is AD which, by itself, accounts for 50 to 80 percent of all dementia cases [4][6]. AD is a type of dementia that occurs most at the age of 65 years or older [6]. Thus, the set of accessibility guidelines, presented in this work, are mostly identified from relevant works on design of user interfaces for both elders and people with dementia available in the literature.

The remainder of this paper is structured as follows: Section II describes the methodology used to identify, extract and systematize the set of design guidelines presented in this paper. Section III reviews the characteristics of AD patients (AD-related changes and the age-related changes). In Section IV, a selection of the most relevant works on design guidelines of user interfaces for elders, people suffering from dementia, people with dyslexia and people with aphasia, available in the literature, are presented and summarized. Section V presents the proposed set of accessibility guidelines. In Section VI, we validate the proposed design guidelines on a software application that target AD patients (CAPTAIN MEMO memory prosthesis). At last, in Section VII, we conclude the present work and we propose some perspectives.

II. METHODOLOGY

In this section, we detail the methodology used to identify the set of accessibility guidelines presented in this work. We used a User-Centered Design (UCD) approach. The methodology is described in the following four phases:

Phase 1 -"Characteristics of AD patients": In a User-Centered Design approach, we firstly study the problems of the target user group.

Phase 2 – "Studies selection": From the literature, we select a set of the most relevant works that focus on designing of user interfaces for older adults, persons with dementia, people with dyslexia and people with aphasia.

Phase 3 – "Extraction": In this phase, we perform a triage to extract the design guidelines from the selected works identified in Phase 2. Then, we regroup the initial set of accessibility guidelines according to problems identified in Phase 1. Then, we do another arrangement process to generate unique guidelines and avoid redundancy, since many guidelines, from different authors, present similar statements. The final step in Phase 3 is to add, for each category, the missing design guidelines.

Phase 4 – "Consolidation": In this phase, we do another grouping process. We group the design guidelines, contained in each category, based on a similarity criterion.

III. CHARACTERISTICS OF ALZHEIMER'S PATIENTS

This section discusses the usual changes which accompany AD patient. Most people with AD are old. Thus, they have the expected limitations associated with the age [2]. So, compared to healthy young people, AD patients suffer from AD-related changes and age-related changes.

A. Alzheimer's Disease-Related Changes

We group the disabilities related to AD into the following five groups.

"Memory impairments" - The most common symptoms of AD is the memory impairments [1][4]-[6], especially the short-term memory that means forgetting the recently learned information. The semantic information is normally preserved in long-term memory [2], e.g., languages.

"Cognitive impairments" - The cognitive ability decline due to AD [1][4][5]. Cognition is the ability to think, to generate ideas, to focus on and to remember. AD causes a decrease in cognitive abilities, such as the ability to solve matters, level of intelligence, reasoning, judgment, capability to learn and speed of information processing.

"Attention and concentration changes" - People with AD experience changes in attention and concentration. They are more easily distractible by details and noise [23].

"Personality changes" - Persons with AD experience changes in mood and personality [4][6]. The national Alzheimer's association reports that over 40% of AD patients suffer from depression. AD patients may refuse to learn and they are anxious about new technology [3].

"Declining language abilities" - AD patients suffer from a decline in language and communication abilities [4][6]. In fact, AD patients in early stage can substitute the words that have the same meaning. Patients showing moderate sign of AD have an increased difficulty in naming things.

B. Age-Related Changes

We group the disabilities related to aging into the following six groups.

"Visual impairments" – The elderly suffer from a decline in their vision [2]-[4][6]-[11]. Aging is related to an impairment of near-focus including a computer screen [2][7][8], a loss in visual acuity [4][5][8][10], decline in dark adaptation [3][8][10], decrease in color sensitivity [2][3][7][8] and decrease in peripheral vision [2][7]-[10]. The Alzheimer's association estimates that up to 60% of person with AD suffer from a decline in at least one visual capacity.

"Hearing impairments" – Age is accompanied by decreases in the auditory acuity [2]-[4][6]-[10]. At the age of 65 years and above, over 30% of women and 50% of men suffer from hearing impairments [8]. The elderly may experience another complaint that they can hear others talking, but they can't make out the words [2]. They may have difficulty to follow the synthetic speech [3]. They find it hard to follow long sentences [9].

"Mobility impairments" - Adults experience a decline in their motor functions [3][4][6]-[11]. Old people with manual dexterity impairments find it hard to operate with the keyboard and the pointing device [3][7]-[9]. They may have difficulty to position the cursor if the target is too small [8][9], maintain continuous movements [3] and control fine movements [9]. Because of the reduced mobility, more errors may occur during fine movements [8][9].

"Decent/no computers skills" – The older generations are not proficient in using computer and related technologies [3][23].

"Decent/no literacy skills" – Nowadays, the illiteracy rate of adults aged more than 65 years are important [23]. In addition, many adults have basic literacy skills. They may not fully understand text-based information. Older adults may have difficulties with typing since they forget how to write correctly the words [23].

"Declining speech abilities" – The speech ability decrease with age due to the reduced mobility of tongue and lips [9]. The elderly have difficulty to pronounce complex words. Thus, inputs via the speech modality can be limited by voice tremors. The elderly need more time to produce words sentence [9].

Based on these changes, we are convinced by the fact that AD patients face several difficulties if we adopt standard user interfaces in software applications or websites.

IV. STUDIES SELECTION

From the literature, we select the most relevant seventeen works, published between 2005 and 2015, divided into nine works on design guidelines for older adults, four works on design guidelines for people suffering from dementia, two works on web accessibility and people with dyslexia and two works on design guidelines for adults with aphasia.

A. Review of Design Guidelines of User Interfaces for Elderly People

Works on design guidelines for older adults are divided into works for designing web pages [7][11][12], mobile user interfaces [13], multi-touch user interfaces [10], multimodal user interfaces [9], user interfaces for games [3] and user interfaces for both websites and software application [2][8].

Arch and Abou-Zhara [7] summarize the main age-related changes, addressing specifically, vision decline, hearing loss, motor impairment and cognitive effects. After,

they suggest teen accessibility guideline for designing websites and web applications.

Darvishy and Good [11] present 9 areas of guidance for designing elderly friendly web pages, e.g., structure, language, navigation and search. For each of these areas, the authors define a list of checkpoints which can be used to test the accessibility of web pages.

Zaphiris et al. [12] identify of a set of 38 age-centered web design guidelines which are grouped under 11 categories such as target design, links and navigation.

Al-Razgan et al. [13] discuss a set of design guidelines for touch based mobile phones that target old people. These guidelines are grouped in three categories: look and feel, interaction and functionality.

Loureiro and Rodrigues [10] identify a number of 113 accessibility guidelines that focus on the design of multi-touch interfaces for elders. The authors regroup the identified guidelines under 10 categories such as user cognitive design, text design and audio.

Jian et al. [9] review the changes related to aging, precisely, changes in vision, speech ability, hearing, motor abilities, attention, memory and intellectual ability. Then, they present a set of design principles for designing multimodal interfaces for the elderly.

IJsselsteijn et al. [3] review the expected changes related to the aging process specifically, changes in sensory-perceptual processes, motor abilities, response speed and cognitive processes. For each age-related change, they propose a number of accessibility guidelines for designing user interfaces of games that target elderly users.

Farage et al. [2] summarize the main age-related changes. The changes fall into several 5 categories: vision, hearing, touch and temperature perception, memory and cognition and balance and mobility. For each one age-related change are suggested a number of concrete design guidelines to attenuate these limitations.

Williams et al. [8] review the barriers the elderly face when using computer. Then, they present solutions for these problems. The difficulties are categorized into: cognition, auditory, haptic, visual, and motor-based troubles.

B. Review of Design Guidelines of User Interfaces for People Suffering from Dementia

Friedman and Bryan [14] are the first to formally present a set of web guidelines for designing user interfaces targeting people with cognitive disabilities, including AD patients.

The Web Accessibility Initiative (WAI) proposes a set of guidelines of web guidelines for people with cognitive or neuronal disabilities and the accessibility barriers to this target user group [15].

COGA presents the results of a study conducted to identify matters and solutions concerning web accessibility for person suffering from cognitive disabilities [16].

Moutinho [4] presents a set of accessibility guidelines for designing mobile phone for demented old people.

C. Review of Design Guidelines of User Interfaces for People with Dyslexia

De Santana et al. [17] offer a set of 41 web accessibility for people with dyslexia, including people with cognitive disabilities and older adults.

Rello et al. [18] present a number of design guidelines that aim to present texts displayed in web pages in more accessible way targeting dyslexic users. The guidelines are based in quantitative and qualitative results collected from a set of an experimental study carried out with people suffering from dyslexia. These guidelines are categorized into the following categories: font and background, colors, font size, character, line and paragraph spacing and column width.

D. Review of Design Guidelines of User Interfaces for People with Aphasia

Kane and Galbraith [19] list a set of 7 accessibility guidelines for designing a voting technology for adults suffering from aphasia and other communication disabilities.

Daemen et al. [20] present the design and evaluation of a storytelling software application for people with aphasia. The design guidelines are categorized into 3 categories: simplicity, structure and layout and use of accessible and portable technology.

V. ACCESSIBILITY GUIDELINES

A set of 147 distinct design guidelines resulted from Phase 3. They were grouped under 11 distinct category headings, covering the main age-related changes and AD-related changes. They were categorised into AD-related guidelines and age-related guidelines, as illustrated in Figure 1.
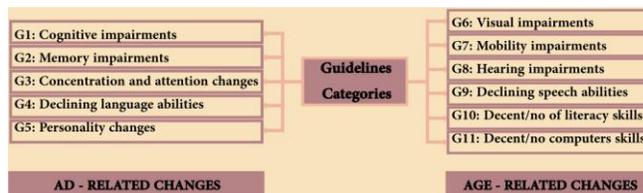

Figure 1. Guidelines categories.

In Phase 4, we did a second triage. For each category, we grouped the guidelines based on a similarity criterion. This process resulted in 9 criterions carefully labeled to represent common elements in the user interfaces. The criterions are: "*Visual elements*", "*Textual and pictorial content*", "*Navigation*", "*Customization*", "*Feedback and support*", "*Audio*", "*Inputs*", "*Multi-touch interactions*" and "*Hardware*".

The full set of accessibility guidelines ordered by category and criterion is presented in Table I.

TABLE I. THE PROPOSED DESIGN GUIDELINES

G1: Memory Impairments	
"Feedback and support"	Give feedback after every action [4][14][16]; Use short feedback messages; Give consistent feedback messages [4];

Category	Recommendations
	Help users in their interaction e.g., through a speaking front end; Provide help tutorials [12]; Provide event-based reminders [2];
"Navigation"	Ensure that navigation is consistent throughout the website or application e.g., similar fonts, colors and sizes, the use of the same set of buttons menu in the same place on each screen, the use the same symbols and icons throughout the website/ application, consistent hyperlinks [10][14][16][17]; Make difference between visited and unvisited hyperlinks [12][17]; Change the color of the visited links;
"Textual and pictorial content"	Provide short paragraphs [16][17]; Provide short sentences [2][4][17];

G2: Cognitive Impairments

Category	Recommendations
"Textual and pictorial content"	Ensure that text is simple and facile to understand [2][3][4][9]-[12][14][16][17][19][20]; Avoid abbreviations and symbols [16]; Use active voice rather than passive voice [10][17]; Avoid using double negatives [17]; Don't hyphenate words at the end of phrases[14]; Provide simple examples [14]; Ensure that grammar and spelling are correct [16]; Categorise content semantically into short categories [10][11][16][19]; Express only one idea per paragraph; Provide summaries or a table of contents for lengthy content [16]; Give each page and frame a title [14]; Highlight keywords and main information [12][16]; Provide the fewest possible of choices to users [10][12]; Provide content in many multimedia mediums e.g., text, videos, pictures, audio [2][4][15]-[17][19]; Provide content through multiple modalities [3][4]; When possible, give alternative representations to numerical content e.g., charts and graphs [19]; Provide simple and facile to understand images and icons [3][10][12][16][20]; Make sure that images and icons have an alternative text (alt attribute) [12][14][15][17]; Avoid pure images and icons , place them near the significant description [9][13][15]; Provide users enough time to use or read content [12];
"Visual elements"	Highlight information via boxes [14]; Use uppercase to highlight keywords [2]; Display main information on the center of the screen [2][4][10][12]; Put a space to separate paragraphs [18]; Put a spacing line between paragraphs [17]; Underline only links [16][17]; Use different colors to categorize information visually [17]; Place the search field in the upper right or upper left side of the screen;
"Navigation"	Avoid deep hierarchies [10]; Name links in a bulleted list [12]; Provide descriptive links [11][14] e.g., do not use "click here" [17];
"Feedback and support"	Ensure that error feedback messages provide mechanisms for resolving the error [16]; Ask for confirmation before critical instructions [4]; Make actions as simple as possible [19][20];
"Multi-touch interaction"	Ensure that the screen is not off when being idle [13]; Separate keypads for numbers and letters [13];

G3: Attention and concentration changes

Category	Recommendations
"Visual elements"	Provide simple design [2][3][8][14][17][20]; Devise the layout of the screen as simple as possible [9][20]; Display only important information [2][3][10][12][16][17]; Avoid utilising too much colors [9][20]; Avoid utilising too much images; Avoid unnecessary decoration [4]; Avoid details ; Ensure that images are not only for decoration [9][12][10]; Avoid animation e.g., animated images, moving text [10][12][14][17]; Add simple and slow animation only in necessary cases; Remove from the user interfaces unnecessary elements calling attention such as ads banners [2][9][11][16]; Limit the number of the used fonts [14]; Present only one message in a single user interface [10];
"Audio"	Remove background music or sound distractions[10][16];
"Navigation"	Provide a maximum of 6 links in the menu [14];

G4: Personality changes

Category	Recommendations
"Textual and pictorial content"	Use wordings that suit the semantic field of elderly; Include pictures of old people or old thing; Add fun and humour e.g., funny emoticons;
"Feedback and support"	Ensure that error feedback messages make it clear that the user is not the cause of the problem[10]; Ensure that feedback messages are not in commando-style; Provide encouraging feedback messages to allow users experience some level of success [3];

G5: Declining language abilities

Category	Recommendations
"Inputs"	Reduce the need for keyboarding e.g., selecting choices from a dropdown list [4][14];

G6: Visual impairments

Category	Recommendations
"Visual elements"	*/Images and icons*/ Provide large images and icons [2][7][10][16][20]; */Text presentation*/ Provide larger font type [2][7][9][10][13][14][16][20]: from 12 pt to 14 pt for body text and 16 pt for titles [9][12][14][17][18]; Avoid decorative font type [2][7][10][12]; Utilize a sans-serif font type e.g., Arial, Helvetica, Verdana and Tahoma [2][4][10][12][14][16][17][19]; Use medium face type; Avoid justified aligned text [17]; Use left text alignment [10][12][14][16]; Avoid large blocks of italic text or bold text or underlined text [7][14][17]; Use bold only to highlight keywords or titles; Use lower cases to write the main body [10][12][14][17][22]; Avoid the use of the shadow effect; Ensure that the spacing between lines is from 1,5 to 2 [10][12][14][16][17]; Use white space [16][17]; Ensure that the text size for printing is from 12 pt to 14 pt [2][17]; Avoid lengthy lines of text (more than about 70 characters per line) [14][16][18]; Provide large distance between words [18]; Avoid narrow columns [18]; */Colors*/

	Use soft colors [2][10][14]; Avoid fluorescent colors [7]; Avoid combinations of green and red or yellow and blue (for users suffering from some degree of colour-blindness) [10]; Maximize the contrast between the foreground and the background colors [2][4][10][12][14]-[19]; Avoid using tones of similar lightness near to each other; Provide maximized contrast between main information and its surroundings [4][9]; Avoid patterned backgrounds [2]; Avoid background images [17]; Avoid white color background [10][12][17]; Avoid dark color background; Avoid a pure black text on a pure white background[18]; Avoid the green and blue colors[12];
"Navigation"	Avoid transparent menus [17]; Provide large menu buttons [2][7][10][20]; Use links only at the end or at the beginning of the sentence [17];
"Customization"	Allow users adjust font type, color scheme (background color, text color, and printing colors), and text size at their will [3][10][14][17]; Make it facile for users to adjust contrast without needing to utilize browser controls; Allow users zooming the screen[3];
"Audio"	Use sounds to represent information available on the visual display;
"Hardware"	Avoid utilizing small-screen devices;
G7: Hearing impairments	
"Audio"	Utilize, by default, higher volume for delivering the auditory background [2]; Increase the duration of the sound beeps [10]; Use male voices [2][10]; Use natural speech than synthetic speech [2][3][10]; Reduce the speed of the auditory background [4]; Make a pause of some seconds after each spoken sentence [2]; Do not rely only on the auditory background [4];
"Customization"	Enable users to skip the audio background [19]; Enable users to replay auditory messages [10][19]; Enable users to control the volume themselves [2][10][14][15]; Enable users to adjust the speed of the audio background [19];
"Visual elements"	Ensure that the volume control is in a facile to find emplacement [8];
G8: Mobility impairments	
"Navigation"	Use static menus, and avoid fly-out or pull-down or dropdown menus [7][12][17]; Provide an audio supported menus; Avoid using scroll [3][10][12][14][16][17]; Ascertain that the minimum possible clicks are needed to do a given instruction; Use single mouse clicks[7][12]; Avoid difficult movements e.g., dragging[9];
"Inputs"	Provide a facile way to enter characters that need pressing at the same time two keys such as '@' and '€';
"Visual elements"	Increment the size of the zone round an hyperlink; Provide a cursor to show the selected information [10];
"Hardware"	Avoid slide-out or separated keyboards [13]; Use touch screen devices [9][20];
"Multi-touch interactions"	Provide large distance between buttons [13];

G9: Decent/no computers skills	
"Navigation"	Provide a site map [12][14][17]; Show the current location all the time [10][11][12]; Make the navigation menu visible all the time [10][17]; Provide "undo" or "back" button to help users recover if lose [9][14];
G10: Decent/no literacy skills	
"Textual and pictorial content"	Use images or soundings to supplement text-based information [2]-[4][14][17]; Use video to facilitate understanding text [14]; Avoid Roman Numerals [14];
"Inputs"	Minimize the use of keyboard [9]; Use automatic inputs as possible[4]; Utilize the speech-to-text or dictation mode for typing; Use spelling checker in input and search fields [10][12][14][16][17];
"Navigation"	Present menu buttons by icons and labels [17];
G11: Declining speech abilities	
"Inputs"	Use acoustic models dedicated to seniors for the speech recognizer [9].

VI. VALIDATION ON THE CAPTAIN MEMO MEMORY PROSTHESIS

In order to evaluate the effectiveness of our work in providing a better interaction for people with AD, the proposed guidelines were applied for designing the user interfaces of the CAPTAIN MEMO memory aid [21].

CAPTAIN MEMO is developed in the context of the VIVA (« Vivre à Paris avec Alzheimer en 2030 grâce aux nouvelles technologies ») project [22] to help AD patients to palliate mnesic issues. In [23], we presented the design, development and evaluation of the user interfaces of this memory prosthesis. They are user-friendly, multimodal, configurable and enjoyable. Figure 2 shows a screenshot of CAPTAIN MEMO, which shows the user interface associated to the authentication step. This interface illustrates a number of guidelines presented before, including, but not limited to, the use of images to facilitate understanding text-based information (the key metaphor associated to the connection step), the use of a black font on an orange background to maximize the contrast between the foreground and background colors, the use of droll image (old parrot).

Figure 2. Screenshot of CAPTAIN MEMO which shows the user interface associated to the connection step.

The evaluation of the interfaces' accessibility and ease to use was carried out with 24 AD patients who are living in an assisted living environment in Sfax- Tunisia (Street Manzel Chaker km. 8). The participants had an average age of 64 years – the youngest is 55 years old and the oldest is 78. Most patients had AD in early/moderate stage. Their profiles were summarized in terms of age, stage of AD, difficulties in vision/hearing, computer skills and literacy skills.

This study was performed from July 2015 for about two months. Tasks were performed on tablet PC. A stylus pen is used to input commands to the touch-screen. The questionnaire covers five dimensions which include: "*Overall Reaction*", "*Visibility*", "**Speech-to-text**", "*Terminology*" and "*Auditory Background*". A five point scales are used: strongly disagree (1), disagree (2), neutral (3), agree (4) and strongly agree (5). Table II summarizes the results and the mean score for each dimension.

TABLE II.   SUMMARY OF THE QUESTIONNAIRE'S RESULTS

Question	(1)	(2)	(3)	(4)	(5)	Mean
OVERALL REACTION (overall mean=4)						
Are the interfaces easy to use?		3	3	5	9	4
Is it easy to learn to use the interfaces?		7	3	10		3,15
Are the interfaces funny-to-use?			1	3	16	4,75
Are you satisfied about the interfaces?		3	3	3	11	4,1
VISIBILITY (overall mean=4.75)						
By default, can you read the main body?		4		4	12	4,2
By default, can you read headlines?				2	18	4,9
Is the ability to adjust text size useful?					20	5
Are images large enough?				2	18	4,9
SPEECH-TO-TEXT (overall mean=3.8)						
Is the speech-to-text mode helpful?	5			4	11	3,8
TERMINOLOGY (overall mean=4.72)						
Are the command names meaningful?				2	18	4,9
Icons are easy to understand?			2	3	15	4,65
Is the use of text labels improves the icon's interpretation?					20	5
Are error feedbacks helpful?		4	2	1	13	4,15
Are informative feedbacks straightforward?				2	18	4,9
AUDITORY BACKGROUND (overall mean=3.825)						
Is the voice speed reasonable?	6			10	4	3,3
Are vocal feedbacks useful?	6	2			12	3,5
Are spoken interactions helpful?	6	2			12	3,5
Is the ability to adjust volume useful?					20	5

Only 20 participants fully complete all tasks. The others just start the first test. They said that they are too old and have no motivation in learning a new technology. Those participants were the oldest with AD in moderate /late stage. They had no computer skills. We call them "patient-restricted users".

As shown in Table II, the overall mean score of the 5 dimensions is between 3.8 and 4.74. Overall, the results indicate that the users almost agreed that the developed interfaces are accessible and easy to use.

55% of all participants were strongly satisfied with the system. They said that they will use the CAPTAIN MEMO memory prosthesis frequently. Those participants suffer from AD in early stage, familiar with computers and have good literacy skills.

25% of all participants said that it is easier for them to type with a virtual keyboard since their voice volume is not enough to be captured by the device's microphone. Thus, in the next iteration, we will use acoustic models specialized for elderly persons for the speech recognizer. Illiterate participants were very satisfied with the dictation modality.

30% of all participants totally ignored the speaking front end since they did not understand words. Thereafter, in the next version, we will use slower voice speed.

VII. CONCLUSION AND FUTURE WORK

In this paper, we proposed a set of accessibility guidelines for designing user interfaces dedicated to older adults suffering from AD, refined and extracted from the most relevant works presented in the literature. This set of design guidelines is structured in a very detailed way, covering the main age-related changes and AD-related changes that might affect the usability of the interactivity in the user interfaces. Based on these design guidelines, we made the design of CAPTAIN MEMO that is developing to be used by AD patients. Afterward, a user satisfaction evaluation of the developed interfaces was carried out with individuals with AD. The results confirmed that they are user-friendly and easy to use.

We hope that the proposed set of guidelines will serve as an information base for application developers, designers, usability specialists and researchers to guiding and evaluating the design of user interfaces for AD patients.

Future work will be devoted to take into account the main characteristics of each different stages of AD. Then, we aim to set up a set of principles to adapt the user interfaces for each stages of this disease.

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