DOI: 10.15514/ISPRAS-2023-35(1)-2

Challenges in Conversational Agents to support Informal Caregivers of People with Dementia

[1] *S. Jiménez, ORCID: 0000-0003-0938-7291 <samantha.jimenez@tectijuana.edu.mx>*
[2] *J. Favela, ORCID: 0000-0003-2967-9654 <favela@cicese.mx>*
[1] *A. Quezada, ORCID: 0000-0001-5706-8047 <angeles.quezada@tectijuana.edu.mx>*
[3] *R. Ramachandran, ORCID: 0000-0003-0355-698X <raj.ramachandran@uwe.ac.uk>*
[4] *R. Juárez-Ramírez, ORCID: 0000-0002-5825-2433 <reyesjua@uabc.edu.mx>*

[1] *Instituto Tecnológico de Tijuana,*
Tijuana, México, 22424
[2] *Centro de Investigación Científica y de Educación Superior de Ensenada*
3918, Ensenada-Tijuana Highway, Ensenada, México, 22860
[3] *University of the West of England,*
Coldharbour ln, Bristol, BS16 1QY, UK
[4] *Universidad Autónoma de Baja California,*
Ensenada, México, 21100

Abstract. People who have dementia (PwD) experience deteriorating executive functions, in particular their working memory, and therefore find it hard to complete multistep tasks or activities of daily living. There is no doubt that during the pandemic, PwD and their caregivers were particularly vulnerable, often isolated which affected their mental and physical health. Their ability to live independently was hampered, fomenting depression in the PwD and burnout on informal caregivers. Information technology can support dementia care improving the quality of life of PwD and easing the burden on caregivers. There is an increasing demand to support informal caregivers and improve their well-being by making dementia challenges less severe. This study uses qualitative techniques to design a model with technological strategies based on semi-structured interviews applied to seven informal caregivers from two different countries. Based on these interviews we developed design insights for implementing solutions to help informal caregivers take care of their PwD at home using conversational agents. We hope that the findings presented in this study will help researchers, and developers design solutions that can support PwD and informal caregivers.

Keywords: Dementia; caregivers; Semi-structured interviews; Conversational agent

For citation: Jiménez S., Favela J., Quezada A., Ramachandran R., Juárez-Ramírez R. Challenges in Conversational Agents to support Informal Caregivers of People with Dementia. Trudy ISP RAN/Proc. ISP RAS, vol. 35, issue 1, 2023. pp. 25-34. DOI: 10.15514/ISPRAS-2023-35(1)-2

Проблемы использования разговорных агентов для поддержки неформальных опекунов людей с деменцией

[1] *С. Хименес, ORCID: 0000-0003-0938-7291 <samantha.jimenez@tectijuana.edu.mx>*
[2] *Х. Фавела, ORCID: 0000-0003-2967-9654 <favela@cicese.mx>*
[1] *А. Кесада, ORCID: 0000-0001-5706-8047 <angeles.quezada@tectijuana.edu.mx>*
[3] *Р. Рамачандран, ORCID: 0000-0003-0355-698X <raj.ramachandran@uwe.ac.uk>*
[4] *Р. Хуарес-Рамирес, ORCID: 0000-0002-5825-2433 <reyesjua@uabc.edu.mx>*

[1] *Тихуанский технологический институт,*
Мексика, 22414, Нижняя Калифорния, Тихуана
[2] *Центр научных исследований и высшего образования,*
Мексика, 22860, Нижняя Калифорния, Энсенада, ш. Тихуана-Энсенада, 3918
[3] *Университет Западной Англии,*
Великобритания, BS16 1QY, Бристоль, Колдхарбор-лейн
[4] *Автономный университет Нижней Калифорнии (UABC),*
Мексика, 21100, Нижняя Калифорния, Энсенада

Аннотация. У людей с деменцией (PwD) ухудшаются исполнительные функции, в частности их кратковременная память, и поэтому им трудно выполнять повседневные многоэтапные задачи или действия. Нет сомнений в том, что во время пандемии инвалиды и лица, осуществляющие уход за ними, были особенно уязвимы, часто изолированы, что сказывалось на их психическом и физическом здоровье. Их способность жить независимо была ограничена, что провоцировало депрессию у людей с инвалидностью и эмоциональное истощение у неформальных опекунов. Информационные технологии могут способствовать лечению деменции, улучшая качество жизни людей с инвалидностью и облегчая нагрузку на лиц, осуществляющих уход. Растет потребность в поддержке неформальных опекунов и улучшении их благополучия за счет уменьшения серьезности проблем с деменцией. В этом исследовании используются качественные методы для разработки модели с использованием технологических стратегий, которые основываются на полуструктурированных интервью, примененных к семи неформальным опекунам из двух разных стран. На основе этих интервью мы разработали идеи по внедрению решений, которые помогут лицам, осуществляющим неформальный уход, заботиться об инвалидах дома с помощью диалоговых агентов. Мы надеемся, что результаты, представленные в этом исследовании, помогут исследователям и разработчикам разработать решения, которые могут помочь людям с инвалидностью и неформальным опекунам.

Ключевые слова: деменция; опекуны, полуструктурированные интервью; разговорные агенты

Для цитирования: Хименес С., Фавела Х., Кесада А., Рамачандран Р., Хуарес-Рамирес Р. Проблемы использования разговорных агентов для поддержки неформальных опекунов людей с деменцией. Труды ИСП РАН, том 35, вып. 1, 2023 г., стр. 25-34. DOI: 10.15514/ISPRAS–2023–35(1)–2

1. Introduction

According to the 2016 World Alzheimer Report it is expected that by 2050 there will be 131.5 million of People with Dementia (PwD). Between the 60 and the 70 percent of all dementia cases are estimated to have Alzheimer’s disease. People who have dementia typically experience deteriorating executive functions, particularly their working memory, and therefore find it hard to complete multistep tasks or activities of daily living [1]. Currently, there is no known cure for dementia, with pharmacological and non-pharmacological interventions focused on improving the quality of life of patients, and caregivers [2].

There is no doubt that during the COVID-19 pandemic PwD and their caregivers were particularly vulnerable considering their mental health and physical health [3]. Recent studies show that the elderly’s mental health was affected by isolation, their ability to live independently was hampered, provoking in some cases depression in the PwD and exhaustion in care providers [3].

Information technology can support dementia care easing the burden on caregivers [4]. Studies have explored the use of virtual assistants, robots, virtual reality, music technology, and Internet of Things to assist PwD [5]. Specifically, Intelligent voice assistants have been suggested as a potential source of assistance to caregivers, who are usually older adults themselves, and have limited technological skills [6].

Rugiano et al. [6] evaluated intelligent voice assistants from a usability perspective, assessing efficiency, effectiveness, and satisfaction. The voice assistants have shown to be useful not only for elderly people but for children with autism as well [7], [8].

There is an increasing demand to provide support to informal caregivers and improve their well-being by lessening the challenges associated to dementia. Devices such as smartphones, tablets, and computers can be a helpful tool in alleviating the caregiver's psychological burden, encouraging social engagement, and easing the burden of daily activities [6], [9]. However, devices with a touch screen are harder to use for elderly people while voice assistant provide a more natural interface [8].

The objective of this study is to design a model with technological strategies based on a qualitative analysis of semi-structured interviews conducted with informal caregivers. The proposed model aims to support technological solutions to help informal caregivers take care of their PwD at home. The findings presented in this study mean to inform researchers and developers in the desing design solutions that can support PwD and informal caregivers.

The rest of the paper is structured as follows. Section 2 describes the related work, Section 3 explains the methodology that guided the interviews, and in Section 4 we present the model that resulted from its analysis. Then, Section 5 presents design insights derived from the study and Section 6 concludes the study and suggests some lines of future work.

2. Related work

A qualitative study analyzed the experience of family caregivers for PwD in China [10]. The authors found that caregivers could positively interact with PwD by employing positive strategies, creating opportunities, and organizing meaningful activities [10]. Such methods are essential for maintaining harmonious family relationships. The authors suggested that nurses can implement or support these activities to the caregivers.

In a systematic review of technology-based interventions for dementia caregivers, it was reported that technology-based interventions often demonstrated efficacy in improving psychosocial outcomes but have not demonstrated efficacy in improving caregiving skills or care self-efficacy [6]. The benefits of using chatbots for healthcare have also been identified for patients and healthcare systems alike [6].

Another study presents a qualitative and quantitative analysis on the use and acceptance of technology in caregivers [3]. This study reveals that computer use decreases with age. And the higher the level of caregivers' education, the more often they use both smartphones and computers. Noteworthy, the level of education decreased as age increased, which could be an additional factor in technology use difficulties. According to [11] voice-based conversational agents are easier to use than touch interfaces, they were proved with autistic users.

Previous studies have highlighted that voice-based chatbots may be especially useful for older adults for health-related communication and information seeking, because they operate through voice-driven conversation, which may be helpful for those with low computer literacy [6].

As conversational agents become pervasive, studies are being conducted to assess its utility and adoption among older adults. A qualitative study with 37 community-dwelling older adults, for instance, found that they have a positive attitude towards the adoption of this technology, particularly to support their health management, although some concerns were raised regarding privacy [12]. Interestingly, a study on the adoption of voice interface technologies among patients with heart failure found that older participants used the technology more frequently [13]. There is increasing evidence that older adults with limited previous exposure to smart speakers adopt smart speakers without much concern, with playing musing and asking health related questions among the most popular tasks [14].

While studies involving people with dementia are less frequent, some early evidence provide optimism about their adoption and their efficacy for caregivers. For instance, a 12-week trial conducted in Canada found that depression and anxiety among caregivers improved as a result of the intervention involving smart technologies with audio prompts to monitor the sleep of PwD [15]. Smart speakers have shown to improve intelligibility among adults with intellectual disability [16]. Solutions have also been proposed to address specific problems, such as a personalized diet voice-assistant implemented to support caregivers of people with Alzheimer's [17]. Finally, a recent systematic review of chatbots to support PwD and their caregivers found only 6 specifically designed for this audience, that while being easy to use the authors found them to have limitations in performance and content, suggesting that more research and development is needed in this area [6].

Speech is largely considered as the most powerful and effective communication mode for an assistive social robot to interact with its users. Recent technological developments and research results are contributing to solving the challenges that characterize the design and implementation of spoken dialogue systems for human-robot interaction with PwD [18].

Additional research has been conducted in addressing symptoms of dementia. For instance, in [13] an ontology is proposed for representing the domain knowledge for agitation in dementia. It represents the domain knowledge specific to non-pharmacological intervention for agitation in dementia, particularly in long-term care setting. In a similar direction [19] proposes an ontology nonpharmacological intervention for dementia to support a model proposed for ambient-assisted intervention systems (AAIS) that really on ambient computing to monitor symptoms and enact interventions.

3. Method

This section presents the design of the qualitative study, describes the participants, data collection and data analysis.

3.1 Design

A descriptive phenomenological qualitative study was conducted [10], [20]. This approach lends to a deep understanding of the experiences and feelings of the caregivers who interact with Patients with Dementia (PwD). The questionnaire designed for data gathering included open-ended questions which let the interviewee describe daily activities, experiences, difficulties, and feelings of interacting with PwD.

3.2 Participants

Caregivers of patient with dementia (describe how these patients were diagnosed) were included. These participants should meet the flowing inclusion criteria: 1) age of 18 years and above, 2) main care for PwD for at least 6 months; and 3) currently living with the PwD. We contacted the participants thought telephone, and seven caregivers completed the interviews. Four women and three men from Mexico and UK participated in this study. All were family caregivers for PwD. The duration of the experience taking care the patient varied from 1-10 years. All the caregivers lived with the PwD. Table 1 shows the characteristics of the participants.

Table 1. Characteristics of participants

P	AP	GP	TE	RPwD	GPwD	APwD
1	45	Male	Y	Son	Female	80
2	74	Female	N	Daughter	Female	96
3	22	Female	Y	Grand daughter	Female	101

4	42	Female	Y	Daughter	Female	68
5	34	Male	Y	Grandson	-	-
6	43	Female	Y	Daughter	Male	80
7	33	Male	Y	Grandson	-	-
P: participant no, AP: age of participant, TE: techonolog experience, RPwD: relationship with the PwD, GPwD: gender of PwD, APwD: age of PwD						

3.3 Data Collection

A semi structured interview guide was developed and then refined via discussion with the study team. The final guide included the following sections: 1) demographic information, 2) experience in the use of technology, 3) experience in caring the PwD, 4) faced difficulties. The instrument has 27 questions, the following are some examples of the questions that we applied:

- How was your experience taking care of the PwD?
- What were the insights that motivates you to search medical help?
- Can you mention a recent situation of frustrations recently?
- Thinking about the last year, what were the most challenging situations that you faced with the PwD related to his/her behavior?
- What was your reaction in the previously mentioned situations?
- Does the PwD faced repetitive questioning or behaviors? Explain them.
- What was the context when the PwD experimented the repetitive behaviors?
- How do you think that a chatbox like Alexa could help in the caring of the PwD?

The interviewer explained the purpose of the interview and discussed the caregiver right to discontinue at any time for any reason. Interview data were collected by audio recording for future analysis. The interviews were conducted at the preferred time of the caregivers to respect their schedules and provide a suitable environment to share their thoughts and experiences. Data were collected from September 2021 to March 2022. The interviews lasted an average of 22 mins (max=40 min, min=12 min).

3.4 Data Analysis

Interviews recordings were transcribed, and the transcripts were read and analyzed by the team. A coding framework was developed through thematic analysis [21]. The researchers became familiar with the information by listening to the interview's recordings during the transcription and repeatedly reading the transcripts. The data were then stored and coded in Atlas.ti. To maintain qualitative rigor, two researchers refined the coding categories.

4. Results

After the interview data were analyzed to identify core categories which describe the family caregivers experience of interacting with PwD. In each one of the categories, we present some of the interviewee answers, also we suggest how the conversational agents could help the PwD and the family caregivers.

4.1 Challenging behaviors of the PwD

It is well known that all the PwD have different behaviors and symptoms and frequently unexpected things happen. For that reason, it is difficult for the family caregivers to be prepared for all the different challenging situations she/he might experience. However, they start knowing the PwD and detecting the most common situations. For instance, in the interviews the participants mentioned:

P1: *“She forgets her things like money and medications”.*

P5: *“He is asking the same questions again and it became frustrating.”*

Forgetting things and repetitive questioning were common challenging behaviors mentioned by the interviewees. As we mentioned before the patients are different and each family faces different situations, for that reason the caregivers need strategies to face these specific problems.

4.2 Strategies to face challenging behaviors of PwD

Informal caregivers learn about the disease and start implementing different positive strategies to face the challenging behaviors they experience. For instance, they try to distract or entertain the PwD by incorporating activities that they like to do.

P1: *“I go out with her and try to make her feel busy”.*

Frequent greetings and presentations are important to situate the PwD know and made her aware of who are the people around. One informant suggested that:

P6: *“It is important to greet him, ask him some questions”.*

Formal caregivers and doctors suggest making the patients remember things so they can train their minds, having conversations about their youth will help too. The main goal is to keep their minds working. As one participant commented:

P6: *“Just ask him questions, I often start the conversation about something from his youth, or his teachings in school, so I just do that now, it definitely works, and it helps him.”*

It is important to follow the conversation with the patient and answer their questions as many times as needed. The participants shared some of their strategies to handle difficult situations with the PwD.

P2: *“I repeat the things over and over again”.*

It is important that the solutions provided to the PwD and the caregivers consider several aspects of both types of user such as: mental health, emotions, physical health, medication and personality. All these aspects could be used by the caregiver assistant to personalize or tailor the tasks.

P5: *“People with dementia tend to ask things, if you tell them to do something they ask why I should do that, so you must explain to them why it is good for them to do that. Basically, give them a short answer.”*

The idea is to make them feel comfortable and loved but not patronize them making them feel as kids.

4.3 Support family caregivers’ emotions

The family caregivers try to make the PwD feel as comfortable as possible, and sometimes they are not taking care of themselves [22]. They expressed that most of the time they feel sad to see how the disease is progressing. They also experience frustration facing all the repetitive behaviors and questioning. However, they are happy to have their loved one with them no matter the circumstances. For that reason, it will be important to provide some solutions that help the family caregivers to take care of the PwD.

P2: *“She is my mother, it does not matter the conditions I want to have her”.*

P4: *“I feel frustrated and desperate”.*

In the next section, we present some design insights based on the results of the interviews proposing a caregiver assistant. The proposal is presented as a conceptual meta-model.

5. Design insight

All the tasks where the caregiver assistant can help are non-pharmacological interventions for example, playing music, telling jokes, or executing relaxation routines. In the medical service interventions, the caregiver assistant will be more limited because it won’t be able to diagnose the disease or provide medication, but it could be useful providing medication alarms and reminders, also it has the option of calling 911 in case of an emergency.

The caregiver assistant can also assess the PwD asking specific questions or tasks to evaluate the PwD's performance and the progression of the disease. These assessments could be helpful for the family caregivers and as well as the physician.

The conversational agents can interact with the patients answering repetitive questions (Fig. 1). They can also act as medication reminders or other scheduled activities. All these activities can be easily handled by these agents helping the caregivers on the support to the PwD and reducing the stress and frustration. There are several attempts on including conversational agents in the activities of daily life like playing music, some relaxation activities, but to the best of our knowledge these conversational agents have not been used to address the phenomena of repetitive questions.

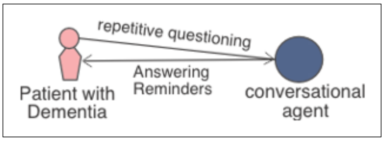

Fig. 1. Patient with Dementia and Conversational Agent Interaction

This model suggest that the caregiver assistant should be aware of the environment. For example, it needs to know if the informal caregiver left the house, if the PwD is moving around the house or if the PwD left the house so it can send a message or call the caregiver to alert the situation. Also, the awareness can be useful for pattern recognition in the future understanding when, where and why the PwD experiences those behaviors.

It is important to understand how the conversational agents will help informal caregivers so we can evaluate how helpful and useful the system is for the caregivers. The evaluation could be performed conducting interviews, questionnaires, and usability evaluation. It is important that the informal caregiver uses the caregiver assistant to relax and reduce the negative emotions mentioned by the caregivers in the interviews (Fig. 2). The conversational agents can provide some relaxation routines to the family caregivers and answering some of the PwD's repetitive questions reducing the frustration of the family.

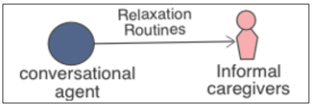

Fig. 2. Informal caregiver and conversational agent interaction

The incorporation of persuasive strategies such as personalization, challenges, tailoring can be an additional value (Fig. 3). These strategies can keep the caregivers and PwD using the conversational agent, because as researchers and developers we want to keep the attention of the users, but also, we want to change their attitudes and eventually impact in the behaviors.

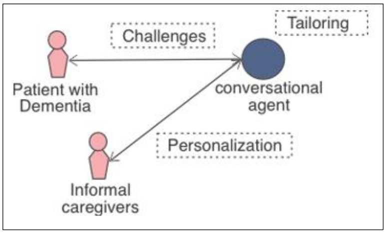

Fig. 4. Strategies in the use of conversational agent

Conversational agents can help informal caregivers provide personalized greetings and some specific clarification to the PwD every morning to start the day or at the end of the day. In specific cases the agent can play some greeting with the voice of the caregiver or with a different voice depending on their needs. Thus, we suggest the following persuasive strategies.

5.1.1 Personalization

The users should be able to personalize the system according to their preference, including name, nickname, gender of voice. Caregivers can modify to its convenience some of the features of the conversational agents.

5.1.2 Challenges

In these cases, the conversational agents could be a useful tool by reading audiobooks, playing music, or other recreational activities such as games.

5.1.3 Tailoring

Informal caregivers can let the conversational agent know that they are going to go out or when they are going to get the meal, so when the PwD asks about it, the conversational agent will answer what is happening or will happen next. The agent can then suggest calling the caregiver or someone else if the PwD feels anxious.

6. Conclusion and future work

In this paper, we presented a qualitative study based on interviews to seven informal PwD caregivers from two different countries. The results suggest that the most challenging behaviors of the PwD are forgetting things and repetitive questioning. Caregivers have faced these problems and have developed different strategies to deal with them such as: follow the conversation, go out with the PwD to distract him/her, ask questions for the patient to reflect on where he is and who he is with, and for mental stimulation.

In all the informal caregivers' interviews, the caregivers expressed that taking care their loved ones trigger negative emotions like frustration and stress.

Based on these results, we suggest a model that describes the ecosystem of PwD assistance and how a caregiver assistant can support informal caregivers with some activities. The conversational agents can be an effective tool to support PwD answering repetitive questions, monitoring and evaluating the PwD. The evaluation could be useful for the assessment of disease progression. These patterns can detect specific situations in specific days or with specific context.

The proposal includes some persuasion strategies can help on change the PwD attitude and eventually change their behaviors.

This study suggests the next lines for future work:

1) Design an ontology using the conceptual model presented in this paper. The conversational agents can be developed taking advantage of such ontology.
2) Design a conversational agent that implements the strategies presented in this model.
3) Use a commercial conversational agent such as Alexa, Siri or Cortana to determine the acceptance and impact on PwD and informal caregivers.

The proposed model can be a basis for researchers and developers for implementing strategies and suggestions to support PwD and informal caregivers.

References

[1] Boyd H.C., Evans N.M. et al. Using simple technology to prompt multistep tasks in the home for people with dementia: An exploratory study comparing prompting formats. Dementia, vol. 16, issue 4, 2017, pp. 424-442.

[2] Kelly P.A., Cox L.A. et al. The effect of PARO robotic seals for hospitalized patients with dementia: A feasibility study. Geriatric Nursing, vol. 42, issue 1, 2021, pp. 37-45.

[3] Wójcik D., Szczechowiak K. et al. Informal dementia caregivers: Current technology use and acceptance of technology in care. International Journal of Environmental Research and Public Health, vol. 18, issue 6, 2021, pp. 1-14.

[4] Guan C., Bouzida A., Oncy-Avila R.M. Taking an (embodied) cue from community health: Designing dementia caregiver support technology to advance health equity. In Proc. of the Conference on Human Factors in Computing Systems, 2021, article no. 655, 16 p.

[5] Huelat B., Pochron S.T. Stress in the Volunteer Caregiver: Human-Centric Technology Can Support Both Caregivers and People with Dementia. Medicina (B Aires), vol. 56, issue 6, 2020, article no. 257, 17 p.

[6] Ruggiano N., Brown E.L et al. Chatbots to support people with dementia and their caregivers: Systematic review of functions and quality. Journal of Medical Internet Research, vol. 23, issue 6, 2021, article no. e25006, 11 p.

[7] Chung K. Elderly Users' Interaction with Conversational Agent. In Proc. of the 7th International Conference on Human-Agent Interaction, 2019, pp. 277-279.

[8] Houben M., Brankaert R. et al. Foregrounding everyday sounds in dementia. In Proc. of the 2019 ACM Designing Interactive Systems Conference, 2019, pp. 71-83, 2019.

[9] Brown E.L., Ruggiano N. et al. Smartphone-Based Health Technologies for Dementia Care: Opportunities, Challenges, and Current Practices. Journal of Applied Gerontology, vol. 38, issue 1, 2019, pp. 73-91.

[10] Yang L., Ye H., Sun Q. Family caregivers' experiences of interaction with people with mild-to-moderate dementia in China: A qualitative study. International Journal of Nursing Practice, vol. 27, issue 4, 2021, pp. 1-8, 2021, article no. e12892, 8 p.

[11] Cha I., Kim S. et al. Exploring the Use of a Voice-based Conversational Agent to Empower Adolescents with Autism Spectrum Disorder. In Proc. of the 2021 Conference on Human Factors in Computing Systems, 202, article no. 42, 15 p.

[12] Choi Y.K., Thompson H.J., Demiris G. Internet-of-Things Smart Home Technology to Support Aging-in-Place: Older Adults' Perceptions and Attitudes. Journal of Gerontological Nursing, vol. 47, issue 4, 2021, pp. 15-21.

[13] Apergi L.A., Bjarnadottir M.V. et al. Voice Interface Technology Adoption by Patients With Heart Failure: Pilot Comparison Study. JMIR Mhealth Uhealth, vol. 9, issue 4, 2021, article no. e24646, 15 p.

[14] Kim S. Exploring How Older Adults Use a Smart Speaker–Based Voice Assistant in Their First Interactions: Qualitative Study. JMIR Mhealth Uhealth, vol. 9, issue 1, 2021, article no. e20427, 12 p.

[15] Ault L., Goubran R. et al. Smart home technology solution for night-time wandering in persons with dementia. Journal of Rehabilitation and Assistive Technologies Engineering, vol. 7, 2020, article no. 205566832093859, 8 p.

[16] Smith E., Sumner P. et al. Smart speaker devices can improve speech intelligibility in adults with intellectual disability. International Journal of Language & Communication Disorders, vol. 56, issue 3, 2021, pp. 583-593.

[17] Li J., Maharjan B. et al. A personalized voice-based diet assistant for caregivers of Alzheimer disease and related dementias: System development and validation. Journal of Medical Internet Research, vol. 22, issue 9, 2020, article no. e19897, 11 p.

[18] Russo A., D'Onofrio G. et al. Dialogue Systems and Conversational Agents for Patients with Dementia: The Human–Robot Interaction. Rejuvenation Research, vol. 22, issue 2, 2019, pp. 109-120.

[19] Navarro R.F., Rodríguez M.D., Favela J. Intervention tailoring in augmented cognition systems for elders with dementia. IEEE Journal of Biomedical and Health Informatics, vol. 18, issue 1, 2014, pp. 361-367.

[20] Schumacher C., Dash D. et al. A qualitative study of home care client and caregiver experiences with a complex cardio-respiratory management model. BMC Geriatrics, vol. 21, issue 1, 2021, article no. 295, pp. 1–11, 2021, 11 p.

[21] Braun V., Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology, vol. 3, issue 2, 2006, pp. 77-101.

[22] Connors M.H., Seeher K. et al. Dementia and caregiver burden: A three-year longitudinal study," International Journal of Geriatric Psychiatry, vol. 35, issue 2, 2020, pp. 250-258.

Information about authors / Информация об авторах

Samantha JIMÉNEZ, Doctor of Science, Full Professor. Research interests include Software Engineering, Usability, Educational Technology, Human-Computer Interaction.

Саманта ХИМЕНЕС, кандидат наук, профессор. Область научных интересов включает разработку программного обеспечения, удобство использования, образовательные технологии, взаимодействие человека и компьютера.

Jesús FAVELA, Ph.D., Professor, Computer Science Department. Research interests: Ubiquitous Computing, Human-Computer Interaction, Medical Informatics.

Хесус ФАВЕЛА, кандидат наук, профессор кафедры компьютерных наук. Область научных интересов: повсеместные вычисления, взаимодействие человека и компьютера, медицинская информатика.

Ángeles QUEZADA, Ph.D. in Computer Science. Research interests: Neural Networks, Pattern Recognition, Fuzzy Logic, Neural Networks and Artificial Intelligence, Computational Intelligence, Fuzzy Clustering, Computer Vision, Autism Spectrum Disorders, Autism.

Анхелес КЕСАДА, кандидат компьютерных наук. Научные интересы: нейронные сети, распознавание образов, нечеткая логика, нейронные сети и искусственный интеллект, вычислительный интеллект, нечеткая кластеризация, компьютерное зрение, расстройства аутистического спектра, аутизм.

Raj RAMACHANDRAN, Lecturer in Computer Science. Research interests: speech to text, software engineering, requirement engineering, user acceptance, philosophy in technology.

Радж РАМАЧАНДРАН, преподаватель компьютерных наук. Научные интересы: преобразование речи в текст, разработка программного обеспечения, инженерия требований, приемлимость для пользователей, философия в технологии.

Reyes JUÁREZ-RAMÍREZ, Doctor of Computer Science, Full Professor. Research interests include software Engineering, software uncertainty estimation, and human-computer interaction.

Рейес ХУАРЕС-РАМИРЕС, кандидат компьютерных наук, профессор. Область научных интересов включает разработку программного обеспечения, оценку неопределенности программного обеспечения и взаимодействие человека и компьютера.