Alternatives for Designing Augmentative and Alternative Communication Systems for People with Disabilities and Older Adults

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Abstract. Augmentative and Alternative Communication Systems (AACS) provide a variety of forms of expression used to improve the communication skills of people with disabilities and/or older adults. These systems consist of physical or digital communicator boards that use pictograms to represent an object, a person or an action. The objective of this article is to analyze some easy-to-implement alternatives of SAACs systems, including low-cost digital resources such as websites and Apps; as well as both high devices such as virtual assistants, AI chatbots like GPT, and tangible interfaces. The research analyzes the difficulties that older adults have in activities of daily living, and a proposal is presented that allows to adapt in a dynamic and scalable way. The prototypes generated allowed us to identify some strengths and weaknesses of the possible solutions. These results provide an opportunity for technology designers to take on board the recommendations and use them to design more robust systems adapted to their environment.

Keywords: SAAC · older adults · disabilities · Alexa · Makey-Makey · functional diversity · daily living activities · IA

1 Introduction

Augmentative and Alternative Communication Systems (AACS) refers to a range of tools and techniques used to support communication for people with disabilities and/or older adults who have difficulty speaking or writing. These systems provide alternative ways to express themselves, such as through visual aids, gestures, symbols, and electronic devices [1].

In the first case AACS can be used by individuals with a wide range of disabilities, including those with physical, cognitive, or sensory impairments. For example, someone

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who has a physical disability that affects their ability to use their hands or arms may benefit from a communication device that is operated with their eyes or mouth. Similarly, someone with a cognitive impairment may benefit from using picture symbols or a visual schedule to help them understand and communicate. The goal of AACS is to improve the communication skills of individuals with disabilities, enabling them to better express their wants, needs, and thoughts, and to participate more fully in their daily lives. AACS can also enhance social interactions, reduce frustration and anxiety, and improve overall quality of life.

Regarding the second case, it is important to highlight that numerous research studies are currently being carried out on the use of AACS in older adults, as it has traditionally focused on children. These tools include communication boards, speech-generating devices, manual signs, and other electronic and non-electronic supports [2, 3].

In this article, a comprehensive review of the latest advances and trends in the field of AACS is offered, exploring its use in various contexts such as healthcare, education, and social communication. In addition, innovative ideas are presented to create proposals with cutting-edge technological tools, such as virtual assistants, AI chatbots like GPT, and tangible interfaces. Finally, the challenges and opportunities posed by the use of AACS, as well as emerging technologies and future directions of research in this field, are discussed [4, 5].

2 Related Works

AACS (Augmentative and Alternative Communication System) is a tool that enables people with speech disabilities to communicate using images, videos, drawings, and writing. This system is designed to help people who face challenges in verbal communication due to cognitive impairments, physical disabilities, or other related issues. Prior to implementing AACS, it is important to assess the individual's communication needs, cognitive abilities, and interpretation skills to provide tailored support. Several studies have explored the effectiveness of AACS in improving communication outcomes for adults with communication problems (e.g., [2, 3, 6]). One of the latest studies by Johnson et al. [7] demonstrated that AACS can significantly enhance the communication skills of individuals with speech impairments, leading to better quality of life and social participation.

Similarly, the paper "Computational cognitive training for older adults: A systematic review" discusses previous research on computational cognitive training for older adults. The authors review several studies that have demonstrated the potential benefits of such interventions for improving cognitive functions, including attention, memory, and executive functions. They also highlight the importance of individualization and personalization in cognitive training, as well as the need for further research on the long-term effects of these interventions. The paper also addresses the potential use of assistive technologies, such as AACS, in cognitive training for older adults with communication difficulties. The authors suggest that AAC systems could enhance the effectiveness of cognitive training by providing tailored and interactive support for communication and cognitive skills. They emphasize the importance of developing AAC systems that are user-friendly and accessible to older adults, and call for further research to explore the

potential of these systems in cognitive training. Overall, the paper provides valuable insights into the potential of computational cognitive training for older adults and the role of assistive technologies in enhancing the effectiveness of such interventions [8].

Based on the aforementioned documentary information, it can be identified that there is a critical need to create a method that integrates existing solutions with new intelligent assistive technologies based on Artificial Intelligence (AI) techniques to better adapt to the specific needs of older adults.

Artificial intelligence is an important complement for this type of application, as evidenced by several studies in the domain of AAC systems that employ AI and its techniques. Bautista et al. [9] presented a Spanish text-to-pictogram translator that used natural language processing (NLP) techniques, performing syntactic analysis followed by n-gram processing. The goal of this translator was to predict the pictogram(s) that best described the mentioned word or phrase with greater accuracy. Additionally, Pahisa-Solé and Herrera-Joancomartí [10] evaluated an AAC system that transformed pictograms into natural language. The system was tested with four participants with severe cerebral palsy over a total of 40 sessions. An interesting aspect of this article was that they were able to adapt the system to the linguistic characteristics of each person. Finally, they reported that quantitative results showed an average increase of 41.59% in communication rate compared to the same communication device without the compression system, as well as a general improvement in communication experience when the output was in natural language.

Therefore, this article aims to analyze and apply various forms of interaction in a pictogram-based AAC systems. The proposed solution should include multiple forms of HCI to promote a comfortable, transparent, and versatile use of technology, enabling effective communication for adult individuals.

3 Method

To identify different forms of interaction of AAC systems, we conducted a focus group discussion with an interdisciplinary group of 12 experts to obtain detailed information about their experiences, as well as to analyze existing solutions in depth, in order to establish their strengths and weaknesses in detail and, through the use of technology, enrich their usefulness.

3.1 Participants

The group of experts was composed of 12 researchers from four Ecuadorian universities. Among them were a neuroscientist, a specialist in technology development for people with disabilities, a visually impaired researcher, an expert in artificial intelligence, a data scientist, an expert in human-computer interaction, a communicator, an educator, a psychologist, and several software developers.

3.2 Instruments

For this study, a discussion guide was employed to gather qualitative data on the perceptions and experiences of a particular group of participants regarding the research topic.

The guide, which was specifically designed for this purpose, consisted of open-ended questions that aimed to explore the communication needs and preferences of older adults and people with disabilities. The guide was administered to a focus group composed of 12 experts, who participated in two online sessions that utilized a virtual chat board for brainstorming and defining the key characteristics that a new alternative augmentative communication system should possess, taking into account the various perspectives of the participants.

To analyze the data, the discussions from the focus group were transcribed, and emerging themes and patterns were identified. The insights gained from the discussion guide were then used to inform the development of a new augmentative alternative communication system for older adults and people with disabilities. In conclusion, the discussion guide proved to be a valuable tool in collecting in-depth qualitative data on the perceptions and experiences of a specific group of participants. Its use was crucial in understanding the communication needs and preferences of people with disabilities and in guiding the design of the new augmentative alternative communication system.

3.3 Procedure

This study was conducted using a six-phase approach to develop a new augmentative alternative communication system for older adults and people with disabilities. In Phase 1, the study team recruited and selected 12 experts who had experience working in the field of augmentative and alternative communication with this particular population. In Phase 2, the team developed a discussion guide specifically for this study to collect qualitative data on the communication needs and preferences of the participants. Phase 3 involved administering the discussion guide to the focus group in two online sessions, which were recorded and transcribed verbatim. In Phase 4, the data were analyzed using thematic analysis to identify emerging themes and patterns. The insights gained from the analysis were then used to inform the design of the new system in Phase 5. Finally, in Phase 6, the team conducted a validation and evaluation of the system with a separate group of participants to ensure that it met their communication needs and preferences. Overall, this multi-phase approach proved to be an effective method for developing a new augmentative alternative communication system that addresses the specific needs of older adults and people with disabilities.

4 Results

The results of this study provide valuable insights into the communication needs and preferences of older adults and people with disabilities, as well as the design and development of a new augmentative alternative communication system. In the upcoming section, we describe the study's findings and highlight some of the most innovative solutions that were discovered.

By utilizing emerging technologies, such as tangible user interfaces, RFID technology, augmented reality, voice assistants, and artificial intelligence, a range of alternative solutions were explored. One idea presented in the study involved the use of Makey

Fig. 1. Makey Makey as an AAC Strategy for older people

Makey to create a tangible augmentative board, which allows for the conversion of tangible pictograms into spoken words. Figure 1 shows an idea of the proposal.

The aim of using Makey Makey is to introduce the use of alternative augmentative boards to children with disabilities and older adults, in order to familiarize them with the system prior to utilizing a more complex system on a computer or tablet.

Other recommendations included implementing radio frequency cards to enhance scalability and enable customized pictograms for elderly users, as well as incorporating tangible components for children with disabilities. Figure 2 shows an idea of the proposal.

On the other hand, another proposal was put forth. For instance, by utilizing Alexa's skill configuration, individuals with speech impairments could benefit from the recognition of specific sounds, which would then be translated into pictograms and ultimately synthesized into complete sentences. Within this context, various applications can be utilized with Alexa, including "Speak2See," "AskSARA," and "SpeakIt!" These apps are highly customizable and programmable to meet the unique needs and preferences of individual users, empowering them to communicate effectively across diverse environments and situations.

Augmented reality is one of the emerging technologies that is gaining more and more ground in different fields. In the field of augmentative and alternative communication (AAC), augmented reality can be especially useful. Thanks to it, a board of pictograms can be created which, when scanned with the camera of a mobile phone or a tablet, is complemented with multimedia elements such as explanatory audios or videos. In this way, people with communication difficulties can access information in a more visual and intuitive way, which can be especially beneficial in situations where quick and effective communication is required. Additionally, being highly customizable, augmented reality can be adapted to the specific needs of each user, making it a very versatile and powerful tool.

We are currently witnessing a boom in artificial intelligence (AI), and this trend has opened up new opportunities for the implementation of Augmentative and Alternative Communication (AAC) systems. Several AI-powered applications, such as Chat GPT, Synthesia, Proloquo2Go, Eye-Gaze, and Speechify, have emerged as invaluable support tools for individuals with communication challenges.

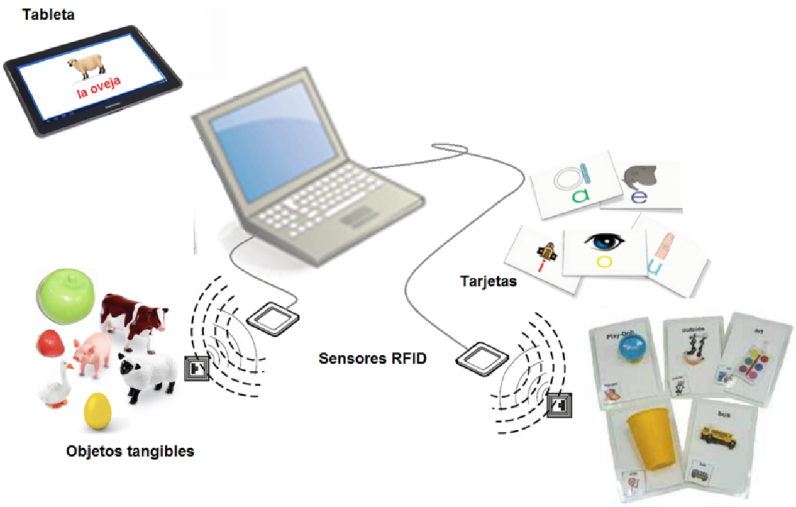

Fig. 2. RFID technology to build tangible pictograms

For example, Synthesia AI video creation allows the creation of avatars with text-to-speech capabilities, while Proloquo2Go features word prediction functionality that suggests phrases based on user input, streamlining communication and enhancing efficiency. Eye-Gaze employs cutting-edge AI algorithms to detect and track eye movement, converting it into commands for typing and communication. Furthermore, Speechify utilizes advanced speech recognition technology to adapt pronunciation and tone of voice to meet the unique needs and preferences of users.

These innovative applications represent significant advancements in augmentative and alternative communication, providing valuable resources for individuals with communication challenges. With the power of AI, we can now develop more personalized and effective communication strategies that can greatly improve the lives of those who rely on AAC systems.

5 Conclusions

In conclusion, the use of a discussion guide has proven to be a valuable tool for gathering in-depth qualitative data on the perceptions and experiences of a specific group of participants. Moreover, the integration of various technologies, such as tangible user interfaces, RFID technology, augmented reality, voice assistants, and artificial intelligence, has significantly impacted and improved the lives of older adults. Emergency technology, with its intuitive design and ability to stimulate long-term memory, is a prime example of how technology can enhance the quality of life for older adults. As technology continues to evolve, the potential for further innovations that empower and enrich the lives of older adults is truly exciting.

Overall, technology has opened up endless possibilities for older adults, allowing them to enjoy greater autonomy and improved quality of life. This transformative power of technology in the lives of seniors cannot be overstated. If we continue to embrace technological advancements, we can look forward to even more exciting breakthroughs that will enhance their well-being and enrich their lives. The integration of technology into the daily lives of older people has the potential to revolutionize their experiences, making everyday tasks more manageable and enjoyable. These exploratory results will provide a foundation for future work to design prototypes, evaluate their effectiveness in a given context, and identify the most suitable solutions for our environment.

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