

ARTis: How AR supports the guided experience in museums for people with Autism

Salvatore Vita^a, Luigi O. Borrelli^a, Floriana Canniello^b, Andrea Mennitto^{ab} and Luigi Iovino^{ab}

^a *Garage94, Via Funari SNC, Ottaviano, 80044, Italy*

^b *Neapolisanit, Via Funari SNC, Ottaviano, 80044, Italy*

Abstract

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by persistent difficulties in communication and social interaction along with a restriction in interests and the presence of repetitive behaviors. In recent years the impact of augmented reality (AR) in the world of the autism spectrum has been repeatedly confirmed in various areas: improving social skills, improving autonomy, increasing cognitive and motor skills. However, there are still many fields to explore. In recent years, the use of AR in public and different environments, such as universities, parks, and museums has increased exponentially, making these places more accessible even to people with disabilities. ARTis is a project that takes advantage of AR as a vehicle and support to facilitate the accessibility and visit of museums, trying to break down the barriers that hinder the usability for people with ASD.

Keywords 1

Autism, AR, New tech, IoT, Museums

1. Introduction

Autism spectrum disorder (ASD) represents a heterogeneous group of disorders with onset in developmental age, which present a variable clinical expression between subject and subject and, in the same subject, over time [1]. However, despite this variability, there are still some common characteristics that make it possible to identify a sufficiently defined symptomatological nucleus: impairment of social communication which is associated with poor flexibility of interests and repetitive behaviors [1]. In the landscape of processes and methodologies used to support rehabilitation and teaching, new technologies especially in the last decade have been a precious source for ASD [2] [3] [4]. In particular, augmented reality (AR) has occupied an important place especially in the field of social communication [5] [6] and Social interaction [6]. Augmented reality is a visual, highly interactive method of presenting relevant digital information in the context of the physical environment [7] and is a way to enrich the real-world environment by superimposing cues and information [5]. A new and interesting way to use augmented reality is to apply it in public and cultural spaces, such as in museums [8] [9]. As augmented reality enables a level of digital content to be seen in a real-life scenario, many museums are adhering to new ways to give visitors a richer view of history [9]. Often people with ASD have little interest in the surrounding world or have a limited number of interests; some studies have shown how the use of augmented reality can increase the motivation of people with ASD for the context [5] [10], and in the case of museums, exhibitions, parks, how it can be a navigational aid in these places [8]. This article aims to illustrate the ARTis project: ARTis is an APP that allows people with ASD to make easier use of places of culture. Being equipped with localization systems and being easily usable, ARTis has the practicality of being able to be used by various people respecting the criterion of heterogeneity that distinguishes the autism spectrum. The APP is in fact designed to varying levels of

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EMAIL: vita3913mail.com

ORCID: 0000-0002-2690-5196



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severity (from high functioning up to people with intellectual disabilities) offering a unique opportunity to break down the barriers that separate culture from disability.

2. ARTis

ARTis is an APP that allows seeing virtual content overlapped with the surrounding reality through a smart device's camera, creating a path inside a museum to help the user orientate and "experience" an appealing and interactive visit.

ARTis will guide the user through the whole process step by step.

In the first phase the tutor, who is accompanying the child through the museum, will be able to select the level of difficulty according to the child's abilities through a user interface. These levels differ mainly in the help provided (prompt) and the level of complexity of the several activities offered.

The second one is the information and presentation phase.

The user will be given all the information on how to use the APP to explore the museum and on the interactions with the various points of interest of the museum, clearly, the language and methodology used is tailored to the target audience.

Thanks to ARTis, the real world is virtually enriched with additional graphical and textual information generated by software using, for example, graphic animations, interactive characters, environmental simulations, multimedia cards, interactive and educational content, and so on.

The goal is to add to the visual perception of the physical space images taken from the virtual space, with the result that the real and virtual environment seem to coexist and in this way the user will be motivated in the exploration of the environment and will be able to interact with it.

ARTis allows users to interact with this kind of content thanks to the presence of a virtual guide (a friendly avatar) who will accompany and help the user throughout the visit to the museum and will allow a better and safer exploration by providing information and support in case of need (Figure 1).

ARTis will also allow the user to interact with the museum's artworks with activities in the form of mini-games (Figure 2), such as virtually breaking down the artworks as if they were pieces of a puzzle or adding graphic elements to a statue to allow interaction with it or simulating the restoration of a painting or tapestry using the tablet's touch screen or matching games or exploring and collecting objects, which will provide a form of entertainment and provide, through non-formal methods, information about the artworks and the museum itself.

The main objective is to create an inclusive and formative moment during which the end-user will be at the center of an experience in which he/she would not have been able to participate before the implementation of ARTis. This type of experience is very useful to increase and improve social skills, through a greater sense of self-efficacy and autonomy [14]. Indeed, one of the strengths of ARTis is its customization and adaptability. In fact, Artis can be easily modified for use in different contexts and environments.

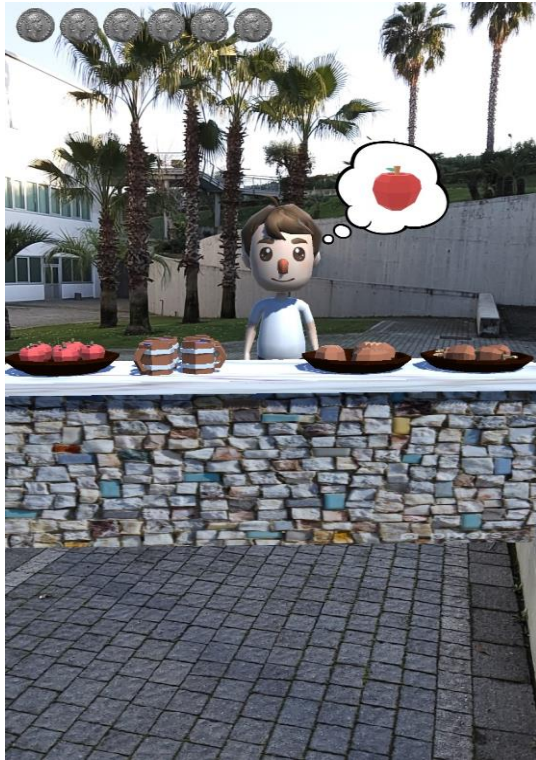


Figure 1: Avatar



Figure 2: Minigame

2.1. Development and evaluation

ARist does not require an internet connection to operate but uses Bluetooth and GPS to interact with its surroundings.

The software used to create the ARtis is Unity and the C# as a programming language. Unity is a cross-platform graphics engine developed by Unity Technologies that enables the development of video games and other interactive content, such as architectural visualizations or real-time 3D animations.

We tested our APP using a Samsung Galaxy Tab S5e, but any device (tablet or smartphone) that supports ARCore can be used as the hardware.

ARCore is a software development kit developed by Google that allows the creation of augmented reality applications.

The first step in the development of ARTis was the planning and development of scenarios based on the typical interests of autistic children, the works of art present, and possible interactions with them.

The next step is the real strength of ARTis, the user interface.

Each activity is preceded by a specific and detailed tutorial using simple language and full of visual examples that can be viewed several times.

Many studies have shown that children with autism spectrum disorders have difficulty sustaining their selective attention [15].

Attention management techniques involving the use of verbal and visual stimuli have been used in the development of ARTis.

The beta version of the application was tested by two children diagnosed with autism (Group 1) and two neurotypical children (Group 2), and preliminary data were collected through a self-report questionnaire (which measures understanding of what has been taught and general interest) completed by the children's tutors, as shown in Table 1.

The autistic children were 10-year-old boys and the normal children were 10-year-old boys.

Table 1
Outcomes of self-report questionnaire

	Group 1	Group 2
General understanding	20%	37%
Overall interest	15%	30%
Duration of the visit	45'	1h.30'

2.2 AR and IoT

Many children with autism are very interested and motivated to use smart devices such as computers, tablets, smartphones [2]. These types of assistive technology devices allow children with autism to interact with their surroundings, make choices, express needs, and interests, and communicate with their friends and parents [16]. Using these devices also increases their sense of self-efficacy, allowing them to gain more and more skills and knowledge while improving their abilities.

Because of their familiarity with these types of devices, children with autism will have no difficulty using a tablet or smartphone on which ARTis is configured. Inside the museum, ARTis will interact with each point of interest, which will be marked with a recognizable symbol, through the use of beacons.

Beacons are small, wireless, battery-powered sensors powered by Bluetooth Low Energy (BLE) technology. They can be used to detect and store signals from the environment (temperature, air pressure, humidity) or to interact with other devices exchanging information.

Beacons are a good example of technology related to the Internet of Things (IoT), which is a term that describes the interconnectivity of machines or computing devices via the Internet. For the interaction in outdoor environments, a GPS system has been used which, thanks to geolocation, tells the device to initialize a given scenario. This double system of interfaces allows ARTis to be flexible in its use and therefore to be used both in museums and in outdoor places such as archaeological parks.

Therefore, AR and IoT will represent a valuable tool that can be widely used in these types of systems allowing children with autism to have many more experiences, thus improving their social skills and quality of life [14].

3. Conclusions

As shown by the literature, the use of AR with software, digital books, computers, and other devices can be beneficial in the treatment process for ASD [5] [7]. However, AR can be an additional resource in a much broader area than simple treatment: social integration and usability of services. Today there

are still major limits for the accessibility of people with disabilities to places of culture, entertainment in bars, restaurants, etc ... [6] AR, integrating itself into the broader field of the Internet of Things (IoT), offers a unique opportunity both to help the user to move more easily in the environment and to increase his motivation in accessing the resources of the environment itself. Augmented reality, being directly connected to the reality that surrounds us and allowing you to view 3D virtual objects generated by the device in the real scene, is directly related to reality and can make it easier to generalize the experience. The test conducted in the Excavations of Herculaneum has shown how the application of ARTis should also be adapted to a cultural context other than a museum or (for example, archaeological excavations Precisely, art galleries, monumental complexes, etc.). However, the test carried out has numerous limitations: the subjects were highly functioning, a comparison with a normative sample was not conducted and a comparison was not made between the visit of the excavations without the aid of ARTis and with the aid of ARTis.

Future research goals will focus on the use of ARTis in various museums and on the implementation of research protocols to measure the usability of the tool and whether its use improves the visitor experience of the user. Moreover, it would be interesting to extend the use of the tool to other contexts such as scientific and research poles, where the user is guided to the discovery and knowledge of the work carried out in these places. Still, an important integration could concern the school context to evaluate the increase in knowledge about history, art, science, etc...

The strength of the integration of augmented reality with the IoT is to make the cultural tour more enjoyable and more motivating (thanks to the use of games, pop-up videos that are activated in the presence of admirers, etc.).

Artis can represent a turning point in the landscape of technologies for the service usability of individuals with ASD, use to good advantage from a technology already widely used in museums and places of culture [9], making art a moment of integration for people with ASD.

4. References

- [1] H. Hodges, C. Fealko, N. Soares. " Autism spectrum disorder: definition, epidemiology, causes, and clinical evaluation." *Transl Pediatr.* 2020 Feb; 9(Suppl 1): S55–S65P.
- [2] J. Vlachou, A. Drigas, "Mobile Technology for Students & Adults with Autistic Spectrum Disorders (ASD)". *International Journal of Interactive Mobile Technologies (iJIM)*. 2017. DOI: 10.3991/ijim.v11i1.5922
- [3] M. Ponticorvo, A. Rega, O. Miglino. (2018). *Toward Tutoring Systems Inspired by APPLIED Behavioral Analysis*. 10.1007/978-3-319-91464-0_16.
- [4] S. Vita, A. Rega, L. Iovino, A. Mennitto "TED": Teaching Educational Device, a digital tool to educational practice for special needs". *PSYCHOBIT 2020 Psychology-Based Technologies 2020*
- [5] A. Rega, A. Mennitto, S. Vita, L. Iovino. "New technologies and autism: can augmented reality (AR) increase the motivation in children with autism? Conference Paper · March 2018 DOI: 10.21125/inted.2018.0959
- [6] C. Berenguer, I. Baixauli, S. Gómez, M. de El Puig Andrés, S. De Stasio. "Exploring the Impact of Augmented Reality in Children and Adolescents with Autism Spectrum Disorder: A Systematic Review". *Int J Environ Res Public Health*. 2020 Sep; 17(17): 6143.
- [7] K. Khowaja, B. Banir, D. Al-Thani, M. Tahri Sqalli, A. Aqle, A. Shah, S.S. Salim. "Augmented Reality for Learning of Children and Adolescents with Autism Spectrum Disorder (ASD): A systematic review". March 2020, Digital Object Identifier 10.1109/ACCESS.2020.2986608
- [8] D. McMahon, D. F. Cihak, R. Wright, "Augmented reality as a navigation tool to employment opportunities for postsecondary education students with intellectual disabilities and autism," *J. Res. Technol. Educ.*, vol. 47, no. 3, pp. 157–172, Jul. 2015, doi: 10.1080/15391523.2015.1047698
- [9] M. Ruiz, F. Mata, R. Zagal, G. Guzmán, R. Quintero, M. M. Ibarra. "A recommender system to generate museum itineraries APPLYING augmented reality and social-sensor mining techniques". *S.I. Virtual Reality, Virtual Reality volume 24*, pages 175–189 (2020)
- [10] S. Parsons et al., "Development of social skills amongst adults with Asperger's Syndrome using virtual environments: the 'AS Interactive' project," in *Proc. The 3rd International Conference on Disability, Virtual Reality and Associated Technologies, ICDVRAT*, 2000, pp. 23–25.

- [11] B. P. Douglass, D. Harel, M. B. Trakhtenbrot, Statecharts in use: structured analysis and object-orientation, in: G. Rozenberg, F. W. Vaandrager (Eds.), *Lectures on Embedded Systems*, volume 1494 of *Lecture Notes in Computer Science*, Springer-Verlag, London, 1998, pp. 368–394. doi:10.1007/3-540-65193-4_29.
- [12] M. Ponticorvo, A. Rega, O. Miglino. (2019). “Multisensory Educational Materials: Five Senses to Learn”. 10.1007/978-3-319-98872-6_6.
- [13] Smith, I.C., Reichow, B., Volkmar, F.R. “The Effects of DSM-5 Criteria on Number of Individuals Diagnosed with Autism Spectrum Disorder: A Systematic Review”. *J Autism Dev Disord* 45, 2541–2552 (2015). <https://doi.org/10.1007/s10803-015-2423-8>
- [14] Lorenzo, G., Gómez-Puerta, M., Arráez-Vera, G. “Preliminary study of augmented reality as an instrument for improvement of social skills in children with autism spectrum disorder.” *Educ Inf Technol* 24, 181–204 (2019). <https://doi.org/10.1007/s10639-018-9768-5>
- [15] Noterdaeme, M., Amorosa, H., Mildenerger, K. et al. “Evaluation of attention problems in children with autism and children with a specific language disorder”. *European Child & Adolescent Psychiatry* 10, 58–66 (2001). doi.org/10.1007/s007870170048
- [16] Sula, A., Spaho, E., Matsuo, K., Barolli, L., Xhafa, F., Miho, R.. A new system for supporting children with autism spectrum disorder based on IoT and P2P technology. *International Journal of Space-Based and Situated Computing*, 2014 Vol.4No.1, pp.55-64. doi 10.1504/IJSSC.2014.060688