Events

REAACH 2023 - REpresentation Advances And Challenges AI-XR Connections

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The fourth edition of the REAACH symposium, coordinated by Andrea Giordano (University of Padua), Michele Russo (Sapienza Università di Roma) and Roberta Spallone (Politecnico di Torino), was held in telematic mode from 10 to 11 October 2023 (fig. 1). Resuming the debate addressed in previous editions, on the challenges that the new digital methods offer to experts and scholars in the field of representation, the event aimed to focus attention on the possibility of connecting 'extended'' reality (XR) technologies –which includes augmented reality (AR), virtual reality (VR) and mixed reality (MR)– with the disciplines that employ artificial intelligence (AI). In this sense, the call proposed an exposure, in terms of applications and experimentation, to the worlds of tangible and intangible cultural heritage, architectural, environmental, infrastructural and product design, and education, as a place of higher education as well as a tool for educational enhancement.

The proceedings were opened by Roberta Spallone, President of the REAACH Association, who emphasised the rich participation of researchers from all over the world –more than 190 authors from five continents and 65 selected contributions– who were able to interpret the symposium topics in an interesting and innovative way.

Institutional greetings followed from Francesca Fatta, President of UID (*Unione italiana per il Disegno*), who highlighted the relevance of the issues addressed and the excellent organisation of the event promoted by REAACH, founded as a social promotion association aimed at the mutual exchange of knowledge and multidisciplinary research on the progress and challenges of representation. This was followed by greetings from Alessandro Luigini, President of the IMG Association –also founded with the aim of promoting interdisciplinary research that links the themes of representation with those of education– whose participation in the event was intended as a tangible sign of the possibility of consolidating the network of research interconnections that REAACH promotes.

The first day of the symposium continued with four plenary sessions, which offered twenty-five contributions selected for oral presentation, focusing on topics related to *AI&XR and Heritage Routes* (sessions 1 and 2), *AI&XR and Classification/3D Analysis* (session 3), *AI&XR and Museum Heritage/AI&XR and Historical Sources* (session 4) [1]. On the second day, a further three plenary sessions were held, scheduled for the oral presentation of a further twenty contributions, the first of which still focused on *AI&XR and Museum Heritage/AI&XR and Historical Sources* (session 5), and the other two on *AI&XR and Shape Representation and AI&XR and Education* (session 6) and *AI&XR and Building Information Modeling* (session 7) [2] (fig. 2).

Particularly emblematic of the transversality of the topics covered were the three invited contributions presented on the first day.

The first of them, entitled *Beyond the visuals: future collaboration scenarios between architects and artificial intelligence* –speakers Alberto Pugnale and Gabriele Mirra– highlighted how applications based on artificial intelligence are finding wide diffusion in the field of architecture, with the aim of not only automating procedures but also supporting the creative process itself. In this sense, the greatest challenge is to model the cognitive path of the designer, opening new possibilities for interaction between man and machine based on visual output or natural language, and focusing on how to train the algorithms developed to support design.

A further challenge is the use of AI applications to develop decision support systems for different domains. This was the theme of the second invited talk, entitled *Artificial Intelligence in interdisciplinary research domains: case studies and future perspectives* –presented by

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Fig. 1. Banner of event.

Marina Paolanti– in which a wide range of solutions was explored, ranging from automatic driving to the tracking of people flows in a confined environment in order to predict their movements, passing through the use of NeRF networks for the reconstruction of architectural spaces from photographic datasets, a possible future alternative to the consolidated photogrammetric protocols.
Testifying to the interdisciplinary and multidisciplinary spirit of the initiative was the third invited paper, entitled *Artificial Intelligence for space weather prediction* –speaker Michele Piana. In particular, the contribution analysed how AI algorithms can operate in the prediction of those phenomena, related to solar activity, that can affect the performance and reliability of space and groundbased technological systems, to the extent of potentially endangering human life and health.
Many general points of reflection emerged from the other interventions. Among these, several contributions addressed the capability of 'extended' reality to promote experiences of digital knowledge and enjoyment of cultural heritage.
For instance, *Hybrid construction of Knowledge Graph and Deep Learning experiments for NotreDame de Paris' data*, by Kévin Réby, Anaïs Guillem and Livio De Luca, illustrated a scientific project for multimodal data management. Using deep learning computer vision models, robotic processes were outlined to support researchers and specialists in a hybridisation that is fundamental for the comprehension of monuments and architecture rich in history and significance.
And again, the paper by Riccardo Florio, Raffaele Catuogno, Teresa Della Corte and Caterina Borrelli, entitled *Immersive technologies for the remote enjoyment of an archaeological complex that cannot be visited: experiments on the Cento Camerelle site in the Campi Flegrei Archaeological Park* proposed a work of superimpositions, interactions and contaminations between real and virtual space, to transform the 3D model into a 'digital scene', i.e. a participatory place in which to fully realise access to the cultural contents related to the model.
The contribution by Roberta Spallone, Fabrizio Lamberti, Johannes Auenmüller, Davide Calandra, Fabio Fasano and Martina Rinascimento, *Immersive experience for the contextualisation of Sekhmet statues*, also drew attention to the importance of devising information models that are not limited to the description, deduced from survey data, of the vestiges of architectures of cultural interest, but that create virtual spaces capable of 'narrating' structured and appropriately contextualised information.
The design of a spatial storytelling system was the aim of the research group consisting of Sandro Parrinello, Anna Dell'Amico, Francesca Galasso and Giulia Porcheddu. In their contribution, *Virtual spaces for knowledge preservation. The digitalisation of the archaeological excavation of Arsinoe*, a sourcebased modelling was proposed for the virtualisation of the investigated archaeological area, conveyed through a navigable digital space and special web pages for the dissemination of information content (survey data, historical images, drawings, excavation journals, …).
Another application of AI to the field of architecture concerns the possibility of developing predictive models for monitoring buildings. Among others, the contribution proposed by Massimiliano Campi, Sergio Di Martino and Marika Falcone, *Predicting architectural decay by AI applied to 3D survey*, has set the ambitious goal of going far beyond current applications. In fact, the idea is to implement a knowledge discovery process that –starting from the outputs deriving from the survey with terrestrial laser scanner (TLS), mobile mapping system (MMS) and close-range photogrammetry– is aimed at predicting the evolution of the decay phenomena affecting the Salerno cathedral, thus going beyond the architectural aspects alone to embrace the engineering and computer science fields as well.
Still addressing the potential of artificial intelligence algorithms in the processing

of data derived from digital surveying is the paper by Alessandra Tata, Pamela Maiezza, Stefano Brusaporci and Luca Di Angelo, *A proposal of Integration of Point Cloud Semantization and VPL for Architectural Heritage Parametric Modeling* in which they described processes for the automatic extraction of features from point clouds (based on geometric attributes) and visual programming systems to automate the parametric modelling process, thus simplifying scantoBIM applications.
However, AI systems are equally capable of generating synthetic images from textual descriptions in direct relation to the field of representation. Giorgio Buratti and Michela Rossi, with the contribution *From text to image. Comparative evaluation of AI for design and representation*, analysed the main approaches for pursuing this purpose, highlighting their benefits and drawbacks.
The same topic was addressed by Giovanni Caffio, Maurizio Unali and Fabio Zollo, whose presentation *–Hypotheses of images and architectural spaces in the age of artificial intelligence–* explored the possibility of shaping architectural spaces through AI. Experimenting with a series of processing steps and their interactions, they illustrated the transition from text to image to morphogenerative modelling through semantic transitions of planar images and threedimensional spatial systems.
The issue of digital applications that make use of 'extended' reality technologies as a tool to support design was also taken up in the contribution by Maria Linda Falcidieno, Maria Elisabetta Ruggiero and Ruggero Torti *–Via Porro: readings and inspirations from an urban space–* albeit with a different slant to that described so far. Through virtual reality applications, perfectly combined

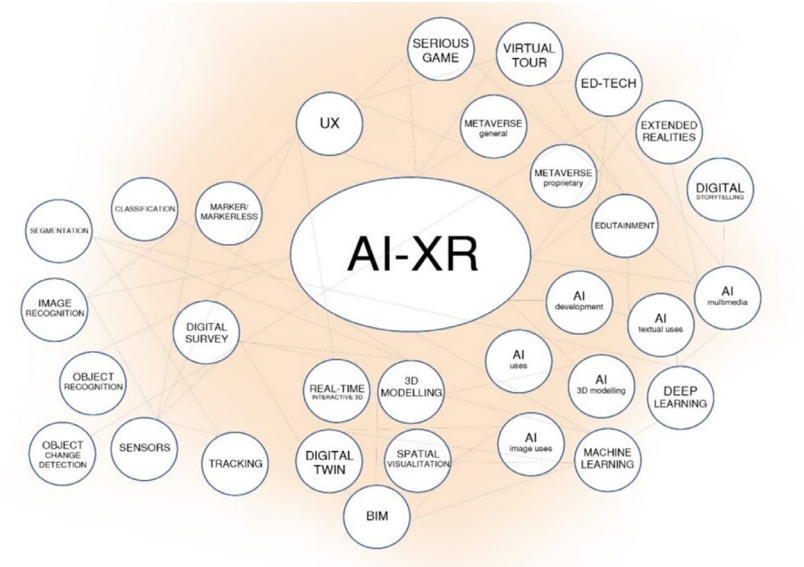

Fig. 2. Topics and key-words.

with parametric modelling systems, an animated narrative capable of simulating the ways in which the space will be used becomes possible.
Still addressing the opportunities offered in the field of design and use of architectural spaces, is the contribution by Teresa SánchezJáuregui Descalzo, Nicolás Gutiérrez Pérez, Tomás Abad Balboa, Pilar Chías Navarro, entitled *Immersion through Extended Reality as a tool applied to wayfinding inside hospitals*, which aimed to highlight the capacity of new XR technologies –combined with AI and GPS systems for geolocation– to simulate virtual visits in real environments that are difficult to navigate, thus guiding the 'navigation' in them of users, especially the most vulnerable ones.
The availability of so many digital tools generally imposes a review of their correct implementation in the field of architecture, closely related to the specific purposes of the applications. This theme was explored by Fabrizio Ivan Apollonio, Federico Fallavollita and Riccardo Foschi, in the contribution *Immersive Investigation of the Hypothetical Reconstruction of 1816 Canova's Exhibition in Spirito Santo Church in Bologna*, in which the potentialities and criticalities of the most popular visualisation technologies were analysed, contributing to the definition of a best practice in immersive virtualisation processes applied to architectural heritage.
Andrea Giordano and Michele Russo, respectively VicePresident and Secretary of the REAACH Association, concluded the proceedings by emphasising how the broad participation of speakers and authors [3], diversified in terms of the topics and experiences

proposed, allowed the symposium to be dense with content and interesting insights. These could be a source of inspiration for the advancement of research in all areas gravitating around the connection between AI and XR, thus initiating a new transdisciplinary way of thinking [4].
In conclusion, the symposium constituted a rich and stimulating moment of confrontation for all researchers and scholars who, thanks to the skilful use of advanced technologies, tools, and digital devices, are experimenting with renewed ways of interacting with reality.

Notes

[1] Session 1 – *chair*: R. Spallone, M.G. Bevilacqua.
Session 2 – *chair*: M.G. Bevilacqua, B.E.A. Piga.
Session 3 – *chair*: V. Cera, M. Russo.
Session 4 – *chair*: A. Luigini, R. Spallone.

[2] Session 5 – *chair*: A. Giordano, C. Santagati.
Session 6 – *chair*: A. Luigini, V. Cera.
Session 7 – *chair*: F. Maietti, S. Brusaporci.

[3] To enrich the plurality of interventions, the contributions presented in the plenary session were complemented by a further 20 videopresentations, collected in a specific YouTube session. The two days of the symposium, together with the dedicated Youtube session, are available at the link <https://youtube.com/playlist?list=PL_o0V_i87eE28unV86QJwAJ6i0hPaTvVk&si=Udak3v-rOJiK6wF3b> (accessed 29 November 2023).

[4] The papers presented orally and on video were refereed by the session chairs and the scientific committee of the symposium, in order to provide useful suggestions for the development of an extended paper which will be subjected to peer-review and, if positively evaluated, published in Springer's *Digital Innovations in Architecture, Engineering and Construction* (DIAEC) series.

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