The Multiple Effects of Digital Archaeology in the Future Space

Jiawei Li[1(✉)], Mingdong Song[1], Yanwei Li[2], and Yinghui Shang[2]

[1] Royal College of Art, London W12 7FN, UK
799974@network.rca.ac.uk
[2] Tianjin College of Commerce, No. 23 Yaguan Road, Haihe Education Park, Tianjin, China

Abstract. Today, as the global ecological crisis continues to assault mankind, we are all faced with a worrying ecological fate, yet we all share the desire to escape from it and to live happily ever after. In the context of the growing global ecological crisis, the construction of a future ecological community has also become a real need. Well-understood archaeological research has intrinsic value in terms of innovative knowledge and the development of innovative research methods. Examining historical narratives can make us aware of different cultures and ways of life throughout history, while techniques from the archaeological past and understanding and using them can also contribute to the renewal and development of design research. This paper plans to investigate the role and significance of digital archaeological technologies in the transfer of information about the sensory features of material and immaterial culture from the analogue to the digital realm in a future context, in conjunction with innovative design thinking tools of the retrospective method, in order to contribute to the construction of a future organic ecological network system composed of the natural world, the sensory world and the meta-universe.

Keywords: Digital archaeology · Ecological Community of the Future · Retrospective method · Innovative design thinking tools

1 Introduction

Historical and cultural heritage has a unique and significant role in spreading culture, conveying friendship, preserving the world's cultural diversity and creativity, promoting the exchange and mutual appreciation of civilisations, and facilitating the building of a community of human destiny. Today, cultural relics have become the most important signposts, connecting historical accumulation with contemporary development and prosperity, linking a country's vast and profound culture with the magnificent and diverse civilisations of the world, and building bridges of dialogue between different civilisation forms and social systems. Archaeology is a very important discipline. The history of human origins over millions of years and the history of prehistoric civilisations over tens of thousands of years have been constructed mainly on the basis of archaeological results. Even the history of civilisation after written records has to be referred to, corroborated, enriched and improved by archaeological work. Historical and cultural heritage

not only tells a vivid story of the past, but also profoundly influences the present and the future.

Janus, the Roman god of beginnings and threshold space, is often depicted in iconography as having two faces pointing in opposite directions [1]. Despite the close proximity of the faces of the two-faced gods, they cannot see each other. In many ways, Janus' predicament is a good metaphor to describe the current relationship between science-oriented archaeology and social disciplines. While archaeologists were among the first users of digital technologies such as GIS, disciplinary boundaries between fields such as anthropology and history have led to a loss of intellectual and material opportunities.

Although there is no academic consensus on the definition, the discipline of digital society entails the use of computational methods to study social issues. Scholarship that explores what digital social disciplines are or speculates about their future form has turned out to be an important issue. Speculating on their future forms has become a genre piece. Like archaeology, the digital social discipline is an interdisciplinary field characterised by a collaborative project-based approach to research. In addition to these features, it promotes open-ended, exploratory research designs rather than the use of empirical models of hypothesis or model testing. As a result, there is a tendency to favour the avant-garde or visionary when looking for alternatives to traditional models of knowledge production. In archaeology, by contrast, geospatial technologies are often considered powerful tools for analysis or data capture [2], although there are important exceptions to the general trend, such as applications in cultural heritage management, museum studies or joint methods surveys [3].

The future of technologies such as GIS in science-oriented based archaeology depends on how practitioners envision the nature of their intellectual endeavours. Are archaeologists scientists engaged in model testing to develop universal theories, or are they humanists using scientific methods such as GIS to answer historically specific and contingent questions? The study of the epistemological shifts that have emerged in landscape studies is particularly revealing. Recent decades have seen a shift in the theoretical focus of regional landscape studies in Anglo-American archaeology [4]. The cultural ecology approach that prevailed in the mid-twentieth century has been challenged by various postmodern, post-positivist philosophies [5]. While some archaeologists previously equated the concept of landscape with the physical environment, a growing number of scholars now embrace a socio-historical perspective on the study of past landscapes. As a result, the scope and focus of GIS research has also shifted to the exploration of humanities and social science questions. In response, landscape archaeologists [6]. have called for approaches that combine social and spatial theory [7] leading to a shift in the field from an emphasis on patterns of interacting behaviour to the social dimension of landscape production [8].

A review of the current literature shows that archaeologists have internalized criticisms of postmodern, post-positivism in recent decades [8] and are examining traditional humanist lines of research, such as spatial experience or tracing historically specific developments. Given that the concept of landscape has shifted from the environment to social history, it is useful to define the areas in which geospatial approaches can be broadened through engagement with digital disciplines and spatial history, as landscape archaeology has many intersections with traditional humanities and social science inquiry.

This thesis will therefore analyse the role and significance of digital archaeological technology in the transfer of sensory information from the analogue to the digital realm of material and immaterial culture in a future context, combined with the innovative design thinking tools of retrospection, in order to contribute to the construction of a future organic ecological network consisting of the natural world, the sensory world and the metaverse.

2   Concept

Over the last few decades, the understanding of what cultural heritage is and how it is defined has changed and expanded its scope. Important international bodies, such as ICOMOS and UNESCO, representing reference points for documentation and conservation, have revised the definition of cultural heritage to include not only elements associated with historical art and testimonies of civilisations, but also their surroundings. In other words, the meaning of cultural heritage has been extended to include the concept of cultural landscapes.

Well-understood archaeological research has intrinsic value in terms of innovative knowledge and the development of innovative research methods. Examining historical narratives can make us aware of different cultures and ways of life throughout history, while techniques from the archaeological past and understanding and using them can also contribute to the renewal and development of design research.

David Sless, Director of the Australian Institute of Communication said in Design or 'Design' - Looking to the future of design education:- "Previously the agenda for change in design has been seen as ambitious, but in my view we should have a more modest vision of design:doing thoughtful, useful, evidence-based work to help progressive, informed and sustainable improvement, considering areas where we can consider and do no harm" [9]. In this vision, creativity is no longer at the centre of the design enterprise, but is seen as a useful part of the treasure trove of design information. More importantly, he mentions that we need to pay attention to two groups of people: those who have already created design tools and methodologies, and those who are happy to evaluate the design systems that have been created. the vision proposed by David Sless cuts through the traditionally perceived radical claims that design is revolutionary and transformative, and replaces them with design as a reconstructive activity embedded in existing social and natural systems.

How can we use digital technology to transcend (disrupt) the boundaries of perception and develop new understandings of self and others, society, life or embodiment? Can we work with digital media and technology to develop new perspectives on a past that transcends the human? Is it possible to grasp and cultivate other non-human moving entities through digital media and technology to create multisensory experiences? How is digitisation changing the relationship between archaeologists, the archaeological record and the public?

The closely related disciplines of archaeological research, anthropology, history and heritage studies offer a new way of thinking about future design: by connecting the past with the future, a retrospective perspective can be found. Whereas in the past future design has mostly been practised through foresight and anticipation, the intrinsic value of archaeology can help us to be able to look back, critique the present and look forward, and develop research methods oriented towards specific problem analysis, thus helping to address a range of challenges facing contemporary society and even the world.

3   Research Cases

Academic research into digital archaeology itself started late, with the Oxford Institute for Digital Archaeology (IDA), the Media Lab at the Helsinki University of Art and Design (DAMD), and Stanford University all currently beginning professional and research studies in the field.

The Oxford Institute for Digital Archaeology (IDA) has developed projects such as 'Olfactory Heritage - The Smell of History', 'Portable Heritage: The Evolutionary History of Books', 'Digital Syria' and 'Heartbeat of the City: 500 Years of Personal Time', all of which involve the use of digital technology and artistic creation to digitally simulate scenes from the past and to future-proof existing things. In "Smelling Heritage - The Smell of History", the IDA director explains that heritage assets take many forms. Some, such as old buildings and huge sculptures, display a strong physical presence. At the other extreme are purely ephemeral forms of cultural expression - dance, gastronomy, music - which have as much connection to our collective past as any building or statue, and are shaped by them. From the very beginning, the IDA has been preserving heritage in a variety of ways. In addition to pictorial and physical reconstructions, considerable effort and resources have been expended on observing, documenting and studying ephemeral heritage. IDA's current focus is on the concept of smell as ephemeral heritage. IDA has developed a suite of olfactory experiences for upcoming exhibitions at the Bodleian Library, Oxford University and the New York Public Library. Rare books and manuscripts for these installations include Edmond Malone's First Folio, a copy of the Magna Carta of 1217, James Madison's Federalist Papers, books from the private collections of CS Lewis and JRR Tolkien, and a range of rare Egyptian papyri, including fragments One of the earliest known copies of the Iliad. Each one has its own distinctive scent that tells its history, in Fig. 1. In 2020, the IDA will be collaborating with Vacheron Constantin, the world's oldest watchmaking company, on a travelling exhibition of clocks and other horological materials. This autumn, at the University of Oxford's Museum of the History of Science, visitors will be able to walk through the heart of a giant watch escapement

and learn more about the workings of these precision machines. The installation - part of a joint venture with Vacheron Constantin - will incorporate an olfactory element, in Fig. 2.
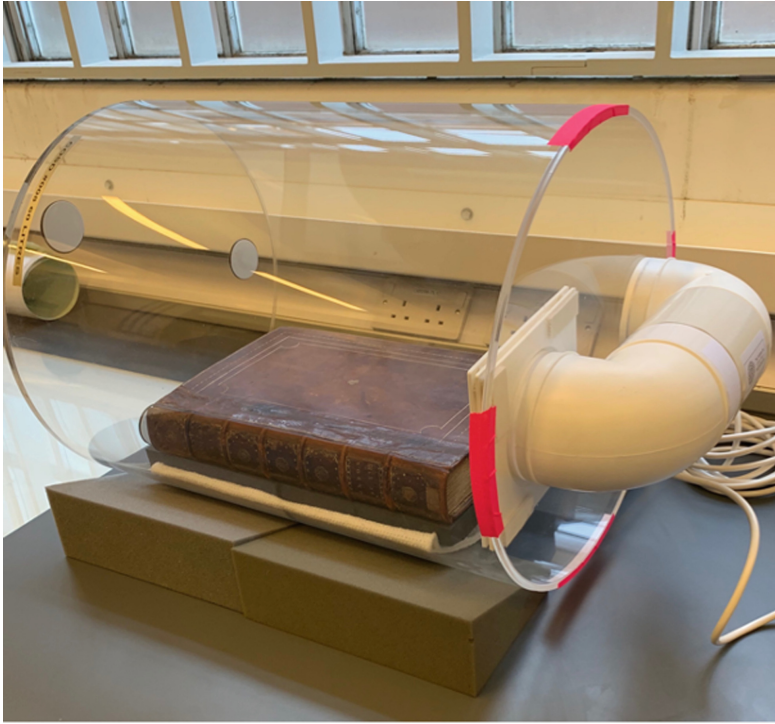

Fig. 1. Edmond Malone's first folio in IDA's proprietary odor extraction device at the Bodleian

The sense of smell is a complex sense with the unique ability to construct or access memories. The study of ancient spices has led to an awareness of the immense history and science contained in scent. working with palaeobotanists and olfactors in the USA, Europe and Central Asia, IDA has explored a range of heirloom varieties of traditional spice plants, recovering scents that in some cases have been forgotten by the world for centuries. They are establishing a herbarium as a living library of these ancient plants, preserving not only their genomes but also their fragrances, as an emerging form of historical conservation that will contribute greatly to the knowledge base of future and future generations.

Digital Archaeology is a design/research discipline being developed at the Media Lab (DAMD) at the University of Art and Design Helsinki, Finland. Emphasising the important contribution of artists to the development of the information environment, it aims to reconstruct and make previously inaccessible cultural artefacts as widely available as possible. Issues of access and preservation, research and intellectual enquiry, and the metaphorical nature of technology are invoked as building blocks for the future. Looking at historical narratives allows us to be aware of the differences between cultures

Fig. 2. Preparing the scents for the 2020 Bodleian library "Sensational Books" Exhibition

and ways of life throughout history, says project organiser Lily Diaz in the discipline description. New technologies facilitate artists' contributions to the knowledge base by collecting suggestions, researching data and other materials used in innovative ways to create art. The advent of digital archaeology is an important step towards building the future of the humanities [10].

The Stanford JANUS Initiative is an interdisciplinary study focused on past, present, and future human experiences of innovation and design, which is co-sponsored by the Center for Design Studies and the Center for Archaeological Studies in the School of Engineering at Stanford University. The initiative combines features from the fields of design thinking, strategic foresight, scenario planning, design-based research, planning and implementation, organisational studies, archaeology, history, ethnography and anthropology. Its research focus on digital business archaeology, such as the work of historians and museums can be used to document the history of a business for good a good outcome, which links past business and corporate experiences to today's business challenges and concerns, using retrospective methods to build innovation capacity for desired future outcomes. The creation of the JANUS initiative's business archaeology knowledge base has become a way to collect examples of archaeological data positively influencing the future innovation capabilities of businesses and organisations.

It is thus clear that digital archaeology is able to make effective use of retrospective methods, focusing on collecting data from the past and summarising the experiences of known cases positively contributing to the future. Digital archaeology has been addressed by academics but has not yet been studied as a broad discipline.

4   Thematic Significance

4.1   Pilot Program

Firstly, a phenomenological analysis and systematic inquiry based on the theoretical foundations of archaeology, communication, sociology and humanities, collecting existing cases of digital archaeology and exploring them in depth in different fields and in different ways of expression.

Secondly, an attempt to connect with the meta-universe: the interpretation, reconstruction and communication of retrospective datasets taught to users using the information provided by the virtual participatory platform allows to work together in the same cyberspace, interacting with models of artefacts, monuments and sites in real time. The study and analysis of archaeological virtual reconstruction processes will contribute to the contextualised reconfiguration of spatial archaeological datasets. The creation of the platform can also be envisaged as an open laboratory, with mechanisms built through an interactive ecosystem. The result will be the creation of new learning, research and educational processes in the virtual archaeological world, communicating and interacting in a 3D cyberspace [11].

Then attempting to make connections with the sensory world: archaeology is often thought of as a visual discipline. With many sites and objects trapped behind walls, isolation strips and glass, the visual dimension of these materials has historically been the only point of contact for all people, trying to use senses such as smell, sound visualisation and touch to change the way people interact with objects [12].

Finally, attempting to make connections with the natural world: attempting to design the documentation of cultural heritage in areas affected by natural disasters and creating online image databases, including through the use of new digital technologies, to preserve the memory of the past and reduce the risk that valuable cultural assets may be damaged or lost.

4.2   Pilot Projects

'E-Trace' is our research project for our second year at the Royal College of Art. The background is based on the value of archaeology in the search for memories that have been lost in the history of human civilisation. The relics of the past can inspire our future and re-examine our present. So, as people living in the 'now', have we ever wondered how humans will explore our lives a hundred years from now? What will be part of the valuable 'artefacts' of our everyday lives and how they will be stored?

The main goal of the project is to create a meta-universe space, set in a future world, where users facilitate the interpretation, reconstruction and communication of archaeological datasets through remote virtual participation. In the first phase, we plan

to use our custom-developed application to build the spatial database and create different interpretations of the archaeological model. At this point, the framework is not intended to facilitate interaction between large numbers of users, for example in a massively multiplayer game, but rather to allow interactive communication between small groups of up to five users. In the second phase, the data and results of the interpretation process will be disseminated to a wider audience of educators, students and others via the Internet. In this respect, we plan to make use of emerging multi-user virtual communities, such as the OpenSimulator environment.

OpenSimulator is an open source 3D application server that can be used to create virtual worlds that can be accessed by others over the Internet using various protocols. The engine is also compatible with SecondLife® protocols and client applications, making it potentially possible for SecondLife® users to enter OpenSimulator virtual worlds [13]. In our web archaeology framework, spatial databases created by our collaborative applications can be synchronised with SQL Grid databases supported by these environments. Users of openSimulator can access virtual archaeological sites and explore artefacts linked to other data sources. Due to the exceptional limitations of this environment, models need to be greatly simplified (e.g. reduction of texture resolution, optimisation of geometry) to allow remote access to interactive imagery, in Fig. 3.
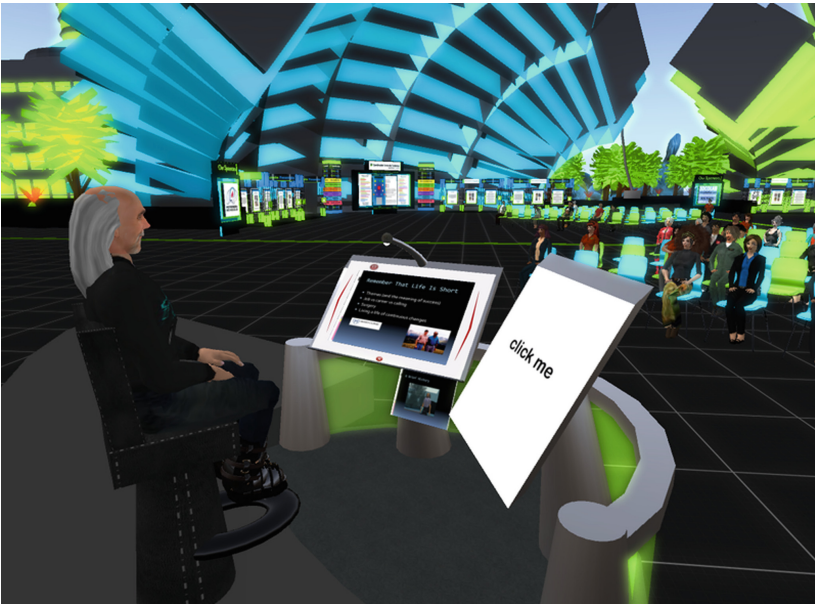

Fig. 3. Grady Booch presentation at Opensimulator community conference 2013

Archaeological datasets can also be shared with virtual communities through the Open Cobalt environment, an open source project that aims to create, share and hyperlink virtual workspaces for research and educational purposes (Open Cobalt 2010). The platform allows the creation of simplified virtual worlds that can be connected to each

other through portals. The interactivity and reliability of the platform is currently quite limited (note that the project is in alpha phase); however, 3D datasets can be imported and presented in a simplified form in these virtual environments, and our research on remote immersion plans to create realistic and dynamic personas that can be integrated into these and existing virtual communities (e.g. OpenSimulator) [14]. This will allow users with stereoscopic cameras to achieve a higher level of immersion, while allowing users with limited technical capabilities to interact in the same environment. Dynamic avatars will allow users to express their emotions and body language, which will make the use of applications more intuitive than using predefined scripts, such as pointing out different features or making eye contact with other users [15]. The metaspace is seen as a social space where groups of active users create avatars and can share the space and communicate and interact with each other in three dimensions.

5   About E-Trace

The goal of this space is to teach the interpretation, reconstruction and communication of archaeological datasets using all the information provided by the virtual participatory platform. Users from different geographical locations, represented by 3D avatars, can work together in the same web space, interacting with models of artefacts, monuments and sites in real time. This prototype collaborative application for data archaeology - built on an open source virtual reality framework - aims to demonstrate real-time collaborative interaction with 3D archaeological models associated with video streaming technologies, including lightweight 3D tele-immersion using stereoscopic cameras. The study and analysis of the archaeological virtual reconstruction process will contribute to the recontextualisation and restructuring of spatial archaeological datasets by the virtual community, from the first draft (where data is not yet interpreted) to the final level of communication. The learning activity will involve a bottom-up approach, whereas the analysis of archaeological remains and finds requires a top-down approach, such as the reconstruction of ancient architectural styles, materials, shapes, etc. The field of virtual reality collaboration is a simulated environment where advanced behaviours, actions and new research and training methods will be tested. It can be conceived as an open laboratory: a place where the construction and validation of interpretive processes can be compared, where new relationships between spatial and temporal data can be studied, and where opportunities can be established through interactive ecosystems. The result will be the creation of new learning, research and educational processes in a virtual archaeological world, playing and interacting in a 3D cyberspace.

5.1   Background

The value of archeology is to search for the memories that have been lost in the history of human civilization. The remains from the past could inspired our future and re-examine our present. So as people living in the "present", have we ever imagined how humans in a hundred years time will explore OUR lives? What in our daily lives will form part of valuable 'artifacts' and how they will be stored? Our project presents a hypothetical answer to these questions. By reflecting on today's mechanized society

and the phenomenon of information digitalization, we pictured a future which humans existence is endangered and the human senses- our direct connection with the physical world is preserved in the form of data and becomes the most precious artifacts for post-human to excavate.

5.2   Trailer

We used C4D to create a trailer to give the audience an idea of the background of the story, in Fig. 4. The animation is in Chinese style, interspersed with traditional Chinese elements such as stone lions, lanterns and hexagonal pavilions. Abandoning the original sci-fi futuristic style of green, blue and black, we boldly experimented with the use of reversed colours for the expression of the RGB world. The soundtrack uses oriental instruments such as bamboo flute, Chinese Zither and drums to reflect the majestic and harmonious mood. A geographical message is prompted at the end of the trailer and the viewer is only allowed to proceed to Part 2 once this message has been obtained.
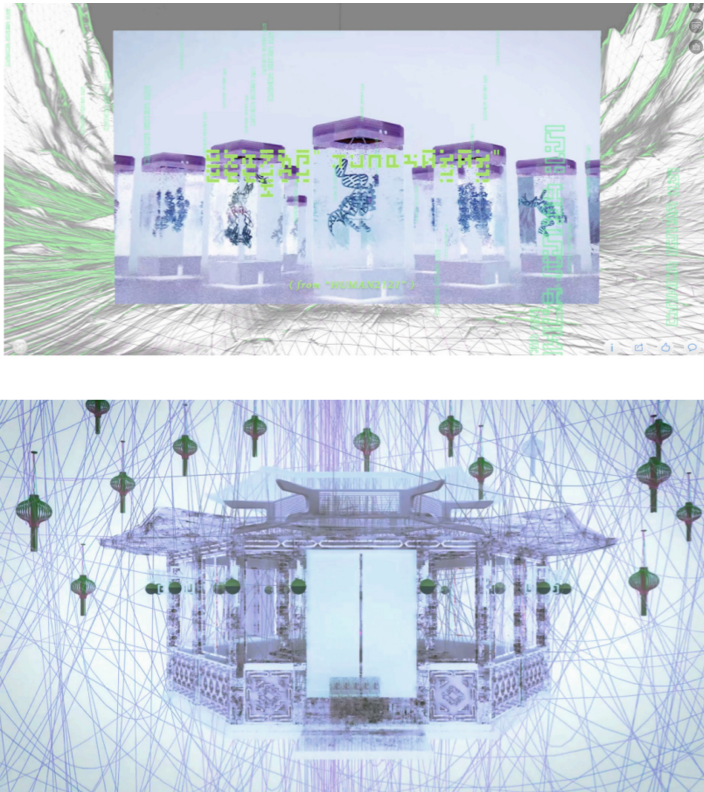

Fig. 4. Pilot film scenes in the E-Trace virtual space

5.3   Virtual Space Archaeology

Our space destination - the Biobank, in Fig. 5. It is a space made up of data, taking out our mobile phones to scan the X-language floating in space and get the sensory information we have been dreaming of. This is one of the most innovative new ways of future storytelling in the whole project - the first attempt to use AR in VR, in Fig. 6.

Once the five sensory data have been collected, the five-digit code formed by combining the first digit of each gene sequence number is the key to gaining sensory abilities, in Fig. 7. (All biosensory prototypes and data are from Protein Data Bank https://www.rcsb.org/).
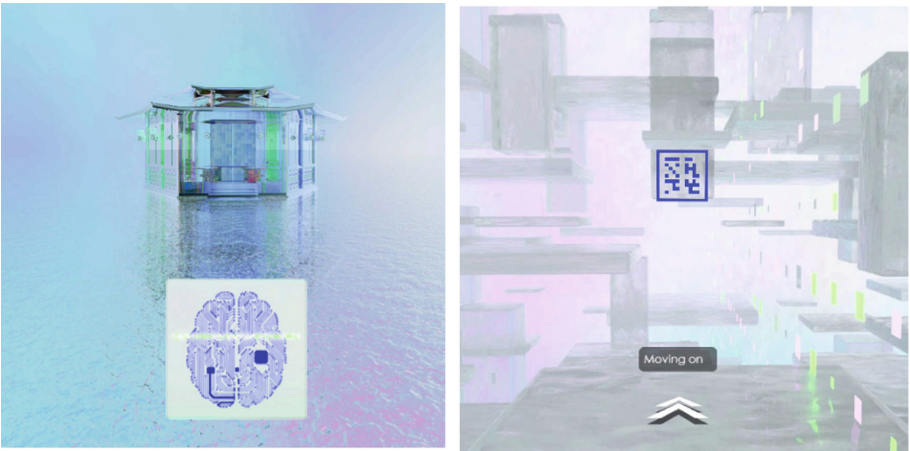

Fig. 5. E-Trace Biobank

Fig. 6. E-Trace AR

6   Conclusion

In terms of direction, in order to conform to the current trend of the times - the common destiny faced by all humanity is ecological destiny - one of the connotations of constructing a community of destiny is to construct an ecological community, i.e. to integrate the construction of an ecological community into the vision and process of building a community of human destiny. In terms of its role, digital archaeology captures the virtual nature of information environments such as digital communication infrastructures and the internet, with the fundamental goal of developing the use of these environments to reconstruct previously inaccessible artefacts and to store modern things. We believe that its greatest strength is its ability to subtly infuse data information from both the natural and artificial worlds on the basis of the creation of virtual spaces such as metaverse, as digital archaeology has already had cases of sensory data preservation as far as developments are concerned, so it can to some extent help build organic ecological network systems for the future.

References

1. Hamer, J.: The physiognomy and artistic representation of Janus with special reference to the coinage in Southern Italy. In: Alfaro, C., Marcos, C., Otero, P. (eds.) XIII Congreso Internacional de Numism?atica, Madride2003. ActasePro-ceedingseActes, pp. 619–624 (2005)
2. Comer, D.C., Harrower, M.J.: The history and future of geospatial and space technologies in archaeology. In: Comer, D., Harrower, M. (eds.) Mapping Archaeological Landscapes from Space, pp. 1–8. Springer, New York (2003)
3. Price, D., Koontz, R., Lovings, L.: Curating digital spaces, making visual arguments: a case study in new media presentations of ancient objects. Digit. Humanit (2013)
4. Patterson, T.C.: The history of landscape archaeology in the americas. In: David, B., Thomas, J. (eds.) Handbook of Landscape Archaeology, pp. 77–84. Left Coast Press, Walnut Creek, CA (2008)
5. Ashmore, W.: Social archaeologies of landscape. In: Meskell, L., Preucel, R.W. (eds.) A Companion to Social Archaeology, pp. 255–271. Blackwell Malden, Malden (2004)
6. Knapp, A.B., Ashmore, W.: Archaeological landscapes: constructed, conceptualized. Ideational. Archaeol. Landsc. Contemp. Perspect. 1–30(1999)
7. Harvey, D.: Social Justice and the City. University of Georgia Press, Athens (1973)
8. David, B., Thomas, J.: Handbook of Landscape Archaeology. Left Coast Press, Walnut Creek (2008)
9. Sless, D.: Design or design-envisioning a future design education. Vis. Lang. **46**, 54–65 (2012). Cincinnati
10. Díaz, L.: Digital archeology: design research and education- connecting historical narratives and digital environments. Leonardo **31**(4), 283–287 (1998)
11. Díaz-Guardamino, M., Morgan, C.: Human, transhuman, posthuman digital archaeologies: an introduction. Eur. J. Archaeol. **22**(3), 320–323 (2019)
12. Ruffino P.A., Permadi D., Gandino E., Haron A.: Digital technologies for inclusive cultural heritage: the case study of Serralunga d'alba castle. ISPRS Ann. Photogrammet. Remote Sens. Spat. Inf. Sci. **IV-2-W6**, 141–147 (2019). DOAJ
13. Sequeira, L.M., Morgado, L., Pires, E.J.S.: Simplifying crowd automation in the virtual laboratory of archaeology. Proc. Technol. **13**, 56–65 (2014). Elsevier

14. Christopoulos, A., Conrad, M., Shukla, M.: Co-presence in the real and the virtual space: interactions through orientation. In: Costagliola, G., Uhomoibhi, J., Zvacek, S., McLaren, B.M. (eds.) CSEDU 2016. CCIS, vol. 739, pp. 71–99. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-63184-4_5
15. Earley-Spadoni, T.: Spatial history, deep mapping and digital storytelling: archaeology's future imagined through an engagement with the digital humanities. J. Archaeol. Sci. **84**, 95–102. ScienceDirect (2017)