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AUTHENTICITY THROUGH VR-BASED DOCUMENTATION OF CULTURAL HERITAGE. A THEORETICAL APPROACH BASED ON CONSERVATION AND DOCUMENTATION PRACTICES

AUTENTICIDAD A PARTIR DE RV COMO MÉTODO DE DOCUMENTACIÓN DE PATRIMONIO CULTURAL. APROXIMACIÓN TEÓRICA BASADA EN PRÁCTICAS DE CONSERVACIÓN Y DOCUMENTACIÓN

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Abstract:

The visualization of 3D reconstructed artifacts often requires significant computing resources. The implementation of an object in a virtual reality (VR) application even necessitates the reduction of the polygonal mesh. Consequently, the communication and dissemination of "authentic" 3D reconstructions via immersive VR technologies has been a nearly impossible feat for many researchers. However, is the issue really computing resources, or is it rather the notion of authenticity in an "auratic" sense, i.e., an excessive focus on physical evidence and survey data? In the present paper, we will discuss the authenticity requirements for virtual archaeology as set by the Seville Principles (2011), and we will analyze some limitations related to the current approaches. Furthermore, we will propose a pluralistic notion based on the contextualization of 3D objects in VR environments with synesthetic (i.e. multisensory) information. This new notion of authenticity relies on conservation meanings rather than physical features. In line with this approach, two case studies will be commented: the multimodal 3D-documentation of the *Jupiter Column* (2 AD) in Ladenburg, and the VR-based re-enactment of a modern work of art, the audio-kinetic sculpture *Kaleidophonic Dog* (1967) by Stephan von Huene. These two projects provide valuable data for a revision of the notion of authenticity in both virtual archaeology and art conservation.

Key words: virtual reality (VR), virtual archaeology, kaleidophonic dog, Jupiter column, synesthetic documentation, progressive authenticities

Resumen:

La visualización de artefactos reconstruidos en 3D requiere a menudo demasiados recursos computacionales. La implementación en una aplicación de realidad virtual (RV) requiere incluso la reducción de la red poligonal del objeto. Consecuentemente, la comunicación y la divulgación de reconstrucciones 3D "auténticas" representa todavía una tarea casi imposible para muchos investigadores. ¿Pero se trata realmente solo de una cuestión de computación, o tiene algo que ver con una noción de autenticidad en un sentido "aurático", es decir, con un enfoque excesivo sobre pruebas materiales y datos mensurables? En este artículo discutimos los requisitos de autenticidad para la arqueología virtual tal y como se formulan en los "Principios de Sevilla" (2011) y analizamos algunas limitaciones de los enfoques actuales. Proponemos, además, una noción pluralista basada en la contextualización de objetos 3D en entornos de RV con información sinestésica (es decir, multisensorial). Esta nueva noción de autenticidad se basa más en la conservación de significados que en la conservación de características físicas. En línea con esta propuesta teórica, se comentarán dos casos de estudio: la documentación multimodal 3D de la *Columna de Júpiter* de Ladenburg (II d.C.) y la recreación en RV de una obra de arte moderno, la escultura audio-cinética *Kaleidophonic Dog* (1967) de Stephan von Huene. Estos dos proyectos ofrecen experiencias valiosas para una revisión de la noción de autenticidad tanto en la arqueología virtual como en la conservación de arte.

Palabras clave: realidad virtual (RV), arqueología virtual, kaleidophonic dog, columna de Júpiter, documentación sinestésica, autenticidad progresiva

1. Introduction

Authenticity is a widely contested concept, not only for its static, Eurocentric origin but also because it is a selling point in tourism and place marketing and other processes of cultural commodification (Dicks, 2004, pp. 30-43; Boltanski & Chiapello, 2007, p. 439-469). While the connection of commodification and authenticity remains yet to be resolved, authenticity as criterion for listing objects and sites as UNESCO-world heritage has been reformulated in the course of the Nara Conference (1994) (Falser, 2012). The new conception allows the inclusion of artifacts and practices that imply rebuilding, dismantling and other forms of alteration in the sense of Lowenthal's "progressive authenticities" (Lowenthal, 2008, p. 4). In the Nara Declaration (ICOMOS, 1994)

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authenticity is described to rely on "truthful and credible values". This implies a variable approach that overcomes the object-related and classic notion of the "original's aura" as the essential form of cultural tradition (Benjamin, 2006). The widely spread use of optical- and computer-based technologies for the documentation of cultural heritage in recent years has favored the conceptual enhancement of authenticity as a criterion for faithful and accurate documentations within the framework of virtualization. Nevertheless, we seldom find projects that consider authenticity as a "layered concept" in a consistent way, for instance by taking into account the check list of the "Nara Grid" (Van Balen, 2008) for the re-creation of meaning in different social contexts. Rather, in the "Principles of Seville" (2011), which directly address virtual archaeology, we find a predominant "aura"-related notion of authenticity, i.e., the authenticity of the original item, or what is supposed to be the original, is the main goal of virtualization. The "Principles of Seville" (IFVA, 2011) constitute the first international charter on virtual archaeology (López-Menchero Bendicho & Grande, 2011). These principles enhance and update the guidelines for computer-based visualization of Cultural Heritage formulated in the "London Charter" (Denard, 2009; Carrillo Gea, Toval, Fernández Alemán, Nicolás, & Flores, 2013). Among other things, the idea of authenticity is introduced as a mandatory criterion: "authenticity must be a permanent operational concept in any virtual archaeology project" (IFVA, 2011, § 4). This is an intuitive notion, a requirement for copying original objects. But does it mean that there is no place for hypothesis? Sometimes, we have to deal with interim solutions based on available data and plausibility, and the "Principles of Seville" also regard this kind of contingency: if the "scientific validity" of the virtualized artifact cannot be guaranteed, "only the main hypothesis will be endorsed" (IFVA, 2011, § 4.1). This authenticity concept evokes the idea of a scalable criterion with concrete demands, but assuming "different levels of accuracy" (§ 4.2) at the same time. These "levels of accuracy" must be scientifically verified and explicitly highlighted, whenever we are working with hypothesis. In § 4.3 we also read that a "virtual archaeologist" should "differentiate clearly between […] conserved *in situ* […], real anastylosis […], rebuild on original remains [...], and […] virtually reconstructed". Accordingly, the accuracy of virtually reconstructed artifacts eventually depends on positivistic criteria of scientific measurability. Even if the "Principles of Seville" do not explicitly relate to the ambitious definition of authenticity formulated in the "Nara Declaration" (1994), we can infer that some aspects of it are present in § 4.1 such as the idea that "archaeology is complex and not an exact and irrefutable science", and therefore, "it must be openly committed to making alternative virtual interpretations provided they afford the same scientific validity." In this sentence, authenticity is determined in a similar way as proposed in the Nara declaration, i.e., through „truhtful and credible values" related to the presumably original context (ICOMOS 1994, § 9). However, "The Nara Document on Authenticity" (1994) goes further considering time, space and cultural aspects as key factors of authenticity. But even here, authenticity is considered an abstract entity linked to the original context or contexts of the past. Its variable qualities, which change depending on different uses and social memories, are extensively being missed. Hence, it is worthwhile proposing to talk about a plurality of authenticities whenever "time" or different, even future "cultural contexts" come into consideration.

The shortcomings of traditional visual representations of monuments and cultural assets have raised hopes that digital 3D technologies can provide more detailed and accurate representations, and therefore, a better approach to the "authenticity" of the originals. Nevertheless, the geometric accuracy of 3D reconstructed vestiges of the past is all but a guarantee for authenticity. It is dubitable that the new technological advances in 3D reconstruction such as photogrammetric bundle adjustment, laser scanning or structured light methods are suitable either for capturing the "meanings" of the past or for understanding the subsequent "authenticities" of an artifact through time, cultural contexts and social memories.

Based on two recent case studies that applied multimodal and synesthetic documentation methods (Muñoz Morcillo, Schaaf, Schneider, & Robertson-von Trotha, 2016), we will draft a framework for contextual enhancement and immersive representation that allows the re-enactment of multiple meanings and "authenticities" of 3D-documented cultural objects. For this purpose, we follow theoretical and practical approaches on authenticity in the field of virtual archaeology and art conservation with a special focus on core strategies for the conservation of media art – i.e. time- and space-based art – such as emulation, migration, re-creation and digital re-enactment (Hummelen & Sillé, 1999; Depocas, Ippolito, & Jones, 2003; Variable Media Network, 2004; Scholte & Hoen, 2007; Rinehart & Ippolito, 2014, and Muñoz Morcillo, Faion, Zea, Hanebeck, & Robertson-von Trotha, 2014). The suitability of these strategies for 3D-based digital preservation and representation of cultural heritage shows that a more pluralistic notion of authenticity is desirable for researching and understanding the changing conditions of both media art and archaeological cultural heritage.

2. Multimodal and synesthetic documentation

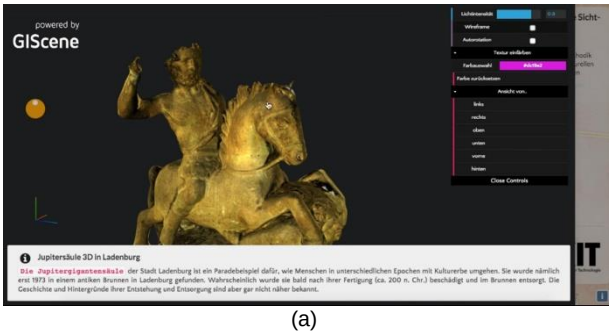
There are many ways to share a digital 3D model of a cultural object with the scientific community or with the general public, but most of them imply a "classical" computer situation with mouse and keyboard. Whenever we look for 3D annotated, contextualized or immersive VR-based communication of art and cultural heritage we either find experimental systems (e.g. Carrozzino & Bergamasco, 2010; Scali, Segbert, & Morganti, 2002) or museum installations (e.g. Sylaiou, Mania, Karoulis, & White, 2009; Herbert, 2014). These are suitable for an approach within the framework of public communication of cultural assets, but they are not appropriate for scientific analysis. We discuss novel concepts of virtualization and documentation of cultural heritage that were developed in cooperation with partners at the Karlsruhe Institute of Technology (KIT) and at the Heidelberg University, namely the multimodal documentation of sculptures using different 3D reconstruction techniques and implementing geodata in a web app, and the synesthetic documentation and immersive visualization of complex artifacts, such as automata and media art installations, via VR technologies.

Figure 1: 3D reconstructions of the Jupiter Column: a) 3D view of the *Jupiter Column*; photogrammetric reconstruction based on approximately 700 photos with a resolution of 36 megapixels/image. Photo: IPF/KIT; b) Front elevation of the *Jupiter Column*; structure light-based reconstruction with the SmartSCAN-3D-HE. Photo: FCGL/Heidelberg University; c) Right side of the main motive (a riding, Titan defeating Jupiter); photogrammetric reconstruction based on approximately 700 photos with a resolution of 36 megapixels/image. Photo: IPF/KIT; d) Left side of the riding, Titan defeating Jupiter; structure light-based reconstruction. Photo: FCGL/Heidelberg University; e) Detail of the photogrammetric reconstructed inscription. Photo: IPF/KIT; f) Detail of the inscription, reconstructed with structured light. Fictive colors. Photo: FCGL/Heidelberg University.

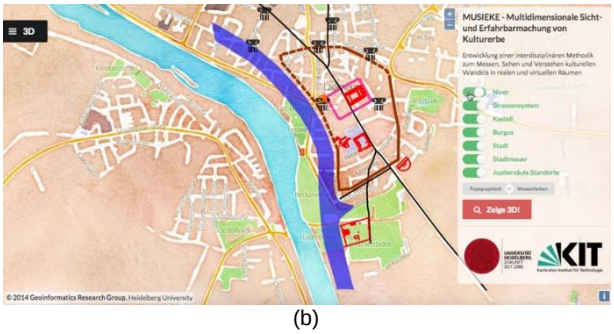
The *Jupiter Column* of Ladenburg (currently at the Lobdengau Museum, Ladenburg, Germany) was used to test interdisciplinary research methods of making various dimensions of cultural heritage perceptible through multimodal documentation. Built roughly after 200 AD, destroyed shortly thereafter, and reconstructed with some changes, the column –a typical landmark in the Roman provinces– was accidentally discovered in the 1970s, in a former Roman well (Heukemes, 1975, p. 39). For the 3D reconstruction of the column, different methods were used. Researchers at the KIT-Institute of Photogrammetry and Remote Sensing (IPF) provided a photogrammetric reconstruction based on approximately 700 photographs captured with DSLR Nikon Cameras in a resolution of 36 Mp/image. For the 3D reconstruction (Fig. 1, a, c, e) they used PhotoScan v. 1.2, one of the most popular and efficient photogrammetric software packages developed by the Agisoft company. They achieved a photorealistic, textured model with a very high resolution.

Members of the Heidelberg University FCGL (Forensic Computational Geometry Laboratory) applied structured light using the Breukmann SmartSCAN-3D-HE (by AICON, http://www.aicon.de), which offers an extremely high resolution, but no texture information (see Fig. 1, b, d, f). In the present case, the same setup as described in Mara, Krömker, Jakob, & Breuckmann (2010, p. 132) was used, but applying a larger Field of View (FOV) of 650 mm. Moreover, an overwritten inscription was partly reconstructed by means of *Multi Scale Integral Invariant* (MSII) filtering. This method was used for extracting the barely readable Latin characters as described in Mara et al. (2010, pp. 133-134) for handwritten cuneiform scripts. Additionally to the images of the column shown in this article, it is possible to apply methods such as the "umbrella transformation", which, e.g. allows for unwrapping the rotationally symmetric parts of the column for a better analysis of its morphology as described in Rieck, Mara, & Krömker (2013).

The results of this multimodal documentation of the *Jupiter Column* were used for a new archaeological and historical interpretation of the object and its original context(s). This critical evaluation was carried out by Dr. Andreas Hensen (Director of the Lobdengau Museum, where the column is preserved) and Prof. Dr. Christian Witschel (Director of the Heidelberg Center for Cultural Heritage, HCCH). In an upcoming publication, Hensen presents new archaeological aspects related to the *Jupiter Column* of Ladenburg including excavation details, circumstances of discovery, stylistic and chronological classification of individual parts, and an analysis of the new findings. For this part, Witschel examined the two-phases of the votive inscription on the monument in detail (Hensen/Witschel, in preparation). In regard to the latter, one of the most interesting interim results is the observation of the final letter of the inscription: It is an "R" (for "*restituit*" –"he has restored") which might have been an afterthought, correcting an original "P" (for "*posuit*" – "he put it up"). Below this inscription faint trace another, even earlier text can be detected. Together with the archaeological remains of the monument, this seems to indicate that the column was dismantled at least twice. Although the reasons for this process remain unclear, the new analysis of the monument does not necessarily point towards 'barbarian' enemies as the initiators of the destruction of the column and its subsequent backfill into a Roman well nearby. If this interpretation is to be confirmed, our knowledge of cultural practices of the past in relation to the manipulation of symbolic monuments might be partly revised.



(a)



(b)

Figure 2: GIScene-based web application: a) 3D viewer with visualization and selection tools; b) Geodata viewer with controls for displaying different parts of the roman city Lopodunum including the localization of the *Jupiter Column* and similar monuments. Photos: Geoinformatics Research Group/Heidelberg University

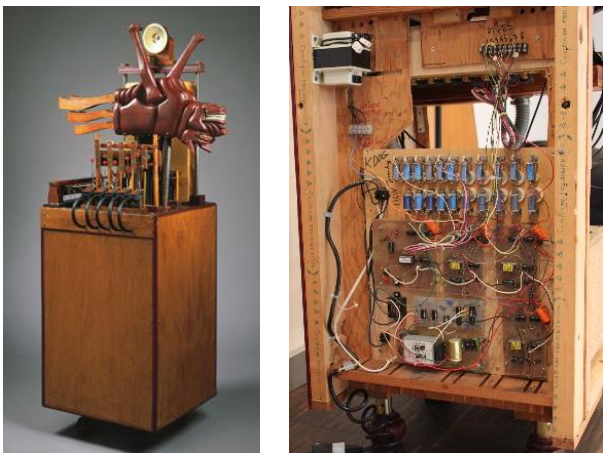
Regarding the visualization of the 3D model, a web application based on the open source tool GIScene (https://github.com/GIScience/GIScene.js) was developed by the Geoinformatics Research Group at the Heidelberg University. It consists of a virtual research environment for the documentation and analysis of archaeological objects that builds on the results of the MayaArch3D project (Auer et al., 2015). Using both 3D display tools and geodata in a web application, researchers and the general public can explore the structure of the *Jupiter Column* (Fig. 2, a) and its chronological and geographical context(s) (Fig. 2, b). This allows a study of the *Jupiter Column* as a specific type of cultural object that, to all appearances, must have fulfilled several functions during the existence of the Roman city of Lopodunum (Ladenburg). In this case, the object itself demanded a processual display, because of its complex record of findings as well as many speculations on its original purpose and several rededications, reconstructions and attempted destructions. Against this background, the spatio-temporal distribution of the statue and the speculations on the historically varying purposes bring the general question of authenticity of cultural heritage to the fore.

In our accompanying research, we found that both computer scientists and heritage professionals acknowledge "the original" and its auratic qualities. However, researchers of the *Jupiter Column* project stressed the importance of accurate research methods for the making of digital reproductions. It can be said that the aura of the original is replaced by the zeal and effort of the scientists, who try to achieve "accurate" and

"geometrically exact" results using scientific surveying methods. Moreover, the participating researchers emphasized the necessity to transmit scientifically produced knowledge to a larger audience. Hence, accurate, realistic, sustainable, and manageable, i.e., user-friendly representations help both to determine what the original artifact potentially was and to reveal its processual nature, providing a basis for further research and public understanding of science. This notion of providing knowledge about and access to the artifact is congruent with the above-mentioned definition of the Nara Declaration (1994), which demands a transparent and therefore "credible" presentation of the sources of information.

The *Kaleidophonic Dog* (1964-67/1983, Fig. 3, a, b) by the German-American artist Stephan von Huene (1932-2000) was virtualized for documentation and conservation purposes using VR-technologies as part of a methodological approach to a new kind of "informational preservation" in the sense of Muñoz-Viñas (2011, p. 25). This audio-kinetic sculpture consists of 8 wooden pipes, a xylophone, a wooden drum, a cymbal, and a wooden dog lying on its back. The figure is covered in red leather and includes movable legs, mouth and head pieces. The 21 kinetic and acoustic parts are actioned by valves and bellows within a complex pneumatic system with both vacuum and blowing motors. For this case-study, an interdisciplinary team composed of KIT-members of the Intelligent Sensor-Actuator-Systems Laboratory (ISAS) and the ZAK applied photogrammetric reconstruction based on 380 photos using VisualSFM, fine modelling in the 3D modelling software Blender as well as two game engines –Unity for testing interaction patterns and Unreal for the final results, i.e. for the implementation of sound and kinetic parameters. The results can be experienced using VR technologies such as a Head-Mounted-Display (HMD) in combination with a tracking system (Fig. 4). VR-Technologies allow a new synesthetic level of experience that includes the multisensorial and temporal context, i.e., not only the surroundings but also the meanings that emerge during interaction with the re-enacted artifact and its environment. In addition to the widely spread optical accuracy of representation (e.g. Bolognesi et al. 2014), we decided to include full sensory perception such as proxemics, spatial, kinesthetic, and acoustic experience levels, since they also transport crucial information for understanding cultural assets.

At the KIT, we addressed this problem with the tests of an Oculus- and Kinect-based VR-system, developed by the ISAS Laboratory (Faion, Friedberger, Zea, & Hanebeck 2012; for other ISAS-developments (see also Pérez Arias & Hanebeck, 2010; Packi, Pérez Arias; Beutler, & Hanebeck, 2010). We used this system for the virtual re-enactment of media art into an "e-Installation". An e-Installation is a virtualized work of media art that reproduces all synesthesia, interaction, and meaning levels of the work identified as relevant (Muñoz Morcillo et al., 2014; see also http://www.e-installation.org). It consists of a 3D model of the work of art and the implementation of its "inner logic" in a game engine. The "inner logic" consists of the programming and dynamic elements of the piece such as audio-visual, haptic, or kinesthetic information, and interaction patterns. Thereupon, the virtualized work of art can immersively be experienced in a VR-System (e.g. HTC Vive or Oculus Rift). The present case study



(a) (b)

Figure 3: *Kaleidophonic Dog* (1964-67/1983): a) View of the original audio-kinetic sculpture. Photo: Artist's State; b) Electronics with EPROM circuits and relais for the control of the instruments and kinetic parts. Photo: ISAS-ZAK/KIT.

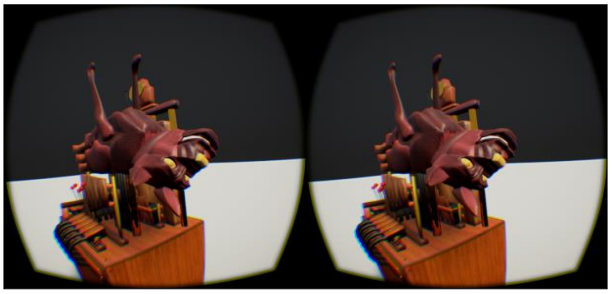


Figure 4: VR-version as seen in Unreal. Photo: ISAS-ZAK/KIT.

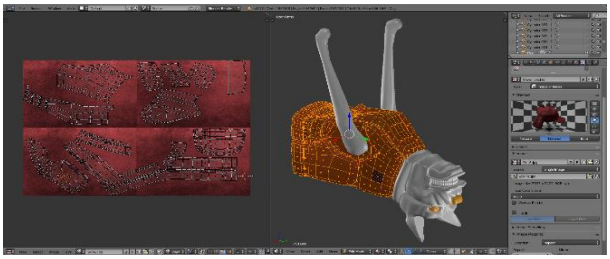


Figure 5: UV map of the Dog's body. Photo: ISAS-ZAK/KIT.

–*Kaleidophonic Dog* (1967)– is an "e-Installation" based on pictures, videos, and a detailed documentation of its electronics and sound composition. It provides results that can be extrapolated for the re-creation of old automata such as those described by Heron of Alexandria (e.g. in *Pneumatica* and *Automata*). For the documentation of the work of art, we followed the pluralistic and multi-perspective approach of the "Variable Media Questionaire" (http://variablemediaquestionnaire.net) that allows for describing many semantic levels beyond the materiality of the object. In this respect, we also opted for the use of pictures of textures for UV mapping the 3D model (Fig. 5) instead of following the photogrammetric information of the original. The use of realistic pictures of leather with a red finish for the figure of the dog provided better results –on a conceptual level– than the use of the photogrammetric

reconstructed textures from the original. In addition, the photogrammetric generated model was too big in order to make the needed manual adjustments for kinetic interaction such as the separation of the legs, mouth and head. Besides, the decimated version was not realistic enough for a "truthful" texturing. Nevertheless, the 3D reconstructed version was taken into account for calculating the right proportions of the individual parts in Blender.

Even if the photogrammetric results of the *Kaleidophonic Dog* would have been outstanding the necessity of making a credible model that can be moved and examined in a VR environment would have required manual adjustments for texturing. In a formalistic sense, it should be noticed that the manual texturing process was close to the original creative process of the work of art. Indeed, UV mapping is the process of projecting a 2D surface to a 3D model's surface, which is very similar to the artist's technique for creating the dog. The artist also covered 3D objects (i.e. hand carved wooden parts) with 2D surfaces (i.e. leather pieces, see Newmark, 1972, p. 69-72; Danieli, 1968, pp. 50-52). In this sense, the making of the "virtual" *Kaleidophonic Dog* focuses on "the craftsman's contribution to preserving authenticity" as formulated in "The Nara Grid" (Van Balen, 2008, p. 40).

As for the composition –an intentional pseudo haphazard mixture of sounds–, there are two historically documented versions: The first one (1964-67) worked with five punched tapes of different lengths that activated the bellows of the instruments and kinetic parts. The second one (1983) is based on electric circuits with EPROMs and relais (Fig. 3, b) with the same purpose as the punched tapes of the first version. As the artist Stephan von Huene 1973 described for the Japan Magazine MIZUE (Kipphoff von Huene & Altner, 2012, p. 58), there are some differences between pneumatically and electrically regulated audio-kinetic sculptures in a sensorial way: the first version with punched tapes was much more "sensuous" since the instruments and the composition depended on pneumatic systems. Therefore, the first version of the audio-kinetic sculpture had a more noticeable corporeal presence. Changing some parameters in the game engine, the reproduction of these different versions would be possible.

The programming of the sound composition itself was reproduced using the artist's binary code for the EPROM-based version of the work of art. Besides the migration of the original data to the virtual environment, we emulated the timing and counter information from the circuits by programming blueprints with these parameters in the Unreal game engine.

The *Kaleidophonic Dog* had been broken for several years and, even before that, the sound composition was affected by mechanical issues. The emulated version using VR technologies allows us to keep the (virtual) audio-kinetic sculpture functioning in case of repeated damage.

3. Discussion: Towards a new definition of authenticity

One reason why digital 3D models based on archaeological objects rarely appear in popular virtual environments –such as "The Virtual World Project" (Simkins & Roddy, 2013), which actually works with photographs–, may be the auratic shine of authenticity that audiences seem to expect. 3D models of archaeological sites and artifacts such as the *Jupiter Column* have a very high resolution so that the finest details –even those invisible to the eye– can be seen. This "over-authenticity" of 3D objects promises an undeniable additional value for research activities, especially if they are embedded in convenient virtual environments, as the virtual re-enactment of the *Kaleidophonic Dog* and its potential multi-versional representation seems to indicate. If the tradition of digital artifacts is to have a sustainable purpose beyond schematic representations, we should define a concept of authenticity that –instead of relying mainly on the artifact itself– also focuses on its informational basis. Indeed, a good documentation allows for the reconstruction of the different meaning levels of a work of art. However, one critical argument regarding the digitization of real objects is the binary nature of the resulting information. Digital data are numerical constructions, information broken down into discrete units and converted for purposes of machine readability and electronic processing in a binary code (Margulies, 2009, p. 13). When we make a digitized version of an object, we are digitally constructing a discrete string of a unique copy. But strictly speaking, there are no digital representations of content, but analogue representations of digital data. The biggest difference to the analogue image is that we cannot analyze digital images on the grounds of physical evidence. The digital string behaves similar to a music score: The algorithmic design requires a terminal for its analog representation in the same way a music score needs a pianist to be transformed into sounds. The continuous preservation of media art in practice also promotes a new concept of authenticity in terms of continuity of representation and decision-making models for future representation challenges, specialy regarding the use of new technologies. In this sense, some "classic" conservation methods such as the environmental and direct preservation –e.g. through minimal changes in the object and its surroundings– are being followed by newer conservation approaches such as the migration of data to similar legacy systems, the emulation using newer technology (e.g. Variable Media Network, 2004), the anticipation of future adaptations (e.g. through Jon Ippolito's "Variable Media Questionnaire") or even the complete virtualization of the work of art as a documentation and conservation measure (Muñoz Morcillo et al., 2014).

In the field of archaeology, we also need an extended concept of authenticity that clearly goes beyond conventions, which are still largely based on the aura of the physical artifact, despite the fact that the idea of preserving a historic object in an unchanged condition presents a paradox in itself. Instead of that, the production of authenticity in conservation practices should be taken into account –especially in settings of digital representations. They are suitable to transport the idea that conservation of the absolute meaning of an object is impossible since its meaning changes through history and since the object does not produce any meaning by itself. Revealing layers of meanings and historical speculations of archaeological research in time-space annotations, both researchers and the general public can greatly profit from digitally reconstructed cultural artifacts.

The idea of the relative irrelevance of the physical source for the documentation of its meaning in a truthful

sense is even clearer in the field of digital conservation as we see in the case study *Kaleidophonic Dog*. For digital artifacts we cannot guarantee the prevention of subsequent changes since for the sake of functionality we often have to accept some conservation strategies, such as emulation or migration that may imply changes in the first version of a digital artifact. The authenticity of a source is therefore something that is actually inexistent. It can only be constructed following scientific methods of documentation and representation. The source can be understood as its absolute physical condition but the authenticity is the result of the faithful transmission of its meaning that does not rely on the physical source. After making a 3D reconstruction, we can see the results on a monitor, a smartphone or even on an HMD-display. Maybe we can even print a 3D version of it. All this visualization and representation methods are not only the output of a discrete string of zeros and ones but also the equivalent version, i.e. the "analogon", to the information we retrieved from the original object. A transmission procedure based on scientifically testable virtualizations cannot utterly ensure the conservation of every meaning level of a work of art, but is not necessarily worse than the "virtual" transmission of ancient texts such as the *Illiad*, which is particularly based on fragmentary papyruses of the Hellenistic period and, above all, on the copies of several manuscripts from the 10th century AD onwards, but it can be dated back in the 8th century BC thanks to the critical analysis of the sources. We find a similar critical approach to authenticity in the work of the conservation theorist Muñoz-Viñas, when he refers to the actual conceptual change in terms of authenticity pointing out that we are going "from the conservation of truth to the conservation of meanings" (Muñoz-Viñas, 2011, p 173).

Furthermore, the virtualization of the *Kaleidophonic Dog* was a complex and enriching knowledge process. It allowed us to document the composition principle of the work from a different point of view than the conservator's one. We studied the electronics, documented its basic parameters, and emulated them using specific blueprints, which made the virtual *Kaleidophonic Dog* sound in an authentic fashion. In this case, the documentation made during the virtualization process revealed the timing and counter parameters for the first time.

4. Conclusions

Even if authenticity will allways remain a guiding principle in assessing and preserving cultural heritage, its theoretical definition and practical notion for dealing with virtualized artifacts can advantageously be enhanced.

The synesthetic and multimodal documentation of cultural objects, the pluralistic contextualization of the knowledge related to them, and the immersive experience in a VR environment provide interesting findings for a reassessment of criteria that experts should take into account when producing and contextualizing their own 3D models: 1. different methods of 3D reconstruction and visualization produce more than one authentic result –every result is a valid one, and the sum of them enhances the perceptible informational basis of the original; 2. in order to understand the different meanings of the objects through time and cultural contexts several contextualization layers are needed –a plausible approach to that is the visualization of multiple representation and interaction choices in a VR environment; and 3. it is worth to work with an investigative notion of authenticity since the discovery of unknown details through VR-based documentation is possible as the virtualization of the *Kaleidophonic Dog* seems to indicate.

The presented results also encourage a specific addition in § 4.1 of the "Seville Principles" regarding authenticity in the sense of the Nara Declaration and the media art conservation theory. In § 4.1 we read that VR-Archaeology "must be openly committed to making alternative virtual interpretations provided by scientific validity". The proposed addition continues the former sentence as follows: "whereby scientific validity should be based on truthful and credible values for different versions of an object, different uses through time, different cultural contexts and memories, and maybe even future projections of meanings".

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References

Auer, M., Richards-Rissetto, H., Von Schwerin, J., Billen, N., Loos, L., & Zipf, A., (2015). MayaArch3D: Web based 3D Visibility Analyses in Ancient Cityscapes – the role of visible structures at the Maya Site of Copán, Honduras [Abstract]. In: *43rd Computer Applications and Quantitative Methods in Archaeology Annual Conference Book of Abstracts* (CAA 2015). Siena, Italy.

Benjamin, W. (2006). *Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit* (later Ed.). Frankfurt am Main, Germany: Suhrkamp.

Bolognesi, M., Furini, A., Russo, V., Pellegrinelli, A., & Russo, P. (2014). Accuracy of cultural heritage 3D models by RPAS and terrestrial photogrammetry. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science*, *40*-5, 113–119. http://doi.org/10.5194/isprsarchives-XL-5-113-2014

Boltanski, L., & Chiapello, È. (2007). *The new spirit of capitalism*. London, England: Verso.

Carrillo Gea, J. M., Toval, A., Fernández Alemán, J. L., Nicolás, J., & Flores, M. (2013). The London Charter and the Seville Principles as sources of requirements for e-archaeology systems development purposes. *Virtual Archaeology Review*, *4*(9), 205–211. http://doi.org/10.4995/var.2013.4275

Carrozzino, M., & Bergamasco, M. (2010). Beyond virtual museums: Experiencing immersive virtual reality in real museums. *Journal of Cultural Heritage, 11,* 452–458. http://doi.org/10.1016/j.culher.2010.04.001

Danieli, F. A. (1968). West Coast Grotesque: Stephan von Huene. *Art Forum*, *Januar 1968*, 50–52.

Depocas, A., Ippolito, J., & Jones, C. (Eds.), (2003). *The Variable Media Approach – Permanence through Change*. New York, NY: Guggenheim Museum Publications.

Dicks, B. (2004). *Culture on Display: The Production of Contemporary Visitability*. London, England: Open UP.

Denard, H. (Ed.) (2009). International Charter for the computer-based visualization of Cultural Heritage. The London Charter 2009. Draft 2.1 (7 February 2009). London, United Kingdom: King's College London. Retrieved from http://smartheritage.com/wp-content/uploads/2015/03/LONDON-CHARTER.pdf

Faion, F., Friedberger, S., Zea, A., & Hanebeck, U. D. (2012). Intelligent sensor-scheduling for Multi-Kinect-Tracking. *Proceedings of the 2012 IEEE/RSJ, IROS*, *October 2012*. Retrieved from http://isas.uka.de/Publikationen/IROS12_Faion.pdf

Falser, M. S. (2012). Von der Charta von Venedig 1964 zum Nara Document on Authenticity 1994. 30 Jahre "Authentizität" in Namen des kulturellen Erbes der Welt. In: Rössner, M., & Uhl, H. (Eds.), *Renaissance der Authentizität? Über die neue Sehnsucht nach dem Ursprünglichen* (pp.63–87). Bielefeld, Germany: transcript.

Hensen, A. & Witschel, C. (n.d.). Ergebnisse des Forschungsprojekts zur Ladenburger Iuppitergigantensäule (IGS) – archäologische Untersuchungen von A.Hensen; epigraphische Beobachtungen von C. Witschel (in preparation)

Herbert, A. (2014). Immaterial Art Stock Project: digital preservation in a 3D virtual museum. *Proceedings of VRIC 2014, 5*. http://doi.org/10.1145/2617841.2617846

Heukemes, B. (1975). Die Jupitergigantensäule von Ladenburg in antiker Zeit und heute – dreimal zerstört und zweimal wiederhergestellt. *Denkmalpflege in Baden-Württemberg 4*(2), 39–43.

Hummelen, I., & Sillé, D. (Eds.), (1999). *Modern Art: Who Cares? An Interdisciplinary Research Project and an International Symposium on the Conservation of Modern and Contemporary Art* (Foundation for the Conservation of Contemporrary Art, Netherlands Institute for Cultural heritage). Amsterdam, Netherlands: Archetype.

IFVA (International Forum of Virtual Archaeology), (2011). Principles of Seville. International Principles of Virtual Archaeology. Final Draft. SEAV (Sociedad Española de Arqueología Virtual). Retrieved from http://smartheritage.com/wp-content/uploads/2015/03/FINAL-DRAFT.pdf

ICOMOS (International Council on Monuments and Sites), (1994). The Nara Document on Authenticity. ICOMOS/ICCROM/UNESCO: Nara. whc.unesco.org/document/9379

Kipphoff von Huene, P., & Altner, M. (Eds.), (2012). *Stephan von Huene – Die gespaltene Zunge. Texte & Interviews. Split Tongue. Text & Interviews*. München, Germany: Hirmer.

López-Menchero Bendicho, M., & Grande, A. (2011). Hacia una Carta Internacional de Arqueología Virtual. El Borrador SEAV. Virtual Archaeology Review, *2*(4), 71–75. http://doi.org/10.4995/var.2011.4558

Lowenthal, D. (2008). Changing Criteria of Authenticity. In: Pamela Jerome (ed.), An Introduction to Authenticity in Preservation, *APT Bulletin, 39*, (2/3), 4.

Margulies, S. B. (2009). *Digitale Daten als Quelle der Geschichtswissenschaft. Eine Einführung*. Hamburg, Germany: Verlag Dr. Kovac.

Mara, H., Krömker, S., Jakob, S., & Breuckmann, B. (2010). GigaMesh and Gilgamesh - 3D multiscale integral invariant cuneiform character extraction. In *Proc. VAST International Symposium on Virtual Reality, Archaeology and Cultural Heritage* (pp. 131–138). Paris, France. http://doi.org/10.2312/VAST/VAST10/131-138

Muñoz Morcillo, J., Faion F., Zea, A., Hanebeck, U. D., & Robertson-von Trotha, C. Y. (2014). e-Installation: Synesthetic Documentation of Media Art via Telepresence Technologies, Preprint: arXiv:1408.1362 Revised version in: Boşteranu, M.; Crăciun, C. (Eds.), (2016). *Space and Time Visualisations* (pp. 173–191). Springer International Publishing. http://doi.org/10.1007/978-3-319-24942-1

Muñoz Morcillo, J., Schaaf, F., Schneider, R. H., & Robertson-von Trotha, C. Y. (2016). Authenticities and Virtual Reality. The case studies Jupiter column and Kaleidophonic Dog. *Proceedings of the 8th International Congress on Archaeology, Computer Graphics, Cultural Heritage and Innovation 'ARQUEOLÓGICA 2.0'* (pp.484–487).

Muñoz-Viñas, S. (2011). *Contemporary Theory of Conservation* (2nd Ed.). Oxford, England: Elsevier.

Newmark, D. (1972). An Interview with Stephan von Huene on his Audio-Kinetic Sculptures. *Leonardo* 5, pp. 69–72.

Packi, F., Pérez Arias, A., Beutler, F., & Hanebeck, U. D. (2010). A wearable system for the wireless experience of extended range telepresence, *Proceedings of the 2010 IEEE/RSJ, International Conference on Intelligent Robots and Systems* (pp. 5226-5231). http://doi.org/10.1109/IROS.2010.5649502

Pérez Arias, A., & Hanebeck, U. D. (2010). A novel haptic interface for Extended Range Telepresence: control and evaluation. *Proceedings of the 6th International Conference on Informatics in Control, Automation and Robotics (ICINCO 2009)*, 222–227.

Rieck, B., Mara, H., & Krömker, S. (2013). Unwrapping highly-detailed 3D meshes of rotationally symmetric man-made objects. *ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences, 2-5/W1,* 259–264. http://10.5194/isprsannals-II-5-W1-259-2013

Rinehart, R., & Ippolito, J. (2014). *Re-collection. Art, New Media, and Social Memory*. Cambridge, England/Massachusetts, MA/London, England: The MIT Press.

Scali, G., Segbert, & M., Morganti, B. (2002). Multimedia applications for innovation in cultural heritage: 25 European trial projects and their accompanying measure TRIS. *Proceedings of 68th IFLA Council and General Conference, August,* 18–24.

Scholte, T., & Hoen, P. (Eds.), (2007). *Inside Installations, Preservation and Presentation of Installation Art*. Amsterdam, Netherlands: Instituut Collectie Nederland (ICN). Retrieved from http://www.inside-installations.org

Simkins, R. A., & Roddy, N. (2013). The Virtual World Project: Touring the Ancient World [Web log post]. Retrieved from http://asorblog.org/2013/06/10/the-virtual-world-project-touring-the-ancient-world

Variable Media Network, (2004). Seeing Double. Emulation in Theory and Practice (Solomon R. Guggenheim Museum; Daniel Langlois Foundation). Retrieved from http://www.variablemedia.net/e/seeingdouble

Sylaiou, S., Mania, K., Karoulis, A., & White, M. (2009). Exploring the relationship between presence and enjoyment in a virtual museum. *Int. J.Human-Computer Studies, 68,* 243–253.

Van Balen, K. (2008). The Nara Grid: An Evaluation Scheme Based on the Nara Document on Authenticity. *APT Bulletin*, *39*, (2/3), 39–45.