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Abstracts

Projekt „4D Imaging: Von der Bildtheorie zur Bildpraxis" (2023-2026)

Digitale Bilder beeinflussen zunehmend, wie Menschen miteinander und mit ihrer Umwelt interagieren. Nicht zuletzt die aktuelle Debatte um das "Metaverse" macht auf veränderte technologische Bedingungen aufmerksam, die den Status des Bildes grundlegend in Frage stellen. Eine besondere Rolle spielen dabei Techniken, die Raum, Bild und Bewegungen miteinander in Beziehung setzen können. Unter dem Begriff 4D Imaging scheint sich eine neue Form digitaler Visualität zu definieren, in der Bild, Handlung und Raum untrennbar miteinander verwoben sind.

Gemeint sind damit etwa Virtual Reality Anwendungen, Augmented-Reality Games oder auch Techniken zur räumlichen Darstellung bewegter Umgebungen, wie volumetrische Videos. 4D Technologien, wie Mixed-, Augmented- und insbesondere Virtual Reality, erfassen, verarbeiten und übertragen Informationen über den physischen Raum und machen ihn in Echtzeit berechenbar. Veränderungen durch Bewegungen und Handlungen werden ebenfalls kalkulierbar, sodass 4D Bilder besonders in solchen ästhetischen und operationalen Kontexten an Bedeutung gewinnen, in denen sie verschiedene Formen der Mensch-Computer-Interaktion neu konzipieren.

Das Projekt *4D Imaging* reagiert auf den wachsenden Bedarf in Wissenschaft und Kultur, komplexe Bildtechniken zu verstehen, zu nutzen und zu gestalten. Es überführt kritisch-reflexive Kompetenzen der Bild- und Medientheorie in praktische Anwendungskontexte, um Nutzer*innen zur Gestaltung und Anwendung von 4D Imaging zu befähigen. Insbesondere in Kulturproduktion und Medizin verspricht 4D Imaging die digitale Erfassung, Visualisierung und Zugänglichkeit von räumlich komplexen Situationen, z.B. einer Performance oder von anatomischen Strukturen.

Das Projekt *4D Imaging* gliedert sich in die Fallstudien "Live Performance in 4D" (PI Prof. Dr. Kathrin Friedrich/N.N., Universität Bonn) und "Learning to see the body" (PI Dr. Moritz Queisner/N.N., Charité – Universitätsmedizin Berlin) um jeweils die sozio-historischen Bedingungen der jeweiligen Anwendungskontexte zu untersuchen, notwendige Bild- und Medienkompetenzen zu systematisieren und Leitfäden für die Gestaltung und Anwendung spezifischer 4D Technologien zu entwickeln. Neben seinem anwendungsbezogenen Einsatz trägt das Projekt insgesamt zu einer gleichberechtigteren Zusammenarbeit von Bildtheorie und Bildpraxis bei, um den gesamtgesellschaftlichen Herausforderungen innovativer 4D Bildgebungstechniken zu begegnen.

Project "4D Imaging: From Image Theory to Imaging Practice" (2023-2026)

Digital images increasingly influence how people interact with each other and with their environment. Not least the current debate about the "metaverse" draws attention to changing technological conditions that fundamentally question the status of the image. 4D imaging in particular currently seems to define a new form of digital visuality in which image, action, and space are inextricably intertwined. 4D technologies like mixed, augmented and virtual reality capture, process and transmit information about physical space and make it computable in real time. Changes caused by movements and actions also become calculable here, so that 4D images gain importance especially in aesthetic and operational contexts in which they re-conceptualise various forms of human-computer interactions.

The project *4D Imaging* responds to the growing need in science and culture to understand, use and design complex imaging technologies. It transfers critical-reflexive competences of image and media theory into practical application contexts in order to empower users to design and use 4D imaging. Especially in cultural production and medicine, 4D imaging promises computing, visualisation and accessibility of spatially complex situations, such as a performance or the moving body. The project consists of the case studies "Live Performance in 4D" (PI Prof. Dr. Kathrin Friedrich/N.N., University of Bonn) and "Learning to see the body" (PI Dr. Moritz Queisner/N.N., Charité – Universitätsmedizin Berlin) in order to investigate the socio-historical conditions of each application context, to systematise the necessary image and media competences and to develop guidelines for the design and application of specific 4D technologies. In addition to its application-related use, the project as a whole contributes to a more equal cooperation between image theory and image practice in order to address the overall societal challenges of innovative 4D imaging technologies.

Extended abstract

Project "4D Imaging: From Image Theory to Imaging Practice" (2023-2026)

Digital images are increasingly influencing how people interact with one another and with their environment. While the transition from analogue to digital images significantly altered the ontological and epistemological status of images since the 1970s, we are now confronted with a technological situation that fundamentally questions the image's status more than 50 years later. What currently culminates in the debate around the term "metaverse", is about to shift the way images mediate human action and perception, at least if we are to believe the ever-increasing capital flow and tens of thousands of developers working in this newly established field. It appears that a new image type is rapidly evolving from a marginal phenomenon to an industrial-scale multi-billion-dollar venture that claims to be the "next medium" after the smartphone and mobile computing. Just as photography and film created and shaped a new iconosphere permeated by technology, new imaging technologies are on the verge of defining a new form of digital visuality in which image, action and space become intrinsically intertwined.

While the vision of the metaverse appears to be a socio-technological imaginary driven by marketing departments and investors, the practices and technologies that give rise to the concept of the "metaverse" are already in use in a variety of contexts. On a technical level, the idea of a "metaverse" is based on new imaging and sensing technologies that register, process, and transmit information about the physical world in real time, a concept that is subsumed under the technical terms "spatial and embodied computing" or, more succinctly, 4D imaging. These computing techniques combine the process of data visualisation with the registration of the topographical quality of physical space while taking their temporal dynamics into account. They convert physical space and objects into geometrical forms, allowing images to be related to a user's or device's orientation as well as to physical objects or structures. To put it in another way, the central concept of 4D imaging is to make physical space computable. However, in addition to existing spatial structure visualisation techniques, such as 3D scanning, 4D images account for the changes in physical space in real-time, which is why they also include movement and action. Accordingly, 4D images gain in importance within operational contexts, particularly as they support, extend, and control a wide range of human-machine interaction with this ability to integrate spatial information in real time.

These multidimensional images deviate from the flat and static representation on the screen. Mobile applications, such as smartphones or virtual reality headsets, in particular, are capable of continuously

adapting visualisations to the user's position and field of view. Visual perception becomes a hybrid media practice in a "metaverse", where physical space and objects can be superimposed with a layer of digital artefacts that integrates shape, motion, location, and perspective. Images in a "metaverse", unlike traditional screen displays, demonstrate a direct impact on how we perceive the physical environment and interact with it. This already applies when navigating a map on a smartphone based on gyroscopic and positioning data or when using an augmented reality application, that allows visitors to an exhibition to augment physical objects with a digital layer. The idea of incorporating space and time into a situation in real-time constitutes a fundamentally new digital image ontology. Typically, images represent spatial properties in a way that does not correspond directly to physical space. This is due to two obvious reasons: first, images are thought to be two-dimensional in a traditional sense. Second, what images depict is usually spatially separated from the image itself. As a result, assigning an image to physical space is typically a cognitive task that necessitates the use of applied visual knowledge to comprehend parameters such as scale, point of view, rotation, or volume. Medicine and cultural production are two fields of application in which 4D imaging as an image practice promises significant impact in rendering spatially complex situations accessible in real-time.

The project *4D Imaging* consists of the case studies "Live Performance in 4D" (PI Prof. Dr. Kathrin Friedrich/N.N., University of Bonn) and "Learning to see the body" (PI Dr. Moritz Queisner/N.N., Charité – Universitätsmedizin Berlin) in order to investigate the socio-historical conditions of specific application contexts, to systematise the necessary image and media competences and to develop guidelines for the design and application of specific 4D technologies. The project's overall objective is to more effectively utilise the competence of digital image research in the humanities in applied contexts, especially by contributing to the conceptualization and design of imaging applications in professional fields. By connecting theoretical findings on 4D imaging from visual and media studies to situations of their practical application, the project responds to a growing demand of research and development to rely on the visual and theoretical competence of image theory to understand, use and design complex imaging techniques.

Case Study "Live performances in 4D", Kathrin Friedrich/N.N., University of Bonn

New 4D imaging technologies, in particular virtual reality (VR) or volumetric video, can record cultural events such as performances or concerts in a way that allows them to be viewed in real time, from any angle, and in any scale. Because the cultural sector relies heavily on physical presence and live character, the Covid-19 pandemic prompted the development of new forms of representation, interaction and affection. Cultural productions such as music concerts, artistic enactments and theatre performances were challenged with the task of transferring their performances to virtual environments. VR can effectively convey an affective spatial interaction, either by mediating physical events in virtual spheres (Fisher 2021, Gemini et al. 2020) or by immersing users in soley virtual scenarios (Friedrich 2016). Popular examples include a Foo Fighters concert in the Metaverse[1] and the National Theatre London immersive theatre experience *All Kinds of Limbo XR* (2019)[2].
Aside from such financially intensive and technologically advanced productions, less established artists and smaller initiatives start to investigate the possibilities of 4D technologies for recording and experiencing various types of performances.

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[1] https://futurism.com/foo-fighters-metaverse (Accessed: 18/02/2022).
[2] https://www.nationaltheatre.org.uk/shows/all-kinds-of-limbo (Accessed: 18/02/2022).

For example, the artist collective New Scenario's 2019 group exhibition *Whiteout* for the virtual extension of the NRW Forum[3] made their performances accessible through VR and explored what happens when a person encounters performers there. The Danish Art Council-funded project *Live Art Denmark* collaborates with cultural institutions to "develop new formats and modes of interaction with intergenerational audiences, from live performance and festivals to educational concepts and documentation for the VR format with a 360 degree camera."[4] Researchers and practitioners are also collaborating in the field of dance performance, to investigate the possibilities of immersive virtual environments. *VR DUST,* which "aims to transform the way people see and experience contemporary dance,"[5] and the interdisciplinary project *Playing with Virtual Realities*[6] are two examples.

The theoretical reflection of such current developments is only now beginning to address the critical role of 4D imaging technologies in producing, experiencing and archiving (live) performances in various cultural contexts.[7] Existing studies of mediated performances (Auslander 2008, Dixon 2007, van Es 2017), screen-based immersive technologies (Hillis 1999, Madary & Metzinger 2016, Verhoeff 2012), and of the temporality of media (Ernst 2016, Hansen 2015) address different crucial aspects that are relevant for evaluating and implementing 4D imaging in the cultural sector.

To critically address both the practical and theoretical desiderata in the realm of 4D imaging in cultural production, we will work together within the case study "Live performances in 4D" and focus on research questions such as:

- How has the development of 4D imaging, particularly advanced tracking technologies and real-time rendering, changed the dimension of liveness?
- Which bodies, abilities, and collectives are barred from participating in immersive experiences (digital inequalities)? Additionally, which new opportunities for collective cultural experience and exchange emerge?
- What kind of "mediated habitus" (Couldry 2004) and subjective disposition do the respective technological artefacts afford from their users and which visual skills are required to participate?
- Which facilities, equipment and practical skills do cultural institutions need for a low-thresh-old production of virtual research environments? How must a VR archive for live performances be designed?
- What kinds of visual skills and innovative methodology do researchers need to develop to critically use immersive virtual environments as research tools?

In close collaboration, we (PhD student and PI Kathrin Friedrich) will explore such questions in regular exchange with the other team members in Berlin and also with practitioners through field visits and expert workshops.

References

Auslander, P (2008): *Liveness: Performance in a Mediatized Culture*, 2nd ed, London: Routledge.
Couldry, N (2004): Liveness, "Reality," and the Mediated Habitus from Television to the Mobile Phone, *The Communication Review, 7(4)*, pp. 353–361, doi: 10.1080/10714420490886952.

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[3] https://www.nrw-forum.de/en/exhibitions/whiteout (Accessed: 18/02/2022).
[4] https://liveart.dk/about-live-art-denmark/ (Accessed: 18/02/2022).
[5] https://vrdust.org.uk/ (Accessed: 18/02/2022).
[6] https://www.gamelab.berlin/portfolio/playing-with-virtual-realities/ (Accessed: 18/02/2022).
[7] See for example the lecture series "VR in Art: Vortragsreihe zu den Themen Virtual und Augmented Reality und Immersion in der aktuellen Kunst- und Designproduktion" at HFBK Hamburg. (https://hfbk-hamburg.de/en/projekte/vr-art- vortragsreihe-zu-den-themen-virtual-und-augmented-reality-und-immersion-der-aktuellen-kunst-und-designproduktion/) (Accessed: 18/02/2022) or research at the Arts Management and Technology Laboratory (AMT Lab) at Carnegie Mellon University (https://amt-lab.org/blog/2021/12/b5h5hwxf7kmk3f8zsp7spmmwj1awrj) (Accessed: 18/02/2022).

Dixon, S (2007): *Digital Performance: A History of New Media in Theatre, Dance, Performance Art, and Installation*, Cambridge, MA: MIT Press.

Ernst, W (2016): *Chronopoetics. The Temporal Being and Operativity of Technological Media*, Lanham, MD: Rowman and Littlefield.

Fisher, J (eds.) (2021): *Augmented and Mixed Reality for Communities,* London: Taylor & Francis.

Friedrich, K (2016): Therapeutic Media. Treating PTSD with Virtual Reality Exposure Therapy, *MediaTropes 6(1)*, pp. 86–113.

Gemini, L, Brilli, S, Guiliani, F (2020): Theatre Dispositif and the Challenge of Covid-19: Mediatisation, Liveness and Audiences. *Mediascapes Journal (15)*, pp.1–15.

Hansen, M (2015): *Feed-forward. On the future of twenty-first-century media*, Chicago: University of Chicago Press.

Hillis, K (1999): *Digital sensations: Space, identity, and embodiment in virtual reality*. Minneapolis: University of Minnesota Press.

Madary, M, Metzinger, T (2016): Real Virtuality. A Code of Ethical Conduct. Recommendations for Good Scientific Practice and the Consumers of VR-technology, *Frontiers in Robotics and AI*, http://journal.frontiersin.org/article/10.3389/frobt.2016.00003/full.

van Es, K (2017): Liveness Redux: on Media and their Claim to be Live*, Media, Culture & Society, 39(8)*, pp. 1245–1256. doi:10.1177/0163443717717633.

Verhoeff, N. (2012): *Mobile Screens: The Visual Regime of Navigation*, Amsterdam: University of Amsterdam.

Project-related publications by the PIs (sorted by date)

Queisner M, Pogorzhelskiy M, Remde C, Pratschke J, Sauer I (2022): VolumetricOR: A New Approach to Simulate Surgical Interventions in Virtual Reality for Training and Education*, Surgical Innovation, (1)*, pp. 1–10, doi.org/10.1177/15533506211054240.

Friedrich, K, Queisner, M, Bruhn, M (2021): Adaptive Images. Practices and aesthetics of situative digital imaging, *NECSUS European Journal of Media* Studies*, 9(2)*, pp. 51–76.

Bruhn, M, Friedrich, K, Queisner, M , Kähny, L (eds.) (2021): *Adaptivität*, Begriffe des digitalen Bildes*, Band 1, Hildesheim: Olms.

Feiersinger, L, Friedrich, K, Queisner, M (eds.) (2018): *Image Action Space. Situating the Screen in Visual Practice*, Berlin/Boston: De Gruyter.

Queisner M, Sauer IM, Tang P, et al. (2017): Mixed Reality in Visceral Surgery. Development of a Suitable Workflow and Evaluation of Intraoperative Use-cases. *Ann Surg, 266(5),* pp. 706–712, doi.org/10.1097/SLA.0000000000002448.

Queisner, M (2017): Disrupting Screen-Based Interaction. Design Principles of Mixed Reality Displays, In: Carsten Busch, Christian Kassung, Jürgen Sieck (eds.): *Kultur und Informatik: Mixed Reality*, Glückstadt: Hülsbusch, pp. 127–138.

Friedrich, K (2016): Therapeutic Media. Treating PTSD with Virtual Reality Exposure Therapy, *MediaTropes 6(1)*, pp. 86–113.