kin_ – An AR Dance Performance with Believable Avatars

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Abstract

Reflecting on the challenges and potentials that Mixed Reality (MR) media present for the production of digital performance art, we present the concept of the Augmented Reality (AR) artwork *kin*. The piece is opening the question on how to transfer a real live performative experience into AR, as well as the question of owning and maintaining agency within an artistic fabric. This is explored with a focus on the interaction of different types of agents, using artistic research at the intersection of art, dance and technology.

Keywords

performance art, believable avatars, augmented reality, digital art, agency

Introduction

How can performance art be transferred into a digital context? What happens when the audience meets performers in digital form? How can believable avatars be created and staged? How can agency be designed within a digital performance? There are many questions that unfold from the initial one, bringing into conversation the rich theoretical background of performance art on the one hand and the theory of digital media, especially MR, on the other.



Figure 1. Mobile Augmented Reality dance performance kin_ © Jochen Müller

As an umbrella term coined in the 1970s to capture all art forms that escaped other categorizations [1], performance art might be the only art form that is being defined as the undefinable within the art. In her attempt to delineate its development throughout the 20th century and up until the end of 1970s, RoseLee Goldberg asserts that it is in the very nature of performance to "defy precise or easy definition beyond the simple declaration that it is live art by artists", adding that any strict definition would actually "negate the possibility of performance itself". [2] With all due acknowledgment of this uneasy and flexible terrain, for the argumentation purposes of this paper we agree to the definition of performance art as "practice that involves a person or persons undertaking an action or actions within a particular time frame in a particular space (...)", central to its execution being "the live presence of the artist and the real actions of his/her body to create and present an ephemeral art experience for an audience". [3] The creation in the moment of performing has been crucial to performance art itself since its beginnings.

Liveness plays an important role in the experience of the piece for the viewer. As an art form that traditionally relies on its physical immediacy, bound to its mediums of body, time and space, performance art seems to be multiply challenged when coupled with MR, which blends the physical and digital world into a new form of interaction and co-existence. AR is defined as a particular form of MR that runs interactively and in real time. The digital content of an AR experience is registered in real space.

The mentioned live presence or real actions are challenged in this context or, more precisely, we are challenged to reconsider the meaning of performance art in the medium that possibly disintegrates its very foundations, molding it into a new digital form that is yet to be defined.

While our first question – How can performance art be transferred into a digital context? tackles the aspects of technological possibilities and practical choices, the second one – What happens when the audience meets performers in digital form? invites for a more philosophical discussion on the experience of human-avatar encounters within a digital medium and its meaning in performance creation. The question – How can believable avatars be created and staged? addresses the production process of suitable AR avatars for the performing arts. Finally, the piece itself tackles the question on – How (...) agency (can) be designed within a digital performance. We argue that with AR it might be possible to attempt liveness within a digitized dance piece without losing the artistic and bodily quality to technology.

The discussion on these questions and notions is being built upon the example of the interactive performative art piece *kin_* (2021), created by artist Charlotte Triebus and an interdisciplinary team of developers of MIREVI Lab at University of Applied Sciences Düsseldorf.

The work *kin* was realized in 2020/2021 and premiered with Erholungshaus Leverkusen and Kunstverein Leverkusen at City C from August till October 2021.

Installation Description

The interactive dance performance *kin* is a dance piece with one up to three moving avatars and audience, developed for AR and freely accessible to download from the AppStore. The performance runs as an app on a personal device. (Figure 1)



Figure 2. kin_ setup at City C Leverkusen 2021, © Charlotte Triebus

AR merges a real life setting with digital content and enables its usage almost everywhere due to its markerless design. Aside from being independent of specific locations, this possibility offers other advantages for developing and experiencing digital artworks that are not site-specific, such as free choice of viewing time and company or lower travel expenses. Although technically playable on any location, *kin_* is designed with an intention of use in spacious museum environments or private surroundings that offer enough space to the dance and the audience experience.

To run the AR experience at its fullest potential, a bright, quiet, and empty space should be chosen and permissions to access microphone and camera need to be given. The use of headphones is highly recommended for appreciating the connected, multidirectional sound experience.

kin is divided up into three dramaturgical parts that give structure to the piece. At starting the application an introduction is given, leading through the process of requirements and recommendations such as the placing of the content. The first part of the piece invites the user to get to know three avatars, their space, functionality and behaviors, by introducing choreographic material and setting the scene to slowly immersing the user into an AR setting. The second part consists of a fast choreographed trio of all three avatars dancing on relations and postures. Meanwhile the avatars do not take notice of the user in the second part, they fuse into one avatar at the beginning of the third part and start following the user in an intrusive manner. During the piece, the avatar(s) move closer to the user: the last part is staged as an interactive, following close up, that adds another layer of reality decomposition by introducing distorted facial expressions of the avatar. The piece ends with the avatar closing its eyes to disappear.

In the design of MR scenarios, a distinction is made between global and local agency:



when global agency is assigned to a user, their decisions cause permanent changes to the entire piece, while assigned local agency gives the possibility to influence individual factors that do not affect the overall event. [4]

For the sake of the dramaturgy within the dance performance, local agency competences of different sizes were assigned to the spectator in order to achieve a balance, so that despite influence, the piece remains perceptible in its entirety.

Making use of their local agency competences it is possible for the user to directly influence the piece through own movement and interaction, as the avatar dancers respond to proximity and distance, direction and angle of movement. The interaction of the user with the avatars is designed to be "indirect" – triggered either by moving, inclining or tilting the device physically towards or away from the avatar, causing a dodging behavior. Direct touch is not encouraged and does not trigger any interaction with the avatar, but offers access to the menu structure of the app.

Each of the three compositional parts begins with a set constellation of the avatars. During the evolution of each part, the avatar corresponds to each user interaction in realtime, using different patterns of reactions, depending on input, angle and intensity of the approach. After dodging, the avatar continues to follow the choreography at a restored, reasonable distance at the new chosen place in virtual space until the end of that part. Each subsequent part continues, after the dodged avatars have restored the needed constellation for that following part. As the piece evolves, the avatar actively follows the visitor and comes very close to the camera for the final scene.

All reactions by the avatars to intended and unintended interactions of the visitor manifest in a uniquely arranged, non-repeatable performance each time the piece is screened. This way, the resulting performances represent a temporally and spatially non-repeatable version of the digital dance piece *kin* in the chosen exhibition space.

For the likewise interactive soundtrack as well as a reactive costume, the artist collaborated with a composer, as well as a digital makeup artist. Three layers of sound are offered: the stereo ambient composition, split for the three different parts, samples, bound to a certain radius of each avatar, and different sound elements for dodging movements. The sound composition is arranged in 360 degrees and adapts to the orientation of the user.

The costume design includes asymmetrical fins reacting with a secondary animation to movements of the corresponding bone that each fin is attached to. The secondary animations of the fins are designed to physically imitate movement in water. Lighting estimation is included in order to adapt the lighting of the virtual scene to the real environment.

For the setup of the installation in a museum, the piece includes three large-scale banners showing high-resolution texture parts of the avatars: eyeballs, facial skin, and the normal map of the scanned dancer's hands and feet. The banners serve as a physical representation and contextual enhancement of the piece. (Figure 2)

Related Work

AR avatars can be reflected on different, mutually related levels - artistic, design-oriented, user-centered, technical, targeting social or ethical implications. Mixed media performance artworks offer an approach for separating the screening of a dance event from its live production tied to a specific time and place. Moreover, artistic experiments with AR can be understood as explorations of interactivity through technological means.

MR applications that revolve around movement related arts can be differentiated according to their two or three-dimensionality. For example, the work *Whiteout* uses videos of performers for displaying several pre-produced performances in virtual reality. [5] In this case, the three dimensionalities of the experience is based only on the 3D surrounding of the VR medium in which the videos are embedded and the perceived effect of depth at a certain distance from the video. The piece *kin*_ is an example of staging three-dimensional avatar dancers which are approachable from every angle.

The approach of a three-dimensional avatar is also the main topic of Julie Curtiss' work *Lune* featuring a nude body which is interactively turning away and hiding its face from the user. [6] A similar approach is used in *kin*_ with the avatar's evasive behavior as the user is coming too close. *Lune* and *kin*_ though differ in integrating the interaction: *Lunes* evasive body movement forms the movement itself, whereas in order to avoid a rupture of the choreography of *kin*_ the dodging behavior had to be integrated seamlessly into the performative fabric, which was not to be disturbed by the interaction.

Martina Menegons work *It feels like home* also features nude avatars in a performative virtual sculpture to be accessed through a webpage. [7] Other than in *kin* the avatars are to be moved by drag and drop, imitating certain gravitational settings.

The design of movement of the avatars within the work can be understood as a second layer for differentiation - unlike projects that use movement loops (such as the artwork *Dance Trail* by Cie Gilles Jobin), [8] the choreography of the project presented in this paper is continuous.

The introduction of an interactive element is adding a third layer to the performance, as shown in the dancing AR Playmoji Stickers of *Google Pixel's Playground* which enables facial reactions of the avatars to the user in real time. [9] Whereas the interaction of the dancing AR character is limited to reactions to certain mimics, the interaction with *kin* is designed to be a full body interaction in virtual space.

The design of avatars is also closely related to the discourse revolving around the uncanny valley effect, showing that the representation of human-like avatars above a certain degree of similarity or realism is perceived as creepy and the interaction with the avatar tends to be unpleasant. [10] An internal research project on efficient avatar production facilitated meeting the objectives of realistic avatar design in *kin* . [11]

Following Photiadis et al., "user experience arises from the integration of perception, action, motivation and cognition in an inseparable meaningful ensemble". [12] Also Law et al. compare user experience to a dialogue with the user's world through action being determined before, during and after the interaction with the experienced object. [13] Using diverse communication channels has been shown to be crucial for presence and interaction attractiveness. [14] Since an enhanced feeling of presence for the user was determined to be crucial for the art experience of *kin_*, an emphasis was put on the animation of expression abilities of the 3D characters, such as facial expressions, a full- body animation and full animations down to the fingertips to support different layers of believable, realistic movement at every moment in the performance.

The technical perspective focuses on the efficient production of believable avatars. Tools like Epic MetaHuman Creator can efficiently produce high quality, believable avatars. [15] However, the design of a fully animated realistic avatar of the dancer herself was not realizable due to the restrictive presets provided by the software. There are several tools for creating virtual characters based on photos [16], hand-held video input [17] or 3D scans [18]. Many approaches also use AI-based methods to generate the avatar structures. Motion capture systems provide an efficient solution for extracting information related to a human skeleton, which is often exploited to animate virtual characters. When the character cannot be assimilated to an anthropometric shape, the task to map motion capture data onto the armature to be animated can be challenging. [16] In [19] the authors addressed the problem to estimate accurate and natural motion sequences and proposes "Video Inference for Body Pose and Shape Estimation" (VIBE), which makes use of an existing largescale motion capture dataset together with unpaired, in-thewild, 2D keypoint annotations. In kin we created animations using a tool-set of motion capturing systems and manual fine-tuning for the recorded animations. As to social and ethical implications revolving around believable avatars we have developed a mediation format targeting this issue, described later in this paper.

Artistic Background

What about mechanically, digitally, or biologically reproduced replicants or clones? It may be that a film or a digitized performance art piece will be the same at each showing. But the context of every reception makes each instance different. Even though every "thing" is exactly the same, each event in which the "thing" participates is different.

The uniqueness of an event does not depend on its materiality solely but also on its interactivity – and the interactiv-

ity is always in flux. If this is so with regard to film and digitized media, how much more so for live performance, where both production and reception vary from instance to instance. Or in daily life, where context cannot be perfectly controlled. Thus, ironically, performances resist that which produces them. [1]

*kin*_is an explorative dance piece about both human corporeality and body-based art through and with digital technology. It is considering several philosophical and sociological discourses, among them the transfer of performativity into the digital, reality entanglements and the dichotomy of surveillance and intimacy.

In the piece, one up to three avatars perform in augmented space and can be approached, influenced and experienced through the user's personal handheld device. To perceive the piece *kin_* in its entirety, the viewer must actively move around the dancers and through the piece.

With the post-digital assumption that humans are so intertwined with surrounding technology that these parts are not separable anymore [20], a cyborg can be understood as a term for certain forms of relationships between body and technology in which the organic and the technical combine in a hybrid life form. [21] In Materialist and Gender Studies the concept of the cyborg stands for the negotiations of traditional dualisms – questioning the distinction between the analogue and the digital, the overcome dichotomy of culture and nature, the social and the technological, sex and gender, and with it the body itself. The cyborg is a material-semiotic creature, entangling the formerly opposed binary opposites. [22]

Following this argumentation, *kin* can also be understood as a playful statement that abandons anthropocentrism and the dancing agents that serve as surrogates for human dancers, and instead, follows the idea of an own techno-organic hybrid lifeform, as dancing cyborg, transferring organic contemporary dance movement onto digital avatars by digitizing a real dancer.

As choreographic material the artist decided to explore the techno-organic aspect by developing tightly choreographed, geometrical body and trio constellations with organic movement qualities, alternating between machine-like and humanly distanced observing poses. As a contrast, system-inherent tracking poses served as input for the choreographic material, to allude to the communication process between human and machine (in this case: the tracking-system). Poses, constellations and forms refer to loops and repetition, alluding to digital reproduction, without actually being repeated. As the dance evolves the poses get slightly shifted and twisted – giving space to the reflection on approximations to an ideal to the piece. Performance art is happening in the very moment of the creation by the agents themselves. [23] Stating that agency is no distinct human quality but can be assigned to otherthan-humans, constellations or inanimate objects, [24] *kin_* appeals to the shift of agency between performer and recipient in moments of interaction. *kin_* is labeled as an interactive performance with up to three avatars and spectator, and according to the definition of agency as "a potential to act"[25], inviting the user to also take part as an agent in the piece. (see also: [26]) Object-ontological theories argue that the connection between multiple actors itself accounts for its own agency. Derived from this, the fusion of a digital being with analogue features leads, at least theoretically, to a new form of being for the performative arts with a possible agency.

Since kin_{in} is experienced with a handheld device, the physicality of the device is creating an inevitable frame through which the piece is being observed. The surveillant aspects of the window for the scene puts the visitor into a surveilling position. (see also: [27])

Through the potential to act and to move around the avatar within AR, the possible engagement is staged as a moment of empowerment for the user, to influence the events of the piece with their own actions. (see also: [28])

The abbreviation *kin*_ in the title is short for kinship. The underscore is suggested for languages with a generic masculine grammar (such as the German language) as a symbol for a gender-equitable spelling that leaves room for a variety of forms and expressions of gender, in this case including digital ones.

The title gives a clue as to how the piece can be read: In order to survive on earth, we need other forms of kinship, following Donna Haraway's train of thought, making kin, both with other humans and non-humans. [29] She argues for a non-anthropological view and questions often propagated human exceptionalism, that we can only survive by "co-becoming" with other ontologies.

Holding up this argumentation, the title *kin*_refers to the respectful exploration of the relationships between human and other-than-human, from the body of the dancer, to the body of the avatar, to the body of the viewer, interweaving different types of agents and agencies (once again.)

Following this idea, it was decided that the design of the AR interaction should take into consideration that avatars can be understood either as other entities, or as a representation of humans, suggesting the audience to interact with the avatars as one would treat another human. Slater et al. refers to the Golden Rule of Reciprocity as a guideline on how to interact in Virtual Reality. [30] This thought lead to uncommon UI decisions for the piece *kin_* such as indirect interaction or an uncommon placing-procedure – at placing the content after starting the application, the avatars would appear outside the frame of view– in order for the avatars not to be touched – as touching without consent is considered disrespectful towards other entities (Figure 3).



Figure 3. Avatar and user in respectful distance © MIREVI

Technical Implementation

The technical implementation of the piece is developed as a mobile AR project available for iOS. The user can download a mobile app in the AppStore [31], which contains the piece including all media assets. For efficient scanning and detection of the environment and the placement of the avatar dancers, an appropriate context recognition is necessary to position the avatars correctly in the real environment and register the virtual elements in 3D space. In addition to the classic RGB camera of the mobile device, *kin_* provides significantly improved detection for devices using LIDAR scanners (e.g. with an iPad Pro). The technical implementation is done using a suitable workflow with the following steps:

- advanced avatar modeling,
- facial expression design,
- interactive costume development,
- dance motion tracking, and
- AR framework integration.

The development of a believable avatar that is not located in the uncanny valley is particularly challenging because a copy of the human performer that is as close to reality as possible had to be created. While it is possible to produce a realistic copy for a high-end character for non-realtime display as a movie clip, there are currently no comparable options for interactive rendering in a 3D engine such as Unity3D. A workflow and tool chain was developed to create, edit, and deploy the female dancer model. [11] The steps follow a pipeline for designing believable avatars in the film domain and are then manually reworked for deployment as an interactive AR app.

The costumes are produced as textured 3D models and combined with the uncostumed avatars by partially binding the models directly to the skeletal structure. This makes it possible to realize the reactivity of the costume in the final AR app, e.g. the movement of the fins when the arm is moved.

The recording of suitable facial expressions of the digital dancers is particularly important for credibility. For this



Figure 4. TEDx video talk on Mixed Reality avatars © MIREVI

purpose, the professional face tracking system dynamixyz was used and all facial animations of the performer were recorded and processed for integration into the AR application. The choreographed motions were recorded as individual sequences with a hybrid tracking approach, using Optitrack and Perception Neuron systems to fuse the results. The integration of the 3D models, textures and animation files was done in Unity 3D, AR Foundation was used for AR functionalities.

Extensive tests for a comparison of Unreal and Unity3D showed clear advantages for Unity3D. Although the production of realistic 3D avatars is easier in the Unreal engine and the rendering is qualitatively better, tracking support and presentation quality in the AR space in Unity3D is more powerful and allows for expressive representations. Additional interaction modules were used to ensure the reactivity of the avatars. A collision detection in the first part of the choreography notices when the user approaches too close to the avatar and starts an evasive movement before continuing with the choreography. In the last part the avatar follows the user in relation to her movements.

Mediation

Although kin_ is impregnated with several layers of meaning, there is no further explanation of the piece nor context within the performance. In order to expose these aspects and bring the peculiarities of MR avatar design and post-digital reality entanglement closer to a broader user group, the piece has been used as a reference point in an alternative mediation format on avatar design and ethics. Instead of a classical artist talk, which discusses the background of kin_ or our development perspective on MR avatars, we developed a format of dialogues between art and technology where we debate on design, production, and use of MR avatars in the post-digital age by combining different levels of narratives.

We are technically able to produce MR avatars, which are difficult to distinguish from humans or can even be manipulated by one, as well as to manipulate or create human images with Deepfakes. Thus, the question continuously arises whether the perceived reality is real, virtual or a blend. We decided to use these intertwined realities not only as a topic for our discussion but its very narrative structure. Using the artistic work of kin as a starting point, different aspects of MR avatars, e.g. user experience, critical distance, ethics and technical production are addressed and made conscious by a dedicated intervention (a medial break) in the representation. The format begins with a somewhat too euphoric presentation of kin in which the protagonist emphasizes the credibility and fascination with MR avatars. At the first media break, one realizes that the presentation is only a video on a mobile device, which is being critically examined by two people. A conversation develops about challenges and opportunities in production and the need for an ethical imperative when interacting with avatars. In the next media break, avatar production is presented on a very technical level including a motion shot, which arrives at the start sequence as a ring closure in the last media break. A final media break is used after the credits to comment on the entire production of the clip from the point of view of the avatars involved.

The production was done as a video shoot using green screen technology and screencasts from the AR app *kin_*. The digital effects were added in post-production. During the broadcast of the format at TEDx Koenigsallee, [32] a live Q&A session was additionally streamed, in which the two protagonists answered questions and presented some technologies in the same digital studio featured in the production.

Conclusion

The interactive dance performance *kin*_shows a way to experience dance qualities with virtual means taking into consideration both artistic bodily as well as digital possibilities. It challenges the visitors to question expected formats of performances and proposes to take part in the piece. The research can thus offer a form of empowerment that participates in the discourse around the contemporary, performative body, both in times of social and travel restrictions and virtual art formats, as well as giving a hint with regard to the increasingly urgent ethical questions in dealing with virtual bodies.

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