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# Montage as a narrative vector for virtual reality experiences

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## Abstract

The goal of our paper is to demonstrate through artistic experimentation that the concept of montage can be an effective vector for conveying complex narratives in immersive, room-scale virtual reality experiences. We review the particularities of virtual reality mediations regarding narrative, and we propose the new conceptual framework of « spatial montage » inspired by traditional cinematographic montage, taking into account the specific needs of virtual reality. We make the hypothesis that spatial montage needs to be related to body action of the user and can play a significant role in relating the immersive experience with an externally authored narrative. To test those hypotheses, we have built a set of tools implementing the basic capabilities of spatial montage in the Unity 3D game engine for use in an immersive virtual environment. The resulting prototype redefines the traditional concepts of shots and cuts using virtual stages and portals and proposes new interaction paradigms for creating and experiencing montage in virtual reality headsets.

## 1. Introduction

The art of montage, practised and theorised since the beginning of the 20th century, has consequently determined the sets of cinematographic forms, both from an aesthetic and semiotic point of view. Today, Virtual Reality narrative experiences are more and more emerging and provoking a certain reflexivity on their forms and conventions, implying a reconsideration of the concept of montage.

One of the specificities of virtual reality systems is the sense of presence they can provoke on an “immersant”<sup>1</sup>. This sensation of “being there”, combining a place illusion and the plausibility of the experience (Slater, 2009), is often considered by designers as an objective of immersive systems (Bowman & McMahan, 2007). Breaks in presence, revealing the seams of the mediation, are considered as factors that diminish the quality of the experience, encouraging designers to favour continuous time-spaces. Putting to the test the sense of presence within the representation space, the practice of montage in virtual reality is therefore quite rare and has not yet enabled the empirical research of an aesthetics of fragmentation and articulation of immersive environments.

Regarding this practical deficiency, we seek to demonstrate, through artistic experimentations, that a narrative power of montage persists in virtual reality mediation. We hypothesise that by linking it to the subject's body actions and playing on the variation of presence in the virtual environment, montage contributes to the evolution of the distance with the mediation, linking the experience lived virtually to the fluctuation of a reminder of the real world. To feed and test these hypotheses, we are developing the “Spatial Montage” system, a tool for staging, cutting and articulating narratives of virtual environments.

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<sup>1</sup>Person immersed in a virtual environment.

## 2. Virtual realities and montage concept

### 2.1. Presence and discontinuities

Virtual reality technologies are now reaching a certain maturity in terms of reception quality. The screens are better defined, fields of vision are widening, the calculation of images in real time is accelerating, interactions are becoming more precise, the equipment is becoming lighter and less expensive. Artists, authors, designers, producers, engineers and developers can thus take hold of these technologies, hijack them, distort them, question them, and try to offer the public new forms and new uses.

Virtual environments constitute spaces of representation in which the subject is immersed by his proprioceptive senses and with which he can bodily (inter)act through his motor activity (Fuchs, 2018). This results in a phenomenon of presence in the virtual environment, a sensation of "being there" when interacting with a mediated environment (Schubert, Friedmann & Regenbrecht, 1999). Depending on the nature of the experience, the scenography and her engagement, the person immersed can access different depths of presence (Slater, Usoh & Steed, 1994). The stronger the phenomenon of presence, the more the subject can be led to have the same emotions and reactions as in a real experience (Riva, Mantovani, Capideville, Preziosa, Morganti, Villani, Gaggioli, Botella & Alcañiz, 2007) and engage physiological and behavioural responses (Slater, 2003).

Thus, if immersive system, resulting from algorithms that can be programmed at will, are a way of exploring new psycho-perceptive potentialities and new types of spaces with arbitrary properties (Quéau, 1993), they also redefine the relationship of distance between a work of art and a subject and thus open up new fields of practical and theoretical reflection on narration.

Today, there are several trends in the creation of virtual reality narrative experiences. On the one hand, there is the utopia of the perfect simulation allowing for a real-time, continuous experience, where presence would be a primordial qualitative factor. As the purpose defined by Philippe Fuchs indicates, virtual reality is implicitly evaluated by its capacity to reproduce or imitate certain aspects of reality, particularly with regard to the phenomenon of presence and therefore the subject's conviction of being physically "there" in the virtual environment. This often results in the search for transparency of the mediation. In other words, they seek to make the immersed person forget that he or she is dealing with mediated images in order to create an illusion of non-mediation (Lombard & Ditton, 2006).

This transparency, which media theorists Jay David Bolter and Richard Grusin refer to as immediacy (Bolter & Grusin, 1999), enables the creation of controlled simulations and a number of applications in the military, industry, health and of course video games. The subjective first-person point of view has been used since 1974 (with the game *Maze War*<sup>2</sup>) and is today a very popular genre in the video game industry, which explains quite well the ease with which this industry has seized on virtual reality devices which are by definition perceived in the first person. It should also be noted that the main manufacturers of virtual reality headsets have close ties with the video game industry<sup>3</sup>. Thus, the resulting experiences are often in line with the continuity of video game blockbusters, advocating experiential continuity rather than the perception of a discontinuous space of representation.

On the other hand, there is a growing number of artists, often from the film, digital and performing arts, who are trying to break free from this "presence at all costs" in the virtual environment and from the utopia of real world simulation. There are a number of works that demonstrate attempts to use interactive virtual environments as theatres of discontinuous narratives with heterogeneous fragments where the mediation, although immersive, remains quite visible.

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<sup>2</sup> *Maze War*, NSI Games, 1974.

<sup>3</sup> The HTC Vive headset was developed by HTC, in collaboration with the video game development company Valve. The Oculus Rift headset's Kickstarter fundraising campaign was initially entitled "Oculus Rift : step into the game", <<https://www.kickstarter.com/projects/1523379957/oculus-rift-step-intothe-.game>> accessed 17 march 2022.

This approach of composite assemblages was particularly striking in the "immersive" selection of the *2021 Tribeca Film Festival*<sup>4</sup> and especially in *A Life in Pieces: The Diary and Letters of Stanley Hayami*<sup>5</sup>. Inside a shack, which constitutes a first frame of representation, 2D mixed with 3D animations and even cut-out videos are presented to our perception. The settings regularly change in texture. For example, we go from environments reconstituted in photogrammetry to scenery drawn with the *Tilt Brush*<sup>6</sup> application. This freedom in the heterogeneity of the representational fragments can be found in *Missing Pictures, EPISODE 1: Abel Ferrara's BIRDS OF PREY*<sup>7</sup> where fragments of storyboard are spatialized in the middle of 3D sets. *The Hangman At Home*<sup>8</sup> also mixes 3D walk-through spaces with small theatres in which traditional animation sketches are cut out and spatialized in depth. Another example is *Paper Birds Pt. 1 & 2*<sup>9</sup> where the environment in which we are immersed is all black, leaving us to perceive only the scenery in which the narrative evolves.

## 2.2. Interactivity and narrative

But if these mentioned works show a richness in the search for new narrative forms, they often come up against the difficulty of coupling narration and interactivity. In the literature studying interactive narration, Ruth Aylett calls the compromise between interactivity and narrative experience the "narrative paradox" (Aylett, 2000). An environment can be fully interactive, but this makes it difficult to control the temporality and content of a particular narrative. In her research, she develops the concept of "emergent narrative" as the result of a dialectic between an author's creation of a "story landscape" which is only actualised and structured around a process of "storification" depending on the engagement of the immersant (Louchart, Swartjes, Kriegel & Aylett, 2008). William Urrichio observes that virtual reality today "builds on the experiential narratives enabled by some game genres far more effectively than on the narrative structures inherited from cinema and literature" (Urrichio, 2018). The freedom of movement and gaze immediately places the subject in a playful relationship with the mediation. In the context of a video game, a particular contract is established with a player, who is ready to put himself in a playful state of exploration, action/reward loop and embodiment.

How then can we combine what seems to be essential in virtual reality, which is a playful state involving bodily actions, while at the same time freeing ourselves from the doxa of immediacy by proposing fragmented time-spaces, allowing us to imagine a diegesis that goes beyond the limits of the experienced simulation?

In a text entitled "Montage and Discourse in Film", Christian Metz explains how, at the beginning of the 20th century, in order to move from the cinematograph to the cinema, the camera needed to "free itself" from the static frame (Metz, 1967). In order to move away from the frontal static shot associated with theatrical representation, the camera had to be mobilised. This liberation could either emerge through the movement of the camera or through the montage. However, history shows that it was the montage that completely prevailed, particularly with the Russian filmmakers and the practices and theories of "montage roi". Christian Metz explains that the reason montage prevailed was that the montage effects were magical, poetic, while the camera movements referred to the filmic nature of the fragment. In Virtual Reality, camera movements are induced by the fact that our point of view is the camera. We must therefore find what would free this point of view and no longer perceive ourselves as a "casked body" (Chatelet & Di Crosta, 2018).

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<sup>4</sup> <https://tribecafilm.com/festival/immersive>

<sup>5</sup> *A Life in Pieces: The Diary and Letters of Stanley Hayami*, Nonny de la Peña and Sharon Yamato, Emblematic Groupe, 2021.

<sup>6</sup> <https://www.tiltbrush.com/>

<sup>7</sup> *Missing Pictures, EPISODE 1: Abel Ferrara's BIRDS OF PREY*, Clement Deneux, Atlas V, Arte France, BBC, Serendipity Films, 2020.

<sup>8</sup> *The Hangman At Home*, Michelle & Uri Kranot, Late Love Production, Floréal Films & ONF, 2020.

<sup>9</sup> *Paper Birds Pt. 1 & 2*, German Heller, Federico Carlini, 3DAR Studios, Baobab Studios, Oculus, 2021.

### 2.3. Movements and montage

Many virtual reality narrative works attempt to reconcile the phenomenon of presence, interaction and narration through the participation of the immersant as a diegetic character. Either continuously, as in *Amends*<sup>10</sup>, or more often in a more fleeting and detached way, as in *The Book of Distance*<sup>11</sup>, where, without embodying a character, interactions with the virtual environment are proposed to us in order to engage ourselves physically and emotionally in the world of the story while keeping a certain distance from it. It seems that it is precisely this distance that allows us to accept extra-dialectical spatio-temporal discontinuities (belonging to a narrative structuring, not perceived by the characters). What if our interactions, rather than giving us a role in the diegesis, gave us a role in its functioning, in its workings, in its rhythm, in its montage?

In this dynamic, we hypothesise that the immersant should be thought of as a battery for the narrative, as a crank that operates the gears of the narrative structure. His/her role would thus be more evident and he/she would have a real corporeal perception of the narrative without necessarily having to be present in the spaces of the diegesis. This body, both spectator and actualiser, would be a sort of evolution of the concept of kino-eye proposed by Dziga Vertov and the Kinoks (Vertov, 2018). A body-machine, present yes, but in a meta way as an instrument for setting a dramatic structure in motion. The phenomenon of presence would then make it possible to inhabit a narrative space at a fair distance from the diegetic entities. However, this intuition comes up against the fact that in order to mentally immerse ourselves in a story, we need to detach ourselves from our consciousness of the space-time in which our body evolves. How can we then combine the essential involvement of bodily action with mental projection into the space-time of a diegesis?

We hypothesise that it is precisely the editing that will allow us to forget the use of this body-machine as an instrument of capture. In the same way that a long sequence-shot makes us perceive the movement of the camera as an aesthetic element at a given moment, a too long space-time in virtual reality reminds us of ourselves as immersed in the process of moving. The montage should therefore allow our body-machine the necessary time and space to activate the world while orchestrating the breaks necessary to distance ourselves from this machination and maintain our mental immersion in the story. The point is therefore to move from the "body-camera" to the "body-montage".

For the Kinoks, cinema enables us to perceive the world through the eyes of the machine, which surpasses human imperfections. Focusing on the essence of the technique, they aim that the understanding of the internal movement of the cinematographic machine can link people and machines in a "creative joy" that they call "kinokism": "the art of organising the essential movements of things in space and time into a rhythmic artistic ensemble, in accordance with the properties of the material and the inner rhythm of each thing". For them, it is the intervals (between two movements) that constitute the material that "drives the action towards the kinetic denouement" (Vertov, 2018). If we follow this theory, the quality of the editing in virtual reality should be highly impacted by the quality of the movement of the person experiencing it. The kinetic power of the montage would then be proportional to the energy deployed by the viewer's movements. If the movements are to influence the quality of the montage, in what way do the possibilities of rupture could have an influence on our movements?

In a movie theatre, the spectator accepts to be placed in an environment where his body must remain still, his gaze directed towards a screen. He can certainly decide on his distance from the screen, but this will remain fixed for the duration of the film. Through the frame and the montage, his vision is organised by the filmmaker, who imposes a distance with the filmed elements. In virtual reality, the body's distance from things depends in part on the movements of the immersant. So, how can the immersed body move if it knows that it is evolving in a universe affected by spatio-temporal discontinuities?

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<sup>10</sup> *Amends*, Mikkel Battefeld, The Animation Workshop (DK), 2020.

<sup>11</sup> *The Book of Distance*, RANDALL OKITA, NFB CANADA, 2020.

## 2.4. Discontinuities and UX Design

Considering spatial breaks in virtual reality comes up with certain cognitive constraints related to the perception of virtual environments involving spatial reasoning (Nnadi, Fischer, Boyce & Nitsche, 2008). There is a difficulty in repositioning oneself in a new virtual environment (Amorim, Trumbore & Chogyen, 2000) and a need to give the user certain visual cues so that he/she can orientate him/herself (Steiner & Voruganti, 2004). It must therefore be taken into account that in a synthetic virtual environment, sensorimotor immersion can indeed open up new relationships between perceptions and body movements, but inconsistencies between our different senses can be a source of physiological discomfort. This partly explains why virtual reality systems base their designs on certain rules of our human sensory-motor schema before exploring borderline cases.

Several studies have been conducted on transitions between virtual spaces (Kohn & Rank, 2016; Oberdörfer, Fischbach & Latoschik, 2018; Husung & Langbehn, 2019). They show the influence of the visible or invisible, predictable or unpredictable, chosen or undergone aspect of the transition on the sensation of presence and the subjective appreciation of the user. They show that the engagement of the body in the mediated space implies a profound reconsideration of the way these transitions are designed if we want to take into account a certain experiential continuity centred on the user. While these researches are mainly based on the impact of transitions on the phenomenon of presence, we seek to study the link between these discontinuities and the distance they may create between the user's experience and the represented story world.

We therefore engage in a study of the narrative potential of a form of montage in virtual reality linked to a body-machine of the immersant, engaging his/herself at a precise distance from a diegesis previously spatially structured by a creator. Based on this theoretical positioning, we are developing an artistic and experimental virtual reality system entitled "Spatial Montage" acting as a reflexive process for our research questions.

## 3. Experimental system: Spatial Montage

### 3.1. A research-creation process

We propose a research-creation process inspired by the practice of film editing to consider a new form of UX design for virtual reality narrative works. The aim is to create a tool that enables us to reconstruct the oscillation of the editor between creation and enunciation, between the space of fabrication and that of diegesis. However, if this oscillation is essential in the practice of montage, it is mainly because enunciation standards are strongly rooted in our image culture. But in virtual reality, the standards that emerge are still fragile and year, creators propose new borderline cases. It seems therefore important, in the articulation between each practice and theory, to distinguish the study of creation from that of enunciation. We propose to build a tool for the study of both creative techniques and their influence on the perception of the meaning expressed.

The "Spatial Montage" system offers an editing tool in virtual reality. It is developed with the Unity 3D game engine<sup>12</sup>. It is a 6 dof (degrees of freedom) device using the HTC Vive Pro Eye headset and its controllers<sup>13</sup>. Thanks to a virtual interactive table, it allows the arrangement of visual, sound and proprioceptive elements in space and time for a narrative and interactive experience in virtual reality. It also sets the basis for a study in narratology and design on the quality of fragmented narratives experienced by an immersant.

Link toward a video presentation of the system : <https://vimeo.com/660613582>

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<sup>12</sup> <https://unity.com/fr>

<sup>13</sup> <https://www.vive.com/fr/product/vive-pro-eye/overview/>

### 3.2. Creation and fragmentation

The first objective of the system is to define the fragments enabled for the creator in order to set his/her staging. The functionalities enabling the manipulation of these fragments, their juxtaposition in time and space and their relationships with each other are therefore the keystone of the system.

First, the creator works fully immersed in the virtual environment, reducing the cognitive load of decoding a 2D interface. He/she composes the space directly in the headset with its controllers in proprioceptive immersion, using low-level cognitive functions. By this way, it makes it possible to imagine the representation space while manipulating it with a top level viewpoint above the model. We thus combine the ego, hetero, object and allo-centric representation systems.



**Figure 1:** *The virtual table*

On a virtual table (Figure 1), we can assemble blocks to structure the geometry of a set. We can also manipulate small characters. A word written above each character refers to its text or action. Sound bubbles (coloured transparent spheres), corresponding to sound atmospheres or music, can be placed within the set.

Then, in order to envisage the montage in virtual reality, it is necessary to question the nature of these fragmentary sets to be assembled in time and space. What would be the molecular units to be connected to structure the spatio-temporal unfolding of a virtual reality experience? In cinema, the frame circumscribes the space of the representation and separates it from the spectator's physical environment. Sergei Eisenstein describes the frame as an editing cell (Eisenstein, 1976). According to Igor Babou, in virtual reality, the concept of the frame, in its semiotic status, does not disappear but is shifted (Babou, 1999). The limits of the representation space take on another form, both in their diegetic (what we are given to perceive) and indicial (reference to a larger form) functions. How then can we define these limits and thus establish editing cells?

The perceptual boundaries of a continuous virtual reality experience are based on the subject's freedom of movement in the real environment. The perimeter of the physical space tracked by the device therefore seems to correspond to a frame. In the virtual environment, it defines a scaled, spatialized and oriented zone in which the subject acquires a limited walking and acting area. We therefore decide to take this zone of potential action as our editing cell. The frame in virtual reality no longer delimits a portion of the image as in cinema, but a zone of possible actions in a space.

On our virtual table, we can therefore move and orientate three zones (a, b and c) representing the spaces to be explored when immersed in the set. The sizes of these zones are relative to the area we can walk through in the physical space. In each zone, we can see the location of our relative position thanks to a small ghost that moves and orients itself according to our physical movements. By manipulating these zones, we

orientate the virtual spatial geometries according to the limits of the bodily action of the person who will be immersed in our narration.

### 3.3. From creation to reception

The second objective is to allow an artist to fragment and articulate his/her narrative while being able to experience its reception at any time. So, when we look at an area and press the thumb button, we quickly smoothly change scale, position and orientation and find ourselves in the place of the little ghost (Figure 2). The light changes. The model set becomes our environment. The little characters become human-sized, change texture, activate and speak according to a system of distance cues (which we will discuss later). If we find ourselves in the location of a sound bubble, we hear the soundscape whose level varies according to our proximity to the centre of the sphere.

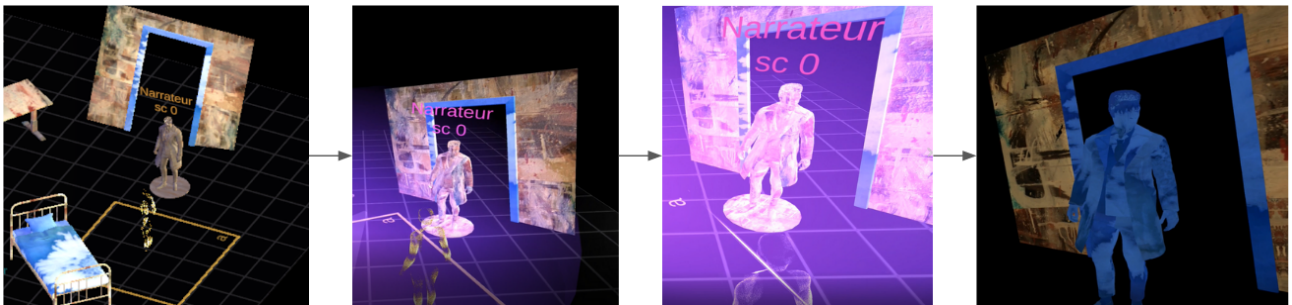


Figure 2: *Passage from the point of view of the creator to the one of the receiver.*

Thus, we quickly switch our status (from creator to receiver) and our point of view (from third to first person) without experiential discontinuity. By pressing the thumb button again, we can go back to the creator position. This function enables us to experience in real time the evolution of the narrative form in construction. In this way, we attempt to reproduce the rhythmic and playful aspect of film editing.

### 3.4. Activation of the narrative

The third objective is to test our hypothesis of a montage intimately linked to our bodily actions in order to generate meaning from the coupling between our movements and our narrative perception. Two strategies can be followed. The first is to assume that the immersant will move according to the virtual scenography. In this case, in order to avoid him/her being “misplaced”, the creator's job is to organise the events in space and time in the aim to attract the immersant's attention and to influence his wandering movements. Another strategy, on the contrary, is to make the environment evolve according to the movements of the immersant. According to his/her gaze, the speed of his/her body movements, his/her position in space, the environment evolves, fractures and articulates itself. In this case, it is the immersant who "puppeteers" the virtual environment and more generally the narrative. This device must therefore be able to analyse those two cases and see how different perception/action couplings can provide new narratological paradigms.

So, in order for the actualization of the narrative experience to be favourable for the receiver, taking into account the desires of the creator, the virtual environment must react according to a system of cues defined beforehand. The two variables we can play with are the movements of the immersant and the characters' animations in the virtual environment. These data are therefore monitored in real time in order to serve as variables for the cues that trigger the narrative sequences in space and time.

Each character has an activation sphere. When this sphere collides with the immersant's sphere (also linked to the point of view), the character changes texture and becomes active. Depending on the character's narrative role, the activation sphere can be larger or smaller. Thus, some characters will only come to life in the intimate sphere of the immersant, while others will only be activated from a large distance and will freeze



if they get too close. Depending on the field of vision and the immersant's distance from the elements, the characters come to life, slow down or freeze. In a sensory-motor loop, the environment is puppeteered by the bodily actions of the immersant, which are themselves influenced by the scenography of the unfolding environment.

### 3.5. Transitions between zones

The final issue is how to move from one zone to another? And how can the creator make him/herself visible or not in this space discontinuity? Initial tests were done by placing a teleporter in each zone. They became invisible when we were immersed in the set. As soon as we arrived in the teleporter's position, we were suddenly teleported (like a cinematographic “cut”) to the next zone. The fundamental problem with this mechanism was that, having previously consciously placed the teleporter on the set, we knew where it was and were searching for its location. So we were biased concerning the probability of an unaware immersant being in the right place.

We then tested teleportation not on the basis of spatial but time data. Depending on the length of the characters' dialogues present in the zone, a calculation was made to give a specific time for the zone before being teleported to the next. But as they did not correspond to any particular event or movement, these cuts were often too sudden and meaningless for the immersant. In addition, the relationship between his/her position and orientation before and after the cut became arbitrary.

We also tested the triggering of teleportation once a dialogue ended. Since the characters' dialogues are only activated when you look at them, we were able to determine roughly where the immersant was going to be before the cut, and thus set up the arrival area accordingly. The fact that the characters only speak and move when you look at them requires the viewer to be in a particular position and orientation if they are to activate and follow the action. Thus, when the cut occurs, the immersant becomes aware of the composition of the image he/she is following. In being aware of the transition from one composition to another, he/she seems to shift briefly from a spatial perception to a pictorial perception. In this fraction of a second, he/she loses the perception of his/her body and presence in the virtual environment. A movement of distancing takes place and the presence of a creator appears.

Finally, the last case we find really relevant is that of the portals. Within each zone, we place and orientate a small frame (Figure 3). The image of this frame is visible in the other zones. This association of the frame and its image constitutes a portal between the zones and we call it a “wormhole”. Inside the set, it appears to the immersant if he/she approaches it and by passing his/her head through, he/she changes zone (Figure 4). In this case, the choice to move from one area to another is left entirely to the immersant, who must make the necessary movement to pass. He/She is obviously in control of the transition moment, but his/her movements must conform to the placement and orientation of the frame planned by the creator. In order to move from one zone to another, the immersant must consciously adopt the extra diegetic narrator's point of view whose presence is therefore signified during the transition.

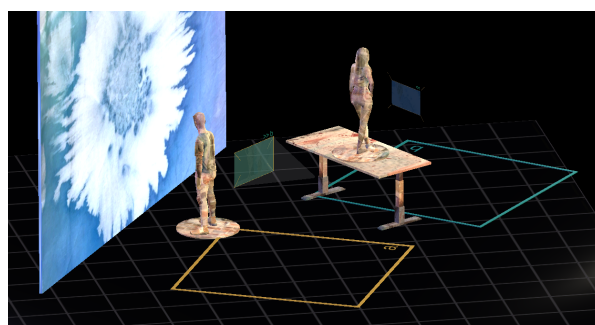


Figure 3 : Wormhole set by the creator in third person view.



Figure 4 : Wormhole experienced in the narrative in first person view.

#### 4. Discussion and conclusion

The Spatial Montage system is complete and effective, and sets the basis of a method for structuring a fragmented narrative space reacting to the bodily actions of an immersant. Preliminary experiments suggest that wormholes are especially relevant for triggering teleportations through bodily movements, allowing active participation in the ongoing story. By requiring consent from the immersant, this also seems to improve the acceptability of the teleportations and to reduce discomfort and disorientation.

The Spatial Montage system is currently being used as part of the “Lines of universe”<sup>14</sup> artistic installation, where participants can create and experience short narratives using a triptych form with three zones and three portals, as shown in Figure 1. The three zones can for example reproduce the Aristotelian notion of an atomic story sequence with a beginning, a middle and an end. But it can also be the basis for looped non-linear stories. This is a useful and generic set-up for experimenting with a variety of film idioms and patterns, and evaluating their effectiveness in the context of virtual reality. Typical examples include navigation between scenes, navigation between characters, temporal ellipses and flashbacks. We are actively investigating those cases as building blocks for assembling more complex narrative structures.

In future work, we plan to augment our empirical, subjective auto-evaluation of the quality of the discontinuities with a more quantitative analysis of the effectiveness of the proposed montage for a naive audience, not involved in the making of the montage. This will require extensive user studies based on an evaluation protocol which still needs to be defined. Future work is also needed for monitoring the immersant’s actions during the experience, measuring the progress of the story and connecting atomic story sequences together into long-form narratives and non-linear, branching interactive stories.

Finally, this future research will have to integrate several identified issues: According to which modalities and contracts can the author make the immersant accept a rupture of the experience in favour of the narrative? In what way, precisely by influencing the phenomenon of presence, do discontinuities acquire a narrative role? And how can the spatio-temporal articulations resulting from discontinuities place an immersant at different distances from the diegesis and its author?

#### 5. References

- Amorim, M.-A., Trumbore, B., & Chogyen, P. L. (2000). Cognitive Repositioning inside a Desktop VE: The Constraints Introduced by First-versus Third-Person Imagery and Mental Representation Richness. *Presence: Teleoperators and Virtual Environments*, 9(2), 165–186. <https://doi.org/10.1162/105474600566709>
- Aylett, R. (2000). Emergent narrative, social immersion, and “storification.” Proceedings of the 1st International Workshop on Narrative and Interactive Learning Environments, 35-44.
- Babou, I. (1999). *L’absence de cadre comme utopie des “réalités virtuelles”*. Champs visuels. Revue interdisciplinaire de recherches sur l’image. L’Harmattan.
- Bolter, J. D., & Grusin, R. A. (1999). *Remediation: Understanding new media*. MIT Press. <https://doi.org/10.1108/ccij.1999.4.4.208.1>

<sup>14</sup> <https://remisagduvr.wordpress.com/327-2/>

- Bowman, D. A. & McMahan, R. P. (2007). Virtual Reality: How Much Immersion Is Enough? *Computer* 40, 36–43. doi:10.1109/MC.2007.257
- Chatelet, C. & Di Crosta, M. (2018). Écran incorporé, corps casqué. *Interfaces numériques*, 7 (2), 264–285.
- Eisenstein, S. (1976). *Le film: Sa forme, son sens*. C. Bourgois.
- Fuchs, P. (2018). *Théorie de la réalité virtuelle: Les véritables usages*. Mines Paristech PSL.
- Husung, M., & Langbehn, E. (2019). Of Portals and Orbs: An Evaluation of Scene Transition Techniques for Virtual Reality. *Proceedings of Mensch Und Computer 2019 on - MuC'19*, 245–254. <https://doi.org/10.1145/3340764.3340779>
- Kohn, J., & Rank, S. (2016). You're the Camera!: Physical Movements For Transitioning Between Environments in VR. *Proceedings of the 13th International Conference on Advances in Computer Entertainment Technology - ACE2016*, 1–9. <https://doi.org/10.1145/3001773.3001824>
- Quéau, P. (1993). *Le virtuel: Vertus et vertiges*. Champ Vallon ; Institut national de l'audiovisuel.
- Lombard, M., & Ditton, T. (2006). At the Heart of It All: The Concept of Presence. *Journal of Computer-Mediated Communication*, 3(2), 0–0. <https://doi.org/10.1111/j.1083-6101.1997.tb00072.x>
- Louchart, S., Swartjes, I., Kriegel, M., & Aylett, R. (2008). Purposeful Authoring for Emergent Narrative. In U. Spierling & N. Szilas (Eds.), *Interactive Storytelling* (Vol. 5334, pp. 273–284). Springer Berlin Heidelberg. [https://doi.org/10.1007/978-3-540-89454-4\\_35](https://doi.org/10.1007/978-3-540-89454-4_35)
- Metz, C. (1967). “Montage” et discours dans le film: Un problème de sémiologie diachronique du cinéma. *WORD*, 23(1–3), 388–395. <https://doi.org/10.1080/00437956.1967.11435493>
- Nnadi, O., Fischer, U., Boyce, M., & Nitsche, M. (2008). Effect of dynamic camera control on spatial reasoning in 3D spaces. *Proceedings of the 2008 ACM SIGGRAPH Symposium on Video Games - Sandbox '08*, 157. <https://doi.org/10.1145/1401843.1401873>
- Oberdörfer, S., Fischbach, M., & Latoschik, M. E. (2018). Effects of VE Transition Techniques on Presence, Illusion of Virtual Body Ownership, Efficiency, and Naturalness. *Proceedings of the Symposium on Spatial User Interaction - SUI '18*, 89–99. <https://doi.org/10.1145/3267782.3267787>
- Riva, G., Mantovani, F., Capideville, C. S., Preziosa, A., Morganti, F., Villani, D., Gaggioli, A., Botella, C., & Alcañiz, M. (2007). Affective Interactions Using Virtual Reality: The Link between Presence and Emotions. *CyberPsychology & Behavior*, 10(1), 45–56. <https://doi.org/10.1089/cpb.2006.9993>
- Schubert, T., Friedmann, F., & Regenbrecht, H. (1999). Embodied Presence in Virtual Environments. In R. Paton & I. Neilson (Eds.), *Visual Representations and Interpretations* (pp. 269–278). Springer London. [https://doi.org/10.1007/978-1-4471-0563-3\\_30](https://doi.org/10.1007/978-1-4471-0563-3_30)
- Slater, M., Usoh, M., & Steed, A. (1994). Depth of Presence in Virtual Environments. *Presence: Teleoperators and Virtual Environments*, 3(2), 130–144. <https://doi.org/10.1162/pres.1994.3.2.130>
- Slater, M. (2003) A note on presence terminology. *Emotion*, 3, 1–5.
- Slater, M. (2009). Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1535), 3549–3557. <https://doi.org/10.1098/rstb.2009.0138>
- Steiner, K.E., & Voruganti, L. (2004). A comparison of guidance cues in desktop virtual environments. *Virtual Reality*, 7, 140–147. <https://doi.org/10.1007/s10055-004-0125-1>
- Uricchio, W. (2018). “VR: Between Hope, Hype, and Humbug.” *Los Angeles Review of Books*, June. <https://lareviewofbooks.org/article/vr-between-hope-hype-and-humbug/>.
- Vertov, D (2018). *Le ciné-œil de la révolution, écrits sur le cinéma*. les Presses du réel.