2026, vol. 13, issue 1, pp. 469-476
RESEARCH ARTICLE https://doi.org/10.5281/zenodo.21918949

IMMERSIVE TECHNOLOGIES IN AUDIOVISUAL PRODUCTION: A STATE-OF-THE-ART REVIEW OF INNOVATION, NARRATIVES AND CONSTRAINTS

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Abstract

Immersive technologies have become increasingly important in the audiovisual sector and have significantly transformed the way in which content is created and experienced by audiences. In today's media landscape, communication increasingly involves the active participation of the audience. Against this backdrop, this article presents a state-of-the-art analysis of the main immersive technologies used in the audiovisual sector, such as virtual reality, augmented reality, mixed reality, extended reality, 360° video, spatial storytelling, volumetric video, motion capture and generative artificial intelligence. The analysis examines the main areas of research and application of these technologies and how they are transforming the relationship between content, creators and the public. A key aspect is the transformation of how audiovisual stories are created. New technologies enable the creation of more interactive and spatial narratives, in which the user can play a more active role. Thus, the sense of presence, the ability to make decisions and the sensory experience become key elements of communication. The study highlights both the advantages of these technologies for the development and innovation of audiovisual content, and the main challenges. These include high production costs, limited access to certain technologies, the need for new professional skills, and ethical issues relating to the use of artificial intelligence.

Keywords: immersive technologies; audiovisual; extended reality; virtual reality; augmented reality; storytelling; virtual production; generative artificial intelligence.

1. Introduction

In the past ten years, immersive technologies such as virtual reality (VR), augmented reality (AR), mixed reality (MR) and extended reality (XR) have become crucial in the audiovisual industry, changing how content is produced and consumed by the public. As a result, production methods have become more varied. Techniques like volumetric capture, virtual production and three-dimensional representation create environments where the viewpoint changes according to the user's position and actions. For example, volumetric video enables three-dimensional visualisation of people and spaces, contributing to storytelling formats that emphasise freedom of perspective and proximity (Jin et al., 2023). Moreover, generative artificial intelligence introduces new possibilities for designing images, characters and digital environments, broadening the tools available to creators. Immersive audiovisual content has also opened new possibilities in narrative strategies, enabling more interactive and participatory storytelling. These technologies increase users' sensory involvement and help develop more accessible and inclusive experiences for diverse audiences (Reinoso et al., 2025; Yu et al., 2025). Progress in these applications is driven by technological advances in spatial audio, haptic technologies and real-time rendering, which create virtual environments with greater realism, interactivity and immersion (Vontzalidis et al., 2025; McEvoy et al., 2024).

The development and introduction of immersive technologies still face several difficulties. These include ensuring accessibility and inclusivity, helping users adapt to new interaction methods, and creating suitable methodological frameworks for evaluating and using these technologies (Yin et al., 2023). In media studies, these advances have led to a research area where technological, aesthetic and cultural aspects converge. Understanding this area requires connecting studies of user experience with those on narrative, audiovisual production and technological innovation. This approach helps identify key concepts and trends shaping research into immersive audiovisual media and establishes a framework for analysing future developments.

2. Method

This study employs a state-of-the-art approach, aimed at mapping and interpreting recent research on the use of immersive technologies in audiovisual communication. The study seeks to identify the main concepts, technologies, thematic areas and theoretical perspectives developed in the specialist literature, as well as to highlight the trends shaping the evolution of the field.

The bibliographic corpus has been compiled by consulting the academic databases Web of Science, Scopus and Erich+, selected to cover international literature in the fields of media, communication, film, digital technologies and human–computer interaction. The period analysed is 2015–2026, a timeframe associated with the rapid development of XR applications, virtual production, volumetric capture and generative artificial intelligence tools.

The search strategy utilises combinations of terms such as 'immersive media', 'immersive audiovisual', 'extended reality', 'virtual reality', 'augmented reality', '360 video', 'spatial storytelling', 'volumetric video', 'virtual production' and 'generative AI'. The selection of studies focuses on their relevance to the production, representation, distribution and experience of audiovisual content, giving priority to peer-reviewed scientific articles and studies published in international academic journals.

3. Conceptual framework

3.1 Differentiating Immersion and Presence

The literature on immersive technologies often uses the terms 'immersion' and 'presence' as synonyms, although they refer to distinct concepts. Confusing them affects the comparability of results. Immersion refers to the objective, measurable properties of the technical system: field of view, resolution, latency, and motion tracking fidelity. Presence refers to the user's subjective response to these properties. The former is a device characteristic; the latter is a psychological state.

This conceptual distinction has important methodological implications. Studies comparing immersive and conventional formats often attribute observed effects to the technology itself, but these effects may also result from differences in content, exposure duration, or perceived novelty. Cummings and Bailenson (2016) found that while technical quality positively correlates with presence, the relationship is weaker than commonly assumed. Later research identified a potential ceiling effect, where further technical improvements yield diminishing returns in presence. In virtual reality research, the central concept is spatial presence, defined by Lombard and Ditton (1997) as a perceptual illusion of non-mediation. Wirth et al. (2007) further modeled it as a two-stage process: constructing a spatial model of the mediated environment and accepting this model as the primary reference for self-location. Slater (2009) introduced a distinction between the 'place illusion,' the sensation of being in a place supported by sensorimotor coherence, and the 'plausibility illusion,' the acceptance that perceived events are actually occurring, supported by the credibility of the scene's behavior. In augmented reality research, the related construct of physical presence refers not to being transported elsewhere but to the sensation that a mediated object exists within the user's physical space.

3.2 A level-based classification of immersive technologies

In this context, classifying the analysed technologies is necessary for a coherent interpretation of the relationship between technical characteristics and user experience. Extended Reality is an umbrella term that primarily includes virtual reality, augmented reality, and mixed reality. These describe ways of relating and integrating the physical environment with the digital one, rather than specific technologies or content formats.

On a different level is 360-degree video, a content format that supports immersive experiences but does not itself constitute a technological category equivalent to virtual or augmented reality. Similarly, volumetric capture and motion capture are data acquisition techniques used to record the shape, position, or movement of people and objects and then integrate them into digital environments. These techniques can form the basis of XR experiences, immersive film productions, or other digital content.

Virtual production should be understood as a production workflow in which technologies such as real-time rendering, LED screens, virtual cameras, and tracking systems are integrated into creating audiovisual content. It does not refer to a type of experience like virtual or augmented reality but to a specific way of conceiving and producing content. Finally, generative artificial intelligence occupies a cross-cutting position within this taxonomy. Unlike categories describing the mode of display, content format, or production workflow, it refers to a technology for synthesising and transforming content, applicable to multiple levels of the XR and audiovisual ecosystem. Generative models can contribute to producing images, video sequences, 3D objects, virtual characters, or interactive elements.

The three display modes grouped under the umbrella term "XR" differ in the relationship they establish between the physical and digital environments, and this difference determines the type of perceptual response they elicit. This distinction has direct consequences for how their effects can be evaluated and precludes treating the three as interchangeable alternatives.

4. Technologies and applications

4.1 Display modes: VR, AR, MR

Virtual reality completely replaces the physical environment and consequently produces spatial presence: the sensation of being transported to another place, supported by the sensorimotor coherence of the scene (Slater, 2009). In media arts, this property enables the construction of multisensory digital spaces in which the user is integrated into the narrative unfolding, which reconfigures the relationship between creator, work, and audience and expands the possibilities for artistic expression (Sun, 2025; Mills & Brown, 2022). In journalism, this same property has been harnessed under the label "immersive journalism," with the argument that accessing an event from a perspective close to a first-person experience would deepen understanding and strengthen the emotional connection to the situation being reported (Reinoso et al., 2025).

Augmented reality does not replace the physical environment but superimposes digital elements onto it. The relevant construct here is not spatial presence but physical presence—the sensation that a mediated object exists within the user's own space. The difference is substantial: the former implies dislocation, the latter co-presence. In audiovisual news production, AR is used for real-time data integration and spatial control of graphic elements, often in combination with volumetric capture and 360-degree footage (Bailly et al., 2025). These solutions address an explicit economic concern—the decline in public interest in conventional news formats.

Mixed reality involves not only superimposition but also real-time interaction between physical and digital elements, spatially anchored in relation to one another (Sun, 2025). This capability enables context-sensitive interactions and forms of storytelling in which digital objects react to the specific configuration of the viewing space. It should be noted, however, that the term is used inconsistently in the literature, sometimes covering the entire reality–virtuality continuum, and at other times referring only to configurations with advanced spatial anchoring—an ambiguity documented by Speicher et al. (2019), which affects the comparability of studies. In the media sector, the adoption of MR remains in the experimental stage.

The common element of the three display modes is the repositioning of the user from the role of recipient to that of participant in the construction of the experience. This repositioning is real and well-documented, but its extent varies significantly: the ability to control the direction of one's gaze is not equivalent to the ability to intervene in the narrative's unfolding, and the latter is not equivalent to co-creation. The literature frequently uses the term "participatory" to describe all three situations, which overestimates the degree of agency actually granted to the audience.

4.2 Content formats: 360-degree video

The integration of 360-degree video into journalistic practice has opened up new avenues for the production and reception of news content. (Erdogan, 2024; Pérez-Seijo et al., 2023; Yang, 2023]. By enabling users to visually explore an event from multiple perspectives and control the direction of their gaze, this format transcends the linear logic of traditional audiovisual representation and contributes to the development of more interactive and immersive journalistic experiences [Rodrigues & Lima, 2022; Kim & Lee, 2022]. This configuration of the media experience can amplify the sense of presence and foster empathic engagement, giving the user the impression of more direct participation in the situation being reported (Pérez-Seijo et al., 2023; Van Damme et al., 2019).

The development of 360-degree video-based journalism must also be analysed in relation to the process of platformisation in media communication. The adoption of this format has been supported by the infrastructure and strategies of major technology companies, as well as by the integration of immersive content into distribution platforms such as Facebook and YouTube (Rodrigues & Lima, 2022; García-Perdomo, 2021). Consequently, this transformation is not limited to production technology, but also involves changes to distribution channels and how the public accesses and interacts with journalistic information.

However, the immersive nature of such content does not automatically guarantee greater engagement or more effective retention of information. Research indicates that audience reactions may vary depending on the intensity of immersion and the tone or nature of the content presented (Bujic et al., 2023; Yang, 2023; Wang et al., 2018). In this regard, the effectiveness of 360-degree journalism depends on how these are integrated into the narrative structure and strategies for communicating with the audience.

From this perspective, 360-degree video can be regarded as a technological innovation, but also as a factor contributing to the reconfiguration of contemporary journalistic practices. Its use is prompting media organisations to rethink how content is produced and distributed, as well as the strategies through which the audience is engaged in the process of consuming news (Gutiérrez-Caneda et al., 2020). At the same time, questions remain regarding users' acceptance of these formats, their narrative effectiveness and the sustainability of their long-term use within journalistic organisations (Kim & Lee, 2022)

4.3 Spatial storytelling in the media

Spatial storytelling is an emerging trend in the media sector, involving the integration of narratives into interactive spaces and the use of immersive technologies such as virtual reality, augmented reality, and location-based media. This approach changes the way journalistic stories are constructed and received by linking narrative content to physical or virtual spaces (Hernández-Rodríguez & García-Perdomo, 2024). In this context, the audience is no longer confined to the traditional role of information recipient. Still, it can navigate through narrative spaces, interact with elements of the story and, in certain scenarios, participate in its construction or development. Consequently, spatial storytelling can help to enhance audience engagement, foster empathy and promote a deeper understanding of journalistic events.

Spatial storytelling in the media harnesses the integration of multiple modes of communication — image, sound and interactivity — to construct rich experiences that engage the user's perceptual, physical and emotional dimensions. In the case of VR journalism and cinematic virtual reality, the use of spatial audio alongside three-dimensional visual representations helps to create a heightened sense of immersion. It can facilitate an understanding of the narrative's structure and meaning (Kim & Khajavi, 2024). Some contemporary spatial storytelling systems allow users to alter their role within the story, navigate narrative spaces and, in certain situations, contribute to the development or direction of the narrative universe. By transferring some of the narrative control to the audience, these technologies can generate more collaborative and reflective journalistic experiences, in which the user actively participates in the process of exploring and interpreting information (Chen, 2025)

4.4 Capture techniques: volumetric video and motion capture

Volumetric video is an emerging technology, currently undergoing rapid development, which enables the three-dimensional capture of spaces, objects and people and their integration into immersive media environments, such as virtual reality (VR), augmented reality (AR) and mixed reality (MR) (Trappen et al., 2026; Bailly et al., 2025). Its use in the media sector is expanding into interactive storytelling and media, offering more engaging experiences that are closer to real-world perception. A key advantage is the ability to navigate from different viewpoints, as well as the creation of a heightened sense of presence within the digital environment (Kräuter & Spierling, 2025). Another advantage of volumetric capture is the ability for directors and content creators to subsequently determine viewing angles and perspectives directly during the post-production stage. This flexibility enables the creation of more dynamic and adaptable narratives (Trappen et al., 2026).

Within the media industry, teams involved in news production regard volumetric video as a tool with high potential for developing immersive storytelling and increasing audience engagement. Its integration with technologies such as AR, VR and 360-degree video enables the enrichment of broadcast content and the development of more interactive broadcast formats (Bailly et al., 2025).

Motion capture (MoCap) technology is an important tool in contemporary media production, enabling the precise digital recording of human movements and their transfer to digital characters and environments. Its use is particularly relevant for animation, virtual production, interactive storytelling and the development of immersive experiences based on virtual reality (VR), augmented reality (AR) and mixed reality (MR) (Jiang et al., 2026).

In digital animation, MoCap enables the creation of high-fidelity representations of human movements and expressions, and is used in film production, video games and digital performances. Advances in neural networks and feature extraction techniques have improved the accuracy of capture and the ability to preserve movement details, including in situations characterised by occlusions or rapid movements (Baltas et al., 2025). The integration of wearable devices, biosensors and real-time programming systems also expands the expressive possibilities of digital characters and media performance (Baltas et al., 2025; Carle & Zannos, 2025).

In the context of immersive media, real-time motion capture enables the development of more realistic avatars and bodily representations in VR environments. By transferring the user's movements to their digital representation, MoCap helps to enhance the sense of embodiment and presence in virtual space (Wu & Chen, 2025). The fidelity of motion capture and the visual realism of the avatar influence the user's experience, and full-body capture systems can produce a level of behavioral realism superior to that achieved through inverse kinematics-based methods Makled et al., 2025).

MoCap also plays an important role in interactive storytelling and the development of participatory media experiences. Motion capture-based systems can transform users' gestures and actions into components of the narrative, enabling more direct interactions with digital characters and spaces. In this regard, the technology contributes to the shift from traditional forms of media consumption towards experiences in which the user

participates physically and actively in the unfolding of the content. Overall, the application of MoCap technology in media contributes to the development of more realistic, interactive and immersive forms of content production and consumption. From animation and virtual cinema to avatars, interactive storytelling and the promotion of cultural heritage, motion capture facilitates the integration of human behaviour into digital environments. It helps to redefine the relationship between the creator, the character, the space and the audience.

4.5 Synthesis technologies: generative AI

Generative artificial intelligence (GenAI), through large language models (LLMs), generative adversarial networks (GANs), diffusion models, and text-to-image and text-to-video systems, is bringing about significant transformations in the media ecosystem and in contemporary communication practices (Nguyen & Wischnewski, 2026; Ferrara, 2024). By automating and accelerating the generation of textual, visual, and audiovisual content, these technologies are reshaping media production and distribution processes and are being integrated into journalism, filmmaking, animation, digital art, and interactive media. At the same time, GenAI facilitates the development of forms of interactive storytelling, personalised experiences and content designed for immersive media, including VR, AR and MR . Furthermore, the adoption of GenAI raises issues relating to ethics, transparency, professionalism and public trust, and the way in which the media frames and explains these technologies contributes to the formation of social perceptions of artificial intelligence.

5. Challenges and limitations of the adoption of immersive technologies

Beyond the findings regarding their effects, the adoption of immersive technologies in audiovisual production faces several structural obstacles.

Production costs and unequal access. The infrastructure required for virtual production — LED volumes, camera tracking systems, rendering clusters — involves high investments, and hiring such equipment remains expensive for independent productions. Volumetric capture in commercial studios typically requires dozens of synchronized cameras, with installation and processing costs beyond the reach of low-budget productions. This barrier to entry has direct consequences for the diversity of audiovisual production, as the capacity to experiment with these formats is concentrated in a few production centres. This observation is particularly relevant for small film industries, including the Romanian film industry, where the infrastructure for immersive production is still in its infancy.

The adoption of these technologies does not involve replacing tools, but rather reconfiguring roles within the production team. Virtual production shifts the work of the visual effects department from post-production to pre-production. It requires hybrid skills, at the intersection of set design, real-time technology and technical supervision. Reports on the creative industries highlight the shortage of specialised skills as the main obstacle reported by firms in the sector, and Swords and Willment (2024) have formulated a research agenda that explicitly addresses this reconfiguration of creative work.

A fragmentation of formats and metrics characterises the field. There is no consensus on assessing content quality using six degrees of freedom comparable to that for conventional video, and the tools for measuring user experience differ across studies in terms of exposure duration, hardware, scales used and the timing of questionnaire administration.

There are also ethical issues that fall into three categories. At the level of representation, there are issues concerning the consent of filmed subjects and the authenticity of the representation, which are exacerbated in the case of volumetric reconstructions, where the boundary between recording and synthesis is not perceptible to the viewer. At the capture level, wearable camera devices raise the issue of consent for people who happen to be within the field of view; for such individuals, the consent models developed for digital platforms do not provide a functional equivalent. At the level of synthesis, the integration of generative artificial intelligence raises questions regarding the authorship of content generated from unattributed training data, the indexical status of the resulting image, and the obligation to signal to the viewer the difference between what is recorded and what is synthesised.

6. Conclusions

The state-of-the-art review proposed in this paper set out to map the main immersive technologies used in the audiovisual sector and to clarify how they reconfigure the relationship between content, creators and audiences. The findings allow three main conclusions to be drawn.

First, the technologies analysed do not form a homogeneous whole, but are distributed across distinct levels of the production and communication chain: display mode (VR, AR, MR, brought together under the umbrella

term XR), content format (360° video), capture technique (volumetric video, motion capture), production workflow (virtual production) and synthesis technology (generative artificial intelligence).

Second, the literature examined indicates real effects of these technologies on the audiovisual experience — especially in relation to the sense of presence, affective engagement and the repositioning of the user from receiver to participant. These effects are, however, less robust and more conditional than the dominant discourse suggests.

Third, the main obstacles to consolidating the field are not technological in nature, but economic, professional and normative: production costs that limit access and concentrate experimentation in a small number of centres, the shortage of specialised skills generated by the reconfiguration of roles within production teams, the absence of common standards for evaluation and the lack of an ethical framework suited to the new forms of content capture and synthesis.

The main contribution of this paper lies in systematising a heterogeneous research field and in proposing a classification framework that makes it possible to delineate levels of analysis. The most promising research direction seems to involve shifting attention away from measuring the intensity of immersive experience towards understanding production conditions, reception contexts and the ethical implications of these technologies.

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