What is and what is not 360° video: conceptual definitions for the research field

Lionel Roche[1]*, Ian Cunningham[2] and Cathy Rolland[3]

[1]Département des Sciences de l'Activité Physique, Université du Québec à Montréal, Montréal, QC, Canada, [2]School of Applied Sciences, Edinburgh Napier University, Edinburgh, United Kingdom, [3]Laboratory Activité, Connaissance, Transmission, Éducation, Clermont Auvergne University, Clermont-Ferrand, France

1 Introduction

Over the previous years, immersive technologies have been increasingly used in different fields (Suh and Prophet, 2018; Tang et al., 2022). Furthermore, Ranieri et al. (2022) underlined that interest toward the educational use of immersive technologies has grown (p. 1200). Despite this emerging craze, some technologies are not recent and do not constitute a real innovation. Indeed, virtual reality (VR) appeared more than half a century ago as Fuchs and Guitton (2011) pointed out and the term "virtual reality" has been used for more than 15 years. Indeed, Gigante (1993) recounts Morton Heilig's (1962) design of a multi-sensorial simulator: the Sensorama. This device had all the hallmarks of a VR system; except that it was not interactive, it offered the possibility to perceive wind, noise, and smells.

In the last decade or so, a new technology has developed in educational settings (Roche et al., 2021b): 360° video. However, Snelson and Hsu (2020) pointed out some vagueness in the naming of this technology in the current scientific literature. This definitional vagueness is in part due to the novelty of this technological tool but the fact that this field of research is emerging (Snelson and Hsu, 2020) and immature (Paraskevaidis and Fokides, 2020; Reyna Zeballos, 2018).

Based on the current literature, the aim of this study was therefore to propose a circumscribed definition for 360° video so that research on this technology is clearly identified. It is under this premise that we believe it is possible to clearly delineate the boundaries of a research field focused on the uses of 360° video.

2 Method

In the current literature, 360° video is referred to using various terms, which creates definitional ambiguity and complicates the identification of key research findings regarding the uses of this technology. This lack of clarity makes it difficult to pinpoint and compare the main research results within this field. To address this issue, we conducted a narrative review (Baumeister and Leary, 1997) to explore and synthesize the diverse definitions and terminologies used to describe 360° video technology, with a focus on understanding the

scope of this ambiguity and its implications for the research field. This type of review approach assists in critically assessing how the terms have evolved and offers a conceptual framework for understanding these terms and their conceptual variations (Grant and Booth, 2009).

In conducting this review, we aimed to critically assess the different terms used for 360° video, analyze their conceptual distinctions, and examine how these terms impact the understanding and application of the technology. Rather than mapping all evidence related to 360° video uses, as it is typical in a scoping review, the purpose of this narrative review was to focus specifically on how the technology has been defined and named in existing research and to offer a synthesis of these definitions to establish greater clarity for future studies.

2.1 Search strategy

To identify the relevant literature, we performed a comprehensive search across six key academic databases: Scopus, ERIC, ScienceDirect, LearnTechLib, ProQuest, and PubMed. We conducted multiple iterations of search queries to capture the broad range of terminology used in the literature. The search was not restricted by publication date, ensuring that we captured a diverse selection of articles that contributed to the evolving discourse surrounding 360° video.

The search queries included a combination of the following keywords and phrases to capture the various ways 360° video is described:

- First query search: "*360 video OR immersive panoramic video OR panoramic video OR 360VR.*"
- Second query search: "*360 video OR immersive panoramic video OR panoramic video OR 360VR OR spherical video, spherical video based virtual reality (SVVR).*"
- Third query search: "*360 video OR immersive panoramic video OR panoramic video OR 360VR OR spherical video, spherical video based virtual reality (SVVR) OR 360°VR video, 360 degrees video.*"

We also employed a "snowball" technique, through which we examined the citations within the included articles to identify additional relevant sources. This iterative search process continued until no new terms for 360° video emerged, signaling saturation in the terminology identified.

2.2 Study selection

In our review, we focused on studies that contributed to the ongoing debate about the terminology and conceptual definitions of 360° video. We included articles that presented or discussed different names and definitions for the technology, whether in academic studies, industry reports, or other relevant publications. After filtering out irrelevant sources, we identified nine distinct terms used to refer to 360° video technology (Figure 1). These terms included the following: immersive panoramic video; panoramic

video; spherical video; immersive video; spherical video-based virtual reality (SVVR); 360°VR video; 360VR video; 360 degrees video; and 360° video.
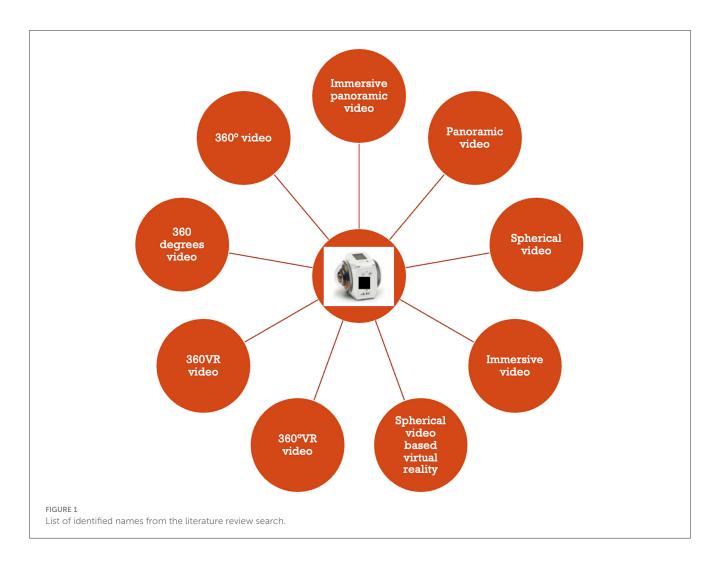
2.3 Data extraction and synthesis

Once relevant studies were selected, we extracted and synthesized the different definitions and descriptions provided for each of these terms. In cases where visual content (such as illustrations or diagrams) was provided, we screened these to distinguish between the literature on 360° video and the literature on virtual reality (VR), ensuring that the definitions applied specifically to 360° video. We then summarized the range of terminology used, highlighting the overlap and differences in how the technology is conceptualized across the literature.

This lack of definitional clarity is clearly explained by Rosendahl and Wagner (2023) who suggested that "on one hand, 360° videos are associated with the medium of video in general due to the recording and sequencing of moving images. On the other hand, it is associated with VR because of its immersive possibilities" (p. 3). 360° video is not yet well established in the research field and is not yet a consensually well-defined field of research. Following the example of Roche et al. (2021b) and Rosendahl and Wagner (2023), we believe it is necessary to adopt a clear terminology to develop robust research in the field of this technology use.

3 A great diversity of names for the same technology

With his seminal study in computer sciences, Nayar (1997) developed the first device that offered the possibility to create panoramic video: the catadioptric omnidirectional camera. Following this study, Neumann et al. (2000) introduced their study on immersive panoramic video, stating that "panoramic video overcomes the passive and structured limitations of how video imagery is presented and perceived" and they added that "viewers of panoramic video become virtual participants immersed in the observed scene, creating a new dimension in the way people perceive video imagery" (p. 493).

This research focused on the development of the first cameras capable of capturing panoramic films, marking the starting point for studies on the applications of this technology. In the 2010s, consumer models of omnidirectional cameras emerged, such as the *Sony Bloggie* (2010), the *Ricoh* (2013), and the *Kodak SP360* (2014). As a result, the name 360° video became more readily available to the public. However, in scientific literature during the same period, the term "spherical video" was also commonly used. For example, Ozkeskin and Tunc (2010) underlined that "spherical videos have the advantage of reflecting the environment as it is" (p. 64). For Yusof et al. (2019), spherical video constitutes a new generation of video that assures bigger acceptance or "immersiveness" than traditional video, and for Fokides and Kefallinou (2020), this technology "surpasses one of the fundamental limitations of regular videos, that of the single point of view, given that they are recorded using cameras able to capture images from a whole sphere. When

FIGURE 1
List of identified names from the literature review search.

viewing such videos, the users can freely select, at any given time, which part of the scene to view" (p. 429).

In line with spherical videos, it is also possible to identify in the literature the existence of spherical video-based virtual reality (SVVR). This technology is used in various application domains, such as journalism (Hendriks Vettehen et al., 2019), medical care (O'Sullivan et al., 2018), or education (Chen et al., 2022). According to Chang et al. (2020), spherical video-based virtual reality (SVVR) "refers to the VR approach that employs spherical videos, allowing viewers to pan and tilt in an uninterrupted circle instead of the fixed viewpoint of a traditional video" (p. 917). This technology allows users the opportunity to look around in all directions and gives them the possibility to control what they want to see (Yang et al., 2022). Furthermore, SVVR solves the problems of using conventional 3D graphic-based VR, which is highly technical and expensive in terms of both time and money. Nonetheless, in the literature, SVVR covers various types of resources such as 360° videos but also 360° hypervideos. Chambel et al. (2011) defined 360° hypervideo as a resource that allows one to interact with the video, explore it, navigate in a space of related information, and open additional content such as links to webpages or links to 2D videos.

Other studies are focused on 360°VR uses such as Pirker and Dengel (2021) had underlined. For example, Kittel et al. (2020b) used 360°VR for improving decision-making with amateur Australian football umpires. Kittel et al. (2020a) specify that "where VR involves virtual characters sourced through motion capture systems, 360°VR uses real-world footage filmed from a 360° camera" (p. 1).

The last name we have identified in the literature is immersive video. In their study for improving decision-making in basketball, Panchuk et al. (2018) used immersive video and stated that it "maintains some of the benefits of VR but is not as resource intensive" (p. 2) because they are based on real images.

4 360° video: it is not VR

Rosendahl and Wagner (2023), in line with Roche et al. (2021b), underlined the necessary terminological separation of both technologies of 360° video and VR. For Wohl (2017), 360° videos are video recordings in which a view in every direction is recorded at the same time by using a specific camera with a fish-eye lens. Furthermore, Snelson and Hsu (2020) highlight that "ambisonics may also be included for a full sphere surround

TABLE 1 Main characteristics of VR and 360° video.

	Virtual reality	360° video
Viewing angles offered by technology	Users can freely choose their viewing angle.	Free choice of viewing angle in a 360° panorama around the camera.
Viewing mode	Viewing on laptops, TV screens, smartphones, interactive screens, and headsets.	Viewing on laptops, TV screens, smartphones, interactive screens, HMD, and smartphone headsets.
Possibilities offered by technology	Viewing what happens in the medium according to the movements and speed of the person acting in the virtual space.	Possibility to view in slow motion, speed up, pause, change angle, and zoom in on the image being viewed.
Interactivity	Touch and move objects with or without haptic feedback.	No interactive devices are used, with the exception of headsets (e.g., no haptic feedback devices).
Design of visual medium	Computer-generated images (computer-generated environment). The sequence of actions is programmed according to an algorithmic logic (decision tree). Possibility of integrating sound (not systematic).	Video image of the real environment (real environments and actions) and of unplanned behavior (unless a scenario is established in advance). Edited or "raw" videos; more delicate editing than 2D video (use of dedicated software). Specific sound to the situation being viewed (omnidirectional or ambisonic sound). Possibility of enriching the video with interactive points (360 hypervideo) to open up additional content.
Movements in the viewed medium	Offers six degrees of freedom (6 DoF). Ability to move around the scene being viewed.	Offers three degrees of freedom (3 DoF). Only ability to look right/left, up/down, and front/back.

sound experience" (p. 404). In comparison with VR, this aspect is specificity of 360° video.

Fuchs and Guitton (2011) defined VR as "…a scientific and technical domain that uses computer science (i) and behavioral interfaces (ii) to simulate in a virtual world (iii) the behavior of 3D entities, which interact in real time (iv) with each other and with one or more users in pseudo-natural immersion (v) via sensorimotor channels" (p. 8). They underlined that VR offers "the possibility of creating computer-generated images in real time and enabling a real-time interaction between the user and the virtual world" (p.6). The purpose of VR is to represent and model human action and a real environment to allow actions and sensory-motor feedback in a virtual world. This is not the case with 360° video. With VR, each person can perceive and act in a virtual world, sometimes with specific devices such as head-mounted displays or haptic gloves. VR is characterized by "the illusion of participation in a synthetic environment rather than external observation of such an environment" (Gigante, 1993, p. 3). VR can be defined based on three main dimensions: (i) computer-generated, (ii) three-dimensional, and (iii) interactive (Bryson, 1996). For Wohlgenannt et al. (2020), VR is based on three main properties: presence (i.e., the feeling of being physically somewhere other than where one actually is), interactivity (i.e., users can manipulate their virtual environment in real time), and immersion (i.e., characterized by different dimensions such as cognitive immersion, emotional immersion, sensory-motoric immersion, and spatial immersion). Unlike VR, 360° video is not interactive and it does not offer the possibility to interact with the environment or objects in the video. Furthermore, Lee et al. (2022) pointed out that 360° video "does not allow the viewer to walk in a VR environment" (p. 310) and the spectator "is not able to move through the space in which the scene was filmed" (Vosmeer and Schouten, 2014, p. 144). This is because this technology offers only three degrees of freedom (DoF) and VR 6 DoF (Griffin et al., 2021). With 360° videos, the user can freely choose his viewing angle in a 360° angle around

the camera, but it is not possible to move in the filmed scene (Table 1).

5 Discussion

Similar to Kardong-Edgren et al. (2019) who pointed out about VR that "the lack of clarity creates problems when reviewing literature and comparing findings" (p. 31), we believe the same is true for 360° video. The wide variety of definitions related to the same technology highlights the lack of standardization or coherence in this field of research. In addition, in order to be able to consider a precise organization of the research field related to the technology allowing to create 360° video of real situations and to capitalize on the research results related to the use of this technology, we propose to adopt the term: 360° video. Indeed, this term seems to be adapted for several reasons: (i) It removes the confusion with VR, (ii) it refers to the production of real images (i.e., a video), and (iii) it corresponds to the name under which this technology is marketed. Indeed, Snelson and Hsu (2020) confirm the call for studies on the effectiveness of 360° videos, but for developing robust research in this field, it is necessary to adopt a clear and shared definition of this technology.

Finally, although some studies (Araiza-Alba et al., 2021; Rosendahl and Wagner, 2023) have highlighted that 360° videos can be viewed with both low-immersion devices (on desktop) and high-immersion devices (HMDs), the use of VR headsets continues to raise concerns about the definition of this technology. However, it is reductive to consider that 360° video would be immersive and would generate a feeling of presence only if they are viewed with an HMD. Indeed, some studies have shown that viewing on a desktop could also generate a feeling of presence and immersion (Roche et al., 2021a). Furthermore, the adjective "immersive" does not constitute a technical characteristic of the audiovisual material but refers to the potential experience that a user may have in a

viewing situation. While some studies aim to characterize these user experiences in a variety of situations, we feel it would be more coherent and prudent not to declare videos to be immersive a priori.

We hope that our contribution will help stabilize a unified definition of 360° video and improve the organization of the research field related to this technology, thereby enabling a clearer identification of all research findings in this area.

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