

CAVA360VR²: An Open-Source Tool for Collaborative Learning and Immersive Analysis in 360-Degree VR Environments

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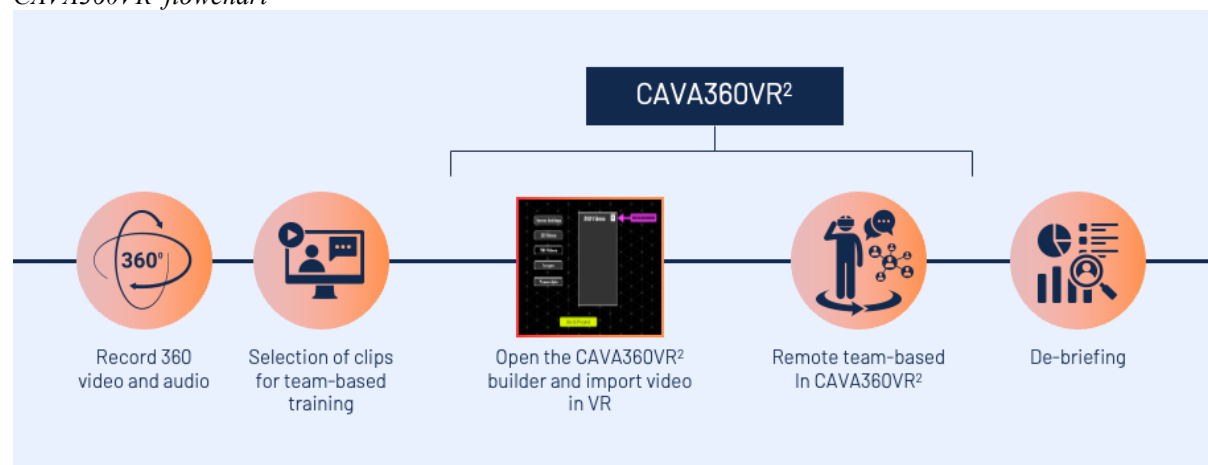
Abstract: CAVA360VR² is a free, open-source multi-user Virtual Reality (VR) tool designed for collaborative learning, immersive analysis, and training. Developed by BigSoftVideo at Aalborg University, CAVA360VR² enables users to explore, annotate, and discuss synchronized 360-degree videos in real-time. The tool supports both VR and desktop modes, making it accessible for users with or without headsets. Key features include timeline navigation, a shared drawing tool, transcript integration, multiple video portals, and real-time collaborative playback. CAVA360VR² is ideal for applications in education, qualitative research, and cross-institutional collaboration, offering a democratic model where all users have equal access to tools. During the workshop, we will demonstrate CAVA360VR² in action and discuss its potential uses for teaching, research, and analysis. This session aims to foster dialogue, gather feedback, and explore partnerships for future development. Participants are encouraged to try the tool and share their insights.

Introduction

CAVA360VR² (Davidsen, McIlvenny, et al., 2024) is a free, open-source, multi-user Virtual Reality (VR) application designed to enable collaborative learning and joint research activities in an immersive environment. Developed by BigSoftVideo at Aalborg University, CAVA360VR² allows users to collaboratively explore, annotate, and analyze 360-degree video content in real-time virtual environments. The tool supports a unique model of democratic collaboration, making it particularly suited for research and educational contexts where the focus is on interaction, reflection, and analysis. A previous version of CAVA360VR² has been used in medical training (Davidsen et al., 2022; Davidsen et al., 2024), teacher mentoring (Paulsen & Davidsen, 2024) and collaborative research activities (McIlvenny, 2020; Vatanen et al., 2022).

CAVA360VR² is built using Unity and Photon Engine. It supports both VR and desktop modes, ensuring accessibility for users with and without VR headsets. The tool is compatible with most high-end VR headsets, including HTC VIVE PRO (1+2), Oculus Rift S, HP Reverb, Valve Index, Oculus Quest 2 (via link cable). For desktop users, CAVA360VR² runs on Windows 10/11. Participants will need a VR-ready PC or laptop and a stable internet connection to participate in a CAVA360VR² session. To use CAVA360VR², session hosts will have to create free photonengine account – this allows up to 20 simultaneous users. After this, users can use the CAVAbuilder to freely generate a 360VR session and distribute the build to trusted users (see Figure 1 for an illustration).

Figure 1
CAVA360VR² flowchart



The workshop aims to showcase how CAVA360VR² can facilitate collaborative learning through innovative use of VR technology. Participants will have the opportunity to experience a live demo of the software, followed by an interactive discussion on its potential applications for learning, teaching, and research in various fields.

Background

CAVA360VR² emerges from the need to integrate collaborative and immersive capabilities in 360-degree VR environments, addressing the limitations of traditional VR platforms designed primarily for individual use. While existing research emphasizes the potential of VR for enhancing individual learning and skill acquisition, the social and collaborative dimensions of learning in immersive VR remain underexplored. Previous studies have demonstrated the effectiveness of shared viewing and mutual awareness in VR video platforms but often lack tools for fostering true collaborative interaction, such as shared annotations, dynamic movement, and synchronized engagement (Jin et al., 2023; Nguyen et al., 2017).

Grounded in participatory learning theories (Sfard, 1998) and interactional theories of embodiment (Streeck et al., 2011), CAVA360VR² is designed to facilitate mutual and embodied awareness, enabling users to engage in coordinated activities within shared 360-degree virtual spaces. By supporting features like synchronized timelines, laser pointers, and collaborative annotation tools, the platform enhances the co-construction of knowledge and shared problem-solving. This approach aligns with the theoretical frameworks emphasizing the importance of mutual awareness and embodied participation in creating meaningful and inclusive learning experiences.

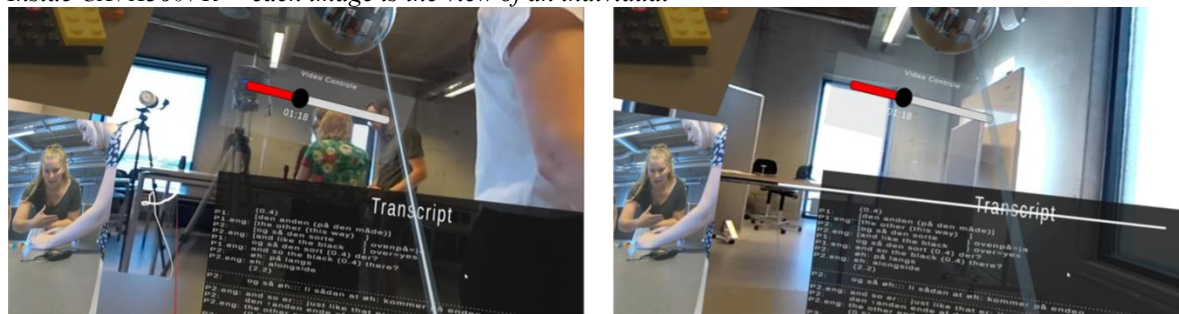
CAVA360VR² builds upon prior work in immersive VR collaboration (Paulsen et al., 2024), integrating advanced networking capabilities and interactive tools to create a robust environment for team-based learning. Unlike conventional VR applications, which often replicate physical activities or rely on static interactions, CAVA360VR² provides dynamic and flexible solutions for immersive learning, fostering a sense of community and collaboration that mirrors traditional classroom dynamics.

Main Features of CAVA360VR²

CAVA360VR² is designed with features that enhance collaborative learning and interaction in virtual environments supporting various activities (see Figure 2 for an illustration of some of the tools inside CAVA360VR²).

Figure 2

Inside CAVA360VR² – each image is the view of an individual



With the CAVABuilder users can create and configure immersive collaborative 360VR projects by adding synchronized 360-degree videos, 2D videos, images, 3D objects, and DOTE transcripts. Then you compile the project into a distributable folder containing media files, Photon App ID, and an executable file (.exe). For the VR mode, we wish to mark the following key features:

VR File Browser

- Access and manage all imported media files (360-degree videos, 2D media, images) within the VR environment.
- Open media files can be repositioned and scaled in the VR application

Timeline Navigation

- Navigate specific moments in videos using a shared timeline.
- Playback is synchronized across all participants (the butterfly effect).

Drawing Tool

- Annotate directly on 360-degree videos with adjustable brush sizes.
- Erase and modify drawings that are visible to all participants.

Laser Pointer with Animated Trail

- Visualize user focus and direction with the animated trail on the right controller.
- Ideal for guiding and highlighting points during discussions without leaving a permanent mark.

Teleport Option

- Move dynamically within the 360VR space.
- Facilitate group formations and enhance spatial interaction.

Multiple Video Portals

- Switch between various 360-degree video perspectives depending on the number of cameras used.
- Communication and synchronization remain intact across portals.

Avatar Customization

- Unique avatar colours for easy identification.
- Colours are reflected in pointers, drawings, and video portal indicators.

Transcript Viewer

- Display and synchronize DOTE transcripts (McIlvenny et al., 2022) with video playback.
- Navigate videos using timestamped transcript entries.

Zoom and Rotate

- Adjust the size and orientation of media objects.
- Enhance spatial alignment for collaborative focus.

Portal Color Indicators

- Coloured rings show participants in specific video portals.
- Dynamically update to reflect real-time user movement.

Mirror camera

- Activate the mirror cam to see what is behind you
- Lock the mirror cam and reposition the window in the 360VR space

Applications in Learning and Teaching

CAVA360VR² supports a wide range of applications in education and research, making it a versatile tool for various contexts. It facilitates collaborative analysis and discussion, allowing students and researchers to jointly analyze 360-degree video recordings of real-world environments, fostering rich discussions on topics such as classroom interactions, fieldwork documentation, and virtual simulations. Additionally, CAVA360VR² is well-suited for immersive training in fields like medical education, emergency response, and classroom management, where realistic virtual environments can significantly enhance learning outcomes. The tool is also highly valuable for qualitative research, particularly for projects that require detailed analysis of recorded interactions, including ethnographic studies, interaction analysis, and digital learning research. Furthermore, as an open-source tool, CAVA360VR² supports cross-institutional collaboration by enabling researchers to share and co-analyze video data in virtual spaces, fostering partnerships and innovative research across institutions.

Structure of the session

Participants in the demo will experience

- Hands-on demonstration of CAVA360VR²: Attendees will experience a live demonstration, showcasing key features of the software, including timeline navigation, annotation tools, transcript viewer and portal switching.
- Interactive discussion on the potential of immersive technologies in CSCL design and research: participants will be invited to discuss how immersive technologies such as CAVA360VR² can be integrated in their teaching and research practices in order to support collaborative learning processes.

Conclusion

CAVA360VR² represents a significant step forward in collaborative learning technologies. By combining immersive VR environments with open-source accessibility, the tool offers new possibilities for teaching, research, and cross-institutional collaboration. We look forward to sharing CAVA360VR² with the learning sciences community and exploring its potential in various educational and research contexts.

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