EXPLORING IMMERSIVE TECHNOLOGIES: A JOURNEY THROUGH THE IMMERSIVE PAVILION

An Educational Guide for the Luxembourg City Film Festival 2025

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NEIMËNSTER

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PHI

FILM FUND LUXEMBOURG

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Welcome Educators and Students,

We are delighted to present the 2025 edition of the Luxembourg City Film Festival's Immersive Pavilion. This educational dossier is designed to guide you through the exciting world of immersive technologies. Whether you're an educator aiming to inspire your students or a student eager to explore new frontiers, this guide will provide valuable insights into how technology is reshaping art and storytelling.

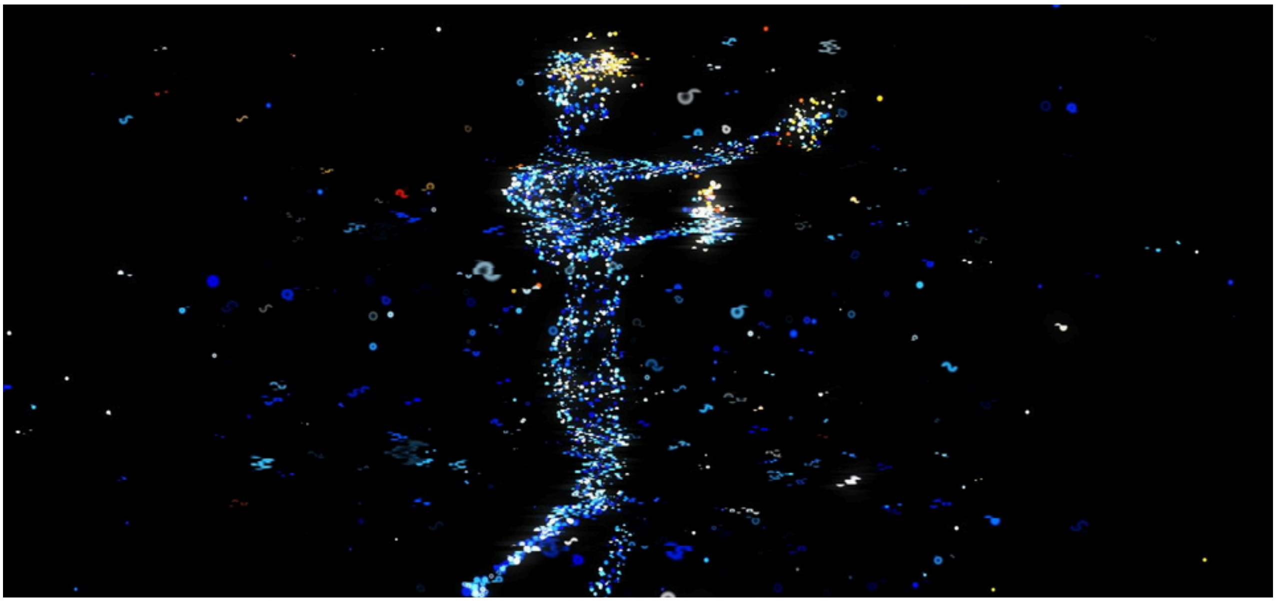
ABOUT THE IMMERSIVE PAVILION

The Immersive Pavilion is a dedicated space within the Luxembourg City Film Festival that explores the intersection of technology, art, and storytelling. Our objectives are to inspire creativity, foster critical thinking, and encourage a deeper understanding of digital media. By highlighting innovative storytelling methods through extended reality (XR), we aim to introduce audiences to the latest developments in immersive technologies.

ABOUT FILM FUND LUXEMBOURG

The Film Fund Luxembourg is a public institution under the supervision of the Ministry of Culture, which supports Luxembourg's film and audiovisual industry by financing film projects, series, and innovative productions. It plays a key role in supporting initiatives related to virtual reality, a rapidly evolving sector that is redefining visual storytelling.

By funding the creation and production of these interactive formats, Luxembourg promotes the emergence of new immersive experiences and thus strengthens its role in audiovisual innovation on an international scale.



ABOUT PHI

Founded and directed by Phoebe Greenberg and based in Montreal, PHI is a multidisciplinary organization positioned at the intersection of art, film, music, design and technology. Offering a panoramic perspective of radical ideas focused on collective experience, social impact, and audience interactivity, PHI is committed to future generations of art consumption.

PHI consists of the PHI Centre, PHI Studio, artist-in-residence programs, and PHI Foundation for Contemporary Art. Through eclectic programming and a strong emphasis on content creation, PHI fosters unexpected encounters between artists and audiences.

AN INTRODUCTION TO IMMERSIVE TECHNOLOGIES

Immersive technologies are revolutionizing the way we perceive and interact with digital content by merging the physical and virtual worlds. Extended Reality (XR) serves as an umbrella term that encompasses Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR).

These technologies offer experiences that engage multiple senses, create a profound sense of presence, and enable interactivity within digital or augmented environments. Immersive art utilizes these technologies to explore the concept of presence, drawing viewers into the artwork to form deeper emotional connections and transforming them from passive observers into active participants.

Consider how immersive technologies could change your daily life. How might you use XR to tell a personal story or solve a problem in your community?

DID YOU KNOW ?

The roots of immersive experiences can be traced back to the 1800s with the invention of the stereoscope, a device that allowed users to view images in 3D, creating an early form of virtual reality.

OVERVIEW OF DIFFERENT IMMERSIVE TECHNOLOGIES

Immersive technologies include a spectrum of tools that alter our perception of reality.

- Virtual Reality (VR) completely immerses users in a digital environment, isolating them from the physical world.
- Augmented Reality (AR) overlays digital information onto the real world, enhancing our environment with additional data and graphics.
- Mixed Reality (MR) blends both physical and digital worlds, allowing them to interact seamlessly.

Each technology offers unique experiences and has different applications across various industries such as entertainment, education, healthcare, and manufacturing.

When you visit the exhibition, pay attention to how artists use these technologies.
Observe how it changes your interaction with the digital and physical world.

FUN FACT
The concept of combining the real world with virtual information was predicted by science fiction writer Neal Stephenson in his 1992 novel "Snow Crash," which introduced the idea of a virtual reality-based successor to the internet called the "Metaverse."

VIRTUAL REALITY

Virtual Reality (VR) creates a fully immersive digital environment that replaces the user's real-world surroundings. By engaging multiple senses, VR transports users into virtual worlds where they can explore, interact, and experience scenarios that might be impractical or impossible.

HOW IT WORKS:

Head-Mounted Displays (HMDs): VR devices use HMDs that place screens directly in front of the user's eyes. These screens display stereoscopic images to create a 3D effect, immersing the user in a virtual environment.

Motion Tracking: Sensors like accelerometers, gyroscopes, and magnetometers track the user's head and body movements. This real-time tracking allows the visuals to adjust instantly as the user moves, maintaining the illusion of presence in the virtual world.

Input Devices: Handheld controllers or motion-sensing devices enable users to interact with the virtual environment. Advanced systems may also use hand tracking or gloves for more natural interaction.

Rendering and Audio: High-performance computers or built-in processors generate the virtual world in real-time. Spatial audio enhances immersion by simulating sound from different directions and distances.

DID YOU KNOW ?

Did you know? The first VR head-mounted display, called The Sword of Damocles, was created in 1968 by Ivan Sutherland. It was so heavy that it had to be suspended from the ceiling!

AUGMENTED REALITY

Augmented Reality (AR) overlays digital information onto the real-world environment, enhancing what we see, hear, and feel. AR systems can range from smartphone apps to specialized glasses and headsets.

HOW IT WORKS:

Capture of the Real World: AR devices use cameras to capture the user's surroundings. Sensors like accelerometers, gyroscopes, and magnetometers help determine the device's orientation and position.

Processing and Mapping: Computer vision algorithms analyze the camera feed to recognize surfaces, objects, and images. Simultaneous Localization and Mapping (SLAM) algorithms build a map of an unknown environment while simultaneously keeping track of the device's location.

Rendering Digital Overlays: Once the environment is understood, digital content is rendered and aligned with the physical world in real-time. Some AR systems use depth sensors (like LiDAR) to measure distances, allowing for more accurate placement of virtual objects.

Interaction: On smartphones, users can interact with AR content using the touchscreen, but more advances in AR technology allow for interaction through hand gestures and voice recognition.

AR offers diverse storytelling possibilities, including interactive books, educational apps, and location-based games.

DID YOU KNOW ?

When Pokémon GO first released in 2016 it popularized AR by reaching over 500 million downloads in its first year.

MIXED REALITY

Mixed Reality (MR) blends the physical and digital worlds to create environments where real and virtual elements co-exist and interact in real-time. MR allows users to interact with both physical and virtual objects, blurring the line between reality and imagination. Both passthrough Head-Mounted Displays (HMDs) and dedicated MR glasses are instrumental in delivering these experiences.

HOW IT WORKS:

Capture and Understanding of the Environment: MR devices use cameras and depth sensors (like LiDAR) to capture the user's surroundings and understand the physical space.

Environmental Mapping: Computer vision algorithms analyze the environment to create a detailed 3D map. Simultaneous Localization and Mapping (SLAM) algorithms keep track of the device's location while mapping the surroundings.

Rendering and Integration: Virtual content is rendered and precisely aligned with the physical world in real-time. This alignment allows virtual objects to appear fixed in the environment and interact with real-world surfaces.

Interaction: Users can interact with virtual content using hand gestures, eye tracking, or voice commands. This enables natural and intuitive interaction with both physical and digital elements.

MR offers possibilities in fields like education, design, and collaboration, enabling experiences where users can manipulate virtual objects as if they were real.

DID YOU KNOW ?

The Microsoft HoloLens, released in 2016, was one of the first devices to provide a true mixed reality experience, allowing users to interact with holograms in their physical environment.

IMMERSIVE AUDIO

Immersive audio creates a three-dimensional sound field that enhances the realism of virtual and augmented environments. By accurately simulating how sound behaves in real life, immersive audio significantly contributes to the sense of presence.

Spatial Audio Rendering: Techniques like Head-Related Transfer Functions (HRTFs) simulate how sound arrives at the ears from different locations, making sounds appear to come from specific directions and distances.

Binaural Audio: Sound is recorded or synthesized using two microphones or channels to create a 3D stereo effect when listened to with headphones, providing a realistic sense of space.

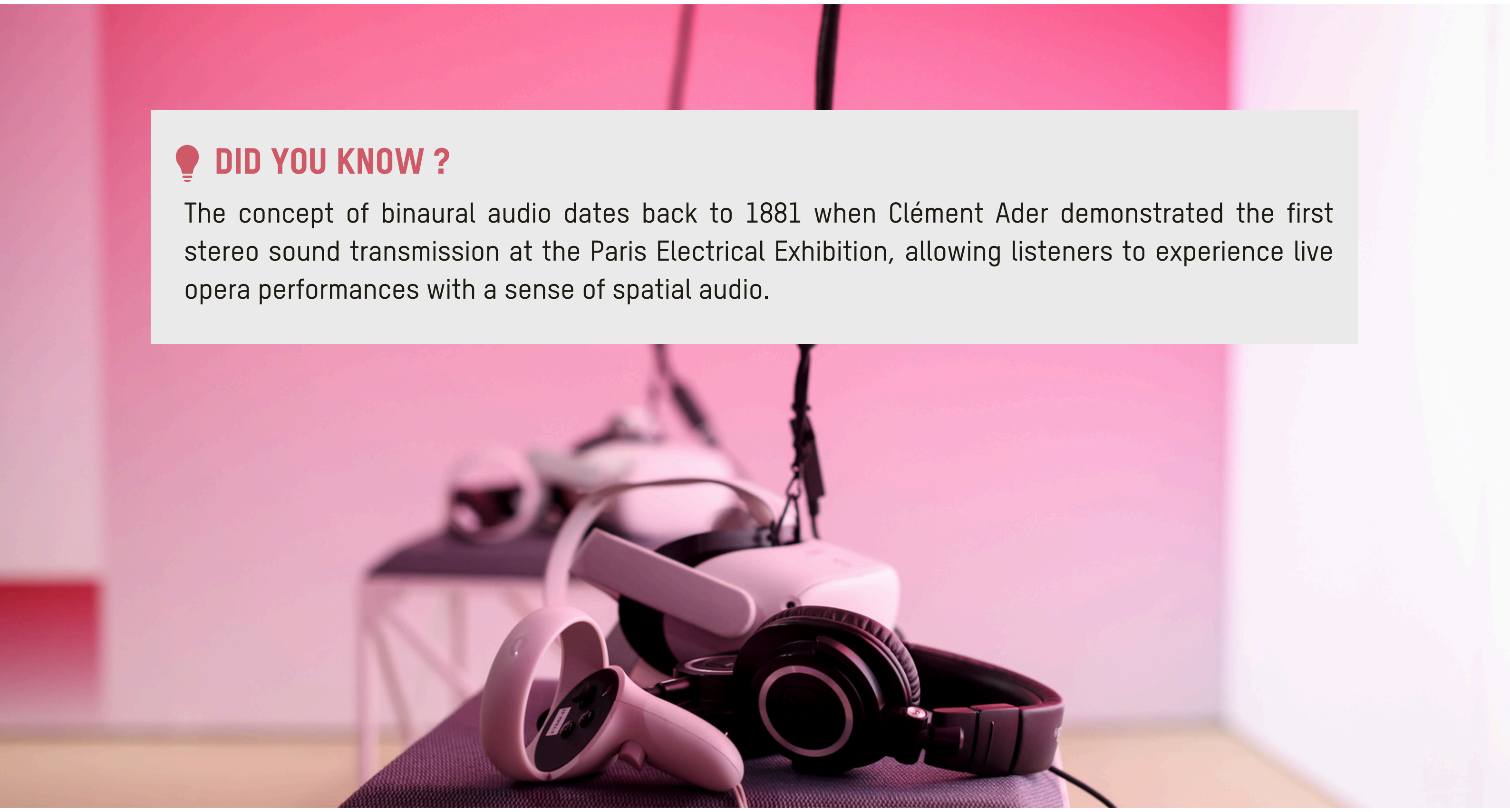
Dynamic Sound Adjustment: Audio adapts in real-time to the user's movements. Head tracking ensures that sounds remain anchored in the virtual environment even as the user moves their head.

Environmental Acoustics: Simulates how sound interacts with the environment, including reverberation and occlusion effects. This adds realism by replicating how sound reflects off surfaces or is obstructed by objects.

Immersive audio enhances experiences in VR and AR by providing a realistic soundscape, making virtual environments more believable and engaging.

DID YOU KNOW ?

The concept of binaural audio dates back to 1881 when Clément Ader demonstrated the first stereo sound transmission at the Paris Electrical Exhibition, allowing listeners to experience live opera performances with a sense of spatial audio.



HAPTICS AND OTHER TECHNOLOGIES

Haptic technology and other advanced systems add layers of interaction and immersion to digital experiences. By engaging additional senses like touch and movement, these technologies make virtual environments more tangible and interactive.

- Haptic Feedback: Devices like haptic gloves, vests, and controllers simulate the sense of touch through vibrations, forces, or motions. Actuators within these devices create tactile sensations that mimic textures, impacts, or resistance, enhancing the realism of virtual interactions.

- Motion Tracking: Sensors track the user's physical movements, allowing for natural interaction within virtual spaces. This includes hand tracking, body tracking, and even facial expression recognition, enabling avatars to mirror the user's actions.

- Gesture Recognition: Systems use cameras and sensors to recognize specific hand or body gestures. This technology allows users to control and interact intuitively without the need of a physical controller.

- Eye Tracking: By monitoring where the user is looking, eye-tracking technology can create interesting interactive components in an artwork or experience. In VR, it can be used for foveated rendering, which enhances graphical performance by rendering sharper images where the user is focusing.

- Projection Mapping: This technology turns irregularly shaped objects or entire environments into display surfaces for video projection. By precisely aligning visuals with physical spaces, projection mapping creates immersive installations and performances.

These are just some of the technologies that can be used to expand the possibilities of immersive experiences, from more engaging VR worlds to interactive art installations and innovative educational tools.

Can you identify which works in the VR Pavilion use some of these technologies?

ARTIFICIAL INTELLIGENCE IN IMMERSIVE ART AND TECHNOLOGY

Artificial Intelligence (AI) is transforming artistic practices by introducing new tools and methods for creation, interaction, and personalization. In immersive art and technology, AI expands the possibilities for dynamic and adaptive experiences, enabling artists to craft environments that respond to users in real-time. The integration of AI into mediums like Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) allows for interactive narratives and artworks that evolve with each interaction.

AI AND ART KEYWORDS:

Generative Algorithms: AI uses algorithms like machine learning and neural networks to generate new content. Generative Adversarial Networks (GANs) are one way that AI can be used to create realistic images, videos, or music by learning patterns from large datasets.

Interactive Environments: AI enables the creation of environments that adapt to user behaviour. Through reinforcement learning, systems learn from user interactions to modify the environment or narrative accordingly. This results in personalized experiences where the artwork changes based on each participant's actions.

Computer Vision: AI-powered computer vision algorithms process visual input from cameras and sensors in real-time. In AR and MR, this allows for accurate object recognition and environment mapping, enhancing the integration of virtual elements with the physical world.

Emotion Recognition: AI-powered computer vision algorithms process visual input from cameras and sensors in real-time. In AR and MR, this allows for accurate object recognition and environment mapping, enhancing the integration of virtual elements with the physical world.

Art has an interesting responsibility to help us unpack how we end up integrating AI in our daily lives. In what way do you think artists can challenge, or celebrate AI as a creative tool?

UNDERSTANDING NEW MEDIA AND IMMERSIVE STORYTELLING

Immersive storytelling is a method that allows the audience to be part of the narrative, often through interactive or sensory-rich experiences. Creative technologists play a vital role by combining art, storytelling, and technology to create new forms of expression, using technology as a tool and a medium.

Key components of immersive storytelling include:

- Interactivity: Immersive storytelling encourages the audience to interact with the narrative. This could mean making choices that affect the story's outcome, or simply exploring an environment that responds to their movements and actions.
- Presence: By immersing users in a virtual or augmented environment, immersive storytelling creates a powerful sense of presence. Whether through VR, AR, or any other mixture of technologies or approaches, presence allows users to feel "within" the story.
- Sensory Engagement: Immersive storytelling can engage multiple senses, such as sight, sound, and even touch (using haptics). This creates a richer, multi-layered experience that deepens emotional connection to the narrative.

Imagine creating your own immersive story. What would it look like, and how would you use interactivity, presence, and sensory engagement to draw people in?

IMMERSIVE TECHNOLOGIES IN EVERYDAY LIFE

We encounter immersive technologies in our daily lives more often than we might realize. Smartphones use AR in apps like Snapchat filters and Google Maps Live View. Gaming consoles bring VR gaming experiences into our homes. Wearables like smartwatches and fitness trackers incorporate haptic feedback.

FUN FACT
Retailers like IKEA use AR apps to let customers visualize furniture in their homes before purchasing.

THE FUTURE OF IMMERSIVE TECHNOLOGY

Emerging trends in immersive technology include 5G connectivity, offering faster data speeds for more seamless AR/VR experiences; cloud computing, processing-intensive tasks remotely to make devices lighter and more accessible; and social VR, creating virtual spaces where people can meet and interact.

Activities for Students: Consider the ethical implications of immersive technologies, such as privacy, data security, and digital well-being. Explore potential career opportunities in XR development, design, and storytelling.

GLOSSARY OF TECHNICAL TERMS

Accelerometer: A sensor that measures the rate of change in velocity (acceleration) of an object, often used in devices to detect movement and orientation.

Adaptive Storytelling: A method of storytelling where the narrative evolves based on the user's choices, behaviours, or emotional responses, often utilizing AI to personalize the experience.

Affective Computing: A field of study and technology that deals with the design of systems and devices that can recognize, interpret, and respond to human emotions.

Ambisonics: A full-sphere surround sound technique that captures sound from all directions, allowing for immersive audio experiences in any listening environment.

Artificial Intelligence (AI): The simulation of human intelligence processes by machines, especially computer systems, enabling them to perform tasks like learning, reasoning, and problem-solving.

Autonomous Behavior: Actions performed by AI-powered agents or characters without human intervention, based on programmed intelligence and learning capabilities.

Binaural Audio: A method of recording or synthesizing sound that uses two microphones or channels to create a 3D stereo effect, providing a realistic sense of spatial audio when listened to with headphones.

Cloud Computing: The delivery of computing services—including servers, storage, databases, networking, software, and analytics—over the internet ("the cloud") to offer faster innovation and flexible resources.

Computer Vision: A field of artificial intelligence that trains computers to interpret and understand the visual world through digital images and videos.

Depth Sensor: A device that measures the distance between the sensor and objects in its field of view, often using technologies like LiDAR, to create a three-dimensional understanding of the environment.

Digital Signal Processing (DSP): The mathematical manipulation of an information signal to modify or improve it in some way, used in audio processing to achieve desired sound effects.

Emotion Recognition: The process by which a machine or program identifies human emotions, typically through facial expressions, voice tone, or physiological signals.

Extended Reality (XR): An umbrella term that encompasses all immersive technologies, including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), which merge the physical and virtual worlds.

Eye Tracking: Technology that measures eye positions and movements, allowing a device or application to know exactly where a person is looking, enhancing interaction and user experience.

Foveated Rendering: A graphics rendering technique that reduces the image quality in the peripheral vision while maintaining high resolution in the user's focal point, optimizing performance based on eye-tracking data.

Force Feedback: A type of haptic feedback that applies forces, vibrations, or motions to the user to simulate physical properties like weight, resistance, or texture in a virtual environment.

Generative Adversarial Networks (GANs): A class of machine learning frameworks where two neural networks contest with each other to produce new, synthetic instances of data that can pass for real data.

Generative Algorithms: Algorithms that use machine learning models to generate new content such as images, music, or text by learning patterns from existing datasets.

Gesture Recognition: The ability of a device to identify and interpret movements of the human body, particularly hand and finger gestures, as a means of input and control.

Gyroscope: A device or sensor that measures or maintains orientation and angular velocity, often used in smartphones and VR headsets to track rotational movement.

Head-Mounted Display (HMD): A wearable device, typically a helmet or goggles, that places a screen or optical display in front of the user's eyes to present virtual or augmented reality content.

Head-Related Transfer Function (HRTF): A response that characterizes how an ear receives sound from a point in space, used to create spatial audio by simulating how sound waves interact with the human head and ears.

High Dynamic Range (HDR): An imaging technology that offers a greater dynamic range of luminosity, allowing for more vivid and realistic images by preserving details in both dark and bright areas.

Inertial Measurement Unit (IMU): An electronic device that measures and reports a body's specific force, angular rate, and sometimes the magnetic field surrounding the body, using a combination of accelerometers and gyroscopes.

Interactive Environment: A digital or virtual space that responds dynamically to user input or actions, often through AI, creating a personalized and engaging experience.

LiDAR (Light Detection and Ranging): A remote sensing method that uses light in the form of a pulsed laser to measure distances, creating precise, three-dimensional information about the shape of objects and environments.

Machine Learning: A subset of AI that involves the development of algorithms and statistical models that enable computers to perform tasks without explicit instructions, by relying on patterns and inference instead.

Metaverse: A collective virtual shared space, created by the convergence of virtually enhanced physical reality and physically persistent virtual reality, where users can interact with a computer-generated environment and other users.

Motion Tracking: The process of capturing the movement of objects or people, used in VR and AR systems to translate physical movements into digital representations.

Natural Language Processing (NLP): A field of AI that gives machines the ability to read, understand, and derive meaning from human languages, enabling interaction with computers using natural speech.

Neural Network: A series of algorithms that mimic the operations of a human brain to recognize relationships between vast amounts of data, used in machine learning for pattern recognition and data classification.

Passthrough Technology: A feature in some VR headsets that uses external cameras to capture the real-world environment and display it inside the headset, allowing users to see their surroundings without removing the device.

Projection Mapping: A technology that turns objects or spaces into display surfaces for video projection, aligning images precisely with physical features to create immersive visual experiences.

Reinforcement Learning: An area of machine learning where an agent learns to make decisions by performing certain actions and receiving rewards or penalties, used to train AI in interactive environments.

Simultaneous Localization and Mapping (SLAM): A computational process where a device constructs or updates a map of an unknown environment while simultaneously keeping track of its own location within that environment.

Six Degrees of Freedom (6DoF): Refers to the freedom of movement of a rigid body in three-dimensional space, encompassing movement along the x, y, and z axes (surge, sway, heave) and rotation about three perpendicular axes (pitch, yaw, roll).

Stereoscopy: A technique used to create the illusion of depth in an image by presenting two offset images separately to the left and right eye of the viewer, simulating binocular vision.

Three Degrees of Freedom (3DoF): Refers to tracking rotational movements only—pitch (up and down), yaw (left and right), and roll (tilting side to side)—without tracking positional movements.

Voice Recognition: Technology that can recognize spoken words, allowing users to control devices or input data using their voice, often integrated with AI for processing natural language.

Waveguide Optics: A technology used in AR glasses that guides light through a transparent medium to project images directly into the user's eyes, enabling the overlay of digital content onto the real world.

Generative Art: Art that has been created with the use of an autonomous system, often involving algorithms and AI to produce new and unique artworks.

FOV (Field of View): The extent of the observable environment at any given moment, often referring to the angle over which a person or device can see or capture visual information.