Rescuer Project and VR Application

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Akademia WSB
WSB University

Presentation Overview

- Implementation of VR applications with scenarios
- Evaluation of the information content of application
- Next steps in preparing the application

Goals and Core Functions of the RESCUER VR Application

Education and Preparation for Mountain Trips

The application offers interactive educational content that teaches users how to plan and carry out mountain trips safely, adapted to to different skill levels and experience.

Hazard Awareness and Decision-Making Training in VR

Users learn to recognize potential mountain hazards (e.g., weather changes, injuries, terrain difficulties) and practice making the right decisions in realistic, simulated VR scenararios.

Adaptation to Different User Groups

The application includes dedicated scenarios and interfaces for seniors, people with disabilities, mountain trip organizers, and rescue professionals — tailored to their specific needs and capabilities.

Knowledge Base and Trip Planning Support

Users gain access to a virtual mountain base featuring maps, safety tips, evacuation algoritnms, equipment advice, and weather updates — structured by user type.

Support for Communication and Group Collaboration

The app enables users to plan trips together, communicate, and practice cooperation in a virtual environment, enhancing social skills and group safety during real-life expeditions.

Personalized Content and Learning Paths

The system customizes educational content and scenario difficulty to match each user's needs and abilities, offering individualized learning paths and recommendations.

Key Milestones in the Development of the VR Application and Scenarios

- Approval of the technological concept and selection of the Metaverse platform
- Development of the functional specification, including accessibility for people with disabilities
- Design of the system architecture and division of the VR environment into two main modules
- Selection of target devices and compatibility standards (mobile, VR headset, web)
- Development of educational content for the informational module (texts, multimedia)
- User interface design in compliance with WCAG accessibility standards
- Implementation of informational zones for four user groups (rescuers, seniors, people with disabilities, trip organizers)
- Translation of informational content into national languages of project partners
- Accessibility and usability testing of informational zones with target user groups
- Design of the virtual mountain trip module structure (simulations and interactions)

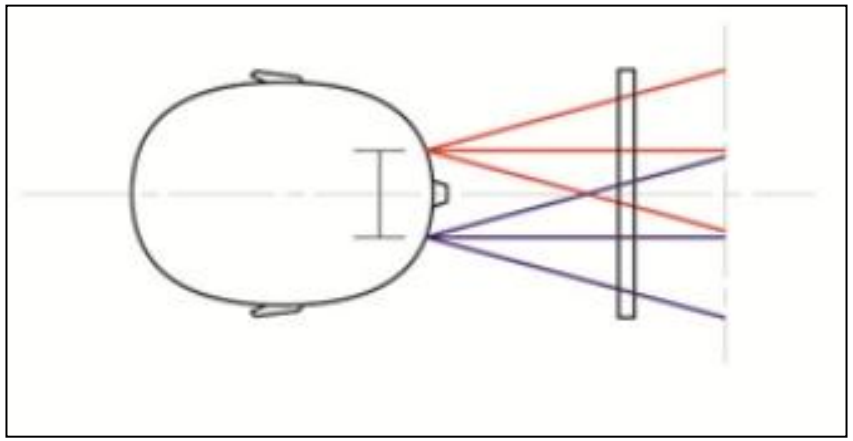
Key Milestones in the Development of the VR Application and Scenarios

- Design and implementation of hazard scenarios (weather, health, terrain-related)
- Development of VR scenarios for four user profiles
- Implementation of interaction and decision-making mechanisms
- Implementation of feedback system after each simulation with educational summary
- Development of group communication and collaboration features in the VR environment
- Testing of VR scenarios with participation of representative users
- Final adjustments, application optimization, and technical documentation preparation
- Official deployment and presentation of the application with training for partners and end users

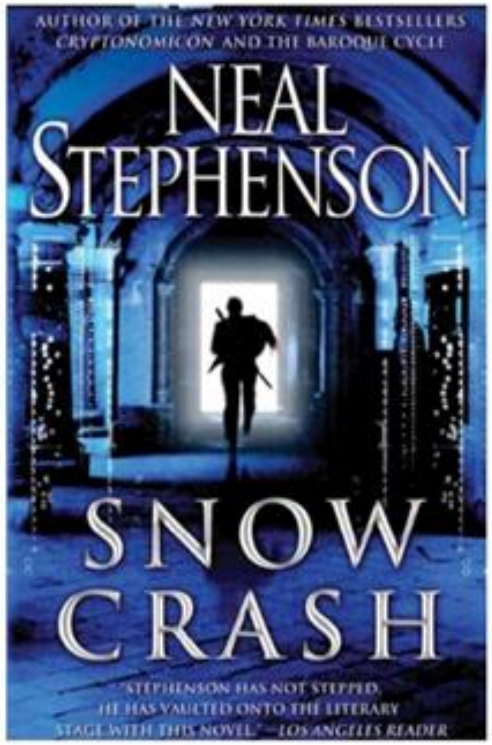
3D visualization in VR and AR

3D Visualization Techniques

- Anaglyph Technique
- Techniques Based on Light Polarization
- Active Glasses Synchronized with the Display
- Use of 3D Headsets

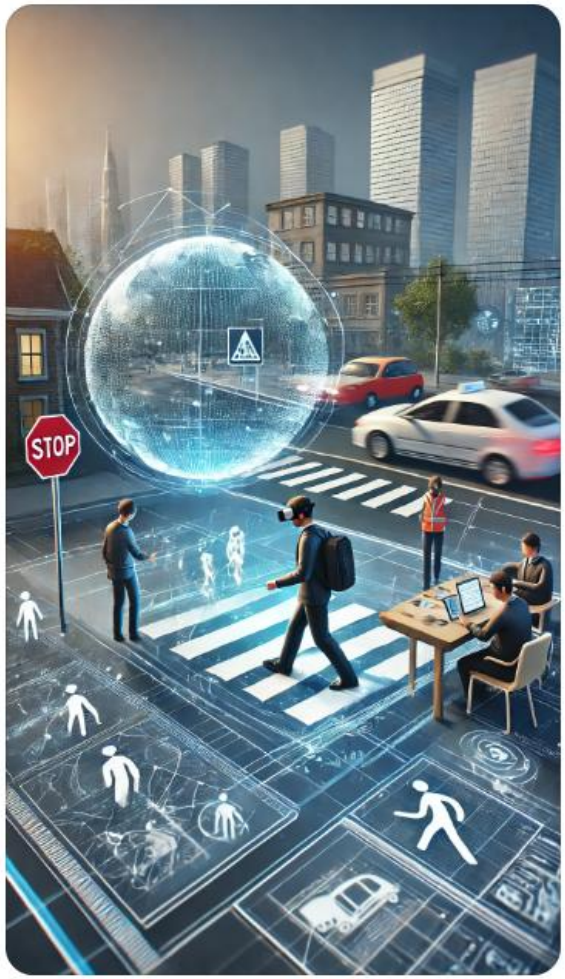


Metaverse



The metaverse is a concept of a virtual world that integrates elements of augmented reality (AR), virtual reality (VR), the Internet, and other digital technologies. It is a fully immersive digital space in which users can interact with both their surroundings and each other in real time, often using avatars. The term "metaverse" was first used by American science fiction writer Neal Stephenson in his 1992 novel Snow Crash. In that book, the metaverse is presented as a virtual reality in which people, using avatars, can conduct their daily lives.

Why the Metaverse environment ?



Realistic 3D Environment:
It allows for creating accurate simulations of mountain trails and weather conditions, helping users better prepare for real-life excursions.

Safe Training Conditions:
It enables rescue exercises and emergency scenarios to be conducted in a controlled virtual setting, eliminating the risk of physical harm.

Interactivity:
Users can actively engage in simulations, enhancing the learning experience through practical, hands-on participation.

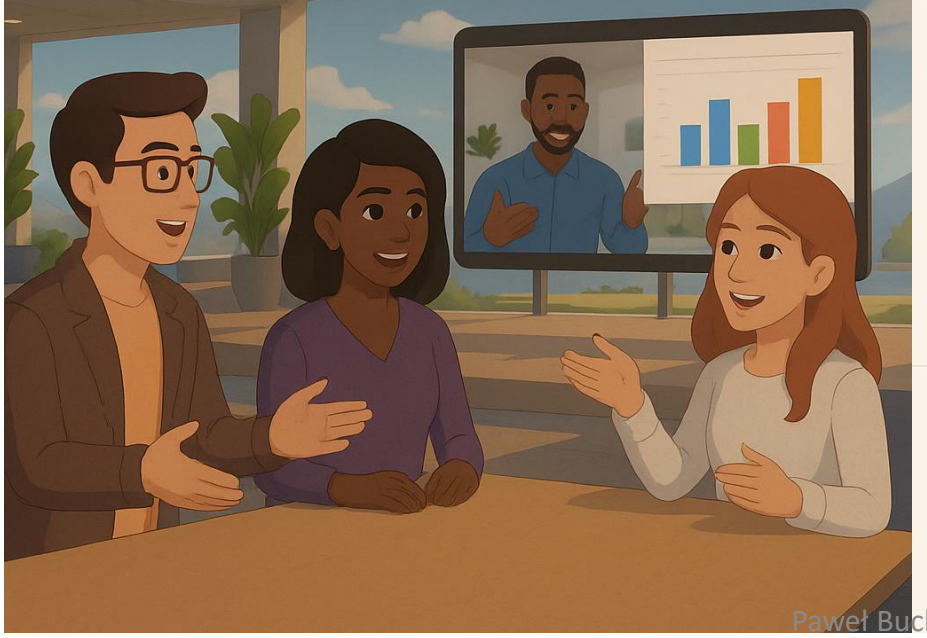
Global Accessibility:
The platform provides access to training and simulations from anywhere, breaking down geographical barriers and reaching even remote areas.

Collaboration and Communication:
The metaverse supports interactions between participants, fostering the practice of coordination and communication essential in rescue operations.

Integration of Modern Technologies:
Easy integration with monitoring systems, sensors, and AI tools enables data collection and behavioral analysis, which helps optimize safety procedures.

Spatial.io

Spatial.io is a cutting-edge platform that redefines virtual collaboration by creating immersive 3D spaces where users can meet, work, and interact. Leveraging the power of augmented and virtual reality. Spatial.io offers a unique, intultive environment that enhances communication and productivity. Whether you are hosting a virtual conference, collaborating on a creative project, or simply connecing with colleagues and friends from around the world, Spatial.io transforms traditional digital interactions into engaging. lifeliike experiences.



Spatial.io: How It Works

Platform Access

Users can access Spatial io through various devices, including VR headsets (like Oculus Quest), AR glasses (like Microsoft HoloLens). and standard devices such as dest-tops, tablets, and smartphones.

Creating Avatars

Upon entering the platform, users create personalized 3D avatars. These avatars can be customizate to resemble the user, enhancing the feeling of presence and interaction within the virtual space.

Virtual Spaces

Users can either create or join existing virtual rooms or environ-ments. These spaces can be tailored for different purposes, such as meeting rooms, conference halls, creative studios, or casual social settings.

Interaction Tools

Spatial io provides a range of tools to facllitate interaction within these virtual spaces. Users can share anu manipulate 3D objects, display documents and presentations, and use spatial audio to communicate naturally as they move around the sp

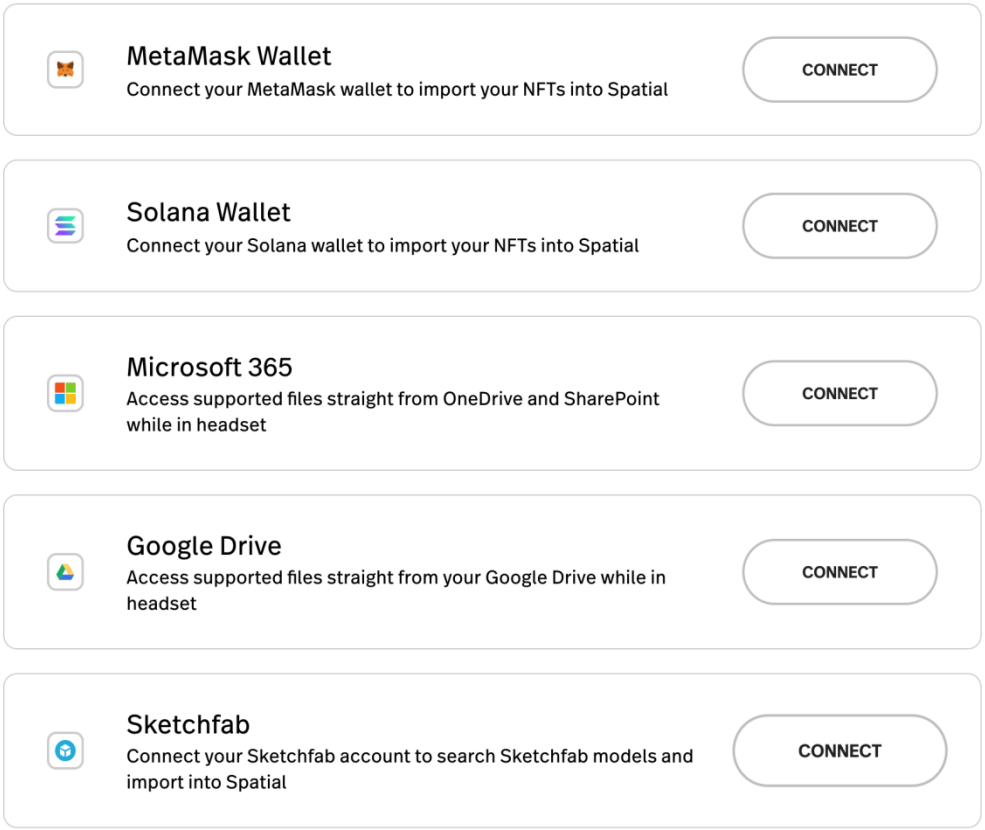
Collaboration Features

The platform supports real-time collaboration, allowing users to wnk together on projects, brainstream ideas, and hold meetings. Features like whiteboards, sticky notes, and file sharing make it easy to collabor-ate as if everyone were in the same

Accessibility and Sharing

Virtual spaces on Spatial io can be easily accessed and shared via links. making it simple to invite colleaques. clients, or friends to join wi:

External platform integration



Supported File Types

Google Workspace:

Google Docs, Slides, Sheets and Drawings

Drawings

Word (.docx)

PowerPoint (.pptx) and Excel

Videos

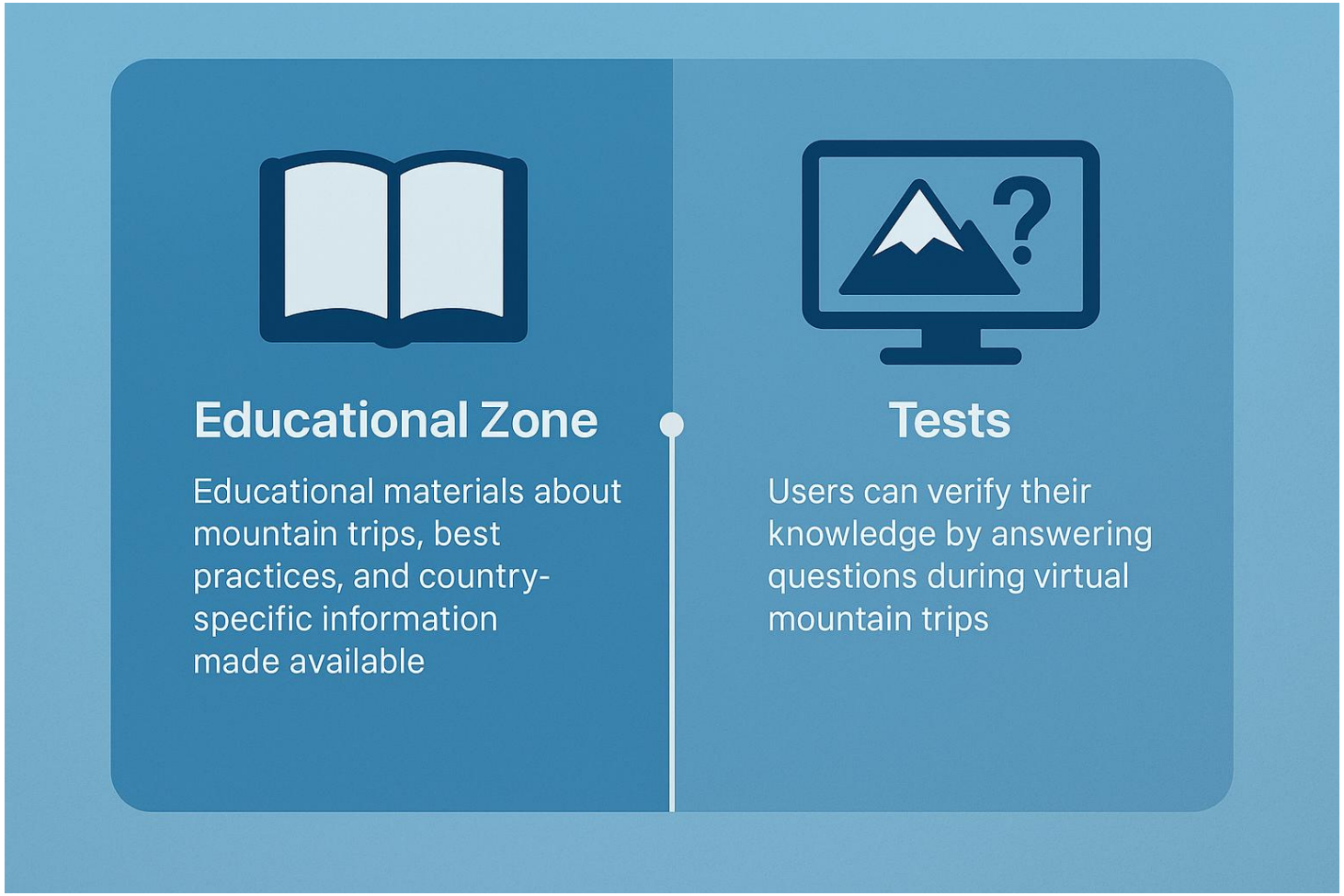
MPEG-4 (.mp4)

Images JPG png) or.jpeg

3D Models

glTF (.glb or gltf)
fbx (.fbx

Two Core Modules of the RESCUER VR Application



Validation Algorithm for Graphic Content Accessibility in Color Vision Deficiency

Problem Statement

Millions face challenges with accessing transport information in Integrated Transfer Hubs (ITHs).

Color vision deficiency (CVD) limits the ability to interpret graphic content.

Standard applications often fail to provide inclusive visual access

Color Vision Deficiency Types

Protanopia
red receptor deficiency

Deuteranopia
green receptor deficiency

Tritanopia
blue receptor deficiency

Each type alters the perception of colors and requires tailored visual design.

Validation Algorithm

Validation Algorithm Overview

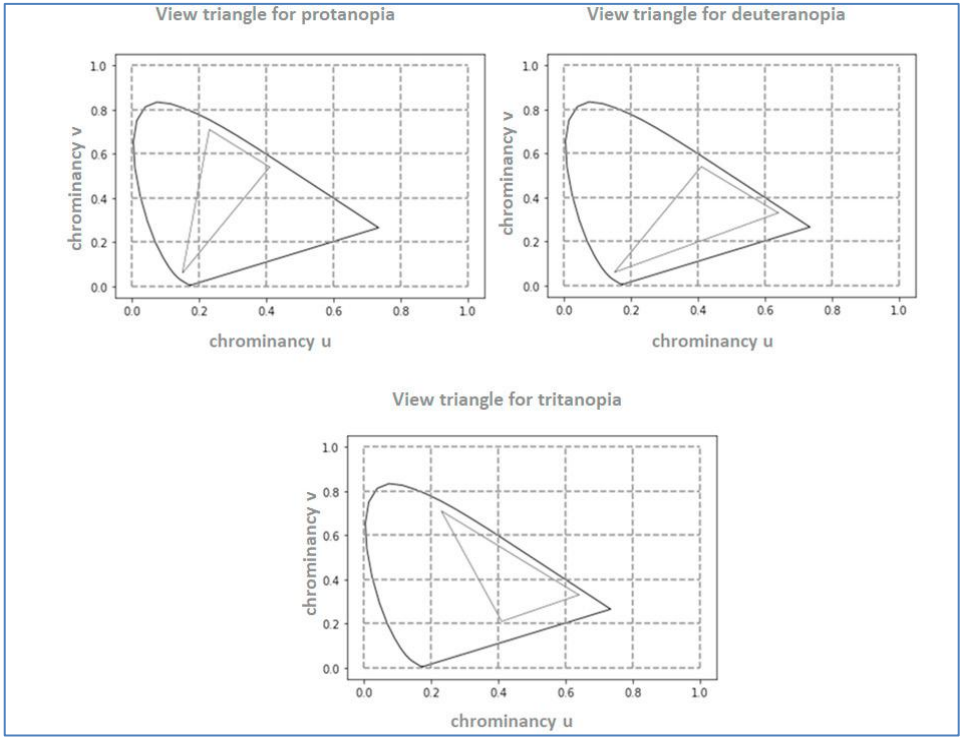
- Based on CIE 1976 chromaticity diagram (u,v coordinates).
- Maps RGB colors to CIExyz → (u,v) chromaticity space.
- Checks if the color point lies within the triangle of recognizable colors for a given CVD type.

Triangle-Based Recognition

- Predefined triangles for Protanopia, Deuteranopia, Tritanopia.
- A color is interpretable if its (u,v) coordinates fall within the respective triangle.

Example triangle for protanopia:

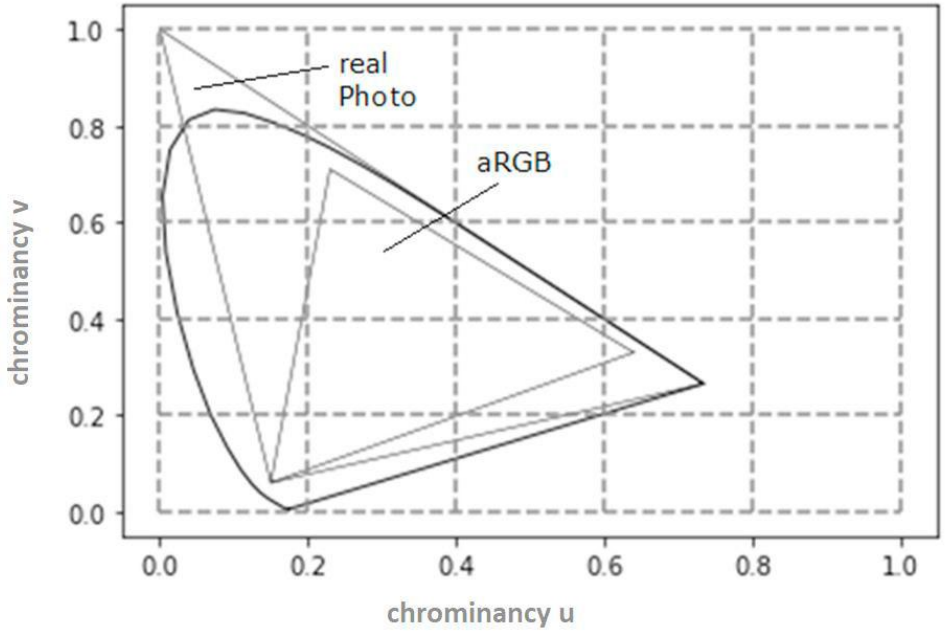
P1 (0.41, 0.54), P2 (0.23, 0.71), P3 (0.15, 0.06)



Implementation Steps

- Convert image pixel color from RGB to CIExyz.
- Calculate chromaticity coordinates (u,v).
- Use geometric check: is (u,v) inside CVD triangle?

Adaptive Content Strategy



- Colors inside the triangle are considered distinguishable. Outside colors require adaptation or replacement for accessibility

Adaptive Content Strategy

- Store user's CVD profile in app preferences.
- Dynamically adjust colors of interface and content.
- Avoid maintaining multiple versions of graphics.
- Compliant with universal design and WCAG.

Conclusion

- The algorithm allows automated validation of graphic accessibility.
- Helps ensure equitable access to public transport info.
- Promotes inclusion for people with visual impairments.

Improving Text Comprehension for Inclusive Digital Design

- Many users, including individuals with cognitive or visual impairments, struggle to understand complex or poorly formatted text in web applications.
- Lack of contrast, overly technical vocabulary, or insufficient context often reduces accessibility.
- Comprehensible information is essential for effective navigation and decision-making in transport hubs and other public services.

Conclusion: Enhancing textual clarity supports broader inclusivity and ensures all users can access vital information.

Text Readability Enhancement Algorithm Using FOG Index and NLP

- Step 1: Text Preprocessing
- Step 2: Calculate the FOG Readability Index

$$\text{FOG} = 0.4 \times \left(\frac{\text{Total Words}}{\text{Total Sentences}} + 100 \times \frac{\text{Complex Words}}{\text{Total Words}} \right)$$

A **complex word** is defined as a word with three or more syllables (excluding proper nouns, compound words, and familiar jargon).

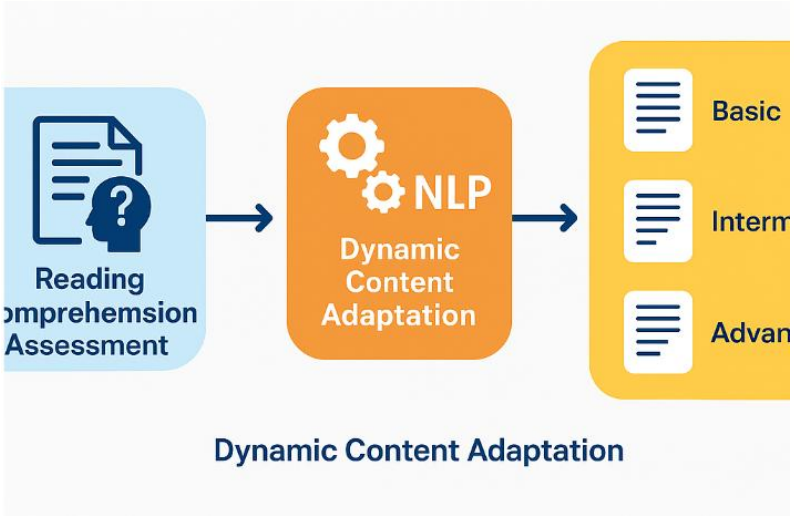
- Step 3: Linguistic Complexity Analysis (NLP)
  - Identify **long sentences** (e.g., > 20 words)
  - Detect **difficult words** using:
    - Frequency analysis (rare vs. common terms from language corpus)
    - Morphological markers (e.g., participles, passive voice)
  - Perform **syntactic parsing** to identify complex structures (e.g., nested subordinate clauses)
  - Step 2: Calculate the FOG Readability Index

How we can use Fog index

Fog Index Interpretation

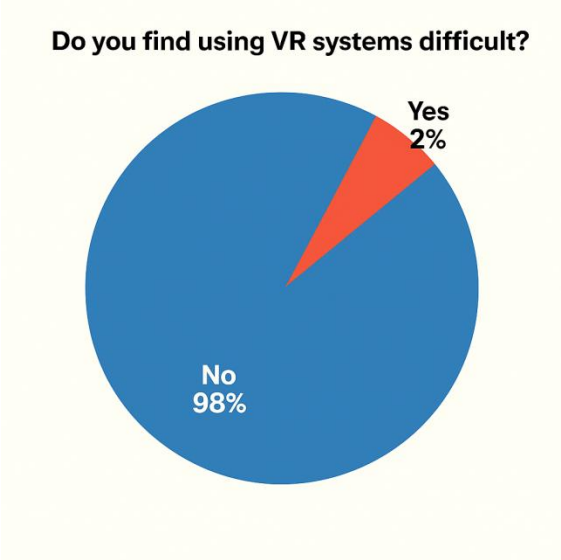
Basic	High School	College	Above College	Challenging
4–7	8–11	12–15	16–17	18*

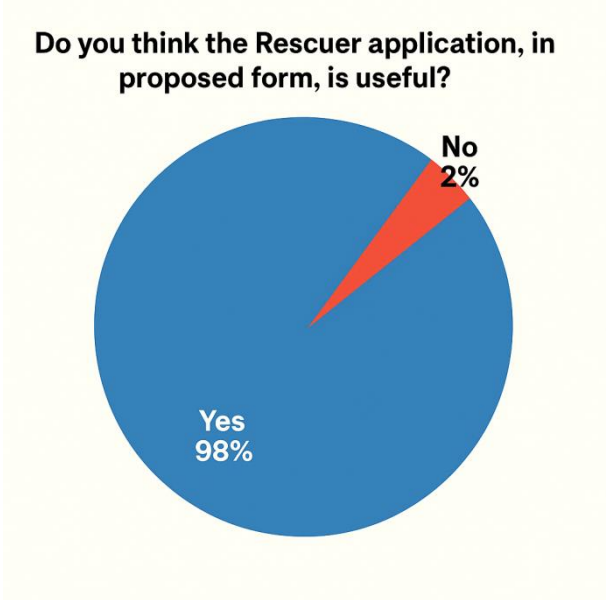
High School



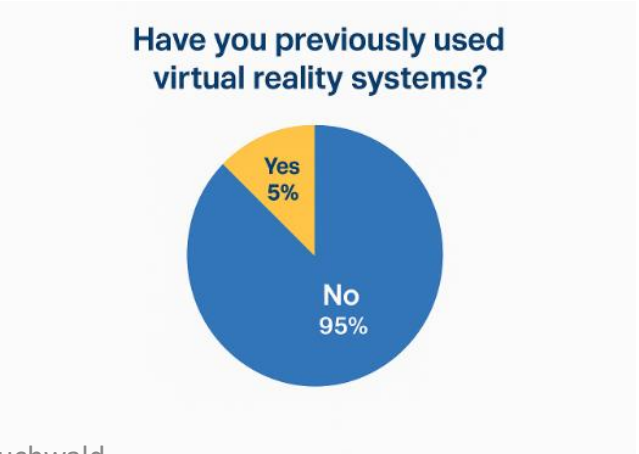
Dynamic Content Adaptation

Answers to survey questions





Respondents responded that the application is understandable and virtual reality does not make it difficult to use.



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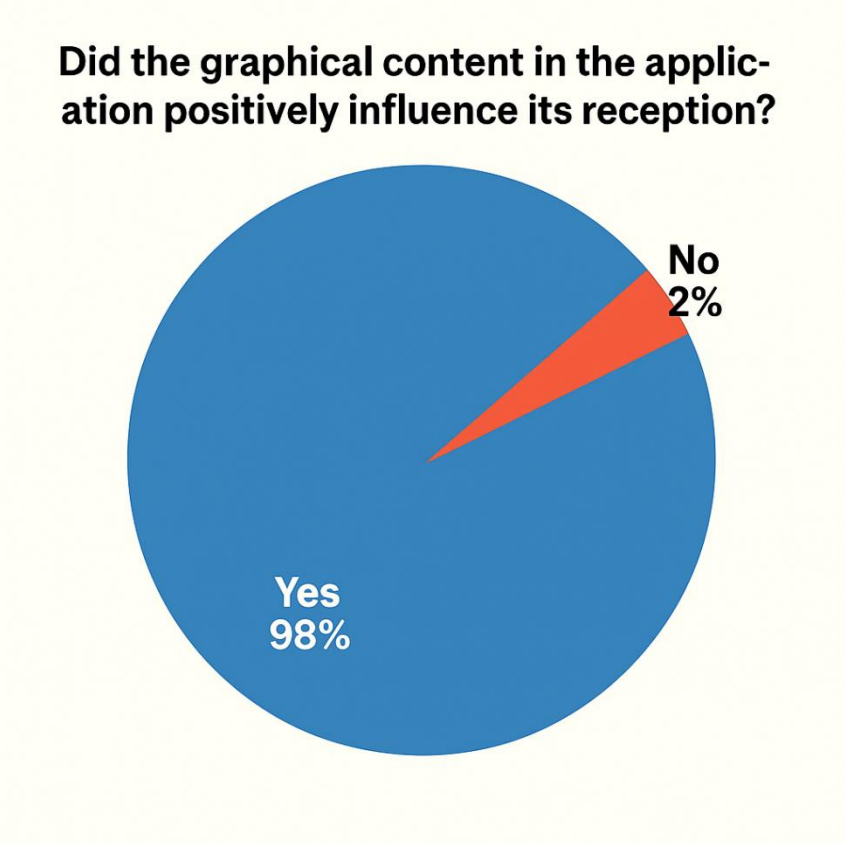
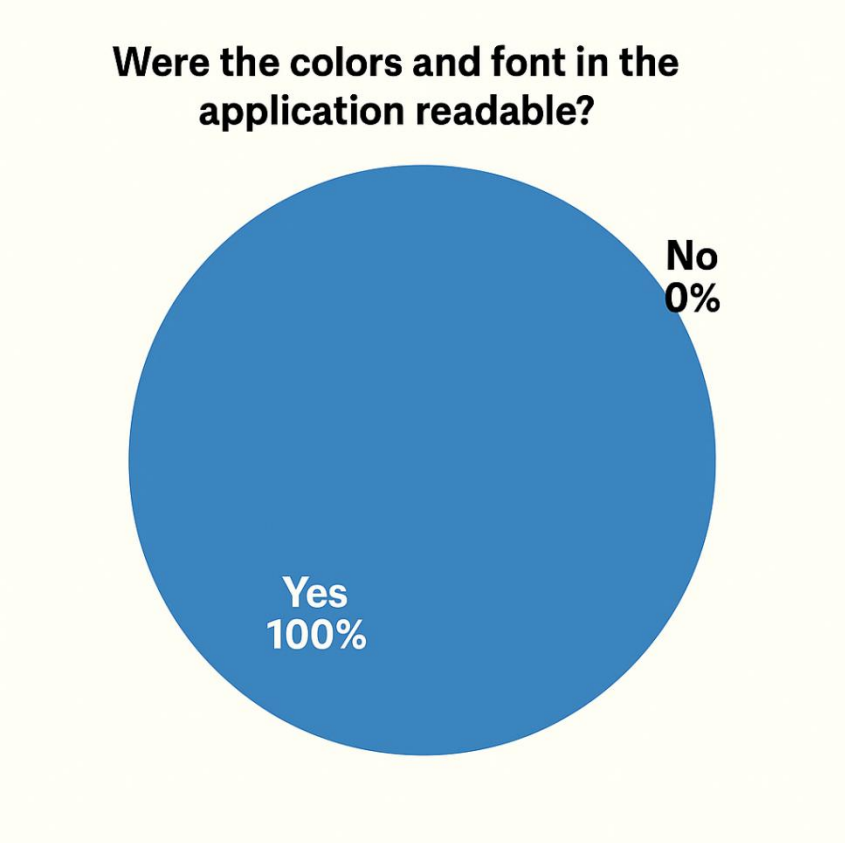
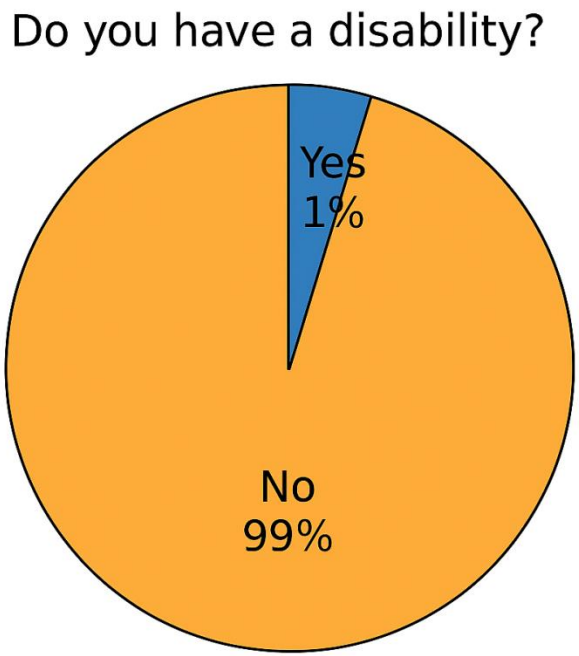
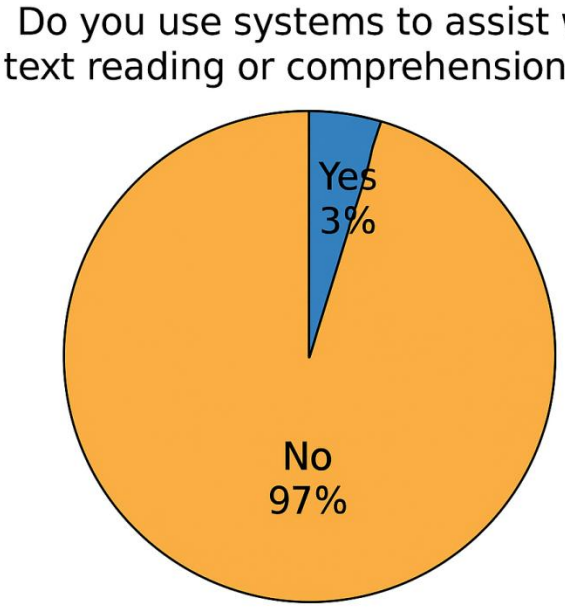




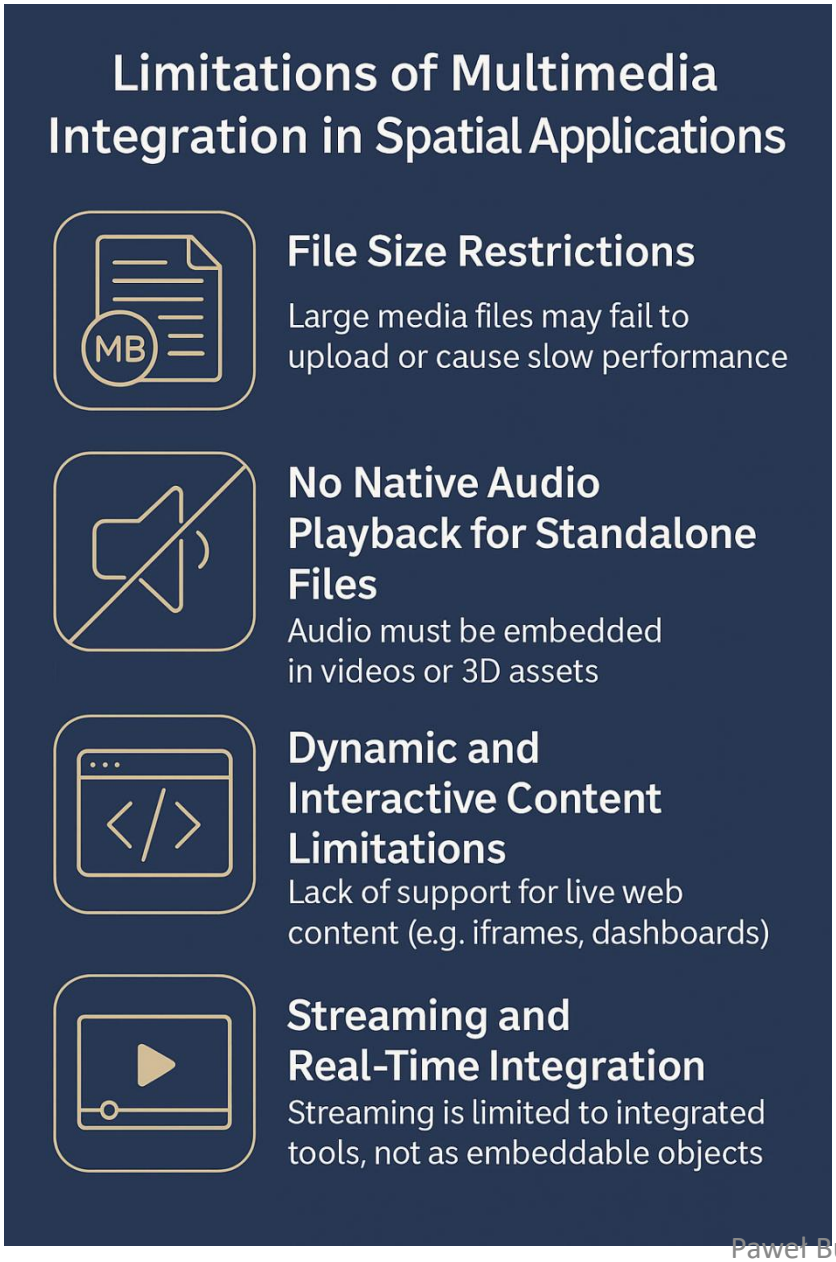
Text and colours ina VR application are correct.

Answers to survey questions



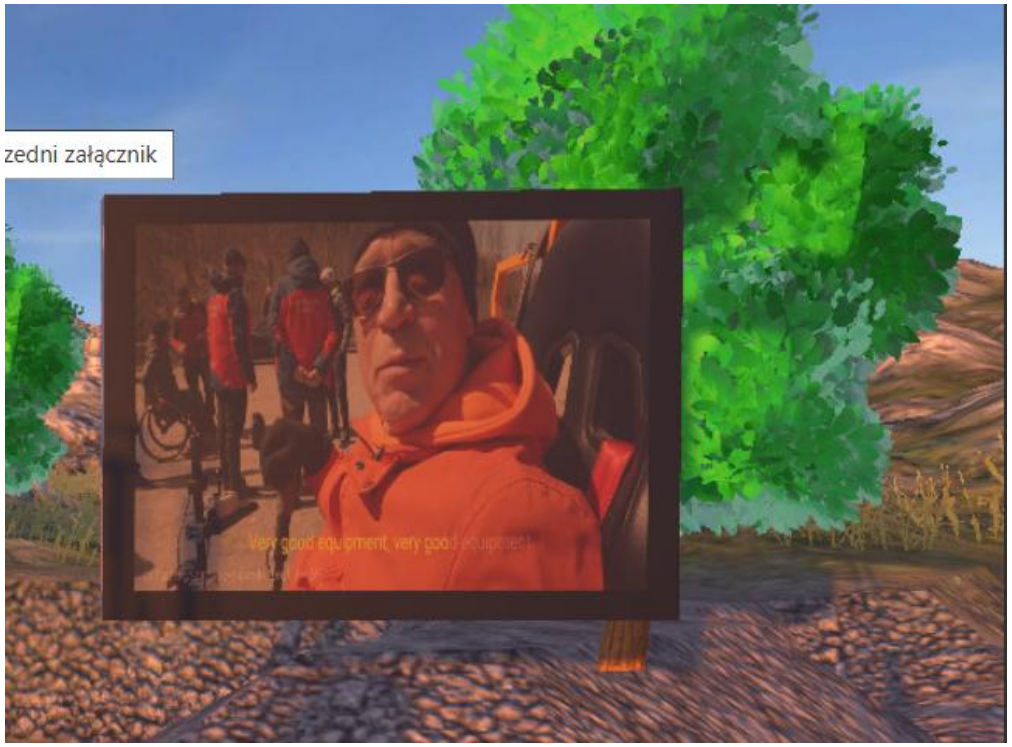


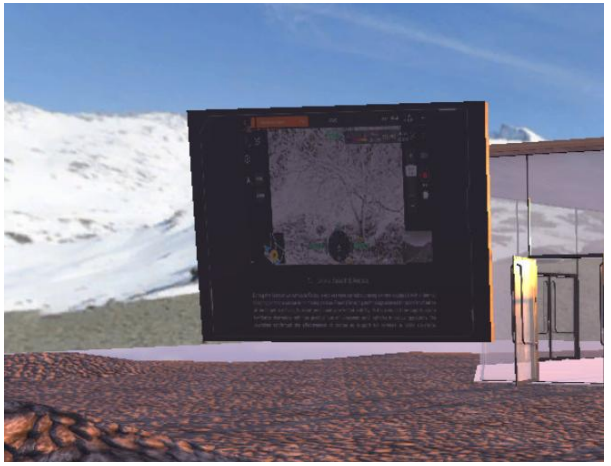
There are plans to extend the research to a larger group of people with visual and cognitive disabilities.



- **File Size Restrictions**
  There are limits on the maximum file size for uploads, especially for 3D models and video files. Large files may result in slow loading times or may fail to upload entirely. Users are encouraged to optimize assets before uploading, such as compressing textures in 3D models or reducing video resolution.
- **No Native Audio Playback for Standalone Files**
  Spatial.io does not currently support uploading standalone audio files (e.g., MP3 or WAV) directly into a scene. Audio must be embedded into a video or a 3D asset for playback.
- **Dynamic and Interactive Content Limitations**
  Interactive media such as embedded web content (e.g., iframes, websites, or live dashboards) is not natively supported. This limits the ability to integrate dynamic or real-time elements directly within the virtual space.
- **Streaming and Real-Time Integration**
  Live streaming or screen sharing from external platforms is only available through integrated services or by using screen sharing within meetings, but cannot be embedded as permanent multimedia objects in a virtual room.
- **Limited In-Scene Editing**
  Once multimedia is uploaded to Spatial.io, there is no in-platform functionality for editing content. Users must prepare and edit all multimedia files externally before uploading.

VR Application with Content

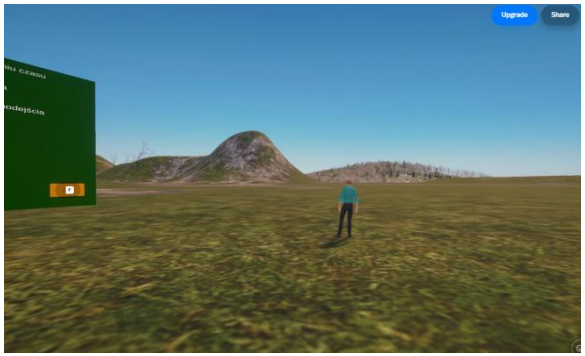


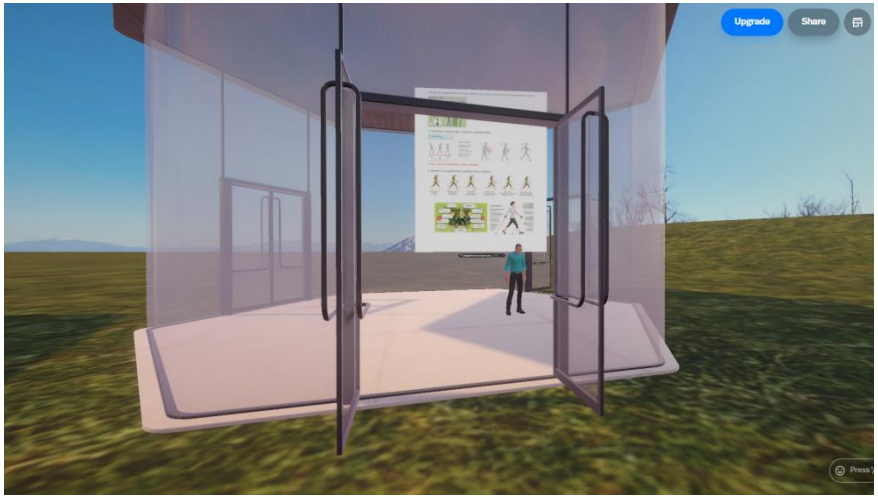


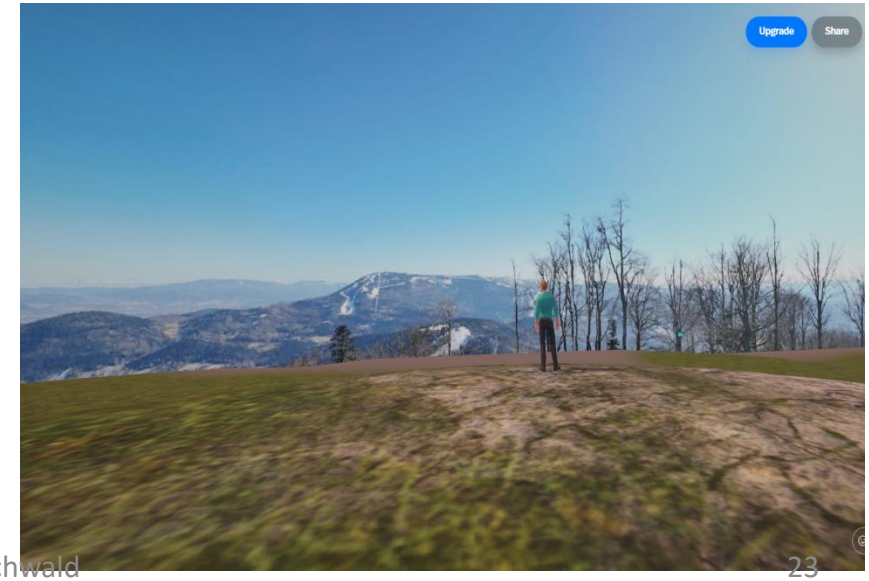
imitations of Spatial.io for Inserting Multimedia Content

While Spatial.io provides a versatile platform for immersive collaboration and content sharing, there are certain limitations regarding the insertion of multimedia elements:

VR Application with Content







Research Output of the Rescuer and VR Application

Participation in the conference

R. Szynowski, O. Nowotny – Czupryna, P. Buchwald „Senior in the mountains, how to prepare for a trip to the mountains”

Scientific articles

"*Możliwości zastosowania informatycznych systemów rzeczywistości wirtualnej przez seniorów i osoby z niepełnosprawnościami dla potrzeb poprawy bezpieczeństwa turystyki górskiej.„* – in preparation for publication.

The Use of Metaverse and Virtual Reality Technologies in Educational Initiatives Aimed at Improving Safety in Road Traffic and Tourism Contexts Safety & Fire Technology 2025 | Journal article DOI: 10.12845/sft.65.1.2025.3