

ENS 491-492 – Graduation Project

Final Report

Project Title:

Design and Development of a VR/AR Editor with Block Programming Capability

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1. EXECUTIVE SUMMARY

The project "Design and Development of a VR/AR Editor with Block Programming Capability" addresses the complex issue of creating a mobile VR application that simplifies the development of virtual environments. This application targets non-technical users, aiming to democratize the creation of immersive VR content through a user-friendly interface.

Our approach involved developing a drag-and-drop interface that allows users to place and manipulate virtual assets effortlessly. This interface is complemented by block programming features that enable real-time, code-free manipulation of objects, making the VR environment both dynamic and interactive. The application was developed using Unity and C#, focusing on a seamless and intuitive user experience. The methodology included iterative testing and feedback loops with potential end-users, which helped refine the user interface and functionality. Significant attention was given to ensuring the application runs smoothly on mobile platforms, addressing the technical challenge of maintaining performance without the need for advanced VR hardware.

Key findings from the project demonstrate that users can create and modify VR environments with minimal learning curve, suggesting that our application significantly lowers the barrier to entry for VR content creation. The project's results showed successful implementation of the core functionalities such as asset manipulation, real-time animation control, and environment saving/loading capabilities.

Conclusively, this project not only fulfills the objective of simplifying VR content creation but also extends the accessibility of immersive educational and recreational experiences to a broader audience. This development has potential implications for educational sectors, particularly in providing interactive learning environments without the necessity for extensive technical knowledge or expensive equipment.

2. PROBLEM STATEMENT

Problem Statement:

Our project is centered around the creation of a sophisticated mobile VR application, utilizing Unity and C# to deliver a seamless and immersive experience for users interested in designing and manipulating virtual environments. The primary goal of this initiative is to provide a platform that is user-friendly and facilitates creative expression without the complexities often found in VR content development. Our motivation stems from a desire to empower users to express their creativity freely and with ease. By incorporating dynamic animations, interactive elements, and a highly intuitive user interface, we aim to make the virtual reality experience more accessible and enjoyable for a broader audience.

To meet these objectives, we plan to implement several key features that will enhance user interaction and creative capabilities. A drag-and-drop interface will be a core component of our application, enabling users to manipulate assets effortlessly. This interface will allow users to easily arrange and customize their virtual spaces, making the creation process both simple and intuitive. Additionally, we intend to integrate block coding features, providing users with the ability to control assets in real-time. This will enable them to make immediate adjustments and see the effects of their changes directly in the live environment. Such a feature is especially advantageous for educational settings as it introduces users to basic programming concepts in a manner that is both engaging and interactive.

Moreover, our application will include capabilities for saving and loading environments. This functionality will support users in saving their progress and revisiting their creations at their convenience. It also allows for the sharing of environments with others, fostering a community of creators who can inspire and learn from each other. The ability to save and share environments not only enhances user engagement but also promotes collaboration and learning within the virtual space.

Ultimately, the goal of our project is to develop a platform that significantly enhances creative expression and fosters educational opportunities in VR. By removing the technical barriers typically associated with creating VR content and focusing on user-friendly design, we hope to democratize the process of VR creation, making it accessible to users with varying levels of technical expertise. This platform will not only serve as a tool for individual creativity but also as a medium for collaborative educational projects, enhancing the way users interact with and learn from virtual environments.

Motivation:

We're excited about this project because it has the potential to change how people use VR technology. By making it easier to create and shape virtual worlds, we want to make VR accessible to everyone, not just experts. This way, everyone can be creative and share their ideas without dealing with complicated tech details.

Our goal is to spark more creativity and teamwork among VR users. We're also paying close attention to practical issues like making sure the app doesn't use too much power, keeping user data safe, and reducing its impact on the environment. By making our app efficient, we help ensure it doesn't strain devices or waste energy. We're also putting strong privacy protections in place so everyone can feel safe while being creative and connecting with others.

In short, this project is about more than just new tech. It's about building a community that supports creativity, learning, and working together, all within a safe and easy-to-use platform. Through this, we aim to redefine what's possible in VR and open up exciting new ways for people to interact and make things.

Goals in Comparison with Literature:

Prior to this project, literature in VR development has focused on various aspects such as immersive experiences, user interfaces, and interactive elements. However, few studies have addressed the specific combination of features we aim to implement in our mobile VR application. While existing research provides insights into VR user experience design, animation techniques, and interactive systems, our project aims to synthesize these elements into a cohesive platform tailored for mobile VR creation.

Compared to existing literature, our goals include:

Implementing a robust drag-and-drop interface tailored for mobile VR platforms, enhancing usability and accessibility.

Integrating block coding capabilities to enable real-time manipulation of assets, providing users with advanced customization options.

Developing a seamless saving/loading system for created environments, facilitating revisitation and sharing among users.

Addressing realistic constraints such as limited resources, privacy considerations, and environmental impact, aligning with ethical and sustainable development practices.

By building upon existing research while addressing gaps in the literature, our project aims to contribute to the advancement of mobile VR application development, providing users with a powerful yet accessible platform for creative expression and interaction.

2.1. Objectives/Tasks

In the development of our mobile VR application using Unity and C#, we are focused on providing users with a seamless and intuitive experience for creating their virtual environments. Our primary feature is a robust drag-and-drop interface, which allows users to effortlessly place and manipulate assets without requiring any technical background. This interface is fundamental in making the VR creation process accessible and enjoyable for all users.

To further enhance user engagement and interaction, we have integrated block coding capabilities that allow for the manipulation of live assets, such as people and dogs. This feature enables users to control movements and actions within the virtual space, thereby enhancing creative expression and ensuring a personalized and interactive experience. Users can engage with their environment dynamically, with options to resize and rotate objects, tailoring the virtual space to fit their specific needs and preferences.

Additionally, we have developed a system that allows users to easily save and load their crafted environments. This functionality not only facilitates the revisitation of previous creations but also supports the seamless sharing of virtual worlds among users.

It's important to note that while we aimed to include specific animations such as crying, laughing, and jumping to assets, this part of the project was not completed. However, the features implemented successfully provide a dynamic and immersive dimension to user creations.

Through the combination of C# and Unity, our application delivers a powerful platform that empowers users to explore the full potential of mobile VR for creation, interaction, and collaboration. This comprehensive toolset allows users to engage in an enriching virtual crafting experience, driving forward the possibilities of VR technology.

2.2. Realistic Constraints

Adapting to limited resources for asset creation and application development requires astute utilization of existing free or cost-effective resources while streamlining development processes for manageable maintenance costs. Ensuring personal privacy and accessibility is paramount in the environments created, achieved through the implementation of robust privacy settings and the cultivation of a diverse, inclusive space for users. Guaranteeing the physical safety of users within the VR experience involves adhering to ergonomic design principles and providing comprehensive guidelines or warnings to ensure a comfortable and safe interaction. Minimizing the environmental impact throughout asset creation and application use is a key consideration, entailing the conscientious selection of resources and processes that prioritize environmental factors while advocating for efficient resource utilization.

3. METHODOLOGY

Problem to Solve The primary challenge addressed in this project is to make immersive VR experiences accessible to a broader audience, especially students, by providing a mobile-based solution that eliminates the necessity for expensive VR gear. The goal is to empower users, particularly educators and students, to create diverse virtual environments without the need for coding knowledge, promoting creativity and learning through virtual experiences.

Developing a user-friendly mobile VR application using Unity and C# is underway, aiming to empower users to create and share their unique virtual worlds effortlessly. Through an intuitive drag-and-drop interface, users will manipulate live assets using block coding, eliminating the need for any coding expertise. The inclusion of a diverse array of assets ensures the creation of varied virtual environments. This innovative approach not only caters to VR enthusiasts but also opens up virtual experiences to students who may not be able to afford VR glasses. The application's potential extends to educators, enabling them to craft educational environments related to cultural events, historical sites, holidays, and more, fostering immersive learning experiences. Advanced coding functionalities allow for intricate VR features, while hardware-related enhancements ensure optimal performance on specific mobile devices, enhancing accessibility and user experience. This project seeks to democratize virtual reality creation and education, making it a powerful tool for both enthusiasts and educators alike.

The project deals with a tough challenge in virtual reality, involving technical and educational hurdles. It's about making different things work together well on phones and making it easy for anyone to create VR stuff. We're using research and VR knowledge to make a simple way for people to build their own VR worlds. The goal is to give all students excellent VR experiences, no matter their money situation. It's not just about education – it touches on how people learn and our society, making learning cool without needing expensive VR gear. Ultimately, the project wants to make things easier for students and teachers through a phone app, offering them new educational opportunities.

4. RESULTS & DISCUSSION

In the final assessment of our mobile VR application project, we observed considerable success in achieving our initial objectives. Each of the primary features envisioned at the project's inception, including the drag-and-drop interface for asset manipulation, block coding for dynamic asset control, and the ability for users to create, save, and load multiple virtual worlds, was successfully implemented. These features were developed to enhance user engagement by simplifying the creation process and enabling a more interactive and immersive experience. On the main screen, we have a canvas. Through the buttons which are placed on the canvas, users can open different sections. The home button lets user go back to the page where he/she can choose a world to open. The button next to it manages the block-code section. The question mark button opens the guide page where the user can see the functionalities. The play button creates a demo scene so that users can understand how players will see the environment from their mobile phones (Fig 1).



Fig 1: Main screen

The block code section makes it possible to give objects dynamic movements and different actions. Users can right-click on an object and make it scriptable if he/she wants that object to be manipulated by the block code. If an object is scriptable, it becomes choosable from the block code (Fig 2).



Fig 2: Block-Code Section

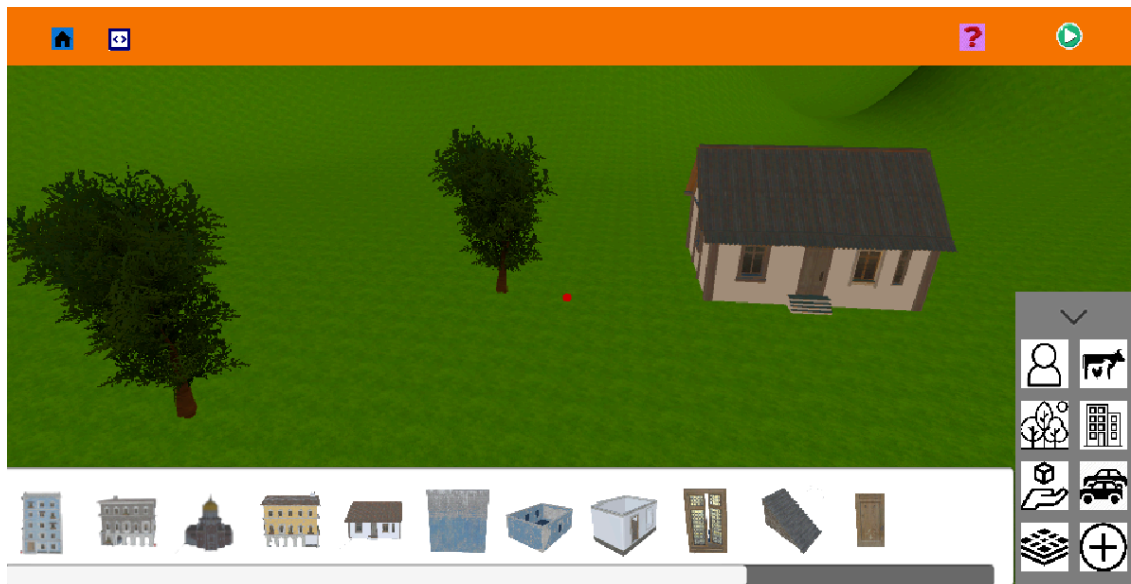


Fig 3: Asset drag-and-drop

The project also evolved beyond its original scope. A significant addition was the development of a dedicated website for user registration (Fig 5). This new component not only streamlined the user experience by providing a straightforward method for account management but also facilitated greater accessibility and a smoother transition for new users entering the platform. Also, sends confirmation mail to make sure that the user uses their own email addresses (Fig 4).

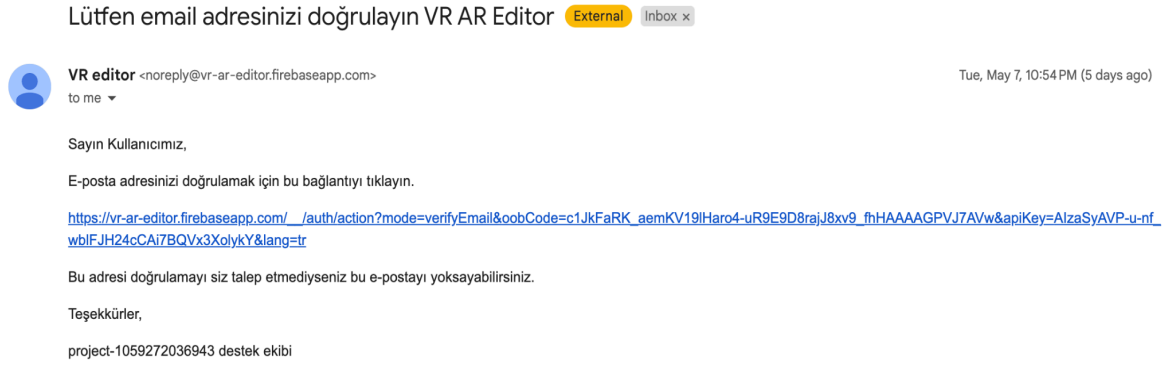


Fig 4: Confirmation Mail Example

Furthermore, through this user management system, each user can create different worlds. They can choose which world of theirs to edit and by using the unique IDs they can share their environments with other users. When a user enters a world by using a shared world ID, they cannot edit the world but only visit it.

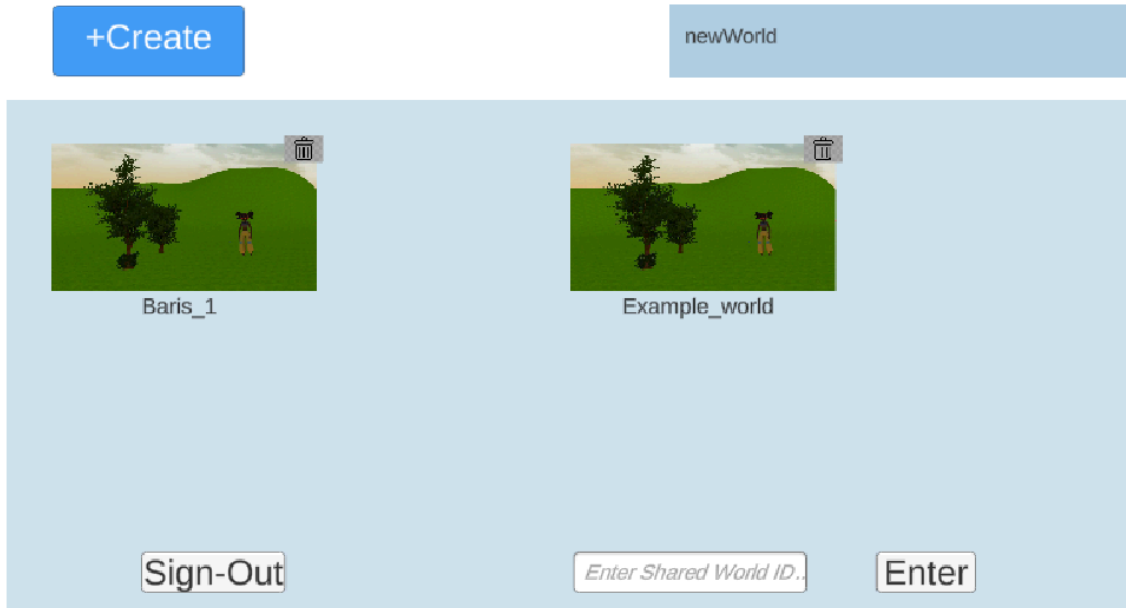


Fig 5: World selection scene

Despite these successes, one area where the project diverged from its initial objectives was in the integration of user-generated animations. This feature, intended to allow users to animate objects within their virtual environments, was not completed. The reasons for this

shortfall range from technical challenges to prioritization shifts within the project timeline, where focus was placed more on core functionalities and user interface development.

In terms of contributions to the state of the art, this project has made meaningful advances. By lowering barriers to entry for VR content creation and enhancing user interaction through simplified coding and design tools, it has extended the accessibility and utility of VR technology to a broader audience. This represents a significant step forward in making virtual reality a common platform for creative expression and collaboration.

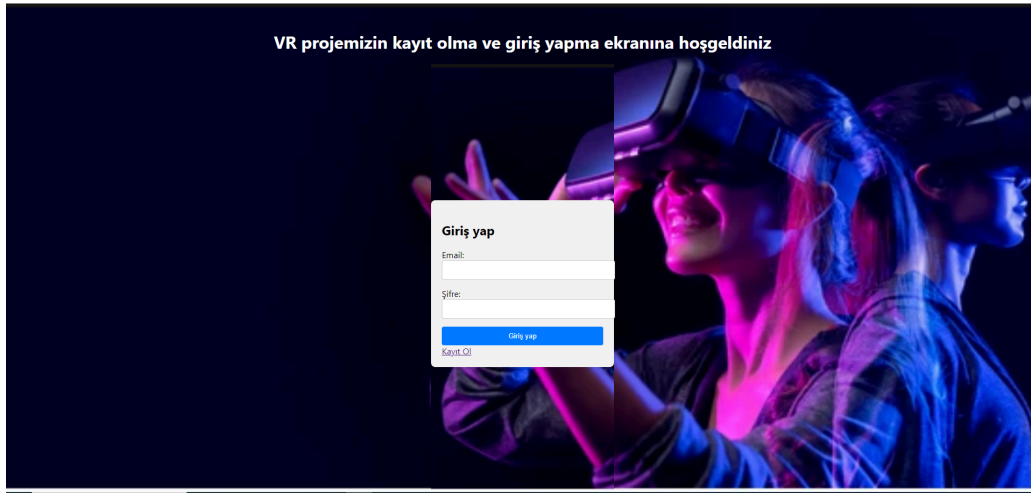


Fig 5: Website Sign Up Page

Overall, the project can be considered a success, having effectively met most of its original goals while also expanding its ambitions with the introduction of additional features. The enhancements and new capabilities introduced by this project have provided valuable improvements over previous VR technologies, contributing positively to the field's evolution.

5. IMPACT

Scientific and Technological Impacts:

Our VR project has significantly advanced both scientifically and technologically. Scientifically, the integration of block coding for asset manipulation in a VR environment introduces a novel method for teaching programming through immersive experiences. This approach can greatly improve the understanding and retention of complex programming principles by providing users with immediate visual feedback on their code's functionality. Technologically, by simplifying the

VR creation process through intuitive interfaces like drag-and-drop, our project lowers the entry barrier for non-technical users eager to explore and create in VR, thereby broadening the technology's reach and appeal.

Socio-economic Impacts:

On a socio-economic level, our project opens up new avenues for interaction and collaboration within virtual spaces, with significant implications for remote education, work, and socializing. Making VR more accessible and user-friendly creates opportunities for its application in diverse sectors. For example, students can learn in interactive 3D environments, and teams can collaborate in simulated workspaces regardless of physical distance, enhancing productivity and engagement across various fields via just their mobile phones.



Fig 6: An example person is experiencing VR technology via mobile phone and headset

Innovative and Commercial/Entrepreneurial Aspects:

Our project introduces several innovative features with substantial commercial potential. The user-friendly design encourages a wider demographic to engage with VR technology, potentially expanding the market. The ability for users to save and revisit their environments not only has creative implications but also commercial applications, such as in real estate for virtual tours and in retail for virtual showrooms. Furthermore, the addition of a dedicated website for user

registration supports scalability and facilitates easy access, boosting the project's potential for commercial success as a versatile platform.

Accessibility and Affordability:

A significant aspect of our project is its affordability and ease of access. Users can experience high-quality VR with just their mobile phones, eliminating the need for expensive hardware. This democratizes the technology, making it available to a much broader audience and potentially transforming it into a mainstream tool for personal and professional use.

Freedom-to-Use (FTU) Issues:

Regarding Freedom-to-Use (FTU), our project uses core technologies like Unity and C# that are broadly licensed for commercial use, but integrating specific third-party plugins or tools might have their own licensing needs. Compliance with all software licenses and intellectual property laws is essential to avoid legal complications and ensure the project's integrity and success.

Overall, our project not only pushes technological boundaries but also has the potential to significantly impact various industries, enhancing the accessibility and commercial viability of VR technology, provided all FTU regulations are diligently managed.

6. ETHICAL ISSUES

In the realm of educational technology, particularly in the creation of virtual environments that reflect diverse cultural backgrounds, it is essential to have a robust asset library. Such a library should include culturally relevant objects and animations to ensure each user can design environments that resonate with their lifestyle and cultural heritage. This approach promotes inclusivity and enhances educational outcomes by allowing users from various parts of the country—or even the world—to tailor their educational spaces to their unique cultural contexts.

Furthermore, the issue of data protection and user privacy cannot be overstressed. As we develop platforms that allow users to create profiles, share content, and interact with others, it becomes imperative to uphold stringent privacy standards. To safeguard users' privacy, it is crucial that no personal data, including names, email addresses, or any other sensitive information, is shared with third parties without explicit user consent. This commitment to privacy must be transparent and enforced through robust security protocols, ensuring that all user interactions within the platform are conducted in a secure environment.

Additionally, ongoing monitoring and regular updates to privacy policies and practices should be implemented to adapt to new challenges and changes in the legal landscape. User education on privacy matters and the tools available for managing their personal information are also vital to ensure they feel confident and secure using the platform.

By addressing these ethical concerns head-on, we can foster a trust-based relationship with users, which is fundamental in educational settings. This trust not only enhances user engagement but also supports the broader educational goals of the platform by creating a safe and inclusive digital learning environment.

7. PROJECT MANAGEMENT

Our project plan was meticulously designed to align closely with our predefined timing table. While we strived to adhere strictly to this schedule, it's inevitable in any complex project that challenges will arise, requiring adjustments and solutions on the fly.

One significant hurdle we encountered was the difficulty associated with transferring large quantities of assets and files between project team members. Given the extensive size and complexity of our project's asset library, these transfers were not only time-consuming but also introduced substantial delays that impacted overall project management. This experience underscored the need for a more robust digital asset management system or the use of cloud-based solutions that could facilitate faster and more efficient file sharing and collaboration among the team. Additionally, we faced several technical challenges during the project's lifecycle. These ranged from gaps in team members' skills to unexpected technical problems that required innovative solutions. Such issues are common in projects of this nature and scale, and

they were largely addressed through a combination of support from our project supervisor, who provided expert guidance, and resources found on the internet, including forums and tutorial sites.

Despite these obstacles, our team remained adaptable and responsive. We utilized available resources effectively and leveraged additional support where necessary. By doing so, we were able to manage these issues constructively and kept the project aligned with our planned schedule as outlined in the table below.

These experiences have been invaluable, teaching us not only about the technical aspects of our work but also about the importance of flexibility and proactive problem-solving in project management. Moving forward, we are better equipped to anticipate potential issues and to plan more effectively for similar challenges.

IP	The name of the jobs and aims	By whom will be Performed	Timeline	Success Criteria and Contribution to the Success of the Project
1	Planning and Analyzing	All of the team members and supervisor	15.9.2023-16.10.2023	Development of the project without infrastructure concerns as a result of a successful technical analysis.
2	Getting knowledge about scratch and how it can be combined with unity and adding scratch coding to the project	All of the team members	16.10.2023 - 01.11.2023	Implementing scratch coding to our project will enhance the usability of our project. The users without any technical knowledge will be able to use the project with code blocks.

3	Implementing Google Firebase authentication for each user	All of the team members	01.11.2023 - 20.11.2023	With this feature, users will be able to share their created worlds with other users. For instance, a teacher can share his/her world with another teacher for help.
4	Developing the project according to users' wants	All of the team members	20.11.2023 - 15.12.2023	Seeing if the scratch block programming and sharing worlds in between works correctly both on the mobile app.
5	Testing the project on users	Teachers	15.12.2023 - 01.01.2024	To test the prototype, it involves discussing with teachers working at primary and middle schools and gathering their feedback.

8. CONCLUSION AND FUTURE WORK

In conclusion, in our graduation project on the "Design and Development of a VR/AR Editor with Block Programming Capability," we have successfully met most of our initial goals. Our mobile VR application has enabled non-technical users to create, save, and modify virtual environments with ease, using a user-friendly drag-and-drop interface and block programming tools. This approach has significantly reduced the barrier to entry for creating VR content and has opened up new possibilities for creative and educational pursuits in virtual reality.

The application has been particularly impactful in educational settings, where it allows students and educators to explore and create immersive learning environments without the need for extensive technical knowledge or expensive hardware. The implementation of features like asset manipulation, real-time animation control, and environment saving/loading has enhanced the interactivity and accessibility of VR technology.

Looking forward, there are several areas where our project can expand and improve:

Integration of User-Generated Animations: As noted, the development of user-generated animations was not completed and remains a significant area for future development. Completing this feature would allow users to animate objects in their environments dynamically, adding depth to the interactive experience.

Enhanced Asset Library: Expanding the virtual asset library to include a wider range of cultural and context-specific items would make the tool more inclusive and useful for a broader range of educational contexts. This enhancement would support the creation of environments that are culturally relevant and engaging for diverse user groups.

Improved Performance Optimization: While the application performs well on current mobile platforms, continuous improvement in performance optimization can extend the app's usability to lower-end devices, thus broadening its accessibility.

Advanced Collaboration Tools: Developing features that facilitate real-time collaboration among multiple users within the same virtual environment could foster more interactive and cooperative learning experiences. This would be particularly beneficial in educational settings, promoting teamwork and collaborative learning.

Commercial Expansion: Exploring commercial opportunities for the application in sectors such as remote collaboration, virtual meetings, and specialized training programs could provide new revenue streams and application areas.

Sustainability and Accessibility Considerations: Continuing to refine the application with a focus on minimizing environmental impact and ensuring it remains accessible to users with disabilities will align the project with global sustainability and accessibility goals.

By continuing to develop these areas, the project can maintain its relevance and utility in the rapidly evolving field of VR technology, thereby supporting ongoing innovation in how we interact with and learn from virtual environments.

Another area that could significantly benefit from improvement is the design aspect of our project. Currently, our team is composed solely of developers, and while we are adept at coding and technical problem-solving, our design ideas have not been as strong or innovative as they could be. Without the input of professional designers, our project's visual appeal and user experience may not be reaching their full potential.

In the future, we could greatly enhance the aesthetic and functional elements of our project by collaborating with a dedicated design team. These experts could assist us in refining the look of the canvas and the world screen, ensuring that each interface is not only visually pleasing but also intuitive and user-friendly. Additionally, professional designers could contribute to creating a more cohesive and attractive asset canvas, which would make our project more engaging and appealing to users.

Incorporating these design improvements would not only elevate the overall appearance of our project but also lend it a more polished and professional feel. This enhanced visual quality would likely create a more positive impact on the perception and spread of our project, attracting a broader audience and fostering greater user engagement. Ultimately, by investing in professional design expertise, we can ensure that our project stands out in every respect, both functionally and aesthetically.

9. REFERENCES

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