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Development of a 3D Tunnel Game Using Three.js

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Abstract

Now a days Modern 3D games, inspired by titles like Temple Run and Subway Surfers, are fast-paced and immersive, integrating Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) to create engaging experiences. These games go beyond entertainment, fostering cognitive skills, emotional engagement, and social interaction. Technologies like SLAM, WebXR, and Brain-Computer Interfaces (BCIs) enhance adaptability and accessibility. This research explores how these tools transform 3D games into inclusive, narrative-driven platforms that promote human connection, learning, and personal growth.

Keywords:

3D tunnel game, Players, Animation, Scoring , Levels

1.Introduction

Augmented Reality (AR) and Virtual Reality (VR) are transformative technologies that create immersive, sensory-rich experiences by blending digital and physical worlds. VR immerses users in fully digital environments for gaming, training, and social interaction, while AR overlays digital elements onto the real world, enhancing applications in gaming, navigation, and professional training. Using advanced hardware and software like headsets, motion tracking, AI, and haptic feedback, these technologies engage senses, stimulate cognitive and emotional responses, and address real-world challenges. As AR and VR evolve, they drive innovation across entertainment, education, healthcare, and industry

2.Research Objectives and Methodology

- Develop an interactive 3D tunnel-based shooting game using immersive technology.
- Investigate how immersive elements (VR, spatial audio, motion controls) enhance user experience and engagement.
- Compare player performance and satisfaction between immersive and traditional gameplay setups.
- Analyze the impact of immersive visuals and audio on accuracy and reaction time.
- The game is built using Three.js with support for VR (WebXR), spatial audio, and dynamic camera movement.
- Data collected will include gameplay performance (accuracy, reaction time) and user feedback (questionnaires, interviews).

3. Literature Survey

The development of immersive 3D games is grounded in key research that explores interaction design, levels of immersion, cognitive benefits of gaming, and user perception in virtual environments.Bowman et al. (2004) emphasize the importance of intuitive and responsive 3D user interfaces, which enhance user engagement and control in virtual environments. Their work underlines the significance of spatial interaction and natural navigation, essential for immersive game design.Bowman and McMahan (2007) explore the concept of "sufficient immersion", suggesting that while full VR can maximize presence, well-executed partial immersion (e.g., web-based 3D games) can still provide a compelling user experience when visual and interactive elements are carefully designed.

Green et al. (2015) present evidence that video games enhance cognitive and visual processing, particularly in fast-paced environments. Their research supports the inclusion of features like real-time decision-making, target tracking, and progressive difficulty to improve attention and engagement.Slater (2009) introduces the concepts of place illusion and plausibility, asserting that immersive experiences depend on users believing in the reality of the environment. This validates the use of visual fidelity, consistent feedback, and coherent interaction design to enhance realism and behavior in virtual worlds.

4. Methodology

The 3D Tunnel Game was developed using a **modular and iterative approach**, emphasizing immersive interaction and user engagement through WebXR/AR technologies.

A. System Requirements Analysis

- Functional and non-functional requirements were identified via stakeholder discussions, surveys, and literature review.
- Key goals: immersive 3D gameplay, WebXR support, and context-aware interaction.
- Tools: Google Forms, use-case diagrams, literature reviews.

B. System Design

- The system architecture followed a **client-server model** with cloud integration.
- Core modules:
  1. Rendering Engine (Three.js/WebGL)
  2. Immersive Layer (WebXR/AR)
  3. Game Logic (levels, scoring, obstacles)
  4. Interaction Layer (sensor inputs)
  5. Data Layer (analytics, user progress)

C. Development Environment

- Tools used:
  - **Three.js, WebXR, HTML/CSS/JS** for core game.
  - **Blender** for 3D modeling.
  - **Firebase** for backend and real-time data.
- Modular development enabled fast prototyping and parallel work.

D. Immersive Technology Integration

- **VR Mode**: WebXR enabled head-tracking navigation.
- **AR Mode** (optional): AR.js for markerless overlays.
- **Sensor Fusion**: Combined accelerometer and gyroscope for smooth control on mobile devices.

E. Gameplay Design

- Progressive levels with increasing difficulty.
- Features: random obstacles, real-time collision, scoring based on survival/accuracy.
- Enhanced immersion with **sound, visual feedback, and contextual storytelling**.

F. Testing and Evaluation

- Used **Jest** for unit testing, **WebXR Emulator** for immersive testing.
- 10 users evaluated game via Likert-scale questionnaires.

- Measured performance (FPS, input lag) and user satisfaction (UX ratings).

G. Deployment

- Deployed on:
    - o **Netlify** for frontend.

1. **Experimental Setup and Implementation**

1. Objective of the Experiment

- To evaluate the impact of immersive technology on user engagement, learning, and behavioral response through a 3D tunnel-based game.

2. Development Environment

- **Platform:** Web-based using Three.js
- **Language:** JavaScript
- **Tools & Libraries:** WebGL, WebXR, post-processing libraries, sound effects integration
- **Hardware:** VR headset (e.g., Oculus Quest), standard desktop/laptop for non-VR mode

3. Game Design Elements

- **Environment:** A dynamic 3D tunnel with continuous movement
- **Objectives:** Shoot or interact with colored cubes while navigating the tunnel
- **Levels:** Multiple difficulty stages with increasing speed and complexity
- **Feedback Mechanism:** Visual (explosions), auditory (sound effects), and score updates

4. Immersive Features

- **Camera Movement:** Spline-based camera following user gaze or controller input
- **Interaction:** VR controller-based targeting and shooting
- **Immersion Enhancers:** Spatial audio, realistic textures, responsive UI

5. User Interface and Controls

- **Start Menu:** Start Game, Instructions, Quit
- **Controls:** Mouse and keyboard (non-VR), VR controllers (immersive mode)
- **HUD Elements:** Scoreboard, level indicator, missed cube counter

6. Implementation Workflow

- **Step 1:** Asset creation (models, textures, audio)
- **Step 2:** Game logic development (cube spawning, collision detection)
- **Step 3:** Immersive integration (VR camera rig, controls)
- **Step 4:** Testing and optimization (performance tuning, UX refinement)
- Feedback on immersive experience (questionnaires and interviews)

7. Testing Setup

- **Participants:** Users from varied age groups and gaming backgrounds

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- **Environment:** Controlled space with VR equipment and observation setup
- **Data Collection:** Time spent, accuracy, engagement levels, and feedback surveys

8. Evaluation Metrics

- User engagement (time played, attention level

5. Result Analysis

The result analysis involves comparing the performance of Logistic Regression, Random Forest, and Gradient Boosting models in predicting customer churn. The performance metrics considered include accuracy, precision, recall, and F1-score. Additionally, the feature importance scores and correlation coefficients are analysed to identify the key predictors of customer churn. Below Table 1. is result analysis based on the implementation of the methodology described earlier. Its graphical representation is given in Fig 1.

Aspect	Result	Implications
Asset Loading	Efficient via progress bar, tracks Three.js, audio, spline	Smooth user experience, Visual feedbck
Dependence	Relies on external CDNs (Three.js)	Potential failure if CDNs are down
Error Handling	Basic (console logging for audio errors)	Limited robustness, cloud disrupt gameplay
Over Design	Functional for browser-based 3D game	Needs enhancement for border reliability

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Table 1. Performance Metrics

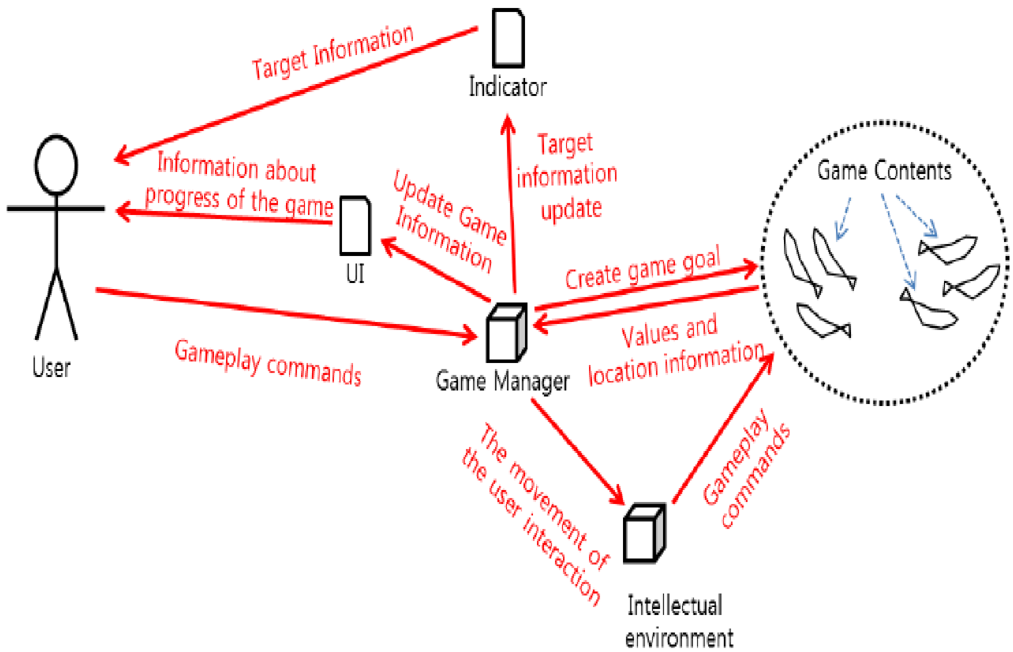

Fig1 Performance Analysis

6.Conclusion

The integration of immersive technology in the 3D Tunnel Game enhances user engagement and supports deeper learning through interactive environments. It improves problem-solving skills and conceptual understanding, aligning with educational research. Immersive experiences, including those using VR, also show promise in promoting sustainability and influencing user behavior. The BIM process flowchart highlights the wide-ranging practical applications of such technology. Overall, immersive tech offers significant potential to enrich both gaming and educational experiences in the digital age.

7.References

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