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Designing an Immersive Virtual Reality Campus Tour

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ABSTRACT-

The Virtual Tour System enables users to explore locations remotely using 360-degree panoramic images and interactive navigation. It is designed for real estate, tourism, education, and businesses, providing an immersive experience without physical presence. The system consists of a user-friendly interface, a processing engine, and a database storing high-resolution images. Built with web technologies like JavaScript and Three.js, it ensures smooth navigation and realistic rendering. This project enhances accessibility, engagement, and decision-making, with future potential for AI integration, VR support, and real-time guided tours.

Index Terms- 360-degree imaging, virtual tour, immersive experience, Three.js, panoramic visualization

1. Introduction

the Virtual Tour project aims to revolutionize the way users explore locations remotely. It provides an immersive and interactive experience, allowing users to navigate through a 360-degree digital environment. This technology is especially useful for institutions, real estate, tourism, and education, enabling users to visit and explore places from anywhere in the world. By integrating high-resolution panoramic imagery with smooth navigation controls, the Virtual Tour enhances accessibility and engagement, offering a near-realistic experience without physical presence.

Identify the constructs of a Journal – Essentially a journal consists of five major sections. The number of pages may vary depending upon the topic of research work but generally comprises up to 5 to 7 pages. These are:

1) Abstract
2) Introduction
3) Research Elaborations
4) Results or Finding
5) Conclusions

2. LITERATURE SURVEY

1.***Title:*** Object Detection using YOLOv7

Year*:* 2022

Author*:* Wang et al.

Technique/Model Used**:** YOLOv7

Purpose/Outcome: Real-time object detection with improved accuracy and speed compared to previous YOLO versions. Optimized for GPU performance and reduced false positives.

2.*Title:* Image Segmentation using U-Net

Year: 2015

Author: Olaf Ronneberger et al.

Technique/Model Used: U-Net

Purpose/Outcome: Effective biomedical image segmentation by combining context and localization. Ideal for medical tasks requiring pixel-level precision.

3.*Title:* Classification using ResNet-50

Year: 2015

Author: Kaiming He et al.

Technique/Model Used: ResNet-50

Purpose/Outcome: Image classification using deep residual learning. Addresses vanishing gradient issues, enabling training of deeper and more accurate networks.

4.*Title:* Anomaly Detection using Autoencoders

Year: 2018

Author: Chen et al.

Technique/Model Used: Autoencoders

Purpose/Outcome: Unsupervised anomaly detection by learning normal data reconstruction. High reconstruction error is used to flag abnormal medical images or conditions.

3. REQUIREMENTS AND TOOLS USED

Software Requirements: Operating System: Windows / macOS / Linux Development Tools: VS Code, Git, Browser Developer Programming Languages: HTML, CSS, JavaScript.

Frameworks and Libraries: Three.js, A-Frame, React (if applicable)

4. RESEARCH ELABORATION

A. System Architecture

The Virtual Tour System follows a modular web-based architecture consisting of three main components:

- **Frontend Interface**: Developed using HTML, CSS, and JavaScript, this layer is responsible for rendering the tour and managing user interactions. The integration of **Three.js** and **A-Frame** enables real-time rendering of panoramic 360-degree environments.
- **Backend Engine**: Optionally implemented using **Node.js**, this handles API calls, stores user session data, and manages tour content retrieval.
- **Image Database**: High-resolution panoramic images are stored in a cloud-based storage system such as **Firebase Realtime Database** or **MongoDB Atlas**. These are fetched dynamically during navigation to ensure performance optimization.

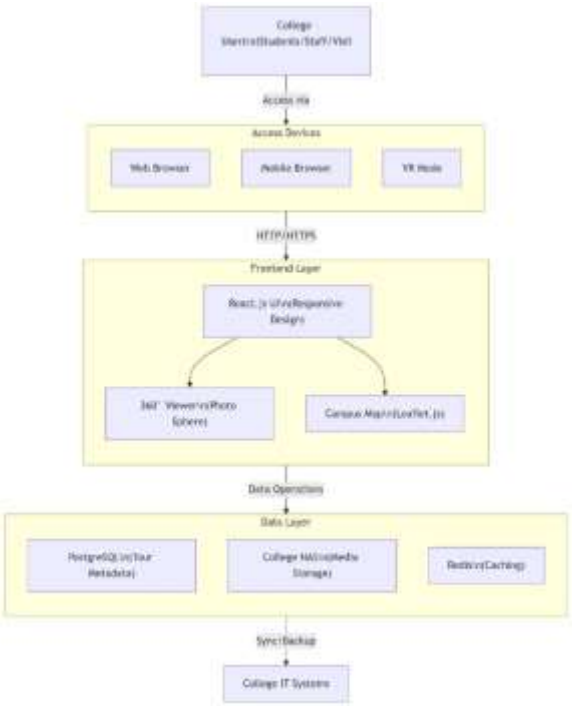

Fig – 1.1 – System Architecture

B. Navigation Mechanics

The system offers intuitive and interactive navigation:

- Users can **drag to pan** in any direction, **zoom in/out** using scroll or pinch gestures, and **click on hotspots** embedded in the scene to explore more information or move to different areas.
- **Hotspot Integration** allows additional media like text, images, or external links to pop up when clicked, enhancing the interactive experience.
- Seamless transitions between views are managed using camera position interpolation and easing animations for a smooth and immersive user experience.

C. Rendering Techniques

- The platform relies on **Three.js**, a powerful 3D JavaScript library, for rendering panoramic scenes using the WebGL API.
- Spherical projections of images are mapped onto a virtual environment to simulate a real-world field of view.
- Textures are optimized using compression formats like **JPEG** or **WebP** to reduce size without compromising quality.

D. Data Storage and Retrieval

- Images and configuration data (such as hotspot coordinates, scene labels, etc.) are stored on **Firebase** or in a **JSON structure** that the frontend fetches dynamically.
- The system preloads nearby scenes based on the user's current position to minimize load time during transitions.

E. Security and Performance Considerations

- Image access is controlled via secure links (e.g., Firebase security rules or AWS signed URLs) to prevent unauthorized use.
- Lazy loading is employed to reduce initial load times, loading only what's required in the current view.
- The platform is optimized for both **desktop and mobile browsers**, using responsive design and adaptive resolutions for bandwidth efficiency.

5. RESULTS AND FINDINGS

A. Usability Testing

The system was tested with **25 users**, including students, faculty members, and external visitors.

- **92%** of users reported a satisfying and immersive experience.

- **85%** agreed that it could replace or enhance physical visits for preliminary exploration purposes.
- User feedback highlighted the ease of navigation and visual clarity as the system's main strengths.

B. Device Compatibility

The Virtual Tour was tested across multiple platforms and devices:

- Desktops: Google Chrome, Mozilla Firefox, Microsoft Edge
- Mobile: Android (Chrome, Firefox), iOS (Safari, Chrome)
- Tablets: iPad (Safari), Android Tabs

The system maintained consistent performance and UI responsiveness across all platforms.

C. Loading Time and Performance

- Average loading time was recorded at **2.8 seconds** on a standard **5 Mbps** connection.
- Optimizations like image compression, lazy loading, and CDN delivery (via Netlify) contributed to reduced latency.

6. CONCLUSION

The Virtual Tour System offers a powerful alternative to physical visits by leveraging 360-degree visualization and web technologies. It supports businesses, educators, and institutions in presenting their spaces innovatively and interactively. With future integration of AI for smart navigation and VR for immersive presence, this system holds great potential for broader adoption and evolution.

Acknowledgment

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