Terraverse: A Unity-Based VR Simulation for Environmental Education and Digital Ecotourism

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Abstract: As immersive technology continues to evolve, its impact on fields like tourism, education, and environmental awareness has become increasingly significant. Terraverse is a Unity-powered simulation project designed to replicate the experience of exploring a national park—virtually. By combining realistic terrain modeling, interactive 3D animal animations, and educational AR pop-ups, the project offers an innovative approach to digital nature exploration. Its goal is not only to entertain but also to educate users about biodiversity and environmental conservation through a highly immersive platform.

Virtual tourism has been recognized as a sustainable and inclusive alternative to traditional travel, particularly when physical access is limited [1][9]. Building upon this, Terraverse uses geospatial data to construct accurate landscapes, making the virtual experience grounded in real-world topography [3] [10]. Users can navigate these digital parks using first-person controls or experience them through immersive VR and AR perspectives. As studies have shown, VR enhances emotional and sensory engagement in tourism [2], while AR significantly improves interactive learning and retention [7] [8]. It showcases how emerging digital tools can preserve heritage, promote conservation, and deliver accessible educational experiences—especially for those disconnected from the natural world [12][13].

Keywords- **Tourism, Augmented Reality, Digital Heritage, Virtual Reality, 3D Simulation, Unity Game Engine, Environmental Education, 3D Simulation**

I. INTRODUCTION

The speed at which AR/VR is evolving and developing is changing how we interact with and experience digital environments. [1] [2] [9]. Terraverse is an innovative simulation built using the Unity game engine, designed to recreate the experience of exploring a national park in a digital format. The project combines high-fidelity terrain, animated wildlife, and AR pop-ups to provide a naturalistic and engaging virtual environment. The simulation is built on Unity, a versatile real-time 3D platform well-suited for creating lifelike virtual environments [4] [5]. Geospatial data is used to generate accurate terrain models [10], while the behaviors of virtual animals are scripted to mimic real interactions. The experience is enriched through mixed-reality principles that combine AR overlays and VR immersion for a more emotionally resonant user experience [6] [11]. Ultimately, Terraverse aims to do more than entertain. It seeks to educate, inspire, and foster a deeper appreciation for the natural world by leveraging immersive media technologies in a meaningful and accessible way [12] [13].

II. LITERATURE REVIEW

(i) Literature Review

1. John Smith – "Augmented Reality in Nature Exploration" (2019)

The application of augmented reality (AR) to improve outdoor nature experiences is examined and studied in John Smith's paper. By overlaying digital content onto real-world environments, AR turns nature walks into interactive learning journeys. Features such as species identification, environmental facts, and guided exploration help engage users more deeply. The paper highlights mobile and wearable devices as key tools for AR delivery. It concludes that AR encourages curiosity, improves educational engagement, and enhances user interaction with nature, making it especially beneficial for young learners. This research supports the integration of interactive features in simulations like Terraverse for educational impact.

2. Maria Rodriguez – "Virtual Reality for Environmental Education" (2020)

Maria Rodriguez's study highlights how virtual reality (VR) can revolutionize environmental education by offering immersive, virtual ecosystems for exploration. VR allows learners to interact with complex environments like rainforests or coral reefs, promoting understanding and empathy toward conservation. The paper emphasizes that immersive experiences improve content retention and engagement compared to traditional methods. It also showcases VR's ability to overcome geographical limitations by bringing distant or endangered environments directly to users. This aligns with Terraverse's goal of combining virtual exploration with learning, providing a meaningful and accessible way to experience and understand natural ecosystems.

(ii) Existing System:[1]

1. T. Jung et al. – "Tourists Experience of Virtual Reality Applications" (2017)

This study investigates how virtual Reality (VR) enhances tourism experiences. T. Jung and team found that VR allows users to explore destinations virtually, increasing interest and emotional connection to places they may later visit physically. Immersive environments were shown to improve user engagement and satisfaction. When physical access is restricted, the study indicates that virtual reality (VR) can be an effective tool for promoting cultural and natural attractions. These insights support Terraverse's concept of offering a virtual national park experience that is both educational and engaging, enabling users to connect with nature through interactive and immersive technology.

2. James Lee – "Geospatial Data in Virtual Simulations" (2021)

James Lee's research focuses on using geospatial data to bring realism to virtual simulations. By integrating GIS and real-world mapping data, simulations can reflect accurate terrains, landscapes, and environmental patterns. The paper discusses how this data-driven approach enhances user immersion and supports educational goals by making virtual environments scientifically grounded. Applications include terrain modeling, ecological simulations, and visualizing environmental changes. This research is highly relevant to Terraverse, which aims to create a natural, believable environment. Lee's findings support the use of GIS tools in building dynamic, realistic simulations that educate users about actual geographic and ecological systems.

Literature Survey Table

Sr. No	Author(s)	Title of the Paper	Year	Key Points Taken
1	Siddiqui, M. S., Syed, T. A., Nadeem, A., Nawaz, W., Alkhodre, A.	Virtual tourism and digital heritage – An Analysis of VR/AR Technologies and Applications	2020	VR/AR help preserve cultural and natural heritage digitally; supports education and conservation.
2	M. C. T. Dieck,T. Jung, N. Moorhouse, and D. T. Dieck,T. Jung.	Tourists experience of virtual reality applications.	2017	VR enhances emotional engagement, user satisfaction, and interactivity in tourism.
3	D Guttentag.	Virtual reality – applications and implications for tourism.	2010	VR enables immersive, cost-effective, and accessible tourism experiences.
4	A. Juliani et al	Unity – a general platform for intelligent agents.	2018	Unity supports real-time, intelligent simulations; flexible for education and interactive media.
5	J. K. , Haas,	A history of the unity game engine.	2014	Unity evolved into a powerful platform for serious games and educational simulations.

III . PROPOSED SYSTEM

- **User Interface**

  The user interface is the first thing the user interacts with when launching Terraverse. It's designed to be clean, intuitive, and welcoming, making it easy for users to navigate through options.

- **Select Park**

  Once inside the simulation, the user is prompted to select a national park or a specific environment. This selection determines the layout, terrain type, animal species, and other unique features to be loaded. This step personalizes the experience, allowing the user to explore different ecosystems based on their preference or curiosity, setting the stage for the immersive journey ahead.

- **AR View**

  The AR (Augmented Reality) view brings nature to life by blending virtual elements into the real world. By using a mobile or tablet camera, users can see 3D models of animals or natural

elements appear in their actual surroundings. This mode is especially engaging for educational purposes, making learning fun and interactive by turning any environment into a digital nature park.

- **VR View**

  The VR (Virtual Reality) view takes immersion to another level. Users step into a fully virtual recreation of the selected park, complete with sounds, visuals, and interactive elements. Using a VR headset or a first-person mode, they can explore trails, observe animals, and feel as though they are physically inside the park. It's designed for users seeking a deeper, more lifelike experience of nature.

- **Generate View from Geospatial Data**

  This block ensures that the simulation is not just imaginative, but also rooted in real-world data. Geospatial information, such as terrain elevation and park layouts, is used to generate the landscape users see in both AR and VR. This adds a layer of realism and authenticity, making each park feel true to life and geographically accurate.
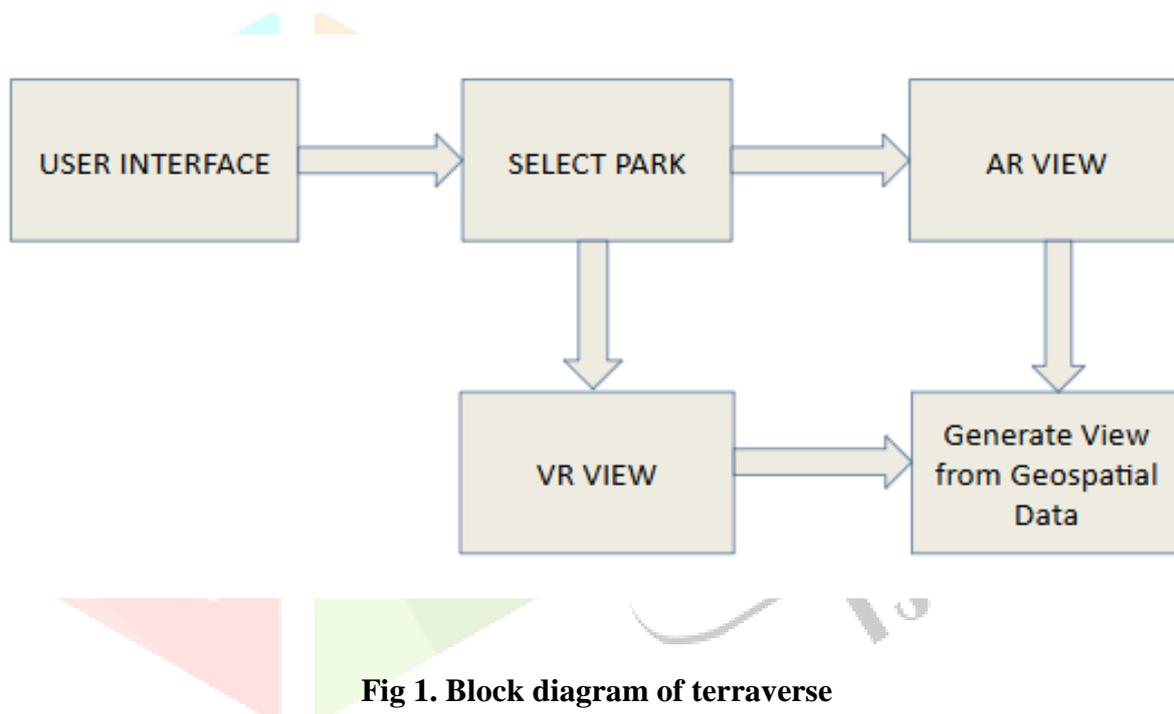

Fig 1. Block diagram of terraverse

IV . METHODOLOGIES

The development of Terraverse was guided by a hands-on, flexible approach. Each major part of the simulation was built using a specific component within Unity, allowing us to gradually shape the project into a rich and interactive experience. Here's how each part of the system contributed to the final result:

Unity Game Engine:
Everything in Terraverse was built on the Unity game engine. Unity gave us a powerful environment to design 3D spaces, animate objects, and script interactions. Its ease of use and real-time testing made it the ideal foundation for a simulation focused on both visuals and performance [4] [5].

Terrain Editor:

We started with building the land. Using Unity's Terrain Editor, we shaped hills, carved rivers, and placed trees and textures to create a lifelike national park setting. This part was crucial for setting the tone and feel of the environment [3] [10].

3D Animal Models:

To make the park feel alive, we added 3D animal models. These were animated using Unity's Animator system, and programmed to move naturally—like walking, pausing, or reacting to users. This added movement and realism to the virtual world [5] [13].

C# Scripting:

All the interactivity—from how animals behave to how users move—is powered by simple yet effective C# scripts. These scripts allowed us to build logic into the world, making it responsive and interactive [4].

First Person Controller:

Exploration is a big part of the experience. Unity's built-in First Person Controller gave users the ability to walk through the simulation just like a video game, offering a familiar and immersive way to explore the park [2] [11].

Canvas and UI System:

To make the experience educational, we used Unity's Canvas system to display pop-ups when users approach animals or specific locations. These informative overlays offer facts and context, turning the simulation into a learning tool as well [7] [8].
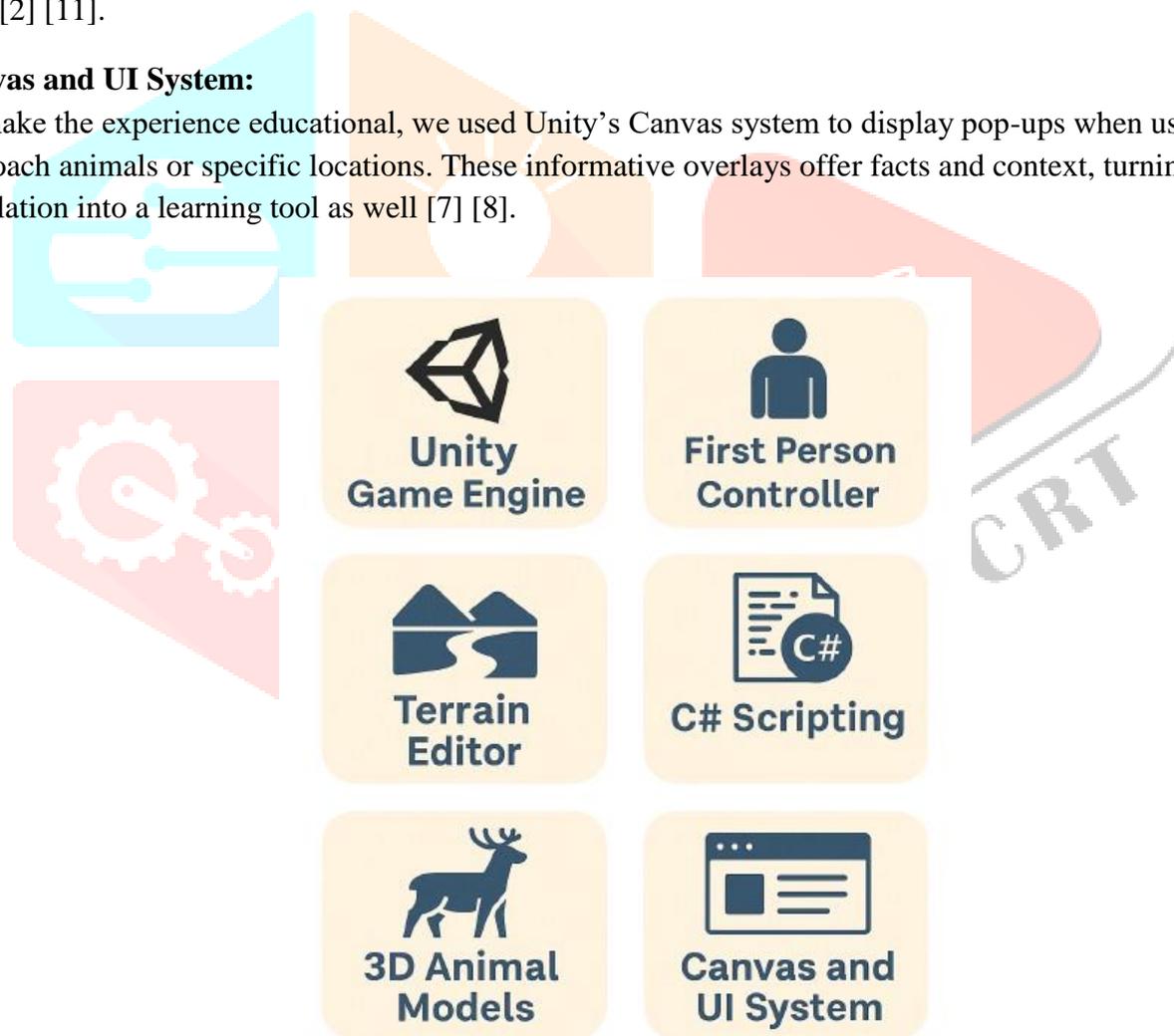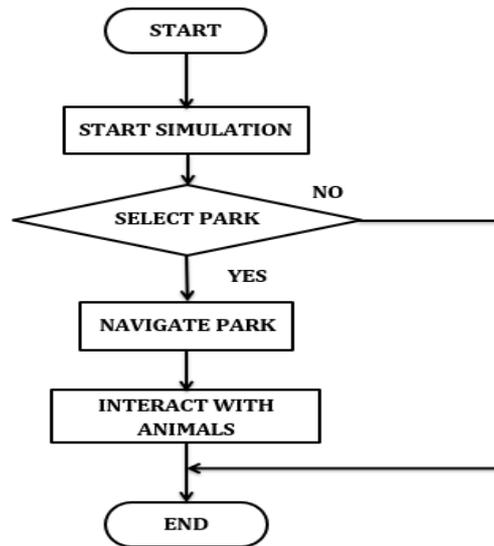

Fig 2. Components of the project

V. ACTIVITY DIAGRAM

Fig 3. Terraverse Activity diagram

VI . IMPLEMENTATION

Admin Panel View

After successful login, administrators gain access to the Terraverse backend dashboard. From here, they can manage virtual park environments, upload and update 3D animal models, monitor user activity, publish educational AR content (if included), and manage terrain elements. They also have the ability to approve or reject new content submissions and updates.

Add Virtual Park

Admins can create and add a new virtual park by specifying its name, description, terrain type, and geolocation data. Along with this, 3D assets such as trees, landscapes, and animal models are linked to enhance realism.

Update Park Data

Existing parks can be updated with new 3D assets, altered terrains, or additional interactive features. This ensures that the experience remains engaging and informative with real-time content modifications.

Send Notifications

Administrators can broadcast pop-up messages, updates, or educational alerts within the simulation. These notifications can guide users, provide ecological facts, or highlight recent changes in the environment.
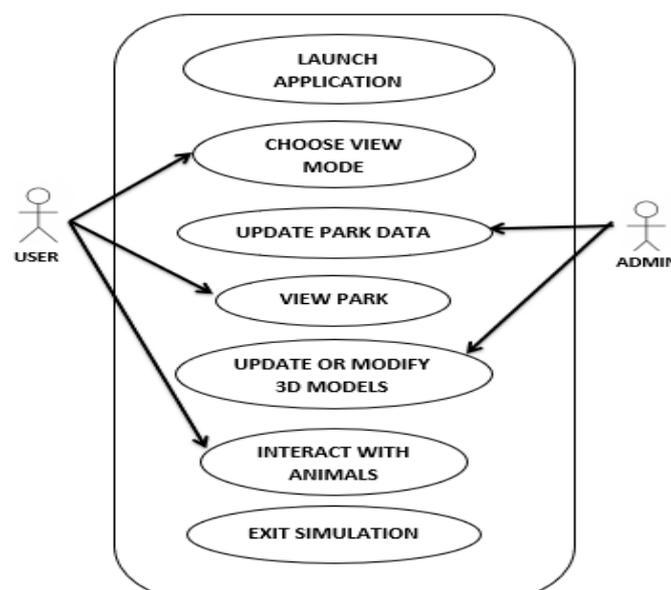
VII . USE CASE DIAGRAM

Fig 4. Terraverse Use case diagram

VIII . SYSTEM OVERVIEW

This project is a virtual park experience that lets people explore nature without actually being there. It starts off simple—you open the app, pick a park you're curious about, and choose how you want to see it. Once that's done, the system brings the park to life with realistic landscapes and lets you look around, take in the views, and even interact with animals. Everything's built to feel easy and smooth, so you can just enjoy the experience without thinking too much about the tech behind it. Whether you're using it to learn something new, preview a trip, or just relax, it's a fun way to connect with nature through your screen.
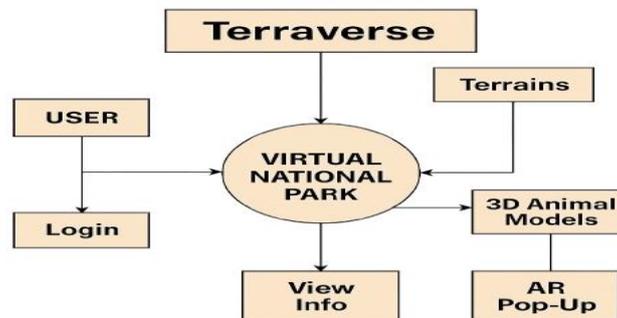

Fig 5. System overview

IX . CONCLUSION

VR/AR are immersive and interesting technologies that can be more than just visually appealing; Terraverse shows how they can be useful teaching tools. Built using Unity, the simulation creates a digital national park that's both visually compelling and intellectually enriching. Through carefully crafted terrain, lifelike animal interactions, and informative AR pop-ups, users are guided through an experience that mirrors real-world exploration while remaining digitally accessible. The project offers a timely solution to challenges in tourism and environmental education. As virtual tourism grows as a sustainable and inclusive alternative to physical travel [1] [3] [9], Terraverse positions itself as a forward-thinking platform that aligns with these values. By grounding its design in geospatial realism [10] and embedding conservation-focused storytelling, it helps raise awareness in a way that feels personal and impactful.Rooted in research on immersive learning [2] [6] [11] and digital education [7] [13], the simulation emphasizes interactivity and emotional engagement. Rather than simply viewing content, users actively participate in their learning experience—an approach proven to enhance retention and empathy. In blending exploration with purpose, Terraverse stands as a compelling example of how technology can inspire environmental consciousness while pushing the boundaries of digital education.

X .REFERENCE

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