Analysis of Immersive Virtual Reality Tourism Resources Based on Navier-Stokes Equations

Liyan Shen
Hangzhou Vocational and Technical College, Hangzhou, Zhejiang, 310018, China
E-mail: 1999010007@hzvtc.edu.cn

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The development of virtual resources and scenic spots, attractions, and transportation as well as information, rather than just staying in the physical space. There are many virtual reality tourism resources in real life. These are natural resources with special characteristics. Natural geographies, such as geological landscapes, and visual elements such as colorful and varied textures and colors can be attractive and are an essential element in the construction of virtual landscapes, attractions, and transport routes. Virtual reality is an emerging field of computer-based, multimedia-based simulation and modeling of physical phenomena in natural and social life, which has a wider range of applications in immersive virtual reality tourism. This paper introduces a 3D physical virtual reality tourism resource analysis system designed based on the Navier-Statics equation software development environment and hardware support.

Povzetek: *Analiza turističnih virov z uporabo navidezne resničnosti in enačb Navier-Stokes omogoča realistično simulacijo naravnih znamenitosti in poti.*

1 Introduction

Online travel is becoming increasingly popular among travelers as a new kind of leisure as the tourism industry grows and individuals focus more on the trip itself. In the process of travel, a very important part is the experience. Virtual Reality is a virtualized, dynamic, and interactive tool for processing online tourism data and information. It simulates complex relationships and behavioral patterns between humans and nature in real time through computers, multimedia, and other means [1-3]. In this paper, we will introduce 3D modeling based on Navier-Stokes equations and virtual reality software, texture mapping method and dynamic interactive virtual scene design, and other related technologies to show the effect of the landscape; and through the construction of the relationship between recreationists and attractions to simulate the real environment in the process of recreation experience to feel the emotional changes [4-5].

Fluid simulation theory refers to the simulation of virtual reality, the flow field, pressure, and other physical quantities in the real environment for analysis, and combined with relevant theories and experimental methods to reach conclusions [6]. The principle is a new theoretical system, it is based on a computer-based platform to establish a new system model based on the combination of digital signal processing technology and intelligent control; it is practical, that the use of virtual reality in the study of human brain nerve cells can greatly improve people's cognitive ability and perception speed so that it can be more easily applied to real life [7], it can effectively improve the tourists in the process of travel It can effectively enhance the emotional feelings and perceptions of tourists during their travels, bringing a huge impact on the tourism industry. Collision detection is an integral part of the construction of 3D scenes, and the real-time, accurate detection of collisions between objects can enhance the immersion and realism of virtual scenes. Collision detection ensures [8,9].

It ensures that we can move freely around the scene without 'walking into the ground' or 'walking through walls'. There are two ways of implementing collision detection, using colliders and triggers, which are used in different situations. Colliders are components, including box colliders, ball colliders, mesh colliders, etc., which are added to the Game Object to detect collision information [10-12]. Triggers, on the other hand, require the Is Trigger property to be ticked in the view panel. Triggers can be used if you need to detect collisions but don't want the physics of the collision to occur or if you just want to detect whether an object is passing through a certain area of space. For example, triggers are used to detect the proximity of a person to a door to control the opening and closing of the door, while colliders are often used when a ball bounces off a collision with an object. When a character is roaming in a virtual tour system, collision detection is used in several ways: firstly [13], between the character and the ground, as the character is always subject to a downward gravitational force, collision detection ensures that the character detects a collision with the ground and does not continue to fall. The second point is between the character and the building, where the building's enclosing box is detected when the character is close to the building [14], preventing "passing through the wall". The third point is the time between the character and the surrounding landscape, such as large trees, rocks, etc., and the inability to pass through the interior of these objects.

2 Related work

Table 1 provides an overview of the studies investigating virtual reality tourism resources, encompassing a comprehensive examination of the relevant research findings, methodologies, and insights in the field.

Table 1: Summary of literature survey

Reference	Objective	Result	Limitations
[15]	The study demonstrated the integration of numerical simulation tools with a virtual reality platform to replicate an evolving fire emergency scenario. Using a fluid dynamic program and the building information model, it is calculated in real-time. Aditionally, a specialized program was utilized to replicate in real-time the dynamics of the crowd in the simulated setting as the emergency was being evacuated.	The findings demonstrate the potential of the suggested virtual reality-based system for simulating fire emergencies. Decision-makers may use it to assist in creating emergency plans, and firefighters can use it as a training tool to practice emergency evacuation procedures.	There are obstacles to this integration, though, such as possible differences in the precision of the simulation and the behavior of actual fires. Furthermore, the virtual depiction may fall short of accurately capturing the complexities of human behavior during evacuations, which would make it harder to forecast the dynamics of actual crowds in emergencies.
[16]	Building suitable coupling methods across nonconforming interfaces is the primary challenge of building nonconforming algorithms. In this case, we use a decoupled interpolation operator-based method that is both computationally simple and efficient.	The resultant plan is conservative element-wise and stable concerning entropy. The method's accuracy, stability, and entropy conservation are verified by numerical simulations of the isentropic vortex and viscous shock propagation.	The given technique successfully conserves entropy and keeps the system stable, although it may not be able to handle complicated fluid dynamics problems. The accuracy and robustness of its real-world applications, beyond the simulated isentropic vortex and viscous shock propagation, may be compromised if it struggles with extremely turbulent flows or complex geometries.
[17]	The study provided a brief overview of ship and watercraft modeling and then investigated its potential for expansion through the use of realistic physics. With the help of the Unreal Engine, we can see how a Landing Craft Utility (LCU) operates and interacts with near-shore waves in VR, creating a hydrodynamic, data-driven, immersive watercraft simulation experience.	The outcomes validate the viability of using DataTables for this purpose. We are also looking at alternative techniques, such as reading binary and HDF5 files straight from output files, bypassing DataTables.	Nevertheless, when dealing with massive datasets, using DataTables could cause speed and scalability issues. Although there may be some performance benefits to reading binary and HDF5 files directly, there may be certain limitations due to compatibility difficulties or the greater complexity of data handling and analysis.

[18]	This study set out to create an easy-to-use semi-automated approach that would allow users to better see CFD findings and related data in an IVE. The process is user-friendly and supports popular CFD software; even inexperienced users were able to finish it in approximately an hour.	Immersive virtual and augmented reality environments allow for stereoscopic viewing, which may aid in the data extraction process from computational fluid dynamics (CFD) models by making use of enhanced depth cues.	However, problems develop when CFD models are not fully integrated with immersive VR/AR. Data extraction from computational fluid dynamics simulations may be hindered by issues such as a small field of vision, the possibility of motion sickness, and the requirement for high-quality technology, all of which can make smooth stereoscopic viewing difficult.
[19]	A virtual reality (VR) tool called QuickAware was created to raise awareness of the dangers of fast clay. This research details its concept, development, and application. The tool's development began with a co-design strategy, which entailed bringing in stakeholder experts to work together on creating virtual reality scenarios and defining the content of the VR environment.	The results show that the tool might help raise knowledge about the dangers of fast clay landslides, which is encouraging.	Although the tool can be useful in raising awareness of quick clay landslides, it is important to note that it has significant limitations. Several factors might restrict its ability to reach broad audiences and increase common knowledge, including accessibility, cultural variances, and technology discrepancies.
[20]	The study provided valuable insights into the expanding field of augmented reality technology and set the stage for future research and advancements, particularly in the fields of education and outreach.	While augmented reality sandbox technology should improve user engagement and interaction, the results reveal that variables like the lack of fun elements reduce its influence.	Several restrictions make augmented reality sandbox technology less than ideal for improving user engagement and involvement. There has to be more fun stuff added to improve the user experience as a whole since things like not having any amusing parts make it less effective.

3. The fluid N-S equation

3.1 Derivation of the equations

Fluid mechanics is based on modern physical theory to analyze complex motions and phenomena and to model their application in physics. The method is characterized by high accuracy, precision, and ease of understanding. It can simulate the deformation and flow characteristics curves and velocity distribution patterns of various objects interacting with each other in a real environment; it can be used to study the vibration characteristics caused by different shapes, sizes or position changes at the interface between the human eye and the ground. From a hydrodynamic point of view, the acceleration of a particle is then able to be derived from the full differentiation of the particle velocity, so Newton's second criterion derives the smoke simulation model needed for this paper, as shown in the following equation.

$$a = \frac{Du}{dt} \tag{1}$$

$$m\frac{Du}{Dt} = F \tag{2}$$

A fluid is made up of many tiny particles, which can be compressed and arranged into small particles under certain conditions. When an object is moving, its gravity will change with the inertial force and make it decrease continuously. When the acceleration reaches its maximum value, it stops moving; after the acceleration reaches its peak, it starts to decelerate or move at a constant speed to the minimum value to stay and gradually increase the energy loss in the process of changing density and size and finally stays in the same place. The process of fluid movement can be divided into two phases: the first phase is the formation of a solid, the second phase is the liquid flow and the third phase is the mechanical flow. When we use these two different types of virtual reality technology together there are several influencing factors: (1) the application of virtual reality technology on physical models; (2) the trend of interaction and interaction between objects in the simulated environment; (3) the energy consumption and velocity loss caused by the fluid movement process in the simulated environment. Since these objects are all based on physical objects, the sum of all the forces is superimposed and then substituted into equation (2) to obtain the following expressions:

$$m\frac{Du}{Dt} = mg - V\cdot\nabla P + V\cdot\eta\nabla\cdot\nabla u \quad (3)$$
$$\rho\frac{Du}{Dt} = \rho g - \nabla p + \eta\nabla\cdot\nabla u \quad (4)$$
$$\frac{Du}{Dt} = g - \frac{1}{\rho}\nabla p + \frac{\eta}{\rho}\nabla\cdot\nabla u \quad (5)$$

For a fluid that cannot be compressed, we can obtain the following equation.

$$\frac{d}{dt}\mathrm{volume}(\Omega) = \iint_{a\Omega} u\cdot n = 0 \quad (6)$$
$$\frac{\partial u}{\partial t} = f - \frac{1}{\rho}\nabla p - (u\cdot\nabla)u \quad (7)$$

3.2 Discrete form of the Two-Dimensional N-S system of equations

The two-dimensional N-S system of equations taking into account the effects of inertia is expressed as follows.
Continuity equation.

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \quad (8)$$

Equations of motion.

$$\rho\frac{\partial v}{\partial t} + \rho\left(u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}\right) - \mu\left[2\frac{\partial}{\partial y}\left(\frac{\partial v}{\partial y}\right) + \frac{\partial}{\partial x}\left(\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)\right] + \frac{\partial P}{\partial y} - f_y = 0 \quad (9)$$

The boundary conditions involved in this paper are divided into two main categories: velocity boundary conditions and pressure boundary conditions. t = 0, the velocity boundary conditions and pressure boundary conditions are

$$u\,|_{\Gamma_i} = \hat{u}, v\,|_{\Gamma_i} = \hat{v} \quad (10)$$
$$p_n\,|_{\Gamma_i} = \hat{p}_n \quad (11)$$

The weighted form of the N-S equation, based on equations (8) and (9), can be obtained:

$$\int_\Omega w_1\left\{\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right\} = 0 \quad (12)$$

$$\int_\Omega w_1\left\{\rho\frac{\partial u}{\partial t} + \rho\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) - \mu\left[2\frac{\partial}{\partial x}\left(\frac{\partial u}{\partial x}\right) + \frac{\partial}{\partial y}\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)\right] + \frac{\partial P}{\partial x} - f_x\right\} = 0 \quad (13)$$

$$\int_\Omega w_2\left\{\rho\frac{\partial v}{\partial t} + \rho\left(u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}\right) - \mu\left[2\frac{\partial}{\partial y}\left(\frac{\partial v}{\partial y}\right) + \frac{\partial}{\partial x}\left(\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)\right] + \frac{\partial P}{\partial y} - f_y\right\} = 0 \quad (14)$$

The above equation gives the weak form of the integral under natural boundary conditions.

$$\int_\Omega w_1\left\{\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right\} = 0 \quad (15)$$

$$\int_\Omega\left[\rho w_2\frac{\partial u}{\partial t} - \rho w_2\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) + 2\mu\frac{\partial w_2}{\partial x}\left(\frac{\partial u}{\partial x}\right) + \mu\frac{\partial w_2}{\partial y}\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right) - \frac{\partial w_2}{\partial x}P - w_2 f_x\right]d\Omega - \int_\Gamma w_2 t_x d\Gamma = 0 \quad (16)$$

$$\int_\Omega\left[\rho w_3\frac{\partial v}{\partial t}\cdot\rho w_3\left(u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}\right) + 2\mu\frac{\partial w_3}{\partial y}\left(\frac{\partial v}{\partial y}\right) + \mu\frac{\partial w_3}{\partial x}\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right) - \frac{\partial w_3}{\partial y}P - w_3 f_y\right]d\Omega - \int_\Gamma w_3 t_y d\Gamma = 0 \quad (17)$$

Since the volume and surface forces are neglected, and therefore are zero, Eq.

$$t_x = \left(2\mu\frac{\partial v}{\partial x} - P\right)n_x + \mu\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)n_y \quad (18)$$
$$t_y = \mu\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)n_x + \left(2\mu\frac{\partial v}{\partial x} - P\right)n_y \quad (19)$$

Since the weight function is arbitrary and its essential boundary conditions have been determined, the pressure term is treated by the penalty function method using

$$P = \eta\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right) \quad (20)$$

After such treatment, the continuity equation may not satisfy the incompressibility assumption, but when η is sufficiently large the quantity on the right-hand side of the equation is small, so the compressive deformation of the fluid is also small and it is considered that it still satisfies the incompressibility condition. In the same region, the N-S equation and the form of the tensor with the penalty function applied to treat the pressure are as follows

$$u_{ij,j} + f_i = 0 \quad (21)$$
$$\mu\left(u_i^{(\eta)} - u_i\right)_{,ij} + \left(p^{(\eta)} - p\right)_{,i} = 0 \quad (22)$$

3.3 Computational cost

Virtual reality (VR) tourist resource analysis using Navier-Stokes equations is computationally intensive. To do real-time rendering, one needs a lot of RAM, powerful algorithms, and a powerful computer to handle the complex fluid dynamics simulations run in the Navier-Stokes framework. To achieve a balance between computing efficiency and immersive quality, high-fidelity virtual reality experiences that faithfully mimic fluid behaviors increase the processing burden. Robust hardware and optimization methodologies are thus required. To provide smooth and lifelike virtual reality tourist experiences, it is critical to address these computational obstacles.

3.4 Algorithmic efficiency

An efficient algorithmic framework is necessary for the investigation of Navier-Stokes equations-based immersive VR tourist resources. To recover effectiveness, the simulation process may be optimized by using parallel computing techniques to share the computational burden. To further improve the simulation's overall efficiency, adaptive mesh refinement techniques can dynamically change the grid resolution, directing computing resources to where they are most required. Utilizing these algorithmic methodologies enhances the solution for investigating virtual tourist situations through the use of fluid dynamics simulations, making it more robust and scalable.

3.5 Challenges faced during implementation

Several obstacles stand in the way of fully immersive VR tourist resources based on Navier-Stokes equations. A lot of processing power is required to integrate complicated fluid dynamics models into the virtual world, which might cause performance problems. Finding the right balance between properly modeling fluid behaviors and ensuring real-time interactivity is a challenging task that demands precise optimization to ensure a smooth user experience. When building an interface to explain complicated physics in a way that is both easy to grasp and entertaining, it can be difficult to strike a balance between scientific precision and user-friendly engagement. For immersive virtual reality experiences like these to become widely used in the tourist industry, certain obstacles must be overcome.

4. Research on roaming control and algorithms for immersive virtual reality tourism systems

4.1 Free roaming design

Free roaming means that the user can freely control the direction, perspective route, etc. when roaming through various input devices including the mouse and keyboard. Users can use external devices to easily and flexibly control and operate the roaming of the virtual scenery. Using the keyboard "W", "S", "A", "D", spacebar "Z", "SHIFT" and the four directional arrows allow the user to move forward, backward, leftward, rightward, upward in controller angle, downward in controller angle and other operations. The mouse can also be used to turn the virtual scenery by dragging and to move the controller forward by clicking. The process of using the mouse and keyboard is to continuously change the coordinate position and angle of the controller and continuously update the rendered scene through the keyboard, mouse dragging, and mouse clicking events.

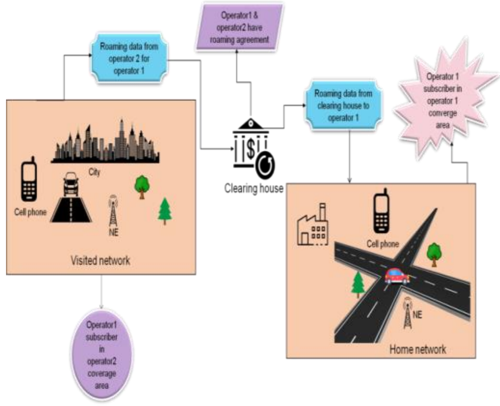

Figure 1: Architecture of free-roaming design

Autorouting is the process of roaming from the user's current position along the shortest route to any target point in the scene. During the roaming process, the user can also control the forward, backward, left, and right turns of the controller with the help of the mouse and keyboard. The main difference with free roaming is that the forward and backward route is already set by the shortest path and the user only needs to control forward, backward, left, right, or stop. Automatic roaming is used when the user wishes to follow the shortest path from the current location to any given location. In this way, the user can easily roam the scene without having to constantly try and adjust the route, while at the same time becoming familiar with and understanding the real situation of the scenery, providing the user with relevant information for the actual tour of the scenery, and increasing the interaction between the user and the attraction, enhancing the user's interest in the attraction. The key point of automatic wayfinding roaming is to find the coordinates and rotation angle of the next forward point and to ensure that the path traveled is the shortest after a series of point findings.

4.2 Point-First Roaming and optimization

When roaming according to point priority, that is to say, selecting a point on the map, within the map reachable. The point on the map is selected so that it passes through as many attractions as possible within the range of the points that can be reached, while the shortest possible distance is required.

The point at the current location is set as the initial point and the location of the selected point is the final point. A complete map is generated based on the nodes of the attractions on the map, and the optimal path is calculated based on the TSP algorithm. If the final point is the initial point, the roaming can be carried out directly according to the calculated most available path, if the final point is not the initial point, the shortest path is generated according to the calculated optimal path, and the final point, when the generated path is non-loop, i.e. the shortest path from the initial point to the final point.

With the help of the dynamic programming method to solve the TSP algorithm, the basic idea of the algorithm is as follows: as shown in Figure 2, v1, v2, v3... As shown in Figure 3, v1, v2, v3...v6 represent node 1 to node 6, n is the number of nodes, n=6 in the figure. v1 is the starting point, as shown in Figure 3, and the distance from v1 to v1 is 0, if there is no path between two points in the figure, then set to infinity, here there is no such path.

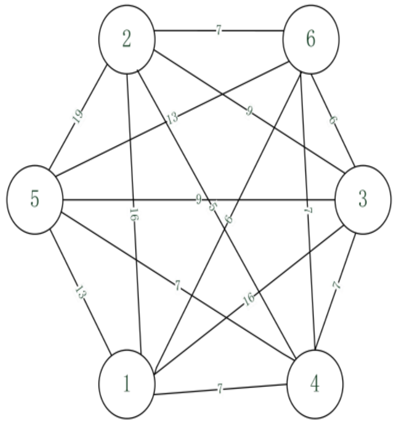

Figure 2: Example diagram of the TSP algorithm

A matrix D is used to store the state of the dynamic programming, with each row of D representing a node and each column representing a subset. This subset contains any subset A of the set V of all nodes except v1.

	v1	v2	v3	v4	v5	v6
v1	0	16	16	7	13	6
v2	16	0	9	5	19	7
v3	16	9	0	7	9	6
v4	7	5	7	0	7	7
v5	13	19	9	7	0	13
v6	6	7	6	7	13	0

Figure 3: Matrix representation of the graph

The optimization idea is roughly as follows: for automatic roaming path selection, a system threshold W is set, representing the current attraction between hotspots exceeding a value of W is considered a congestion situation; the number of current hotspot activities N recorded by the system is fed back to the console, and if N > W, then W is set to infinity. The path is re-planned according to the roaming method chosen by the user, and the time cost overhead is currently the lowest for the new roaming path.

5 System function realization

5.1 D Scene Loading Analysis Design

In the virtual tourism system, the terrain is used to indicate the height and undulation. Take the ancient town as an example, using the natural terrain formed by the hills within the town, most of the surface of the town is covered by buildings and vegetation, and the overall terrain is not very undulating. This paper uses the Unity terrain editor to sculpt the terrain in real-time using brush painting to create mountains, rivers, flatlands, highs, and lows. After creating a new terrain, you can see in the view panel view that the terrain object has a terrain script component mounted on it. This component contains seven buttons that can be used to draw terrain undulations, surface textures, or additional details such as trees, grass, rocks, etc. The creation process is as follows.

- ❖ In the project project, create a terrain by opening the Terrain -> Create Terrain option in the menu bar.
- ❖ Adjust the Terrain Width and Terrain Length values to 600 in the Terrain review panel view to create a 600*600 terrain.
- ❖ (3) Paint different areas of the terrain with the appropriate texture according to the terrain alignment. Here, the mountain areas are painted with a grey texture, the surface is mostly vegetation so it is painted with a green texture and the paths are painted with a yellowish earth color.

Once the terrain has been created, the next step is to add plants to the scene to give it a more realistic feel. Set the brush size, tree size, and density in the setting panel and plant the trees on the ground by left-clicking on the terrain. Similarly, plants and flowers can be planted. You can remove plants from an area by holding down the Shift key and the left mouse button. This method is more suitable for situations where a mass painting of vegetation is required when we need a random number of trees and flowers to appear, to save time and increase efficiency when planting, e.g. large forests, clusters of flowers, etc. Because trees planted with the Terrain planting tool cannot be individually selected for manipulation, they cannot be moved twice or zoomed in and out.

5.2 Map Module Design

In roaming, the navigation and positioning function helps us to see where we are in the scene, also known as. This is the mini-map navigation technique. The main technique is to calculate the ratio of the character's position to the mini-map and to refresh in real-time. The main technique is to calculate the ratio of the character's position to the mini-map and to refresh the position of the character's logo on the mini-map in real-time. The mini-map is created by masking areas outside of the mini-map and moving them around. Flow of map module design shown in Figure 4. The mini-map is created by masking the area outside the mini-map so that all that moves is the background behind it. It can be roughly divided into three parts: firstly, the movable

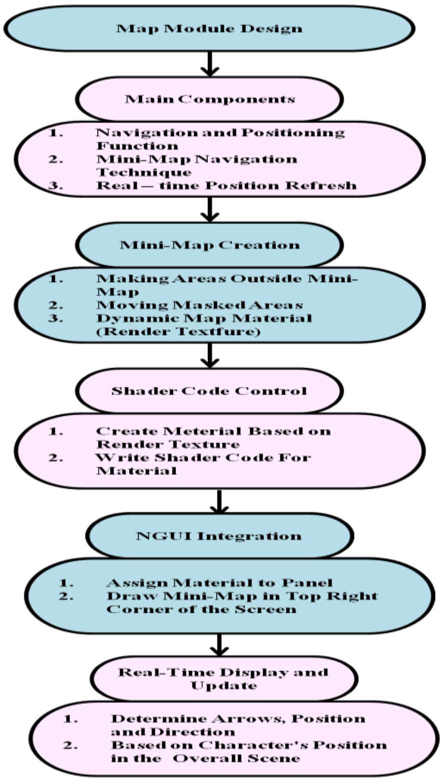

Figure 4: Architecture of map module design

The first is a movable dynamic map material, which in Unity is mainly achieved through the Render Texture dynamic rendering. Secondly, create a material based on the Render Texture we got in the first step, and write a new material to control the shader code for it. The last step is to use NGUI to assign the material to a Panel and draw it in the top right corner of the screen to see the mini-map. The final step is to implement a real-time display and update of the mini-map, which determines the position and direction of the arrows in the mini-map based on the character's position in the overall scene.

5.3 Background sound embedded processing

Audio playback is very important in scene roaming, generally speaking. Unity supports four audio formats, Aiff, Wav, Mp3, and Ogg, the first two are mainly used for short music and the last two for longer sound effects. The main purpose of the background music in the virtual tour system is to make the tour more relaxing and enjoyable for the visitors in the scene, so the background music is chosen to be more ancient and elegant, and the principle of audio playback in Unity is through a sound source Audio Source, and then an audio listener Audio Listener plays the music. The implementation process is as follows: an empty Game Object named Audio Source is created in the menu bar to host the sound source file and provide the music source. After the audio object is bound to the component, to control the pause, resume, stop, and volume of the audio, a script to control this. Take the background music of the start screen as an example, and assign the login_audio.cs script to the camera object and drag the Audio Resource object from the scene to the Music property of the camera login_audio.cs script to assign a value to the Music variable. Once this is done, run the scene to achieve the appropriate functionality.

6 Comparative analysis

We evaluate the effectiveness of the proposed method N-S equation with existing methods like MobileNet [21], VGG19[21], ResNet50[21], ResNet50 [21]. Among the metrics employ for assessment are recall, accuracy, f1-score, and precision. Table 2 shows the overall outcome of proposed methodology.

Table 2: Overall outcomes of the proposed method

Models	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
MobileNet [21]	98.9	99	98.9	98.9
VGG19 [21]	96.1	96.2	96.1	96.1
ResNet50 [21]	93.4	94.3	93.4	93.5
N-S equation [Proposed]	99.2	99.45	99.3	99.02

6.1 Accuracy

In VR tourism, accuracy is the practice of creating an online space that is as realistic as possible to provide users with an engaging and genuine experience. Figure 5 shows the results of accuracy. The suggested N-S equation outperformed the previous techniques, achieving the greatest accuracy of 99.2%. The accuracy of the established approaches, such as MobileNet, VGG19, and ResNet50, was 98.9%, 96.1%, and 93.4 %.

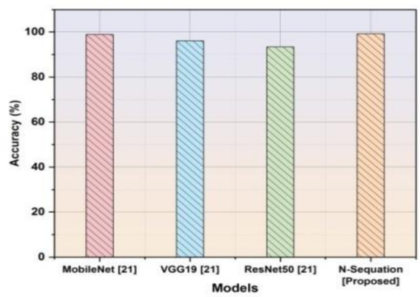

Figure 5: Comparison of accuracy

6.2 Precision

An immersive experience that uses computer-generated surroundings to mimic real-world travel is known as virtual reality tourism. Through the integration of state-of-the-art technology, it facilitates the virtual exploration of many places. Precision in sensory reproduction and user engagement is a measure of precision in virtual reality tourism. Figure 6 shows the results of precision. The suggested N-S equation outperformed the previous techniques, achieving the most incredible precision of 99.45%. The accuracy of the established approaches, such as MobileNet, VGG19, and ResNet50, was 99.0%, 96.2%, and 94.3%

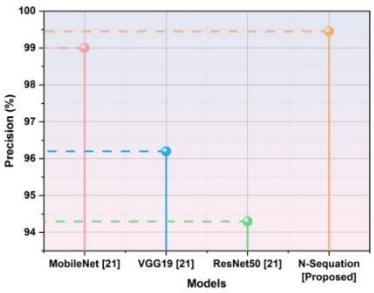

Figure 6: Comparison of precision

6.2 Recall

In the context of VR tourism, recall is a measure of how well the virtual world captures meaningful experiences, suggesting that all significant characteristics of a place are included. The formula for it is the proportion of favorable experiences that were positive relative to the total of pleased and negative events. Figure 7 shows the results of recall. The suggested N-S equation outperformed the previous techniques, achieving the best recollection of 99.3%. The memory of the established approaches, such as MobileNet, VGG19, and ResNet50, was 98.9%, 96.1%, and 93.4%

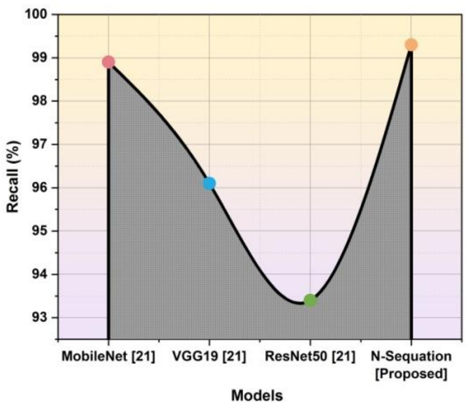

Figure 7: Comparison of Recall

6.3 F1-Score

When evaluating the thoroughness and correctness of a virtual tourist experience, the F1-score is the harmonic mean of recall and precision. Figure 8 shows the results of the F1 score. The suggested N-S equation outperformed the previous techniques, achieving the maximum F1 score of 99.2%. The F1 score of the established approaches, such as MobileNet, VGG19 and ResNet50, was 98.9%, 96.1% and 93.5%

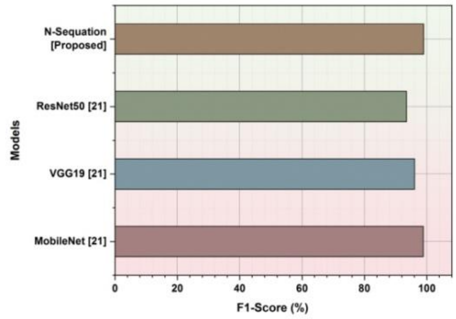

Figure 8: Comparison of F1-score

7 Discussion

Investigating the impact of VR on the travel industry is the main aspect of studying immersive VR tourism. As part of this process, we assess user experiences, emerging technologies, and their potential to transform the travel industry by offering a novel and captivating means for individuals to discover and engage with other locations. MobileNet [21] is that it has to choose between being accurate and being computationally efficient. Its lightweight architecture makes it less accurate than more sophisticated models, which makes it less suitable for applications that need high-level accuracy and fine-grained feature extraction, even if it is optimized for mobile devices. The deep design of VGG19 [21] makes it extremely computationally and memory intensive, which makes it less practical for real-time applications or devices with limited resources, even though it does a great job at feature representation. ResNet's [21] great performance in DNNs isn't without its drawbacks, though. Its deep design increases computational cost, and there's a chance of disappearing gradients and overfitting on smaller datasets. To optimize its performance, careful tweaking is required**.** By finding a happy medium between precision and computing efficiency, our suggested N_S equation approach overcomes shortcomings of popular models such as ResNet, MobileNet, and VGG19. It provides a more effective answer for immersive VR tourist applications by reducing the impact of problems like overfitting, vanishing gradients, and calculations that are heavy on system resources.

8 Conclusion

This paper designs and implements an efficient, highly portable, and scalable Unity3D-based virtual tour system. The system is based on the simulation function of the N-S equation and the Unity3D engine. No additional plug-ins are required, and integration between modules is achieved through XML configuration files, which can be configured by the user. For the bottleneck of 3D scenes in the virtual tourism system, the article optimizes the design of material files and model files for the construction of 3D scenes and the steps of construction to achieve an improved loading and performance display of 3D scenes. The system supports a variety of media methods, including 3D objects, pictures, audio and video, etc. The system's colorful 3D scenes (including undulating surfaces, rich and lush vegetation, and highly distinctive buildings) do not use traditional 3D GIS technology but the Unity engine, which has more mature technology in terms of graphics, physics, interface, and scripting. The system has information query and storage functions, adds roaming background music, makes the virtual tour more vivid, through the particle system more realistic simulation of the water flow effect and waterfall effect, and realizes the user mouse-free way finding and fixed-point way finding function. The proposed method shows significant results when compare to traditional approaches in terms of accuracy (99.2 %.), precision (99.45 %), recall (99.3 %) and f1-score (99.02 %). The system aims to improve China's tourism information development by providing a comprehensive and realistic display of scenic spot information. It is affordable to build and maintain, and its strong portability contributes to the optimization of service capacity and resource allocation. This system enhances user experience and provides practical information for tourists, enhancing the overall tourism experience in China.

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