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Elevating 5G Virtual Reality Projection Screen Platform with Smart Cities Innovation and Big Data Integration

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Abstract: Smart cities' integration of 5G and VR projecting displays changes in city interactions while effortlessly incorporating massive amounts of data. Development may be done in real-time with the help of this convergence, which provides citizens with a rich data experience. This convergence transforms our urban environment and standard of life using 5G, VR, smart cities, and big data. This study focuses primarily on integrating smart cities innovation and big data with the application of elevating 5G virtual reality projection screen platform.A research project is underway to develop a city image system for three-dimensional virtual city modeling and simulation. This system includes several sections, including moving around, scene development, and information collecting. Important data formats include DXF and 3DS, obtained from digital stereo images. The data import/export module converts models into Openflight format. Model editing ansd reconstruction tools enhance spatial and attribute information storage. A scene roaming module selects models from a database to create interactive 3D city scenes. After implementing virtual reality technology, per capita urban humanities awareness increased to 62.1%. Test results validate the system's integration of geographic information systems, virtual reality, and database technology for effective three-dimensional digital city modeling and visualization, facilitating urban image dissemination.

Keywords: *Virtual reality, Smart cities, Big data integration, Projection screen platform*

1. Introduction

An innovative development in immersive experiences combines 5G technology with virtual reality projection panels. This ground-breaking blending of high-speed internet with immersive graphics has the potential to fundamentally alter how people engage with technology and urban settings, making it a key element of the rapidly developing smart city landscape [1].In essence, 5G virtual reality projection screen devices combine the immersion capability of virtual reality with lightning-fast data transfer capabilities [2]. The entertainment, educational, communication, and many other industries benefit greatly from this synergy. The boundaries between the physical and digital worlds will be blurred when users enter immersive digital worlds with previously unheard-of clarity and reactivity [3].

Big data integration added to this technology provides still another level of complexity and promise. This synergy has enormous potential for smart cities, which rely on data-driven insights to improve productivity and quality of life [4]. Cities can optimize transportation, energy use, public services, and more by utilizing the enormous amount of data created by 5G VR projection displays, creating a more sustainable and livable urban environment.In conclusion, a new era of innovation and change is set to enter in to the union of 5G, virtual reality, and big data integration. It promises to improve our communication and entertainment experiences as well as enable smart cities to flourish in a world that is becoming more and more data-driven [5]. This technological fusion represents an exciting and promising area of development because it can transform how we work, live, and interact with the world around us. The limitations of integrating 5G, virtual reality projection screens, and big data include potential access disparities and concerns about privacy, cost, and health effects. Addressing these challenges is crucial for equitable and secure implementation [6].

This study aimed to propose an elevating 5G virtual reality projection screen platform with smart cities innovation and big data integration.This study suggests a technical approach for creating a 3D simulating platform for cities.The city's 3D modeling method's technological structure, including the engine's technological layout, consists of three sections. Within it, primarily including the scientific method for city 3D visualization and the technical development of the simulator systems generator constitutes the technological method of building city virtual reality systems.

The remaining portion of this paper is structured in the following way: Section 2: Related work; Section 3: Methodology; Section 4: Results and discussions; and Section 5: Conclusion.

2. Related Work

A study [7] implemented a big-data, digital city-based visual display system for immersive 5G virtual reality. The

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study created and used a virtual reality picturing structure that makes use of the 3D display modes of hearing, sight, and contact. It produced a real and dynamic 3D visualizing environment that gives people a more natural visual experience. The study employed big-data electronic city technologies. Based on the experimental findings reported in the current study, the simulated reality visualization network test's consistency may reach sixty images per second (FPS), the outstanding rate was approximately 34%, and the model scene-realistic response exceptional level was near to 63.4%.Study [8] investigated the way substantial data and 5G virtual reality were used to create and distribute contemporary city image networks. The work involved designing and developing a technique for imaging cities that depicts and reproduces a virtual community 3D environment. Considering that it combines the related advantages of mapping systems, additives fact, and database-based technological advances, the test outcomes indicate the algorithm can more efficiently identify the planning and modeling of virtual urban areas under the circumstances of 3D imagining.In study [9], the usability of virtual reality (VR) technology was investigated about the use of growing digital twin cities (DTC), which serve as an ideal foundation for the tailored development of immersive VR applications. Considering these results, they recommended using a systematic, user-centered research design to identify potential innovation roadblocks. Additionally, they presented a framework for building VR applications to solve user issues with the technology at available.

Study [10] covered a wide range of 5G-based IoT application-related topics, focusing on Smart Cities settings. At the time of publication, there was some debate about the creation of 5G technology, specifically about the country of manufacture and any inherent cybersecurity risks. The widespread early deployment of 5G may be delayed if these problems are not successfully fixed. But it's anticipated that these problems will be resolved over time."Holistic big data integrated - artificial intelligent modeling (HBDIAIM)"has been suggested in the study [11] as a solution to these problems to enhance the security and confidentiality features of the information interfaces for different applications for smart cities. To create suitable protection for the private data administration interfaces in apps for smart cities, a differential evolutionary approach has been included to HBDIAIM. The efficacy of the suggested methodology was demonstrated by a modeling study that has been carried out considering safety, precision, efficiency, and adaptability.In study [12] presented a detailed analysis of the needs, architecture, and elements of Society 5.0. Modern Society 5.0 and its connection to Industry 5.0 have advanced significantly under our direction. Also nicely explained was the way Society 5.0 fits into the UN's sustainable development goals. Several revolutionary communication and computing algorithms, including 5G-IoT, computing on the edge, computer fog, the web of anything, blockchain technology, and additional associations, have been extensively thoroughly investigated to meet the expectations of Society 5.0.

Study [13] explored the chronological progression of the wireless network's generation's evolution to understand the software, From 1G through powered by artificial intelligence 6G and its applied learning-by-yourself simulations, network production systems have been affected by software and technical demands. With the goal to build dependable and efficient smart city surroundings, they give a classification of the infrastructures utilized by technologically equipped applications for smart cities. They suggested upcoming 6G network research priorities for utilization in smart towns.The history of Mobile Augmented Reality (MAR) and its possibilities in light of 5G networks and related technology, Multi-access Edge Computing (MEC), are covered completely in the study [14]. About the technological evolution of current and upcoming MAR networks with regard to architecture opportunities for cloud-based, border, restricted, and combination systems, they particularly provide an informative analysis. The role of 5G systems in addition to the study also explored the needs and limitations of the technological elements of MAR, such as interaction, mobile leadership, handling energy, services lifting and immigration, safety, and confidentiality.The study [15] proposed developing 5G-based workarounds that can address COVID-19 difficulties in a variety of situations, with a special emphasis on 5G networks and the current problems with wellness. To support developing healthcare applications, the study offers a 5G technology that integrates various digital technologies. The goal of the study was to discover 5G-based solutions than may solve COVID-19 challenges in a variety of scenarios, including an emphasis on 5G infrastructure and the current illnesses.

3. Methodology

3.1 Connection of city image

An innovative project called the city image connection project, which is part of the projection screen platform, intends to use the potential of 5G technology for increasing the VR-based projection screen experience in urban settings. This innovative strategy promises the seamless integration of big data analytics, smart city infrastructure, and 5G connection to transform how cities display their identities and interact with their citizens and tourists through projection screens. Imagine yourself in a smart city setting where fascinating virtual experiences are presented by way of projected onto structures and public areas, successfully fusing the virtual and real worlds. A captivating story is woven by that technological fusion, which is propelled by both cutting-edge technology and urban design, which not only improves the city's aesthetic appeal but also improves the lives of its citizens.

Within the Projection Screen Platform, a new stage of urban innovation is introduced by the integration of big data, smart city initiatives, and 5G technology. By supporting real-time data gathering and analysis, this synergy enables cities to respond quickly to changing situations and utilize their resources effectively. For instance, real-time monitoring and management of variables like traffic patterns, air quality, and energy usage can greatly improve people's quality of life. The VR-based projection screen platform also works well as a flexible tool for enlightening and involving the general audience. From the comfort of their neighborhood streets, residents can take part in virtual town hall meetings, see historical recreations, or go to art and cultural events.Furthermore, a city's projection screen image is improved as a result of its linked, data-driven urban environment, which also actively affects the city's future. A vital, linked urban landscape is largely a result of the flow of imagery that occurs in urban settings, which is fueled by the interaction of 5G technology and intelligent urban infrastructure.

3.2 5G -VR

The 5G -VRhas seen a lot of recent technological activity. By building a virtual city, it is possible to execute the virtual existence of a city outside of distance, clearly recreate the surroundings of the actual city, and system and digitalize city management. This is unique to urban virtual reality technology. The emergence of "digital cities" and the requirements for 3D urban simulation are presented in the aforementioned introduction. The rapid advancement of remote sensing technology has made it possible to obtain Urban 3D cities are expressed using physical coordinates representing urban spatial details as well as image data representing covering communities.

Urban geographic information extraction is made possible by the rapid processing techniques offered by digital photography technological advances that include finding data and the morphological accuracy rectification of images from remote sensors. Virtual reality equipment resolves the issue of urban three-dimensional urban development, while realistic picture-generating technologies achieve a geometric simulation of urban geographical data.The aforesaid issues have been resolved, which has produced excellent circumstances the application of augmented movement, the creation of urban 3D cities, and the creation of a geographic information system for digital cities. This calls for the realistic images to be normalized using gray values $\xi(l)$. Due to the changing color as well as intensity of all of the points in the picture, every point on the captured monochrome image, orthe color images reproduced from the TV show various tones of grey. There are two types of interaction between whites and blacks: a variety of degrees corresponding with the logarithm, and this is known as the "gray grade." The image can be normalized using the gray value, which helps create scenes that are more believable.

$$\xi(l) = \frac{\rho\, min|D_l^n - D| + \rho\, max|D_l^n - D|}{|D_l^n - D| + \rho\, max|D_l^n - D|} \quad (1)$$

D_l^nandD are databases of graphs among them. The latest technological endeavor is the utilization of virtual reality technology for urban growth, leadership, and building. The intersecting check procedure is reduced to a series of straightforward single axes overlapping inspections to increase the calculation performance in the axisymmetric surrounding object. Check assuming the intersection of an axisymmetric encloses generated through the 3D transmission vectors A and B, along with another produced by the axes I and J, have the subsequent effects.

$$H = (B_w > I_w) \vee (J_w > A_w) \vee (B_z > I_z) \vee (J_z > A_z), \quad (2)$$

$$H(B, A) = (B_w A_w)(J_w I_w)(B_z A_z)(J_z I_z) \quad (3)$$

For simpler computation, additionally, a horizontal axis has been proposed for model-based research. dimension C depends on Q, its projection across the N axis will look such that.

$$d = 0.2C_w \times |A_w| + 0.2C_z \times |A_z| \quad (4)$$

$$N = Q_w A_w + Q_z A_z + Q_y \mathrm{A_y} \quad (5)$$

A and B represent the smallest and highest numbers amongst these.The hash operation, which is described in the next section, may determine the identifier coding encompassed by the determined positional object G when a certain layer of data related to geography has an aspect of $O \times P$. To achieve information compression, a hashing algorithm typically produces results that are smaller that the initial data. However, because the hash function's computation is permanent, it is impossible to determine the initial information from the hash result. The function of hashing is therefore frequently employed in application settings where it is necessary to generate data summaries or implement encrypted data.

$$H(w, z) = \begin{cases} w = \frac{Gw}{p} * \frac{Gz}{o} \\ z = \frac{GwGz}{po}. \end{cases} \quad (6)$$

It is mostly used by the spatial query method to acquire the geographic information within the area that interests you and its connection. The search algorithm examines any three-dimensional spatial range as follows:

$$V_{min} = V\left[\log_2 \frac{B}{2} - 1\right] \times \log_{B/2}\left(\frac{A}{B/2 - 1}\right) \quad (7)$$

$$V_{max} = \left[V \log_2 \frac{B}{2} \times (\log_{B/2} A - 1)\right] \quad (8)$$

$$V_{buf} = V \log_2 \frac{A}{2} - V[T] \quad (9)$$

Variable the V is a symbol for time complication. As may have seen, the quadratic level exhibits the poorest the search's effectiveness, whereas the exponential level illustrates the typical complexity of every single method, which has great performance and stability.

$$ROW = \left[\frac{(BV+AV)}{2}\right] \quad (10)$$

$$COLUMN = \left[\frac{\log_2(BV+AV-1)}{2}\right]$$

(11)

As can be observed from the calculation, the ROW computes by averaging the total of $AV$and BV, whereas the $COLUMN$ computes by first computing the logarithm and then dividing. The aesthetic impact can be satisfied when the grid gets decreased. A multi folding's price is described as follows:

$$cust\ (b, a) = |b - a| \times max_{t \in Q\ C} \quad (12)$$

$$cust\ (q, c) = min_{m \in BA} \left\{\frac{1 - B_{normal} * A\ normal}{2}\right\} \quad (13)$$

A is the focal point that needs to be removed, while a and b are two corresponding vertex of the folding edge. The unit normally vectors of the triangular area $A_{normal}$and B_{normal}, correspondingly.What follows is a possible version of the formula:

$$\cos s\ (b, a) = [b - 1] \times max_{w \in Q\ C} \left\{min_{z \in Q\ \ C} \sin^2 \frac{b}{2}\right\}$$

(14)

A series of operations with a lesser computational difficulty, a stronger compressing operation, and greater information recovery should be used when computing. A contrast of computational difficulty is shown in Table 1. The table shows that every sequence has a multidimensional computational difficulty, and the lowest computationally demanding values are for both dimensions 5/3 and 2/6.

Table 1. Difficulty of computations

Model-based research	**6/4**	**3/7**	**SPB**	**10/8-N**	**3/11**	**6/12-d**	**7/15**	**SPC**	**10/8-E**
Shift operation	3	3	3	3	3	3	1	4	5
Addition operation	6	6	8	9	8	11	11	9	13
Multiplication	1	1	2	2	3	1	1	2	3
Total amount of calculation	8	8	13	12	12	14	17	16	16

3.2.1Developing a city model

To build a VR city model, you must first extract the information about the roads, such as their length, width, and texture. Then, we must divide and filter this information to get the true size of the roads, and then we must divide then determine the entire breadth and angle vectors. Understanding how to calculate the status, where $\mu_1\ and \mu_2$valueis the total of the revolutions 12 , lengths h, and breadth x, allows us to determine,

$$\frac{x_1}{\cos \mu_1} = \frac{x_2}{\cos \mu_2} = \|t\| \quad (15)$$

$$\mu = \mu_1 + \mu_2 \quad (16)$$

Equation (15) demonstrates that the connection involving the half-width lengths and the vector of translation length may be created using a value that represents the direction, which is equal to half-width distance between linking the two routes. Somebody can obtain another simpler variation on the calculation by merging the two formulas, which are as follows:

$$\frac{x_1}{x_2} = \frac{\cos(\mu - \mu_2)}{\cos \mu_2} \frac{x_1}{x_2} = \frac{\cos(\mu - \mu_1)}{\cos \mu_1} \quad (17)$$

The vector's width can then also be determined. The calculated angles and the real variable are able to be combined to create vectors in the manner shown below:

$$\mu_2 = \arctan \frac{\cos \mu}{x_1/_{x_2} + \sin \mu} \quad (18)$$

$$\mu_1 = arctan\ \frac{\sin \mu_2}{x_1/_{x_2} + \cos \mu + cos_2}$$

(19)

The compressed block is obtained by connecting these translated target points in accordance with the preceding order. They nevertheless have an identical form, even though certain constants are different. One way to express an overall border problem is as follows:

$$x_{limit} = x_{min} + (x_{max} - x_{min}) \quad (20)$$

To minimize data transfer, in networked simulations, a standardized block is constructed and employed. We find the three-dimensional geometrical translation matrices C of the item. A unitary matrix multiplication form that can be used to describe rotation, translating, and scaling is as the following:

$$C = \begin{bmatrix} a_1 & a_2\ a_3 & a_4 \\ a_{11} & a_{12} a_{13} & a_{14} \\ a_{21} & a_{22} a_{23} & a_{24} \\ a_{31} & a_{32} a_{33} & a_{34} \end{bmatrix} \quad (21)$$

The change function divides the matrix C into four sub matrices to provide geometric modifications, such as proportionate rotation, which can be inferred as follows:

$$[b', a', d', e] = [b, a, d, e]|b + C_b a + C_a d + C_d e| \quad (22)$$

The conversion equation for spinning the location of the coordinate system's origin by an angle concerning the coordinate axis in the right-hand coordinate system is as follows:

$$[b', a', d', e] = [b, a, d, e]\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\rho & \sin\rho & 0 \\ 0 & -\sin\rho & \cos\rho & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (23)$$

Whenever a transformation of geometry is used to determine the collection position of the protest, it is called instancing. Furthermore, urban modeling regularly makes use of VR.The controls on the taskbar can be used to carry out a variety of tasks in VR, including shifting, determining, revolving and reflection. The menu bar is able to be fully exhibited on screens with a dimension of 1280 x 1024 or higher; on screens with a width of 1024 x 768 or lower, it can simply be partially presented. This option can also be used to integrate the full scene with other scenes. As stated in Table 2, the quantity of items and geometrical modifications should be taken into account.

Table 2. Findings from tests

Model	Number of triangles	Number of vertices	Simplify efficiency
a	4577	2649	15.44%
b	5485	2488	46.78%
c	1548	5417	68.18%
f	528	280	86.26%

3.2.2Big data

The explosive growth of information technology has increased Projection Screen Platform's awareness of the ramifications of big data. The distribution and exchange of big data resources have thus become essential areas for advancement with the rise of big data, there is currently a much greater need for quick delivery of data accelerating the development of information technology and accelerating the pace and volume of knowledge exchange.

As a result, there are more requests for information technology transfer. Distance-based clustering algorithms typically use this data in the Projection Screen Platform to determine how similar two data objects are. Here are several measures that are routinely used to gauge these commonalities within the Projection Screen Platform framework.

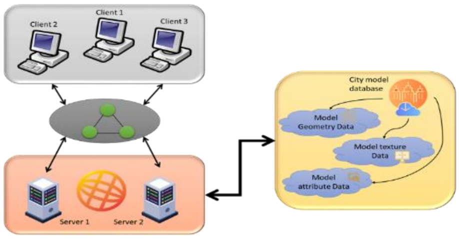
$$c(w, z) = \sqrt{(w_1 - z_1)^2 + (w_2 - z_2)^2 + \cdots += (w_m - z_m)^2} \quad (24)$$

$$\sqrt{\sum_{j=1}^{m} (w_j - z_2)^2}$$

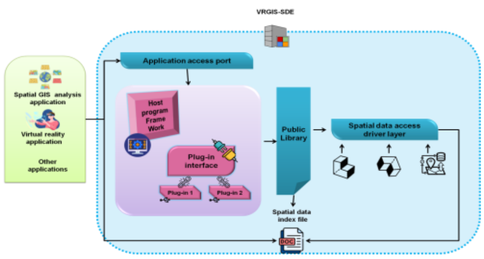
$$c(w, z) = \sqrt{\frac{\sum_{j=1}^{m} (w_j - z_j)^2 (w_i - z_i)^2}{(w_m - z_n)^2}} \quad (25)$$

The directions of corresponding spots designated as$w_m$and z_m are visible on the projection screen. When dealing with multi-dimensional qualities, the capacity to determine impact is less suitable and is best successful with simple features. Buildings, public spaces, streets, and sustainable water features are just a few examples of the many components that make up urban design's physical layout. The main issue is the insufficiency of a single explanation for separation because various detection techniques produce different kinds of abnormalities. Additionally, a number of organizing elements, including the type of dwelling, condominium design, structural dimensions, number of stories, floor-to-area ratio, landscaping speed, and proximity, are at work. Information is also valuable from the construction's qualities, such as weight, materials, color, and their relationships.As therefore, the designer must constantly modify these components and their interactions while designing, which is made possible by augmented reality and enormous amounts of data. A new era of advancement in all spheres of existence is ushered in by the industrial landscape's use of big data and augmented reality technologies.

The current city imaging system created in this research uses a client-server structure in the context of our projection screen platform, as shown in Figure 1depicts the overall structure of our VR city imaging platform.



(a). City image systems



(b). VR based city image system

Fig 1. (a-b) Image system

3.2.3Urban Image System Design

Table 3 depicts the experiment of urban image screen system design**.**

Table 3. Urban image system design

Aspect	**Description**
Architecture of Systems Functionality	The cutting-edge 3D imaging technique of the projection screen platform effortlessly fuses the well-known two-dimensional GIS world with the engaging three-dimensional VR world. Urban planners may now visualize and interactively explore a variety of urban scenarios thanks to this innovative approach. It makes it possible to quickly assess planning results from both 2D and 3D perspectives, leading to a more precise and significant decision-making process for urban design.
System Framework Design	The central point is the system's client-server architecture, seamlessly integrating GIS and VR components for data processing and visualization. It also interfaces with other MIS systems for enhanced functionality. The system primarily emphasizes high-speed access to diverse spatial data, ensuring dynamic scalability and consistent service delivery. This architectural framework serves as the foundation for a comprehensive urban image system.
System Database Design	Effective database design is pivotal in digital city management systems. Poor design can burden clients, complicate server-side tasks, and harm system performance. In contrast, a well-planned database enhances processing efficiency and system scalability, making it a crucial factor in system development.
Creation of 3D Scene	Texture mapping technology is essential for enhancing the realism of virtual city systems. It bridges the gap between 3D models and real buildings by simulating surface texture details. This method enriches the virtual scenes, making them more authentic and immersive. Overall, texture mapping significantly improves the realism of virtual city models.
Model Integration	The key point here is strict adherence to the production process in MultiGen software. It ensures consistency, quality, and effective management of terrain, cultural features, and building data during scene creation. Non-compliance may lead to data disorganization and reduced scene quality.
Virtual Interaction Design	Designing the interaction between users and the urban scene involves seamlessly integrating keyboard and mouse control for navigation and software-based tools for editing and analysis. This fusion is crucial for usability and user satisfaction in the virtual environment. It ensures an intuitive and immersive experience for system users.
System Application Realization	The system's pivotal feature is its user permission hierarchy, categorizing users into three levels. This structure ensures efficient control, data security, and role-specific functionality within the urban image system, crucial for managing database integrity and user effectiveness.

4. Results and Discussion

We only examined a small subset of the system's indicators because it is still being developed and improved. A model having 260,000 vertices, 140 triangle sets, and 87,000 triangle faces made up the original scene that was tested. Following are the picture processing steps: Table 4 displays the dataset.

Table 4. Dataset

Image	**Vertices**	**Triangle Sets**	**Triangle Faces**
Initial	260,000	140	87,000
Image 1	3.13 million	1,680	1.04 million
Image 2	150,000	140	87,000
35,000			

We only examined a small subset of the system's indications because it is still being developed and improved. Table 5 displays the performance outcomes for every operating setting.The section talks about how the elimination of frustums and removing reliability of the immediate system is significantly impacted by the node's data organization.

Table 5. Run results

Frustum culling	Close process I	Open process I	Close process II	Open process II
Initial	39.50/39.50	50/60	50.61/50.61	52.61/64.97
Image 1	2.99/2.97	2.87/5.11	10.47/10.47	10.49/15.43
Image 2	51.85/51.24	56/69	64.81/64.97	65.17/86.06

Without mentioning the kind or optimization technique, it emphasizes that the selection of the system's functioning is significantly influenced by a node's data arrangement. Additionally, a technique for organizing triangular data is presented with the goal of reducing unnecessary vertices while retaining the overall amount of generated triangles, which will lessen the strain on the graphics pipeline.Technologies for frustum culling is described for improving real-time efficiency during tasks like roaming without impairing comprehensive city assessment. Hierarchical scene graph structures are a good fit for this strategy. A comparison of two operating systems, image 1 and image 2, demonstrates that enhanced CPU performance can reduce system constraints.It emphasizes the significance of reforming scene nodes and improving resolution for improved simultaneous rendering while highlighting the assessment used for the primary scenario's drawbacks. Despite the examination's limitations, the results match what was anticipated, proving that the optimized tactics and procedures were effective.Ultimately, the idea of the single-value concept is presented, which postulates that, in instances of testing with reliable random seeds and virtual world scales, the quantity of produced organizations processed in each frame continues to be the sole factor affecting system efficiency and provides a clear direction for future improvement.

Routes and crosswalks, road designs, buildings and their groupings, and other features the generated are all construction designs, depending on this stage. The overall quantity of created objects and the amount of time used during this step make up a system's grading criteria. The complete outcomes are displayed in Figure 2. Figure 3 displays the outcomes of the block generation and building generation tests.

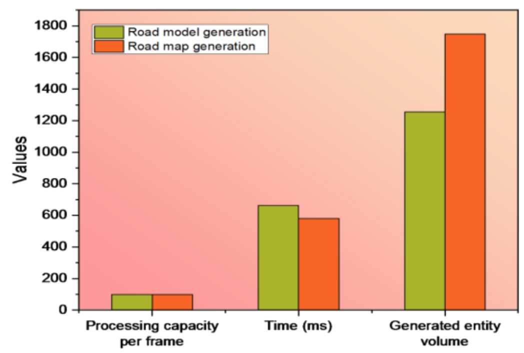


Fig 2. Time-consuming findings and a large number of test entities

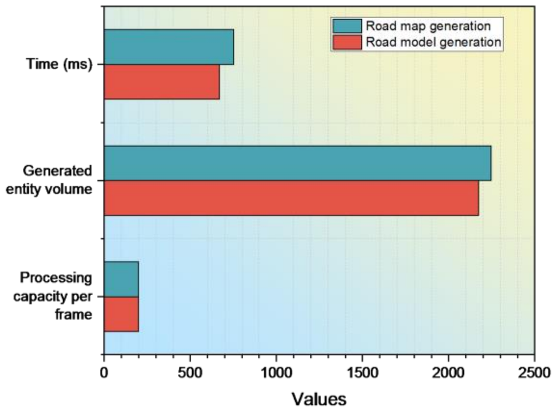


Fig 3. Entity number and time-consuming outcomes for the block and structure generation tests

Change the amount of points we have set up. The modeling time and searching for various locations are included underneath the identical leaf node upper limit, as indicated in figure 4 and figure 5.

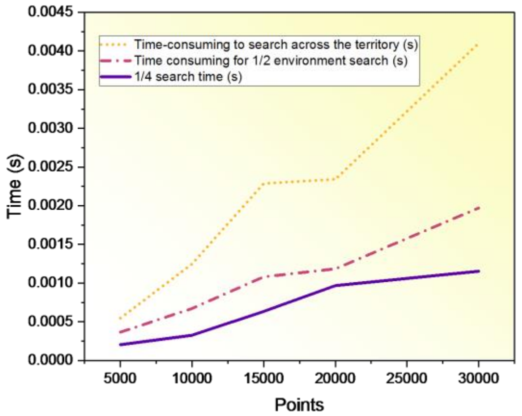


Fig 4. Time-consuming simulation evaluation

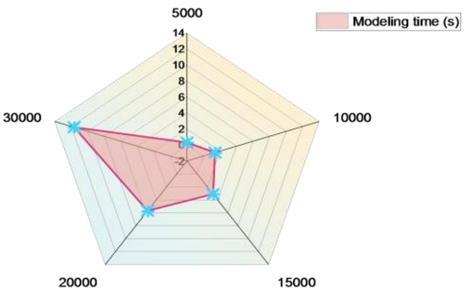
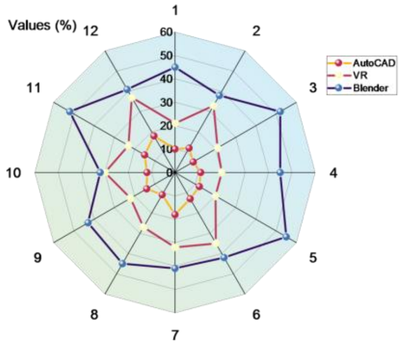


Fig 5. Time-consuming result comparison



(a). Outcomes of simulation evaluation for road design

Figure 6 displays the statistical outcomes of the time-consuming simulation. The graph demonstrates that the simulated performance is typically linear and during the approaches of a certain value the estimation of the time-consuming indices must be maintained between the specified ranges.

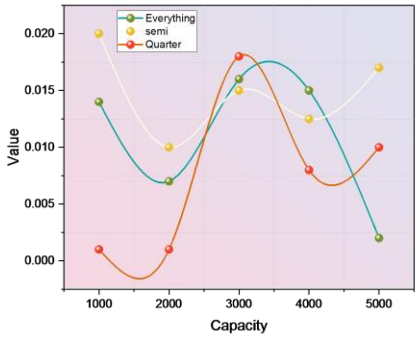
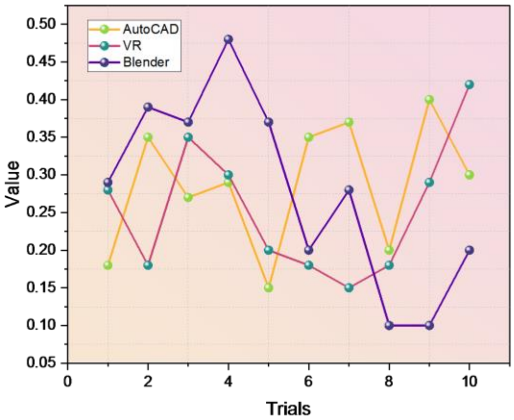


Fig 6. Time-consuming comparison

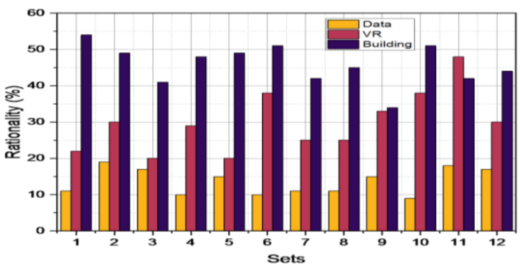


(b). Analysis of roadway design simulator assessment

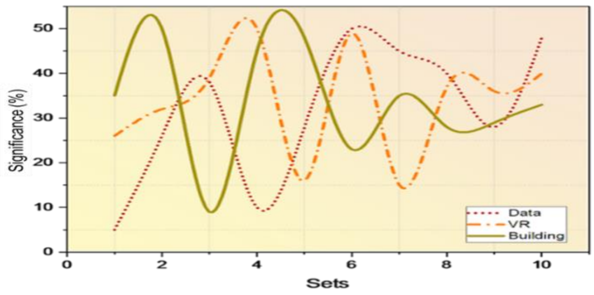
Fig 7. Results of (a-b) simulation analysis for road planning

Figures 7 display the outcomes of the analysis of the road planning simulation.The design process is time-consuming, mainly focusing on 3D construction, with early data collection crucial for later production. AutoCAD excels in collaboration with 3D due to its powerful modeling and user-friendly operations. It simplifies modeling but struggles with facet reduction. In terms of road component lengths and connection, Figure 7 shows results of simulation analysis for road planning. Depending on the associated road segments, clusters acquire ratings. Users can create or open road planning schemes in two dimensions, with Blender for new plans. Road shapes include straight, arc, and bezel, each with specific creation steps. When transferring data to 3D, arcs and curves are split into smaller straight lines.

Because 3D GIS is still in its infancy, most existing GIS software is 2-dimensional or 2.5D. 3D modeling ignores attribute data in VR in favor of geographical representations. VR software primarily handles real scene display and spatial data, overlooking integration with attribute data in 3D. An urban digital virtual design database platform is vital for designers, emphasizing logic, simplicity, and quick information access. This platform should offer comprehensive, accurate, and three-dimensional data. The rationality and significance of virtual city design are shown in figures 8.



(a). Rationally



(b). Significance

Fig 8. Rationality and significance of (a-b) virtual city design

For simulations to be feasible, collision detection is essential. The system's design was centered on a PC-based 3D visual simulation platform that incorporated immediate visualization and a 3D scene collection, and interaction technology. It opted for OpenGL and scene graph tools instead of commercial software. Existing GIS and 3D modeling software were leveraged for efficiency. Collision detection optimization aimed to reduce unnecessary calculations by excluding certain surfaces and using simplified collision bodies.The system supported various navigation modes for immersive exploration and allowed users to record and replay their experiences. Practical tools, like distance measurement, were integrated. Users could adjust building positions and orientations easily, aiding urban planning. In summary, the system offered a comprehensive, efficient, and interactive platform for crafting, navigating, and understanding virtual urban spaces.The digital city management information system integrates diverse urban data for efficient exchange among departments. It supports 3D modeling, data connection, and seamless attribute integration during 3D scene exploration. Entropy weight method replaces Delphi for index weight calculation. Gray comprehensive evaluation measures audience satisfaction, creating an emotional measure for the municipal imaging network. Virtual reality boosts cultural awareness, with historical sites leading at 62.1% awareness. Urban image communication involves subjective selection and dissemination of urban development aspects. Urban culture undergoes historical and social filtering, giving it unique qualities. The analysis section examines system tests, road planning, urban planning, and collision detection optimization. It demonstrates the exceptional efficacy of the technologies used to create cityscape images in virtual reality.

5. Conclusion

The article deals with the function of the city's image in interaction, highlighting its impact on interactions with target audiences. It offered an infrastructure for an electronic city simulation framework that is separated into parts to cater to different needs. Model editing and reconstruction model, an apparatus for altering and converting information are introduced to adapt various data formats to the platform. The article emphasized the expanding importance of 3D visual simulation technology in urban construction and management. It also examined the development and application of VR contemporary planning for cities, citing collaborative software and technology analysis. Virtual reality technology was predicted to revolutionize urban planning and management methods, providing intuitive and realistic solutions. Additionally, it improved the sophistication, applicability, and cost of digital city creativity, making it more widely available for application.

References

[1] Guevara, L. and AuatCheein, F., 2020. The role of 5G technologies: Challenges in smart cities and intelligent transportation systems. Sustainability, 12(16), p.6469.

[2] Ahad, M.A., Paiva, S., Tripathi, G. and Feroz, N., 2020. Enabling technologies and sustainable smart cities. Sustainable cities and society, 61, p.102301.

[3] Zhao, L., Tang, Z.Y. and Zou, X., 2019. Mapping the knowledge domain of smart-city research: A bibliometric and scientometric analysis. Sustainability, 11(23), p.6648.

[4] Lau, B.P.L., Marakkalage, S.H., Zhou, Y., Hassan, N.U., Yuen, C., Zhang, M. and Tan, U.X., 2019. A survey of data fusion in smart city applications. Information Fusion, 52, pp.357-374.

[5] Gharaibeh, A., Salahuddin, M.A., Hussini, S.J., Khreishah, A., Khalil, I., Guizani, M. and Al-Fuqaha, A., 2017. Smart cities: A survey on data management, security, and enabling technologies. IEEE Communications Surveys & Tutorials, 19(4), pp.2456-2501.

[6] Berglund, E.Z., Monroe, J.G., Ahmed, I., Noghabaei, M., Do, J., Pesantez, J.E., KhaksarFasaee, M.A., Bardaka, E., Han, K., Proestos, G.T. and Levis, J., 2020. Smart infrastructure: a vision for the role of the civil engineering profession in smart cities. Journal of Infrastructure Systems, 26(2), p.03120001.0

[7] Tian, F., 2021. Immersive 5G virtual reality visualization display system based on big-data digital city technology. Mathematical Problems in Engineering, 2021, pp.1-9.

[8] Dong, H., Liang, X., Liu, Y. and Wang, D., 2022. 5G virtual reality in the design and dissemination of contemporary urban image systems under the background of big data. Wireless Communications and Mobile Computing, 2022.

[9] Michalik, D., Kohl, P. and Kummert, A., 2022. Smart

cities and innovations: Addressing user acceptance with virtual reality and Digital Twin City. IET Smart Cities, 4(4), pp.292-307.

[10] Minoli, D. and Occhiogrosso, B., 2019. Practical aspects for the integration of 5G networks and IoT applications in smart cities environments. Wireless Communications and Mobile Computing, 2019.

[11] Chen, J., Ramanathan, L. and Alazab, M., 2021. Holistic big data integrated artificial intelligent modeling to improve privacy and security in data management of smart cities. Microprocessors and Microsystems, 81, p.103722.

[12] Mishra, P., Thakur, P. and Singh, G., 2022. Sustainable Smart City to Society 5.0: State-of-the-Art and Research Challenges. SAIEE Africa Research Journal, 113(4), pp.152-164.

[13] Ismail, L. and Buyya, R., 2022. Artificial intelligence applications and self-learning 6G networks for smart cities digital ecosystems: Taxonomy, challenges, and future directions. Sensors, 22(15), p.5750.

[14] Siriwardhana, Y., Porambage, P., Liyanage, M. and Ylianttila, M., 2021. A survey on mobile augmented reality with 5G mobile edge computing: Architectures, applications, and technical aspects. IEEE Communications Surveys & Tutorials, 23(2), pp.1160-1192.

[15] Ahmad, H.F., Rafique, W., Rasool, R.U., Alhumam, A., Anwar, Z. and Qadir, J., 2023. Leveraging 6G, extended reality, and IoT big data analytics for healthcare: A review. Computer Science Review, 48, p.100558.

[16] Mei Chen, Machine Learning for Energy Optimization in Smart Grids , Machine Learning Applications Conference Proceedings, Vol 2 2022

[17] Krishna, K. S. ., Satish, T. ., & Mishra, J. . (2023). Machine Learning-Based IOT Air Quality and Pollution Detection. International Journal on Recent and Innovation Trends in Computing and Communication, 11(2s), 132–145. https://doi.org/10.17762/ijritcc.v11i2s.6036

[18] Dhabliya, D. Delay-Tolerant Sensor Network (DTN) Implementation in Cloud Computing (2021) Journal of Physics: Conference Series, 1979 (1), art. no. 012031