

Research on 3D Visualization of Ports Based on Unreal Engine

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Abstract: This article conducts research on 3D visualization of container ports based on Blender and Unreal Engine software, achieving accurate 3D modeling and realistic scene construction of container ports. Firstly, using the powerful modeling capabilities of Blender software, we refined the modeling of key elements such as containers, quayside cranes, and container trucks to ensure the accuracy of the model in terms of geometric structure and texture details. Secondly, the built model was imported into Unreal Engine 5, and its advanced real-time rendering technology and physics engine were used to build a highly realistic container port scene that included time changes and weather simulation. Through this research, we not only provide an intuitive 3D visualization tool for the design, planning, and management of container ports, but also provide an efficient and practical 3D scene construction method for researchers and engineers in related fields, providing a new situation for port planning, construction, display, management, and other aspects.

Keywords: Unreal engine, blender, 3D simulation, visualization.

1. Introduction

With the acceleration of global economic integration, the role of ports as an important hubs connecting domestic and foreign trade has become increasingly prominent. In order to adapt to the competition in the international shipping market and improve the comprehensive service capacity of ports, China's ports are facing the pressure and opportunities of transformation and upgrading. The "One Belt, One Road" initiative and the "maritime power" strategy proposed by the Chinese government have provided strong policy support for port construction and development[1, 2]. In this context, it has become an urgent need to improve the planning, construction, operation and management level of ports. In recent years, the cargo throughput and container throughput of Chinese ports have continued to grow, which has brought great challenges to the operation and management of ports. Traditional management methods can no longer meet the requirements of high efficiency, safety and environmental protection of modern ports. With the development of information technologies such as cloud computing, big data, Internet of Things, and three-dimensional visualization, the application of these advanced technologies to port management has become a key means to enhance the competitiveness of ports.

In the early stages of port construction, a 3D rendering engine can help designers and decision-makers understand the design more intuitively, and can better evaluate its aesthetics and usability. It is convenient for the project to be

displayed, so that investors, managers and other stakeholders can understand the whole picture of the project more clearly and intuitively. It is convenient for education and training, so that the port staff can be familiar with the working environment even if they are not on site, which greatly improves the work efficiency. It also plays an important role in construction guidance, safety management, operation management, etc.

2. Visualisation Platform

2.1. 3D Modelling Platform

Modeling software is a computer program used to create 3D models, widely used in many fields such as architecture, industrial design, game development, movie, medical simulation, scientific research and education. At present, the common 3D modeling software mainly includes 6 types, i.e., 3ds Max, ZBrush, Maya, Cinema 4D, Brener and Nomad, with the functions of modeling, carving, material, rendering, animation, etc. Among them, 3Dmax, ZBrush and Maya are difficult to get started, the copyrighted software of Cinema 4D needs to be used for payment, and the rendering speed is greatly affected by the display card. Brener not only has all the functions of the above software, but also has moderate entry difficulty, open source, small memory occupied by the software itself, fast rendering speed and many plugins [3]. So, I chose Brener as my modeling software. The following four models are compared, see Table 1.

Table 1. Comparison of four 3D modeling software

	3ds Max	Maya	ZBrush	Blender
Open source or not	No	No	No	Yes
Fee	Paid	Paid	Paid	Free
Difficulty level	Fairly difficult	Fairly difficult	Simplicity	Simplicity
Fuctional area	Construct	Film and television	Sculpture	Modeling, Sculpture, Film and television editing

2.2. Modelling

The container port is mainly composed of berthing

facilities, wharf apron, container storage yard, container cargo terminal, control tower, wharf office building, etc. This paper

mainly models and simulates key equipment such as container ship, shore bridge and container truck, see Fig. 1.

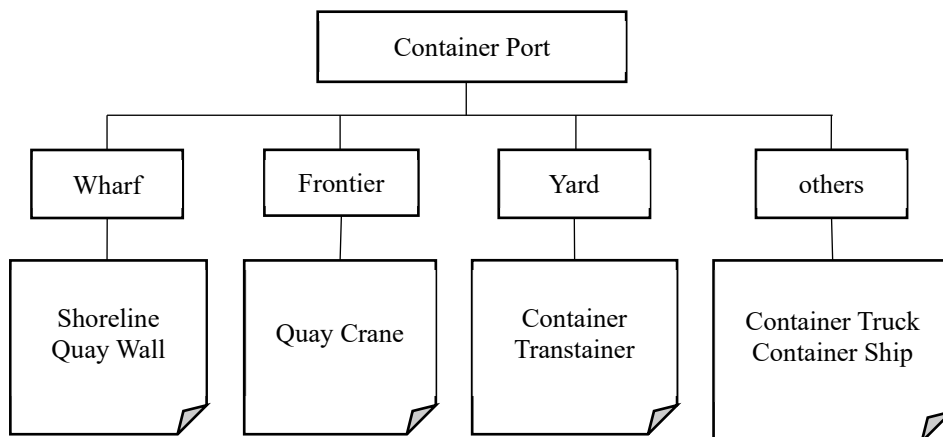


Figure 1. Container port facility

The modeling software in this paper is Brender4.2, which models various models required by container port. Symmetric objects can be added with a "mirror" modifier, which requires only one-half or one-quarter of the object to be modeled. For example, for container modeling, one-quarter of the object

can be modeled and then mirrored along the X and Y axes respectively to model the entire container. The same is true for other models, which not only saves time, but also greatly improves modeling efficiency. The main model of container port References, see Fig. 2.

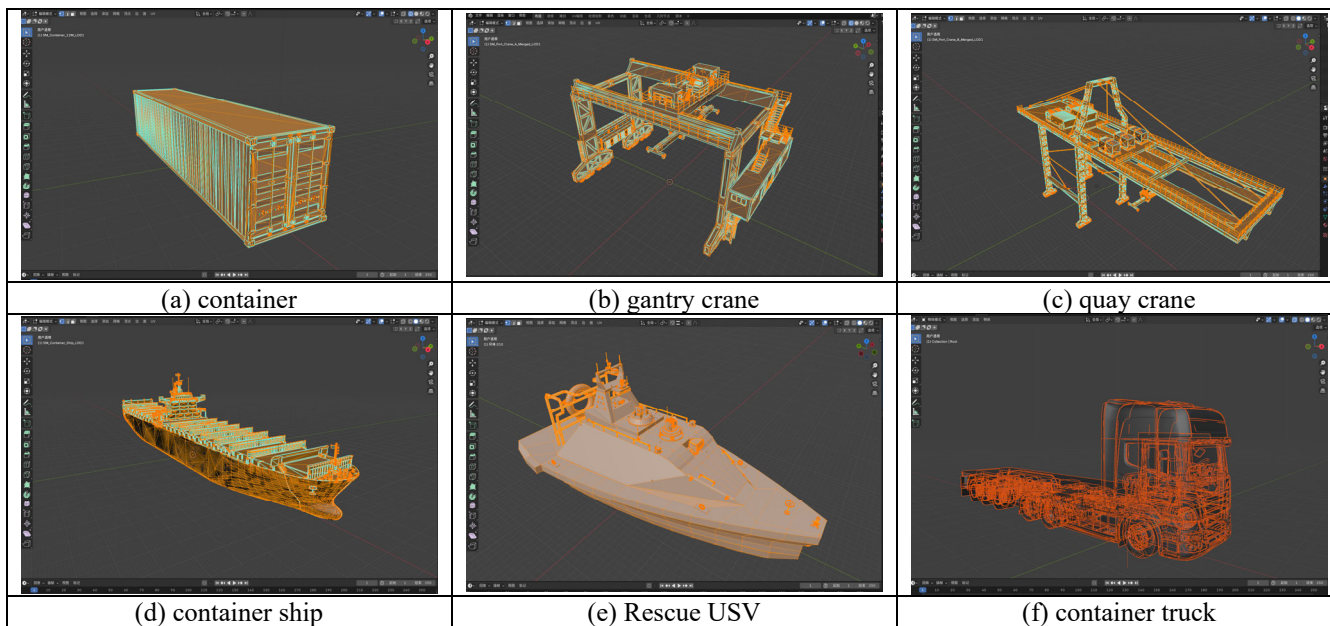


Figure 2. Model display of container port

To make the modeled container more realistic, the container model was UV unfolded so that the material was individually edited for each part of the container, making the

traces that had been used rather than a completely new, seemingly unrealistic state. The UV spread of the container, see Fig. 3.

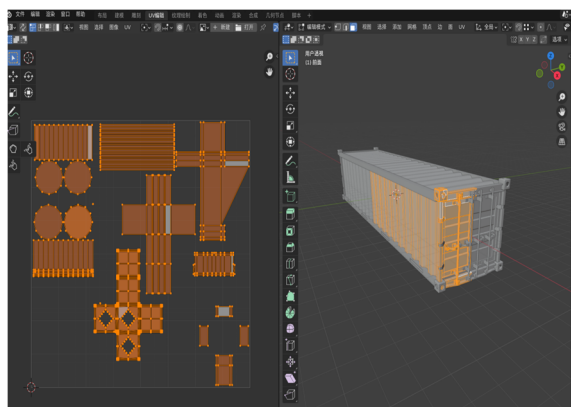


Figure 3. UV deployment of container

2.3. Virtual Simulation Platform

At present, common 3D rendering engines mainly include Open Scene Graph, Unity 3D, Unreal Engine 5, etc. [4-6]. Unreal Engine 5 (hereinafter referred to as UE5) is the most famous and most widely authorized top game engine in the world launched by Epic Games. UE5 is one of the most widely used third-party game development engines currently. It is mainly used in mainstream platforms such as Windows, iOS and PS4. Static global illumination technology (Lumen) is introduced based on the previous version, which can produce more accurate illumination effects in real-time rendering; A more inclusive, imaginary texture system

(Nanite) that handles large scale high detail models without the need for pre-splitting or low polygon approximation; The new animation system (Livelihood) enables the animation artists and developers to work together more closely, preview and edit character animation in real time; Smarter tools and blueprint systems; Support cross-platform development on PC, mobile and virtual reality devices.

UE5 provides game developers and creators from all walks of life with more free, more fidelity, and more flexible sub-generation real-time 3D content and experience. This year's most popular "Dark Myth·Wukong" is made with UE5. Comparison with other 3D rendering software, see Table 2.

Table 2. 3D rendering engine comparison

	Open Scene Graph	Unity 3D	UE5
Programming Language	C++	JavaScript、C#	C++、Blueprint
Learning difficulty	Less data, Code compilation by oneself, Great learning difficulty	More data, paid use	Complete official learning documents
Feature	Cross-platform, excellent rendering performance	Cross-platform, many connectors	Cross-platform, real-time rendering, Blueprint development, many plugins

Based on the comparison of the above 3D rendering engine software, UE5 is selected as the visual simulation platform of container terminal to complete the modeling and simulation work.

then import it into UE5 to add collision box to prepare for perfect interactive operation in the scene in the later period. Then add corresponding maps to the modeling object to make the model closer to reality, so as to achieve the effect of realistic simulation. The imported model, see Fig. 4.

2.4. Import Unreal Engine

Export the completed model in Brener 4.2 FBX format, and

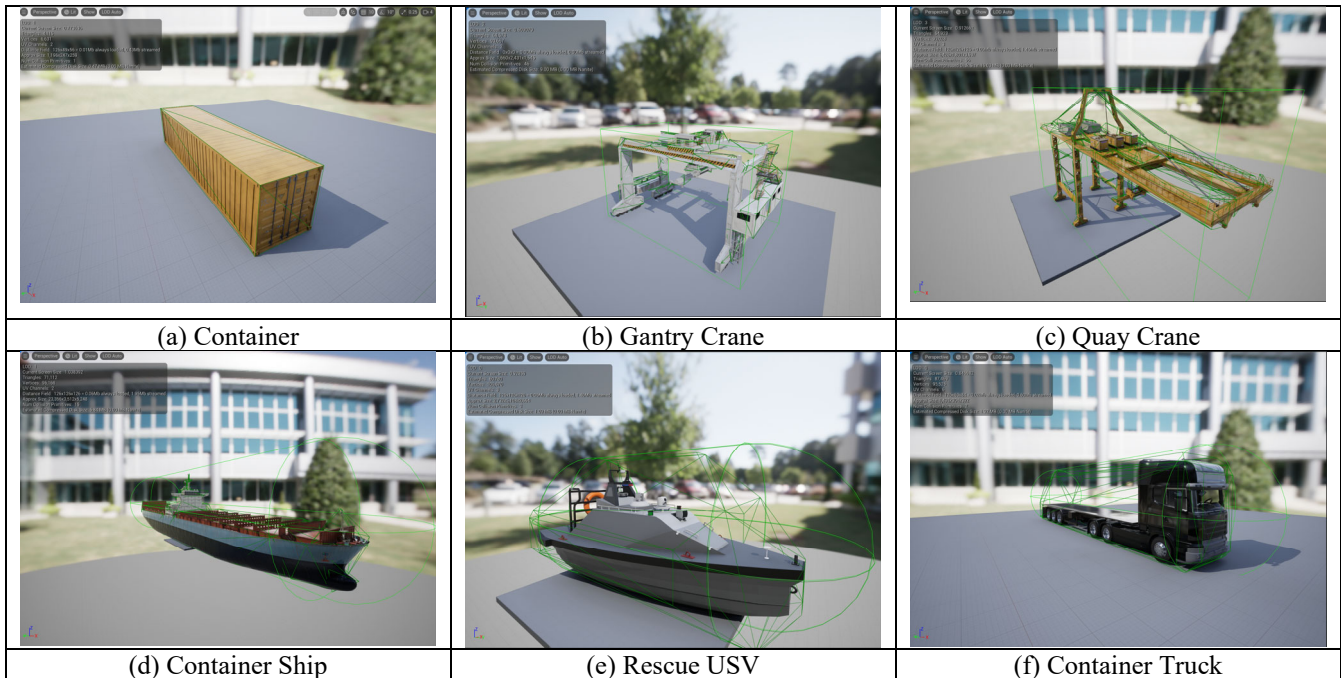


Figure 4. Model imported into UE5

Export the model processed by Brener and import it into UE5 for scene setup. Mainly add marine, time, weather and

other environmental elements. The completed port scene, see Fig. 5.

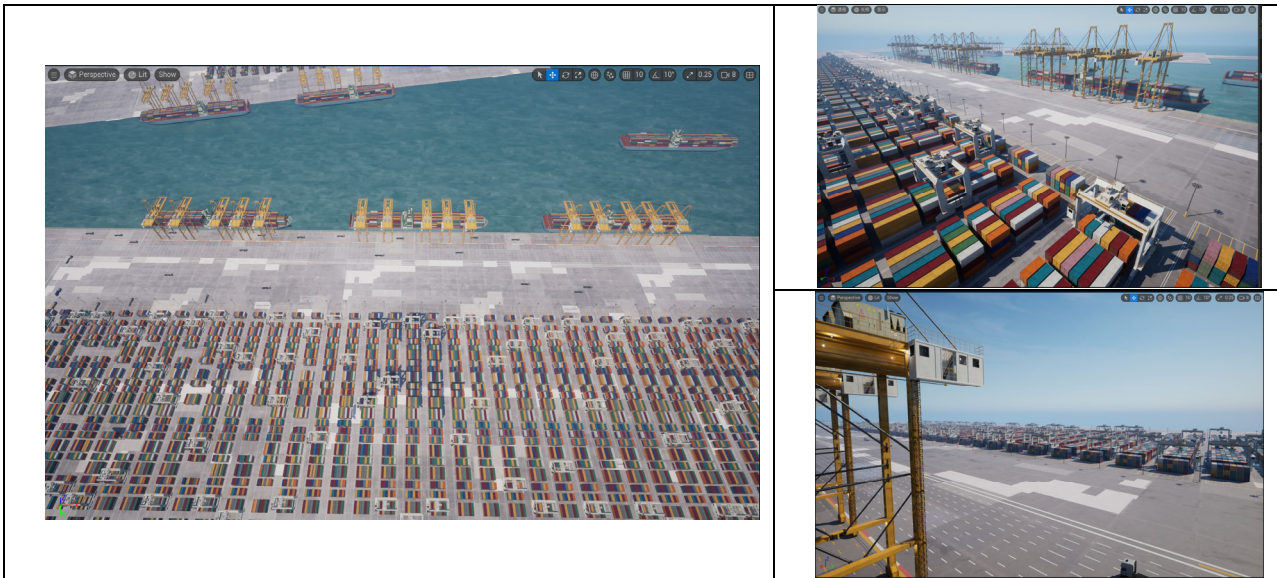


Figure 5. Container Port Scenario

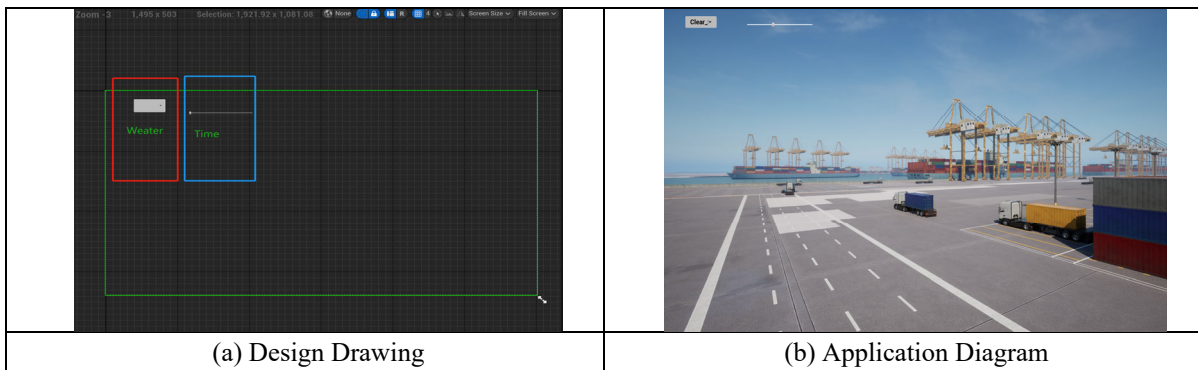
3. Introduce Time and Weather Systems

3.1. Control Interface

This article uses the UltraDynamySky plug-in from the Mirage Mall, a dynamic sky plug-in designed for UE5, to simulate the time and weather conditions of the container port. The core feature of this plug-in is its realistic dynamic sky effect, which can add vivid visual effects to projects such as game development, virtual reality or architectural

visualization. The parameters of the sky can be adjusted freely according to the requirements of the developer. The interface is simple and intuitive and can be quickly used.

To use the UltraDynamySky plug-in, firstly delete the existing default light in the scene, so that the effect of the plug-in can be displayed correctly. Secondly, design the control blueprint, select ComboBox (String) control to design the button menu for switching weather, select Slider control to design the operation control of sliding change time, and finally add the control blueprint and Actor blueprint to the scene. See Fig. 6.



(a) Design Drawing

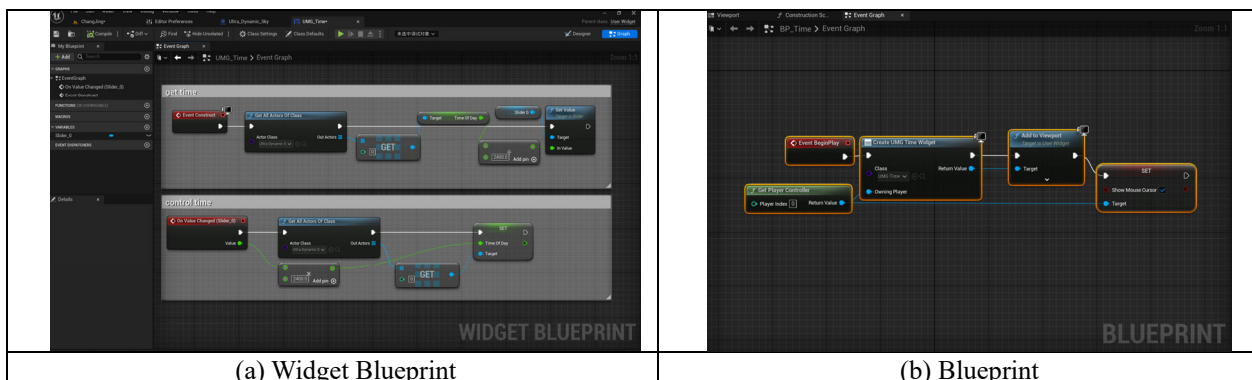
(b) Application Diagram

Figure 6. Operating controls

3.2. Time System

The time change can be adjusted by manually adjusting the

slider, so that the effect can be seen quickly. It can also be carried out in a minute by second manner like the real time. The specific time blueprint, see Fig. 7.



(a) Widget Blueprint

(b) Blueprint

Figure 7. Time blueprint

The scenes of four periods are briefly presented, (a), (b), (c) and (d) are 5:00 a.m., 6:00 a.m., 12:00 a.m. and 8:00 p.m. in

Chinese, see Fig. 8.

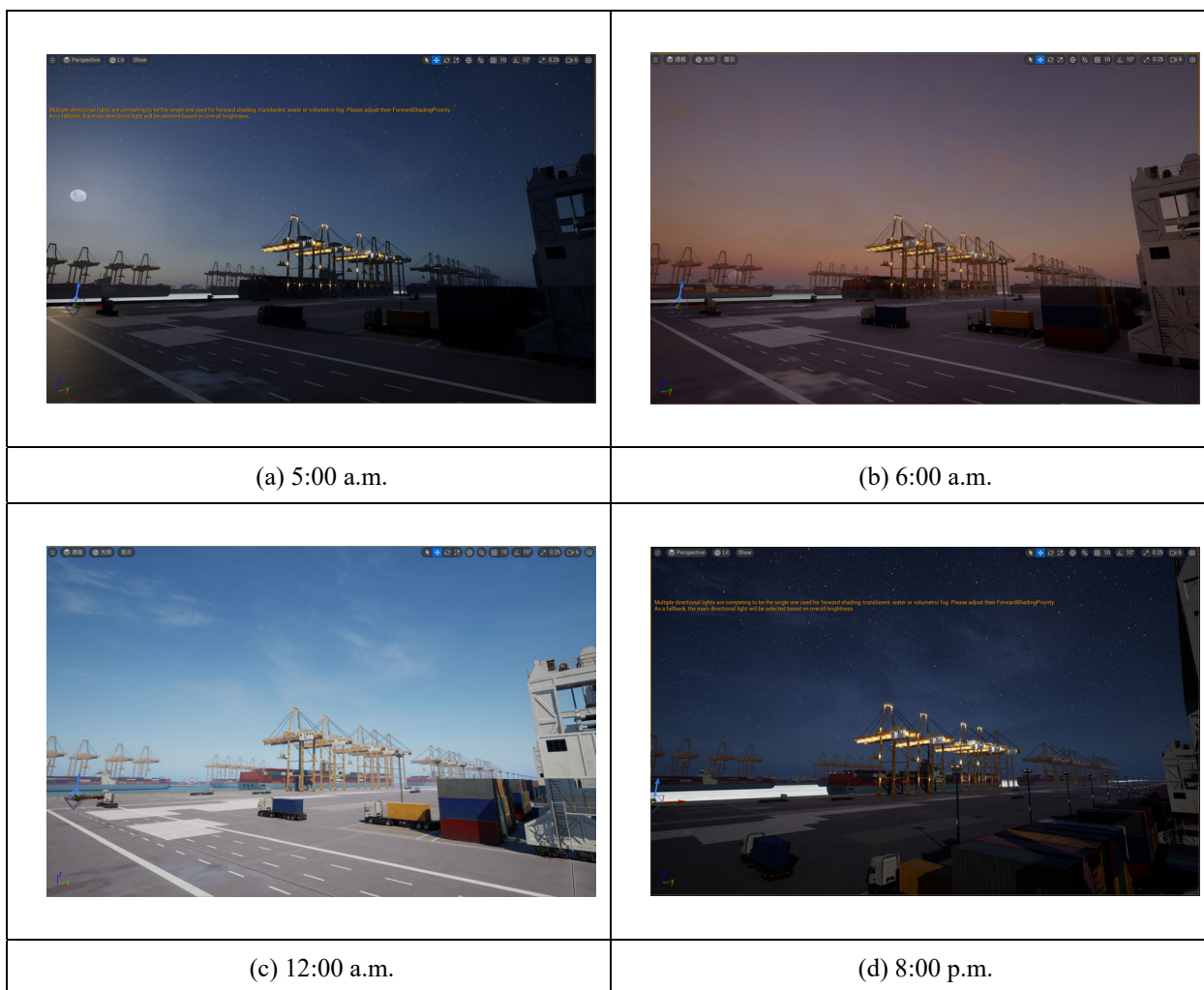


Figure 8. Example of time

3.3. Weather System

UltraDynamic Sky plug-in includes 13 kinds of weather in

total. Edit the control blueprint and set 13 kinds of weather changes to ComboBox (String) control. The weather control blueprint see Fig. 9 and the weather example see Fig. 10.

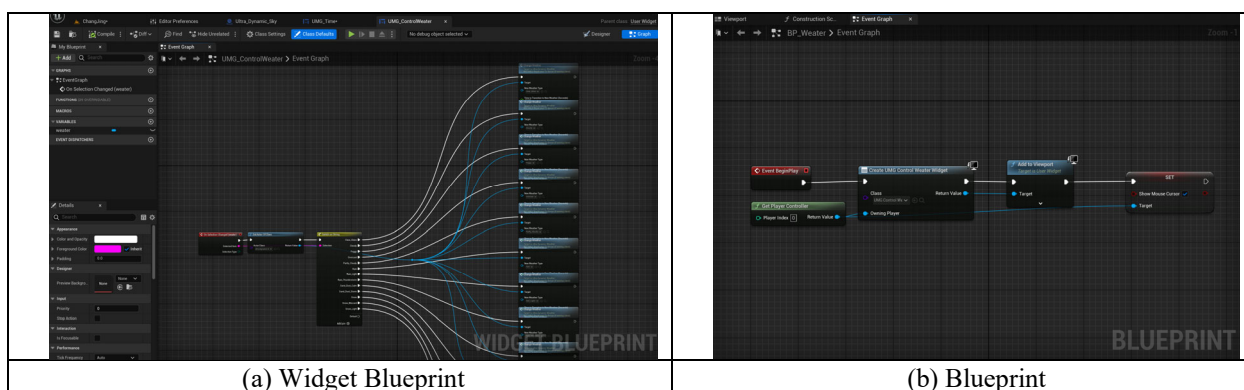


Figure 9. Control blueprint

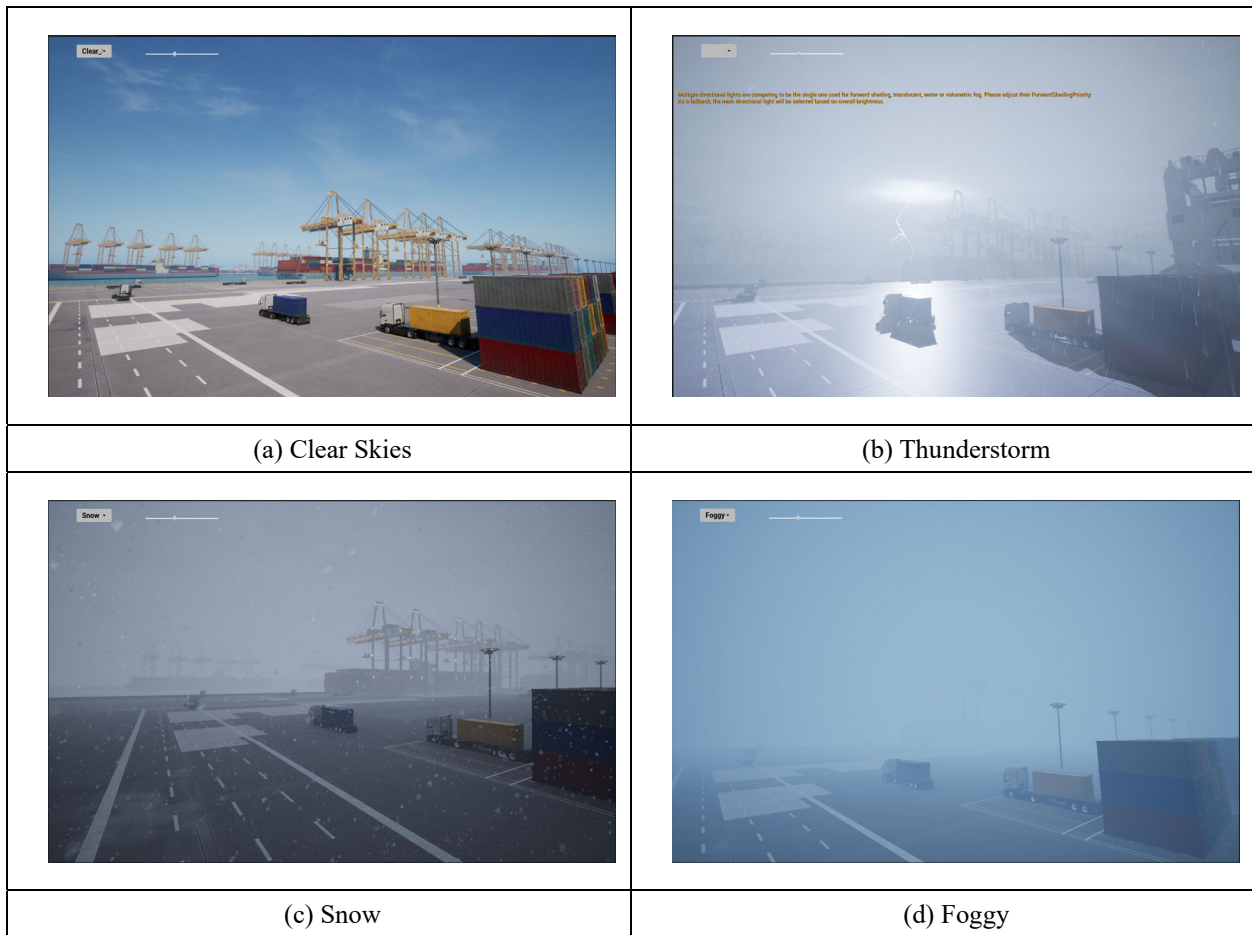


Figure 10. Example of weather

4. Conclusion

In this paper, a detailed 3D model of the container port facility is established by using the Brener software, and a container port scene is established by using UE5. Meanwhile, time and weather changes are added to realize the 3D visualization rendering of the container port. The results show that these tools have a significant impact on creating accurate and interactive representations of complex infrastructures. The established 3D model and visualization not only deepen the understanding of port operation, but also provide valuable platform for planning, management and training, and provide a good example for other aspects of visualization.

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