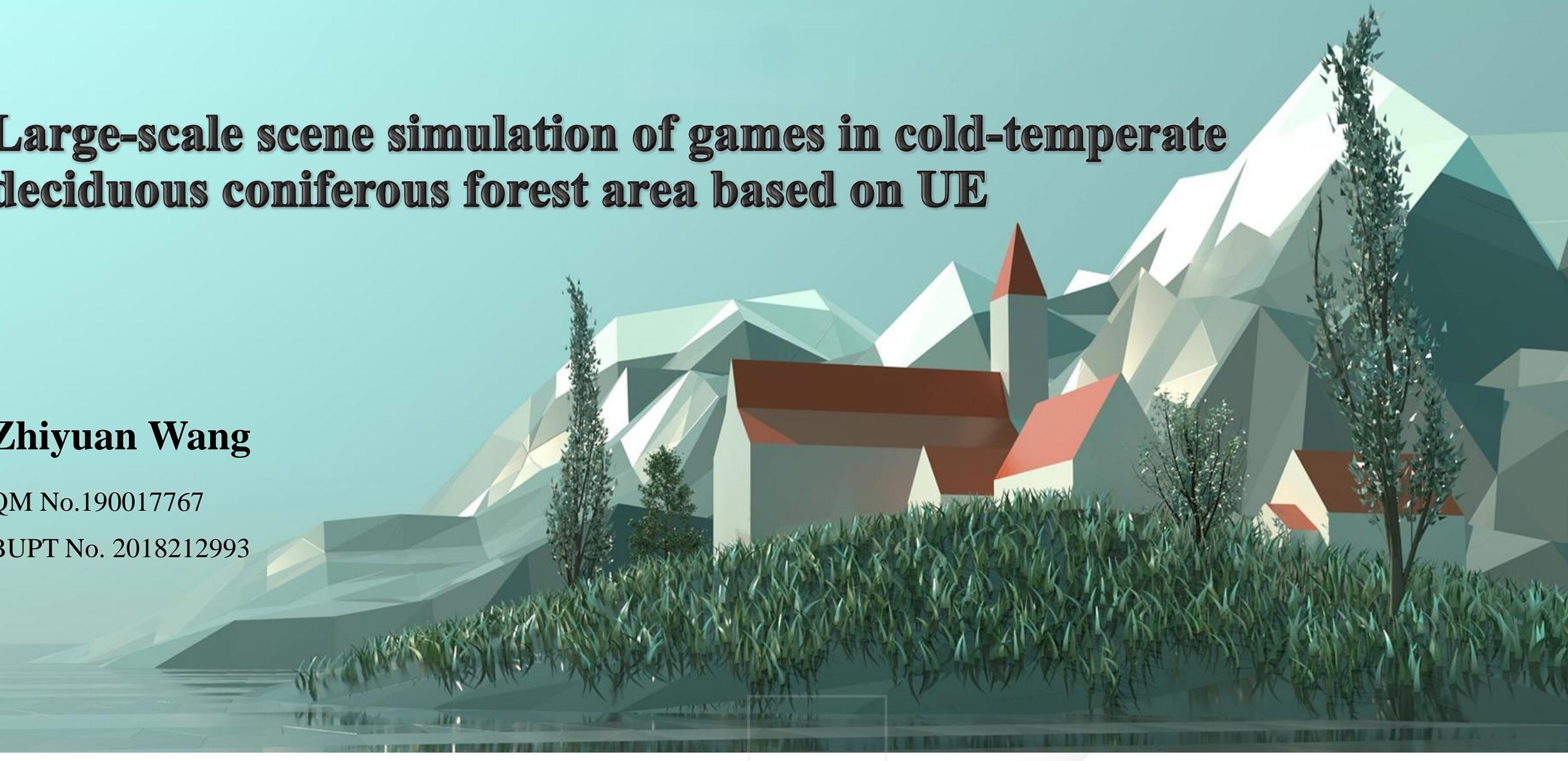


Large-scale scene simulation of games in cold-temperate deciduous coniferous forest area based on UE

Zhiyuan Wang

QM No.190017767

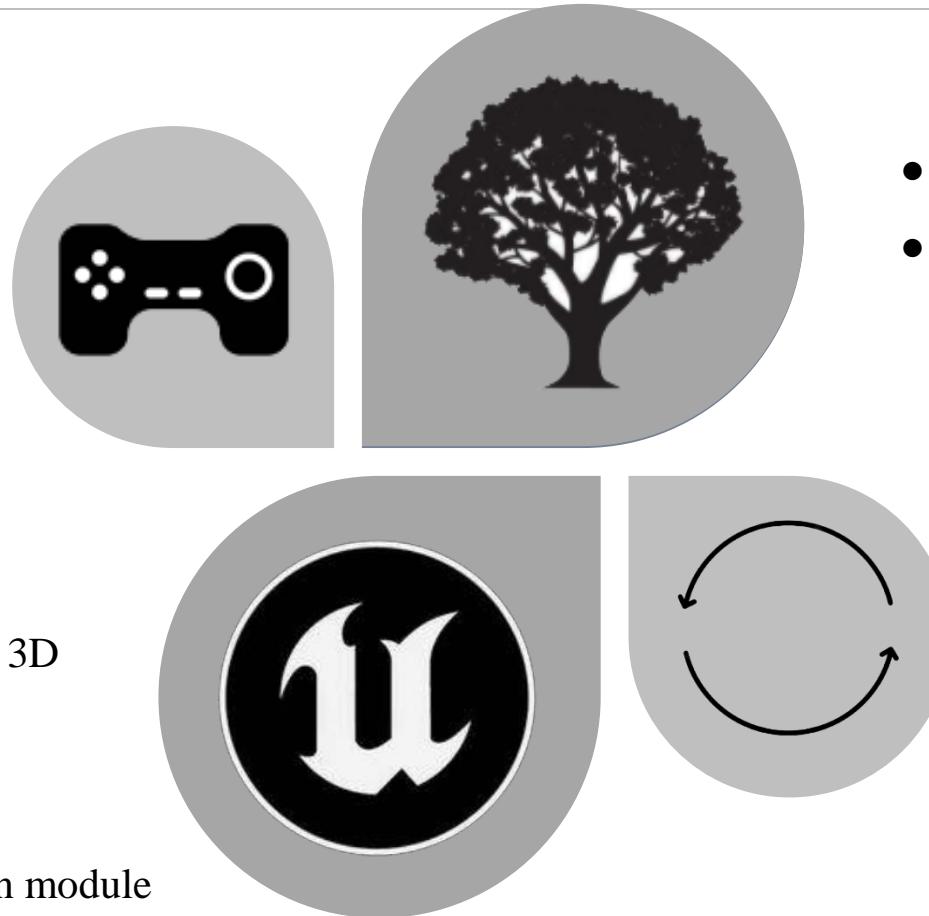
BUPT No. 2018212993



Background

Next-Gen Game

- Next-generation games refer to games that are more advanced than similar games.
- China's game market will reach 278.6 billion in 2020



Unreal Engine

- The Chinese game market lacks a 3D environment construction process integrated into the game engine.
- Through the program scene design module of unreal engine, this study constructed a complete automatic blueprint of cold zone and established a perfect vegetation covers.

Cold temperate zone

- Long and cold winters, short warm summers
- The representative of the cold temperate zone in China, the Greater Khingan Mountains, mainly studies the mixed forest of coniferous and broad-leaved in the cold zone.

Procedural Content Generation

- Procedural Generation (PCG)
- An area is automatically generated using the laws of physical geography, which is the basis of open world games.
- PCG is one of the core technologies of next-generation games.

Research Flow Chart

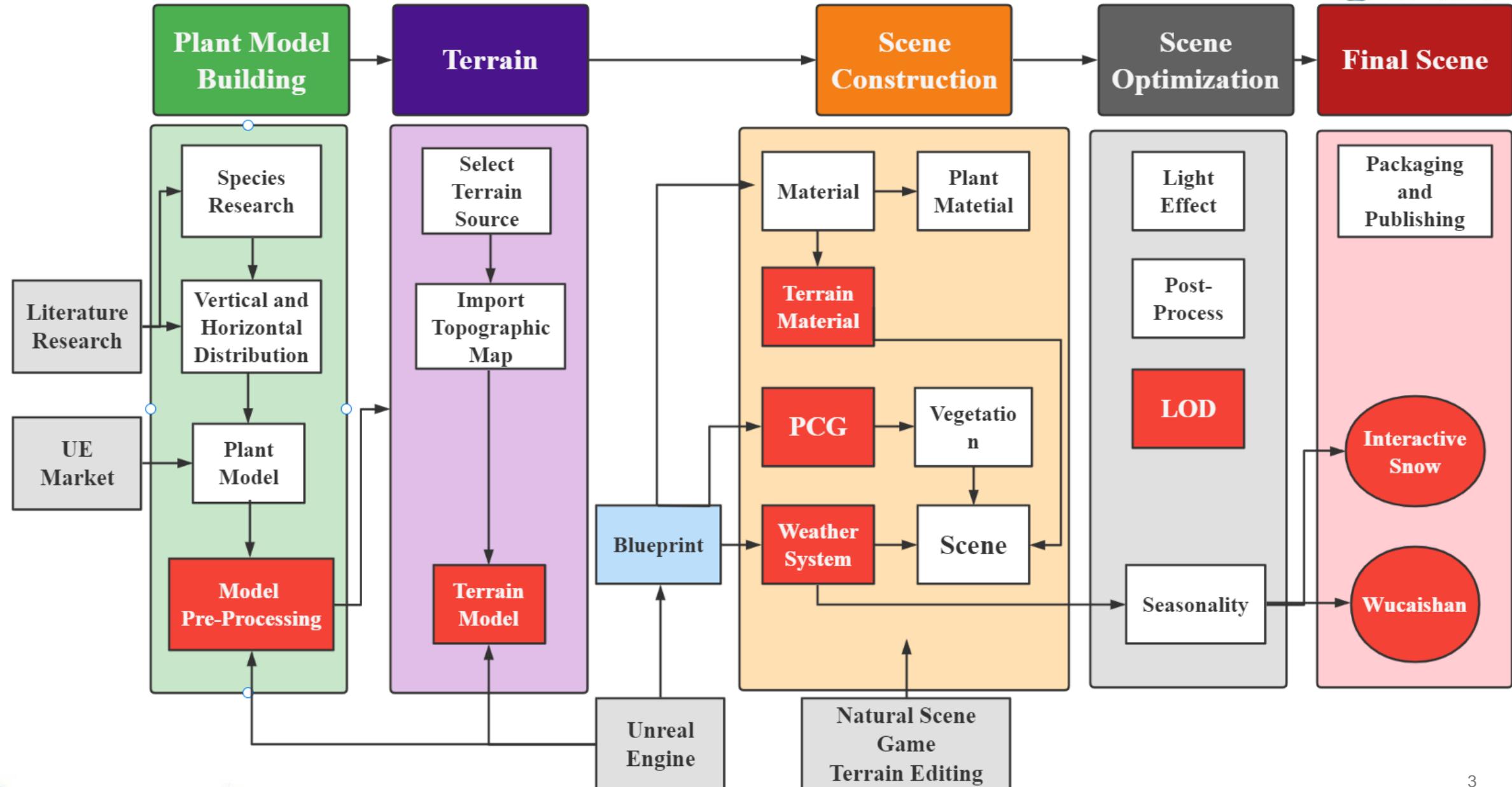


Figure 3.1 Research flow chart

Plant Model Building



Figure 4.1 Schematic diagram of all assets

Plant Model Building-Forest

Forest: Three vegetation subtypes

- **Coniferous forest:** Xing'an larch forest
- **Coniferous and broad-leaved mixed forest:** the mixed forest of Xing'an larch and white birch is only the transitional vegetation type in this area.

Table 3.2.1: Tree Type Table

Tree Type	Latin name	Forest Type
White Birch	<i>Betula platyphylla</i>	Broadleaf forest
Xing'an Larch	<i>Larix gmelinii</i>	Coniferous forest, mixed coniferous and broad-leaved forest
Black Alder	<i>Alnus cremastogyne Burk</i>	Broad-leaved forest, mixed coniferous and broad-leaved forest
Spruce	<i>Picea asperata Mast</i>	Broad-leaved forest, mixed coniferous and broad-leaved forest

- **Broad leaved forest:**
- white birch forest, and small-area black alder forest.



Figure 5.1 Tree table

Plant Model Building

-Grassland

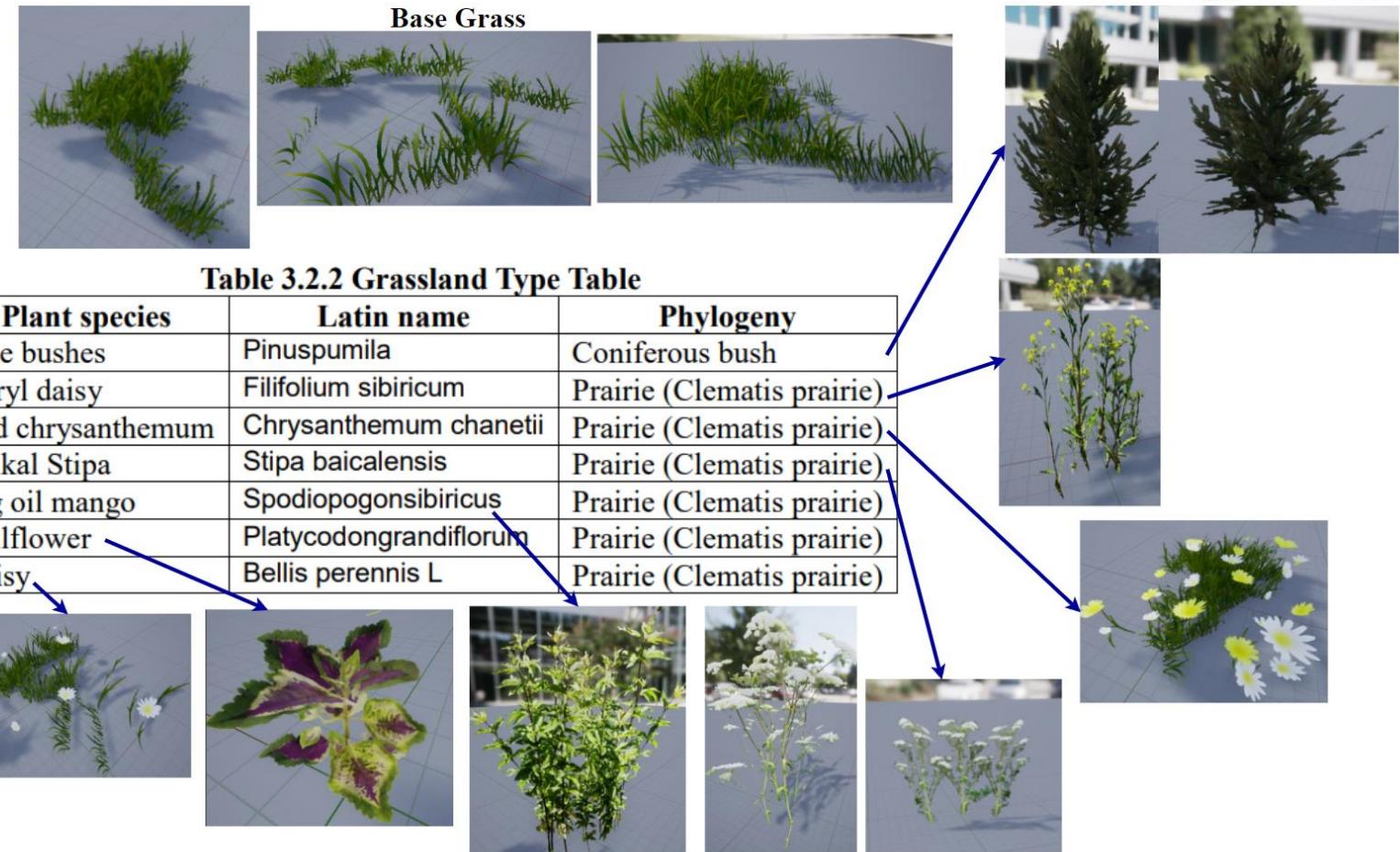
Shrub: Coniferous shrub,
including 2 clusters:
thinopyrus shrub and
Xing'an juniper shrub.

Grassland: thread leaf
chrysanthemum grassland,
Xing'an thyme grassland

Base Grass

Table 3.2.2 Grassland Type Table

Plant species	Latin name	Phylogeny
Pine bushes	<i>Pinuspumila</i>	Coniferous bush
Xeryl daisy	<i>Filifolium sibiricum</i>	Prairie (Clematis prairie)
Red chrysanthemum	<i>Chrysanthemum chanetii</i>	Prairie (Clematis prairie)
Baikal Stipa	<i>Stipa baicalensis</i>	Prairie (Clematis prairie)
Big oil mango	<i>Spodiopogon sibiricus</i>	Prairie (Clematis prairie)
Bellflower	<i>Platycodon grandiflorum</i>	Prairie (Clematis prairie)
Daisy	<i>Bellis perennis L</i>	Prairie (Clematis prairie)



Rose-hips



Figure 6.1 Grassland table

Landscape

Terrain elevation

Information points with elevation values - peaks, saddles and valleys, rivers, roads

Terrain selection

The size of the terrain: the corresponding real map is 8129m*8129m. Use **Google Earth** to do a terrain search.

The terrain is mostly gentle with slopes and is easy to stratify vegetation, including mountains, plains and two rivers.

Real terrain altitude source

Accuracy takes precedence. When selecting an elevation source, exclude sources based on the principle of precision first.

Topographic elevation map processing

The downloaded .geotiff file cannot be directly imported into UE, which requires preprocessing of the downloaded terrain elevation map. **TerreSculptor** software was used in this study, and the final output was 16-bit grayscale output (16-bit grayscale) to generate .png files.

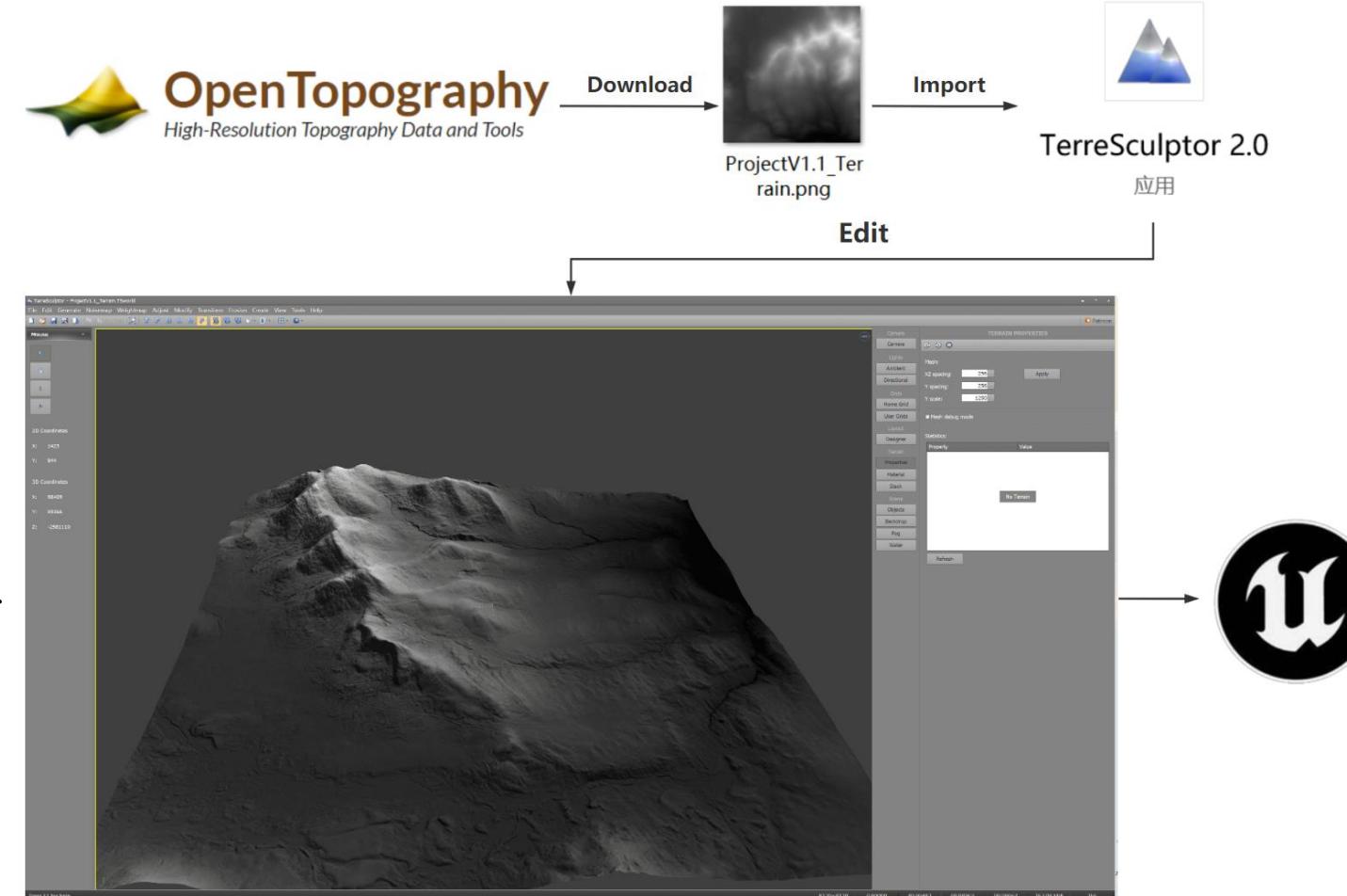


Figure 7.1 Terrain Generation Flowchart

Scene Construction

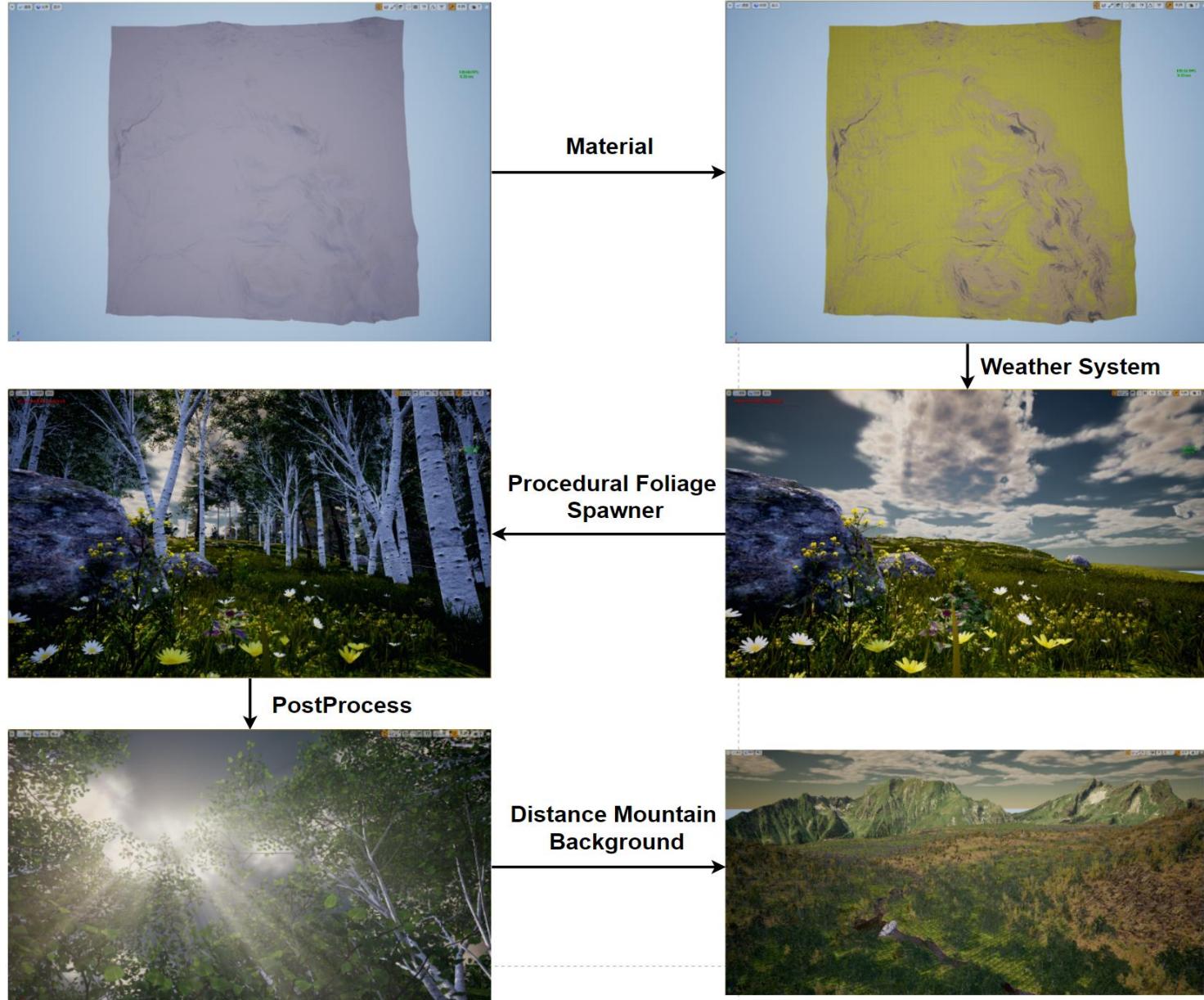


Figure 8.1 Scene structure example

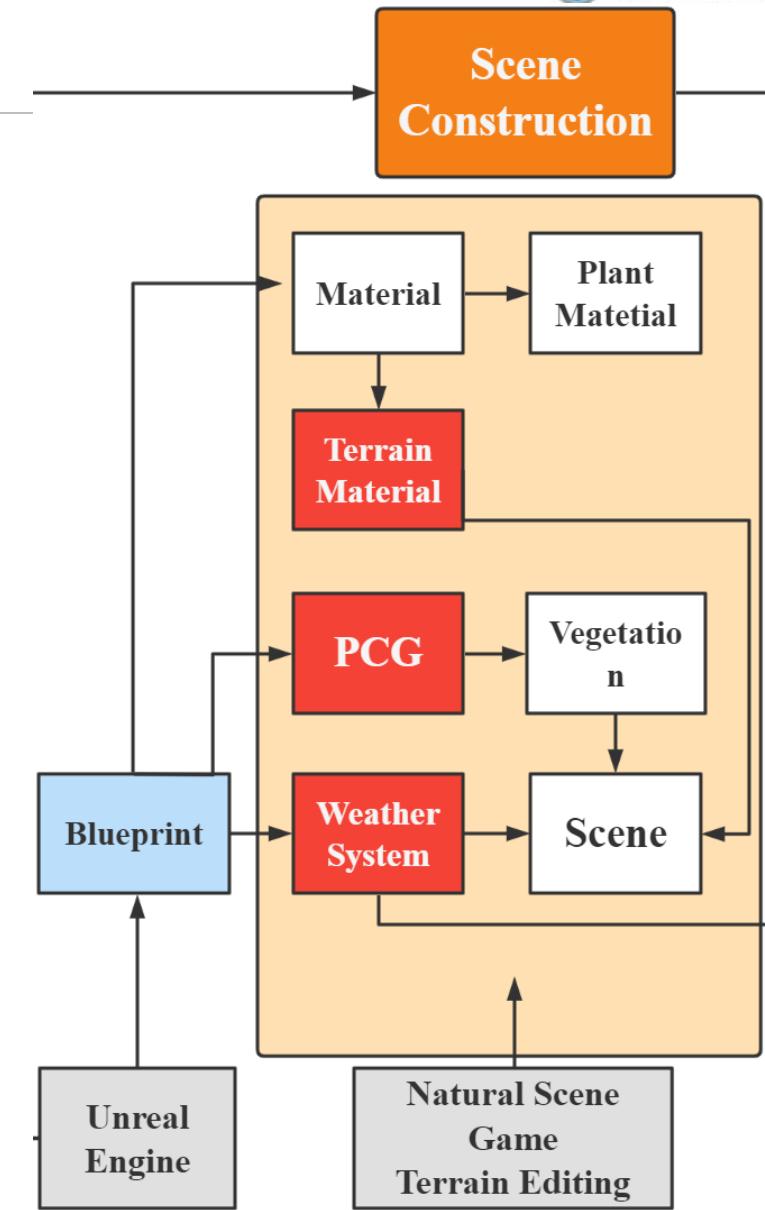


Figure 8.2 Scene construction flow chart

Difficulties in scene construction - Terrain material function

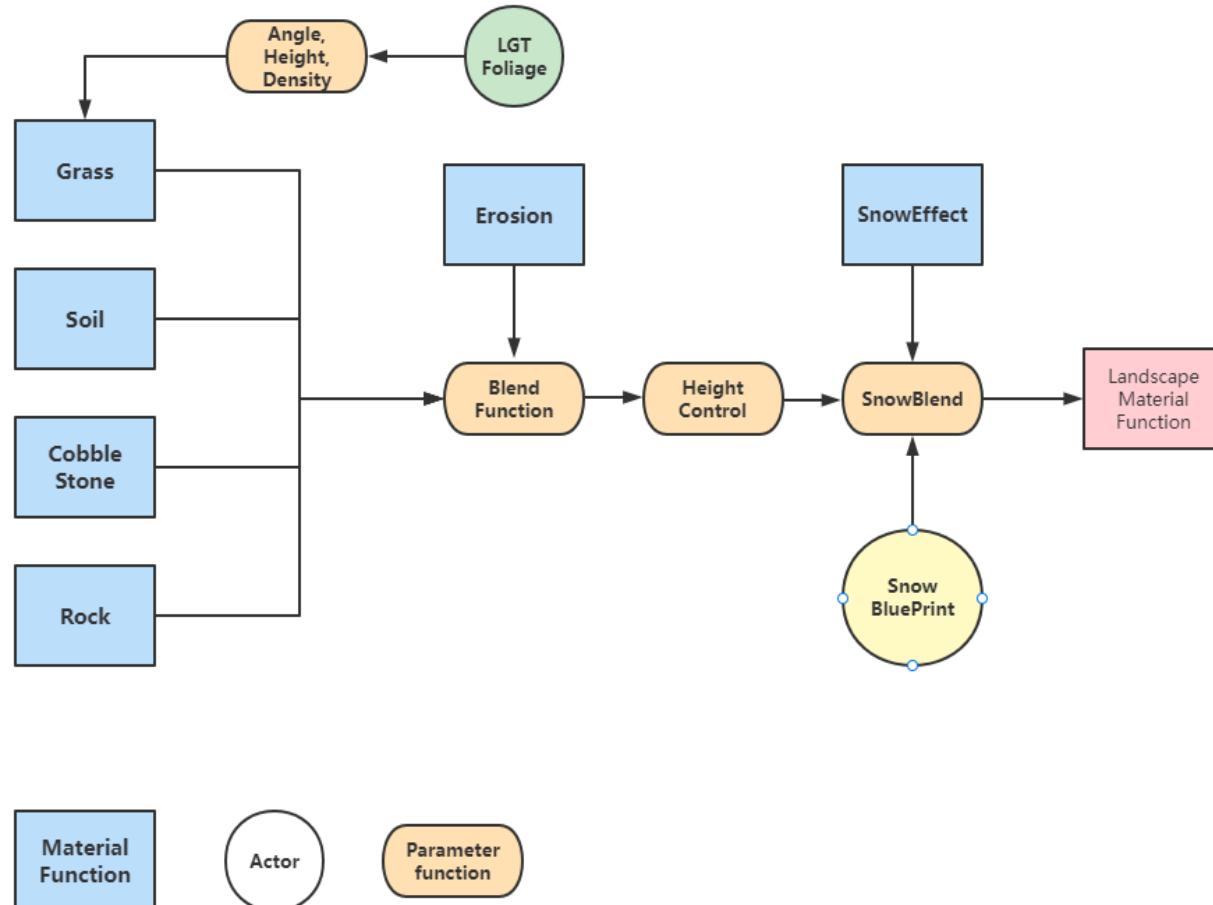


Figure 9.1 Landscape Material Function panel in *White Birch*

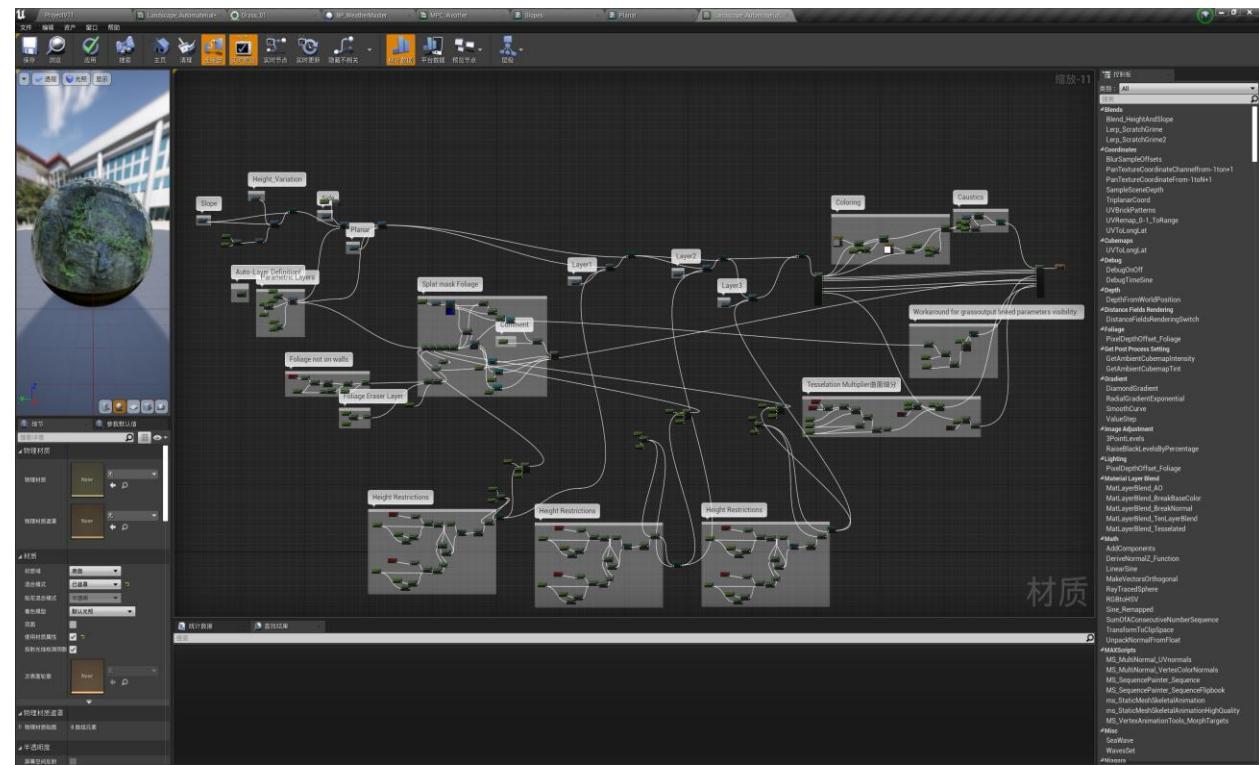


Figure 9.2 Landscape Material Function panel in *White Birch*

Difficulties in scene construction - Terrain material function

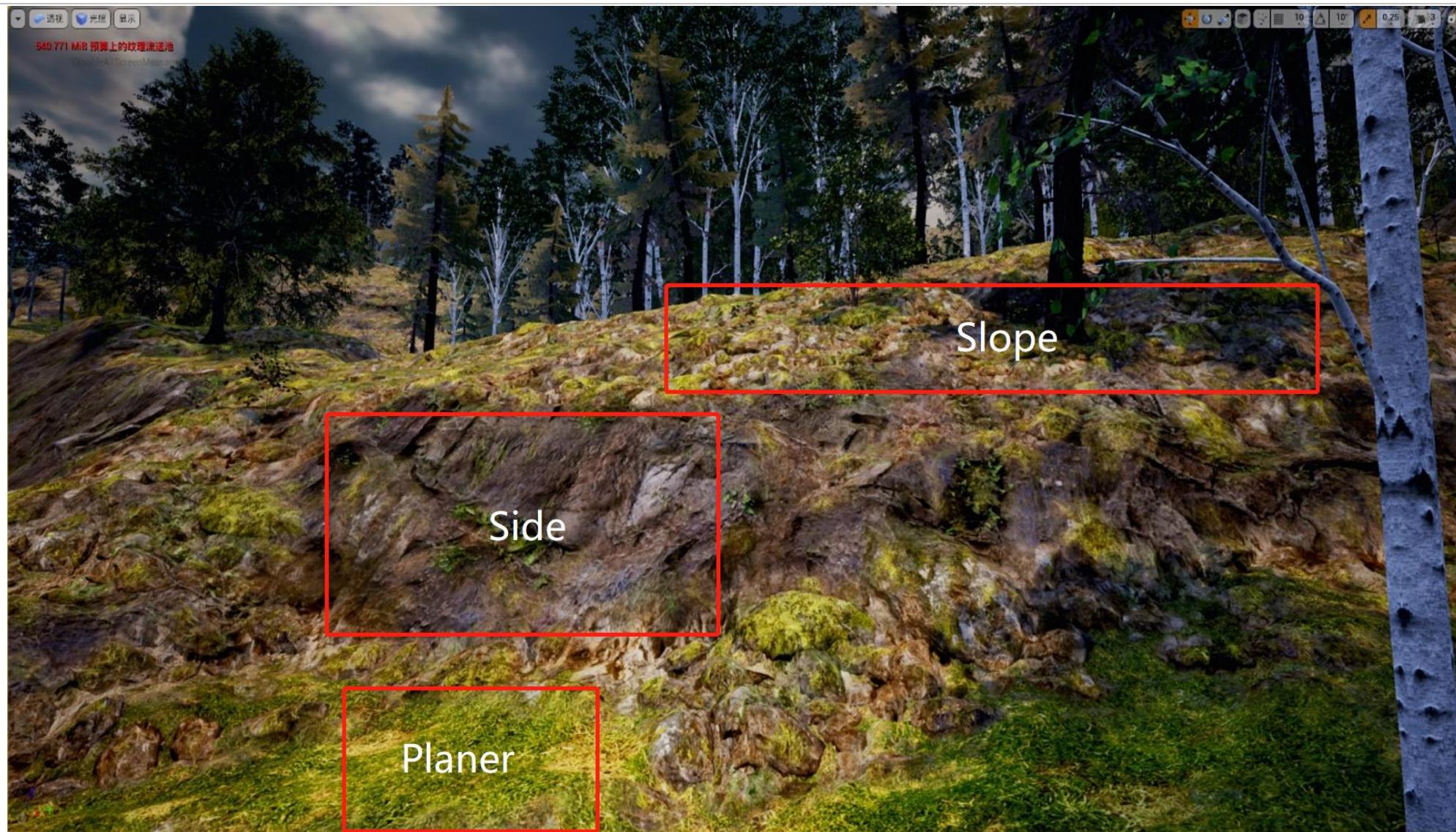


Figure 10.1 Terrain material layering

Scene optimization-LOD

LOD stands for
Level Of Detail

LOD technology refers to determining the resource allocation of scene rendering according to the **position** and **importance of the nodes** of the object model in the display scene, so as to obtain efficient rendering operations.

Table 3.8.1 LOD

LOD Layers	Screen Size	Triangles	Vertices
LOD 0	(0.99,5]	423,509	439,689
LOD 1	(0.8,0.99]	203,065	259,446
LOD 2	(0.4,0.6]	143,457	204,793
LOD 3	(0.3,0.4]	50,491	59,268
LOD 4	(0.15,0.3]	28,020	37,956
LOD 5	(0.15,0.3]	7,111	9,054
LOD 6	(0,0.15]	9	9



Scene optimization- Cull distance

When the camera is **far enough** away from a mesh component, the mesh component can be considered **unimportant** and therefore culled.

Mesh components are automatically culled from the scene after a **certain distance** from the camera, saving computational performance.

The mesh starts to cull gradually when it reaches the start culling distance, and completely culls when it reaches the end culling distance of 0, resulting in a smooth scene gradient effect.

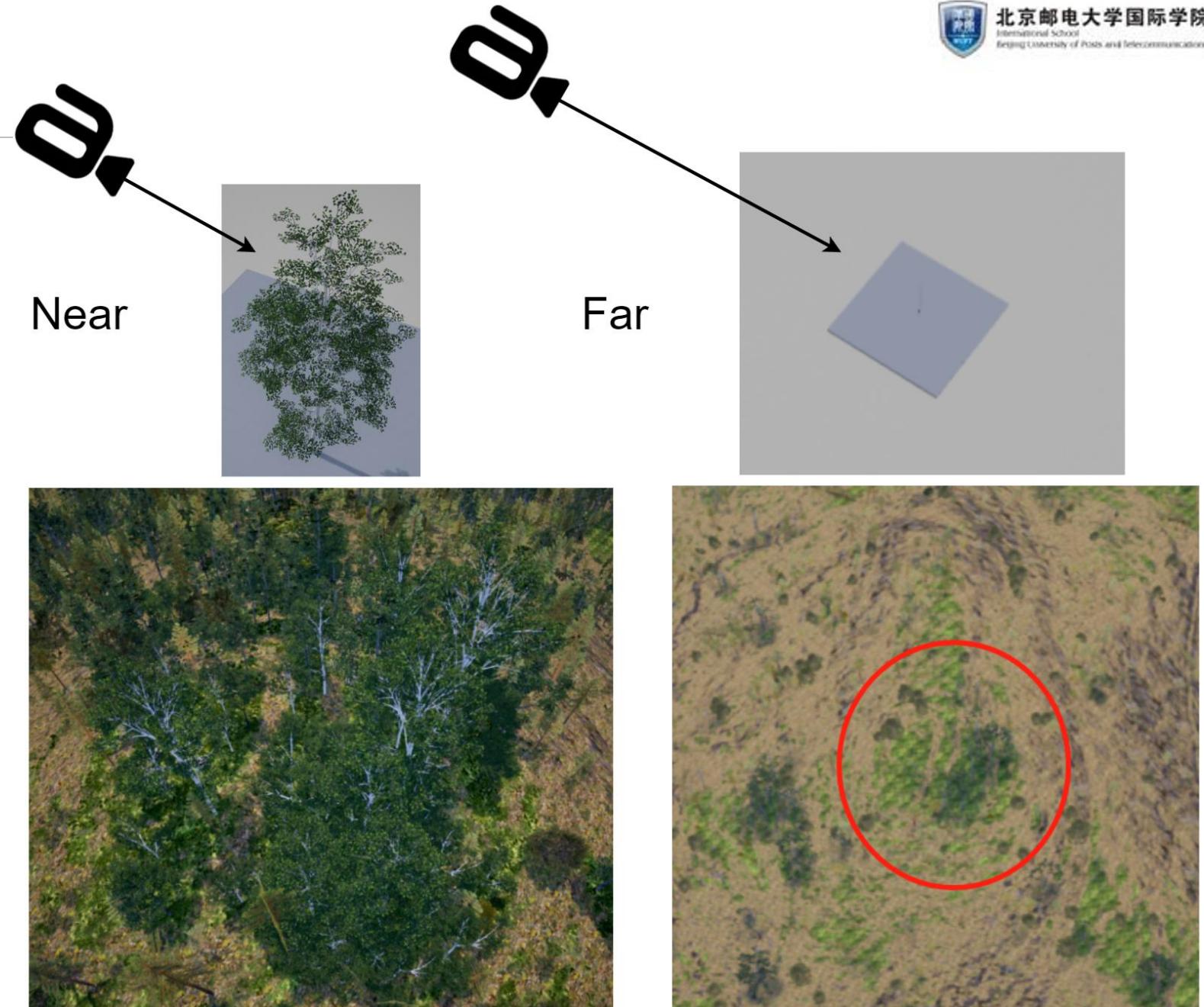


Figure 12.1 Cull Distance

Final Scene



Figure 13.1 Final Scene

Presentation Video

Highlight: Colorful Mountain - Wucaishan



Figure 15.1 *Wucaishan*

Highlight: Colorful Mountain

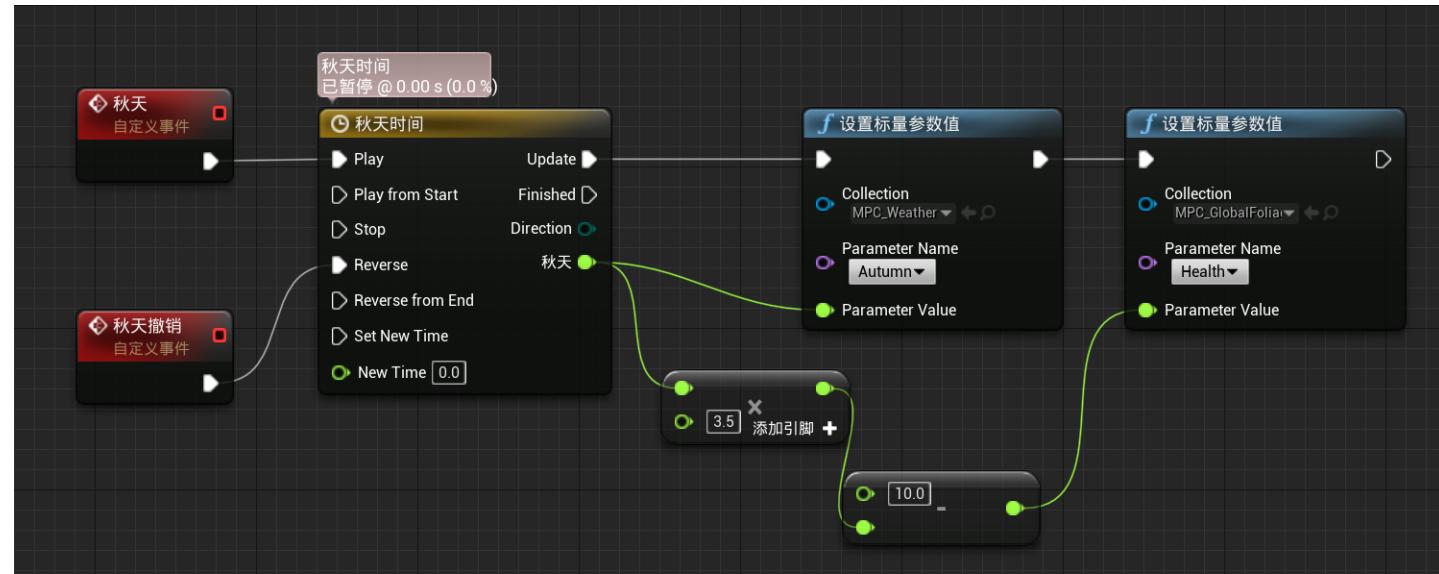


Figure 16.1 Colorful Mountain Blueprint Control

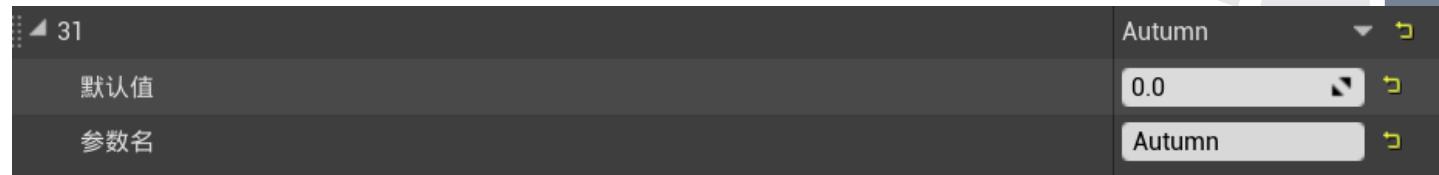


Figure 16.2 Parameter

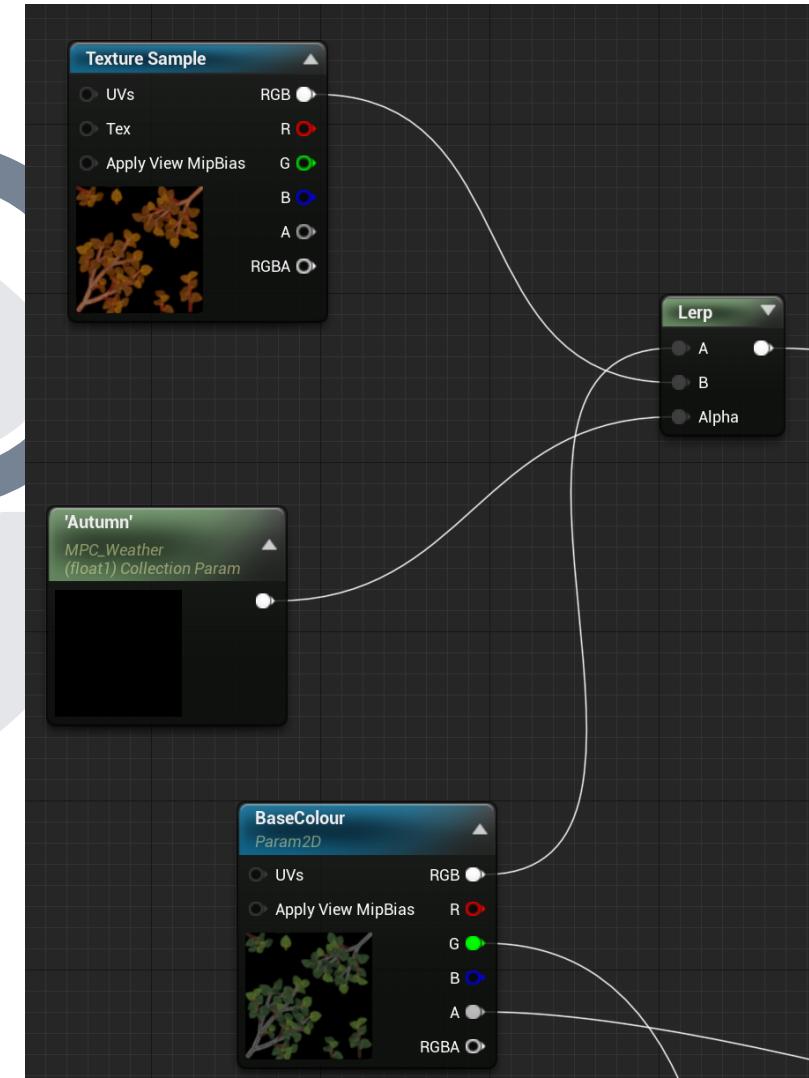


Figure 16.3 Material Control

Highlight: Interactive Snow



Figure 17.1 Interactive Snow

Highlight: Interactive Snow

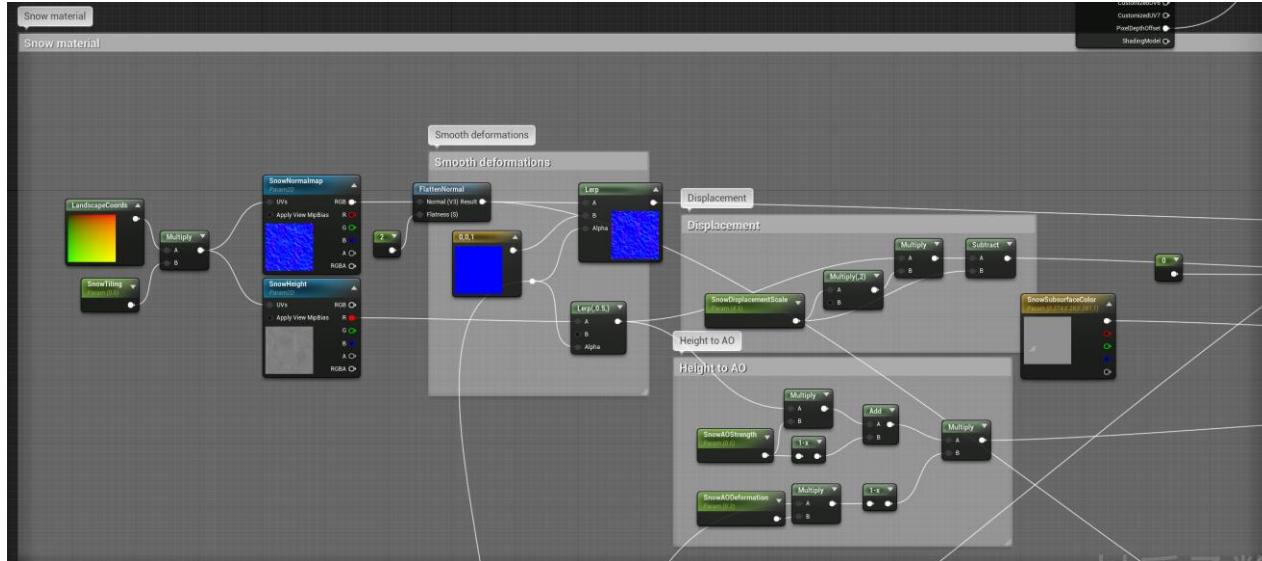


Figure 18.1 Snow generating

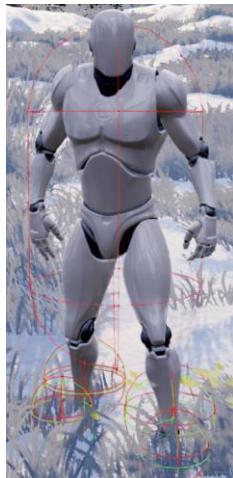


Figure 13.5 Trail collector for character models
 北京邮电大学
 Queen Mary
University of London



Figure 13.4 Tag

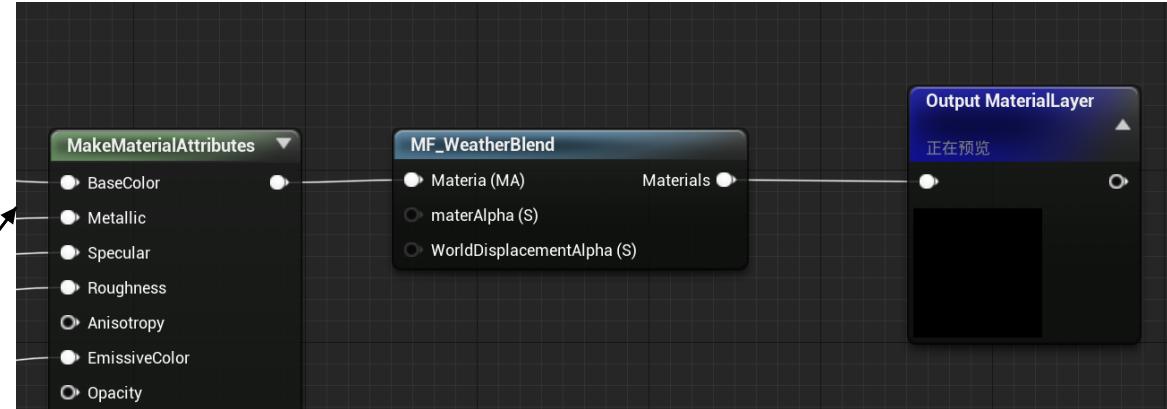


Figure 18.2 Grass layer snow mix

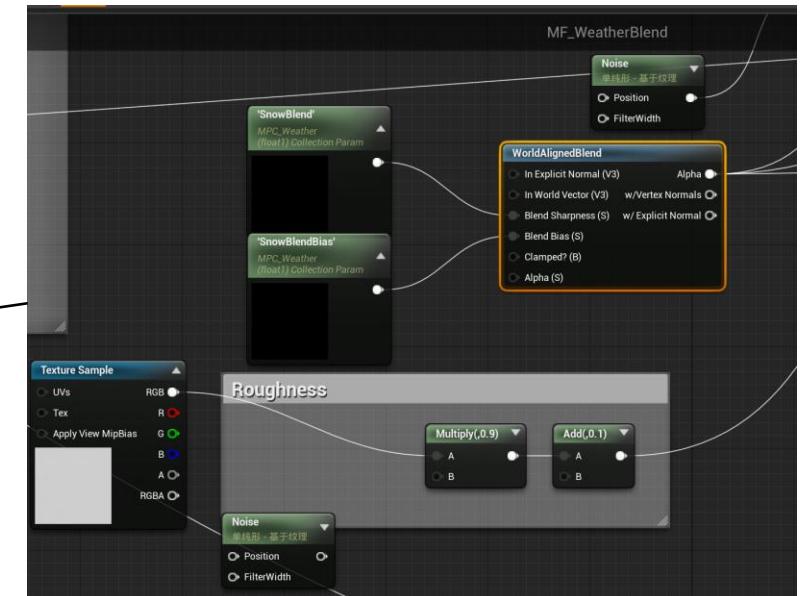


Figure 18.3 The realization of snow effect

Discussion & Further Work

Discussion:

- How to Efficiently Produce Large-World Natural Environments in Unreal Engine
- Based on the **ProceduralFoliageSpawner** component that comes with native UE
- The overall process complexity is low

China has **magnificent** natural scenes, and I very much hope to put China's unique natural landscapes into a unique next-generation game.

Further Work

Virtual texture

- Reduce shader complexity
- Reduce scene rendering resource consumption and improve FPS

In this study, a boreal simulation scenario was created based on the Greater Khingan Mountains. **Fully automated** generation with weather, season and day and night systems.