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ArmA II & ArmA II OA

TERRAIN: INTRODUCTION

Terrain Grid
The ***terrain grid*** is a structure of a height map predefined in the ***terrain editor*** **(*Visitor* 3)**.
NOTE: The size of the ***terrain grid*** is defined (in vertices) in the variable ***_landRange***.

Terrain Cell
The ***terrain cell*** is a square area in the plane with XZ coordinates. Its four corners have heights defined. It contains path planning and ambient sound information, etc.
Each ***terrain cell*** stores the object centers and provides collision detection. Only the certain cell and its neighbors can be searched for objects colliding with some geometry. It defines the limitation on object size.
NOTE: The size of the ***terrain cell*** is defined (in meters) in the variable ***_landGrid***.
Each ***terrain cell*** uses a ***texture material*** that is defined with a segment of the ***map texture***, a segment of the ***layer mask***, and up to four ***layer textures***.
Each ***layer texture*** consists of three maps:

- a color map suffixed with **_co** (assigned in a ***.rvmat** file)
- a normal map suffixed with **_nopx** (assigned in a ***.rvmat** file)
- a macro map suffixed with **_mco** (optional, and is directly used the simulation engine)

The macro map adds some noise to the ***layer texture*** at large range. The *terrain shader* uses this to display the surface when the camera is far enough from the ***layer texture*** and to display a blend of the ***layer textures*** when the camera is closer enough from.
On close range the ***map texture*** is covered by the ***layer textures***. Each the ***terrain cell*** can be covered by a hundred (10x10) of the instances of any ***layer texture*** at all. Therefore, actual size of a ***layer texture*** dependents on the size of the ***terrain cell***.
Example:
Given the size of the ***layer texture*** of 1000x1000 pixels:

- if the ***terrain cell*** has the size of 10x10 meters then each the pixel of the ***layer texture*** covers 1 millimeter of the ***terrain cell***
- if the ***terrain cell*** has the size of 15x15 meters then each the pixel of the ***layer texture*** covers 1.5 millimeter of the ***terrain cell***

Terrain Size
The ***terrain size*** is defined (in meters) as a result of the multiplication: ***_landRange x _landGrid***.
The ***terrain size*** needs to have a value of $\mathbf{2^n}$ or of $\mathbf{2^n x10}$. This means that the terrain is a square area.
Though the ***height map*** should define the ***_landRange*****+1** amount of the ***terrain cells***, it only defines the ***_landRange*** amount of the vertices and the last vertex is duplicated by the simulation engine.
NOTE: The ***class Landscape*** is an area of the ***_landRange x _landRange*** (or ***_terrainRange x _terrainRange***).

Satellite Grid
The ***satellite grid*** is a set of the ***terrain cells*** using the same ***texture material***.
NOTE: The size of the ***satellite grid*** has to be divisible by 4.

Texture Overlap
Mapping a segment of the ***map texture*** to the ***satellite grid***, involves two problems due to the limitation that the segment size needs to have a value of $\mathbf{2^n}$. Apart from hardware limitations, the reason for this is that *mipmaps* need to be generated for the textures:

- The first problem is that you have to specify an ***image resolution*** (in meters per 1 pixel) so that a number of pixels per the ***satellite grid*** have a value of $\mathbf{2^n}$.
- The second problem is that bilinear filtering is applied to the texture. Therefore, sizes of texture tend to be N+1 instead of N. This is why there should always be a certain margin to allow all mip-levels (***power-of-two*** fractions of N) to access the extra pixel and obtain a seamless mapping for the terrain at all zooms.

The result is that only the center areas of the ***map texture*** segments are rendered and the margin areas are copies of the margins of the adjacent segments.
NOTE: This rule also holds for the ***layer mask***.

Example:

Parameters: Terrain Grid = 512x512; Terrain Cell = 15; Image Resolution = 1 m/1 pix; Segment Size = 512.
You can calculate a size of the ***satellite grid*** and of the ***segment overlap***.
The ***terrain cell*** should have 15 pixels mapped to it (*Image Resolution* **/** *Terrain Grid*).
At most 32 ***terrain cells*** (480/15 = 32) will be rendered in the segment of the ***map texture***.
The rest of the segment (512 – 480 = 32) will be the ***segment overlap***.

The overlap of 16 pixels is the default minimum for the *Visitor* 3.
The size of the ***satellite grid*** needs to be divisible by 4. Otherwise, the *Visitor* 3 would round this size down and increase the ***segment overlap***.
NOTE: The decisions about the ***segment overlap*** and the exact mapping parameters (***TexGen*** in the **RVMAT**) are entirely up to the *Visitor* 3.
The engine doesn't care about how the ***layer textures*** are mapped. It uses the mapping values from the **RVMAT**.

Terrain Segmentation
The ***terrain grid*** is rendered with the ***satellite grid***. Each the ***satellite grid*** shares its own segment of the ***map texture*** in an exchange buffer.
NOTE: The exchange buffer is processed with a ***DrawIndexedPrimitive*** (**DIP**) call at a time. Therefore, better way is fewer **DIP** calls per the map frame processed.
When the ***terrain grid*** is loaded, the engine checks how many adjacent ***terrain cells*** share the same texture material (***.rvmat** of the ***map texture*** segment) to define the size of the ***satellite grid*** (terrain cells) and to divide the ***terrain grid*** into the ***land segments***.
NOTE: The ***land segment*** is not the ***satellite grid***.
The limitations on an exchange buffer (the ***DirectX*** standard):

- the exchange buffer may not contain more than 32768 vertices (that is, a bit more than 181x181)
- the ***land segment*** may not be greater than the value of the 32x32 terrain cells

The limitations cause following cases:

- If the ***satellite grid*** is **greater than/ equal to/ less than** the buffer standard **(but greater than the *land segment*)**, the ***terrain grid*** is divided by a size of the ***land segment*** into sections.
- If the ***satellite grid*** is less than the buffer standard (or this grid is not regular), and this is **equal to/less than** the ***land segment***, the ***terrain grid*** is divided by a size of the ***satellite grid*** into sections.

NOTE: Each the section is processed with the **DIP** call.
Because of the limitations above, optimal size of the ***satellite grid*** is **equal to** the size of the ***land segment***.

Multi-Map
In a multi-map (the several maps are glued together) the ***satellite grid*** should be regular. To design the multi-map, choose the tile size of the multi-map to be a multiple of the ***satellite grid*** size.
NOTE: This is now easier to do with the ***non-power-of-two*** map sizes.

Terrain LOD

The engine uses a ***level of detail*** (**LOD**) algorithm in order to increase the rendering performance for higher view distances.

Each ***land segment*** can be generated in up to 7 versions with decreasing the **LOD**. The first **LOD (LOD - 0)** contains all vertices of a ***terrain grid***, the second **LOD (LOD - 1)** contains only every other vertex, and so on. Higher **LOD** are used for distant ***land segment***. The distance, where the first **LOD**-switch occurs, depends on the *terrain detail* setting in the *Video Options*.

Each vertex knows its own height in any **LOD** and the height it would have in higher **LODs**. In fact, the **LOD** has a fractional value that increases exponentially with the distance from the camera. Each vertex uses a height that is a blend between the nearest **LODs**.

The sample size of a terrain (for the *Satellite Image Resolution* value of 1 m/1 pix)

Terrain Grid, v	Terrain Cell, m	Terrain Size, m	Segment Size, m	Segment Overlap, m	Satellite Grid, cells	Segments per terrain
64	15	960	512	32	32x32	4
128	15	1920	512	32	32x32	16
256	15	3840	512	32	32x32	64
512	15	7680	512	32	32x32	256
1024	15	15360	512	32	32x32	1024
2048*	15	30720	512	32	32x32	4096
4096*	15	61480	512	32	32x32	16384

*not recommended for use

Example: the terrain *Chernarus*

Terrain Grid, vertexes	Terrain Cell, m	Terrain Size, m	Segment Size, m	Segment Overlap, m	Satellite Grid, cells	Segments per terrain
2048	7.50	15360	512	32	64x64	1024

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