Inventor

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Title of Invention

Method for generating high resolution two dimensional cartesian coordinate digital topographical maps from lower resolution maps assembled from reusable high resolution tiles with instance specific properties.

Background of Invention

This invention pertains to the representation, processing, and presentation of terrain in computer simulations and games using high resolution two dimensional cartesian coordinate digital topographical maps. These maps are ideal for calculating: line of sight, visibility determination, detection determination, movement impediments, terrain difficulty, and physics associated with the interaction of objects and terrain. This is due to the efficiency of calculating which cells, and thus which elements of the terrain and other objects, are interacting with any specific object and visible to it.

A state-of-the-art implementation requires massive data sets for large topographical maps. If permanent storage is limited, then the map size is significantly constrained. If memory is limited, then the portion of the map contained in memory is relatively small compared to the full map those portions must be replaced by others as needed by streaming them into memory from permanent storage. This creates a performance impact and increased energy demand on the computing device.

Summary of Invention

This invention eliminates the need for the massive data sets associated with large high resolution topographical maps by assembling said map from a low resolution map composed of references to reusable tiles, where each tile defines high resolution topographical data for a much smaller area. Large high detail topographical maps can thus be achieved with much smaller impact on computing device resources. These maps will not reproduce exactly any real terrain but can be adequate representations for many purposes, such as historical battle replays and training scenarios. For fictional terrains they can be an ideal alternative to fully hand crafted maps from the development cost and resource utilization perspectives.

This invention also discloses three associated processes:

1) Method for improving runtime performance by using modern GPUs during map assembly.
2) Method for creating more dynamic and unique terrain by implementing GPU vertex and fragment shaders that can adapt and modify supplied Tile data.
3) Method for blending tiles along edges.

Summary of Drawings

Figure 1 - Example Data Sets for Tile

Figure 2 - Tile Shapes and Example Map Assemblies

Detailed Description

A high resolution topographical map is assembled from a low resolution map composed of instance references to tiles, each tile has a specific geometrical shape and are organized to make contact with their neighbors along edges and vertices in a regular fashion. Each instance reference of a tile includes instance specific geometric data such as rotation, mirroring, and scale. Each tile defines on or more two-dimensional cartesian coordinate textures containing high resolution topographical data within the boundaries of that tile, for example: one texture could contain elevation data, another could contain surface smoothness properties, another could contain vegetation data, or buildings, roads, slope, or practically any data necessary for collision or physics. Furthermore, some of these data may be merged into single textures if they are exclusive.

The assembly process is performed by rasterizing each instance of a tile into the high resolution map using conventional computer graphics surface texturing techniques and orthographic projections. An example is shown in Figure 1.

This process can be optimized by using commercial CPUs that implement texture mapped triangle rasterization.

Each tile instance can be made unique by using vertex and fragment shaders to manipulate the data provided in the Tile texture. Any conceivable effect is possible, some examples include:
1) Adding a constant to elevation at each map coordinate.
2) Adding a dynamic element to elevation determined by some function, or another texture.
3) Trimming vegetation for map coordinates above a specific elevation, determined by sampling the elevation texture.
4) Setting surface roughness based on elevation texture slope at a given map coordinate.

Lastly, data along edges of tiles can be blended with those of adjacent cells using additional textures representing masks, multiplications, divisions, and other methods of modifying the primary texture during its rasterization. This process can include sampling the textures of adjacent Tiles.

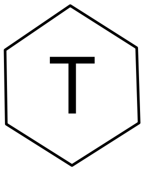
Low resolution maps composed of Tiles having a single geometry work best, but others requiring two or more Tile geometries are possible. See Figure 2 for examples.

Claims

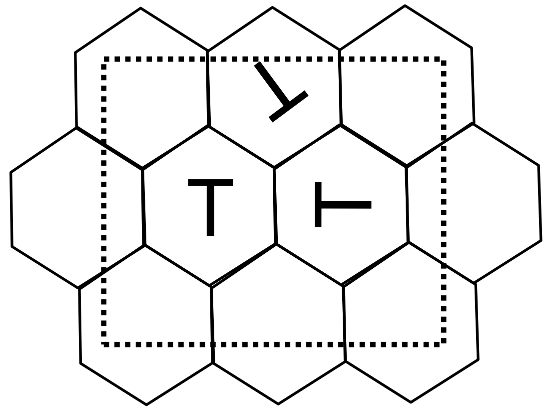
1. A process for generating high resolution two dimensional cartesian coordinate digital topographical maps from lower resolution maps assembled from reusable high resolution tiles with instance specific properties, as described in the Detailed Description section above.
2. The same process described in claim 1, but implemented on a conventional triangle rasterization GPU.
3. The use of vertex and fragment shaders specialized for use with topographical data, as described in this patent.
4. A process for blending topographical data along tile edges according to the topographical data and geometric properties of adjacent tiles.

Figure 1 - Example Tile Data Sets and High Resolution Map Assembly

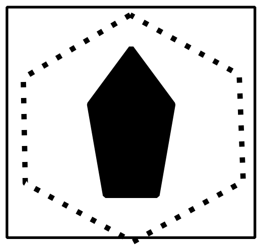
Hexagon Tile classification T



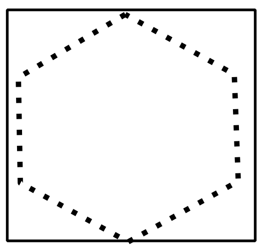
Classification T defines four 2D textures containing topographical properties for any cell using this classification.



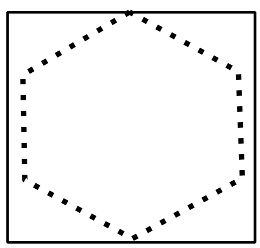
2D Texture containing Elevation Data



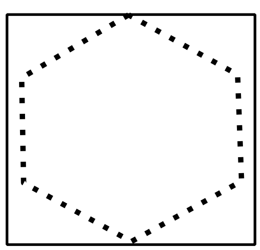
2D Texture containing Roughness Properties



2D Texture containing Vegetation Data



2D Texture containing Structures Data



Each texture is rasterized into the the appropriate map assembly using the geometric properties assigned to each instance: rotation and mirroring.

Example: the above map assembly is rasterized into a topographical map containing only elevation data. That map would look like this:

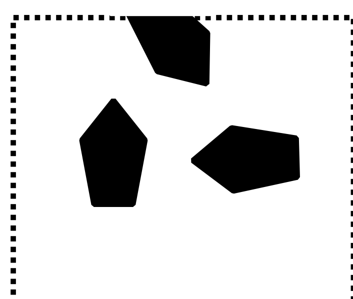
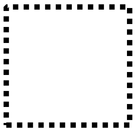
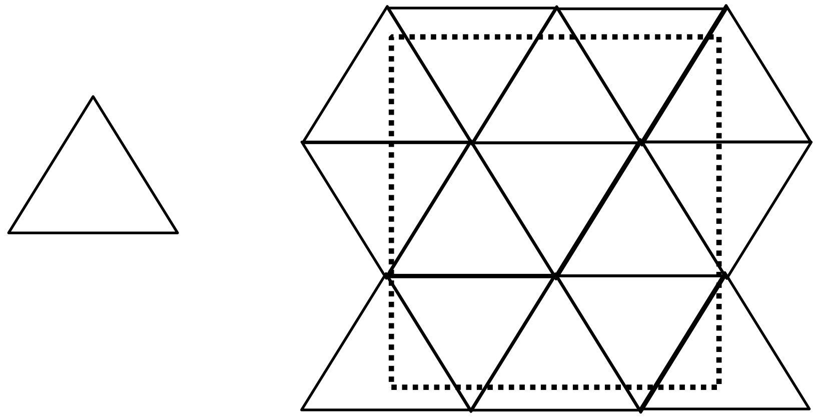


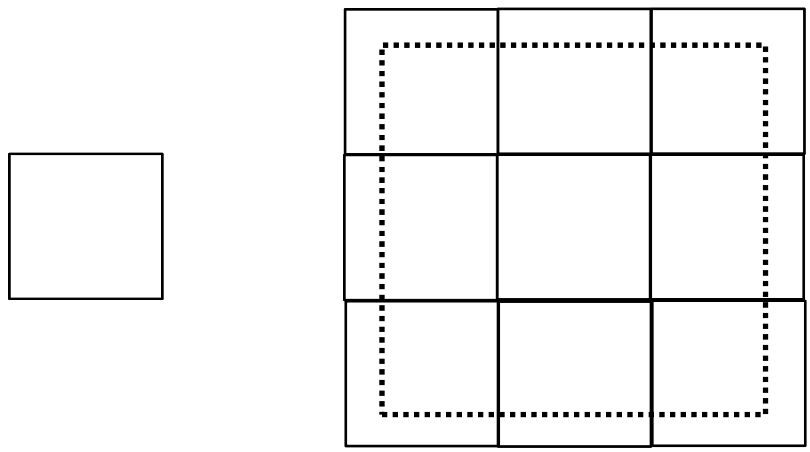
Figure 2 - Example Tile Shapes and Map Assemblies


Cartesian Grid Boundary of Assembled High Resolution Topographical Map

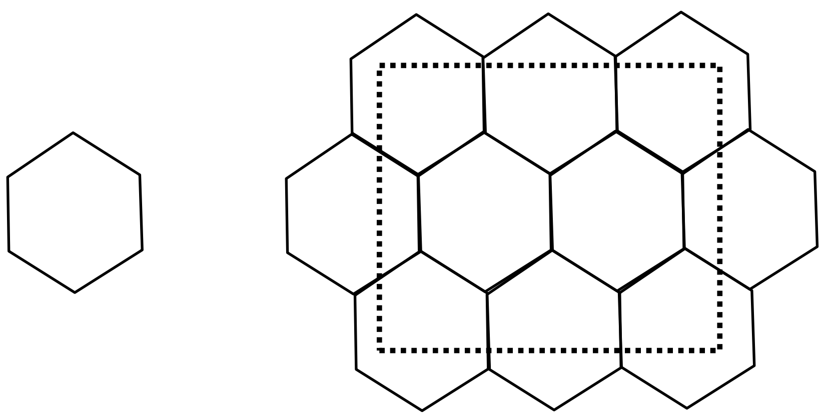
Triangle Tile



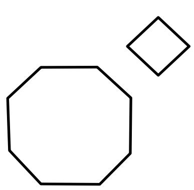
Square Tile

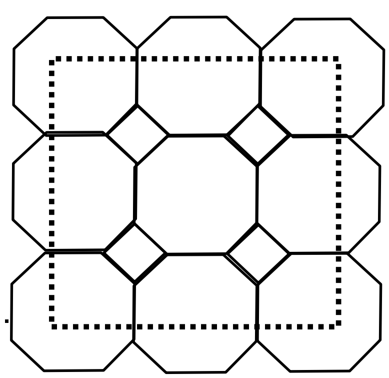


Hexagon Tile



Octagon and Square Tile Pair





Electronic Acknowledgement Receipt

EFS ID:	31580052
Application Number:	62620675
International Application Number:	
Confirmation Number:	9950
Title of Invention:	Method for generating high resolution two dimensional cartesian coordinate digital topographical maps from lower resolution maps assembled from reusable high resolution tiles with instance specific properties.
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Filer:	Jason Staiert
Filer Authorized By:	
Attorney Docket Number:	
Receipt Date:	23-JAN-2018
Filing Date:	
Time Stamp:	14:22:55
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$70

RAM confirmation Number	012418INTEFSW14251600
Deposit Account	
Authorized User	

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