Inventor

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Title of Invention

Method of assembling a tile map from reusable tiles with instance specific properties where each tile instance must have edge properties that match those of adjoining tiles along the shared edge.

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, then 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 provides a method for achieving high resolution topographical maps by assembling said map from a low resolution map composed of references to reusable tiles, where the terrain in each reusable tile is described by vector graphic properties which have been specialized specifically for this invention. 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.

Summary of Drawings

Figure 1 - Schematic depiction of a Tile Descriptor.

Figure 2 - Schematic depiction of the Matching Process.

Detailed Description

A high resolution topographical map is assembled from a low resolution map composed of instance references to tile descriptors, each tile instance has a specific regular geometrical shape and is organized to make contact with their neighbors along edges and vertices in a regular tiling. Each instance reference to a tile descriptor includes instance specific geometric properties such as rotation and mirroring. Each tile descriptor is described by a set of vector terrain properties listed herein:

(A) Vectors defining terrain features which are fully contained within the boundaries of the tile instance.
(B) Vectors defining terrain features which will cross tile instance boundaries. For every such vector there must be two endpoints located on geometrically on tile edges and must be referenced from the tile descriptor ordered set of edge properties. These endpoints can be on any edge including the same edge.
(C) A class of edge properties indicating an entire edge is contained within a specific terrain feature. While not strictly necessary, the existence of this property significantly simplifies the matching algorithm. These properties are created automatically when a (B) is added to the tile descriptor, and is determined by examining the inside vector and placing an instance of this property type in each ordered set on edges "inside" the feature which also do not have a reference to the end-point of the terrain vector.

Each vector terrain property is described by one or more properties listed herein:

(A) A standard vector graphic line description.
(B) A non-line vector pointing to the inside area of the terrain feature represented by the vector, or uphill for contour line vectors.
(C) Dimensions for linear terrain features: width, height, boundary, slope.
(D) For vectors with end points on tile edges, one or more properties specific to the edge matching algorithm.
(E) A terrain type descriptor, such as, but not limited to:
    (a) Contour-line (elevation)
    (b) Major flora, of various specific types
    (c) Minor flora, of various specific types
    (d) Surface properties (examples: roughness, difficulty)
    (e) Water boundary
    (f) Road
    (g) River
    (h) Wall

When a reference to a tile descriptor is placed in a map, a matching algorithm is run against the tile descriptor edge properties for the newly placed reference which share an adjoining edge with each already placed reference. Which edges are tested and the direction of the matching algorithm (whether it processes the set from first-to-last or from last-to-first) is determined by the reference instance specific properties of rotation and mirroring. The algorithm works as follows:

(A) Contour-line vectors are matched in number, and order along edge, and direction of uphill. All must match successfully or the new reference is rejected and removed from the map.

(B) Other vectors are matched in number and order along edge and the direction of the inside vector. All of these properties must match successfully or the new reference is rejected and removed from the map with the exception that vectors with certain properties may float in their position along the edge and may match regardless of the presence of a like vector on the adjoining edge.

(C) Edge properties indicating the edge is entirely inside a terrain feature must match successfully or the new reference is rejected and removed from the map.

The above described matching process may be run on all available tile descriptors to produce a list of acceptable tile descriptors which may be referenced at any given map location. The matching algorithm is not run on edges which are on map boundaries.

Before the map is complete the user must specify the following properties:

(1) The base elevation contour line, its elevation, and the elevation change per contour line.

(2) An optional sea-level contour line and elevation change of below-sea-level contour lines.

The elevation of all counter lines are calculated relative to the elevation of the base contour line and the elevation change per contour line set in (1).

When a new tile descriptor reference is successfully placed in the map the end-points of edge crossing terrain vectors are adjusted to produce a continuous transition on lines crossing tile edges. These adjustments are instance specific properties and do not effect the tile descriptor. This adjusting process preserves the order of each end-point (for end-points which may not float, such as contour line end-points) where appropriate.

The user may apply heuristics to the map which create new terrain vectors, by programmatic or stochastic methods which operate on areas enclosed by designated terrain vectors or on other map properties such as slope in any area.

Claims

1. A tile descriptor which includes an ordered set of properties for each geometric edge of an instance of that tile. Each property is defined by: a vector graphic description of a line, an inside or uphill vector, a reference to a specific terrain feature type, elements which further define the terrain feature represented, and various optional properties which control the matching algorithm.
2. A matching algorithm which is run on the ordered set described in claim 1 from the adjoining edges of the tile descriptors referenced from two adjacent locations in the map. This matching algorithm is run either at the time a reference is added to the map, and this may result in the rejection and removal of the reference from the map (if the match fails), or may be run on the set of all tile descriptors to determine which tile descriptors will match successfully at a given tile location.
3. A map composed of references to tile descriptors, the map defining the elevation of a reference contour line and the degree of elevation change between contour tiles. A map also optionally defining sea-level and the degree of elevation change between contour lines below sea-level.
4. A stitching algorithm which creates a continuous line description for terrain vectors crossing tile edges.
5. A set of stochastic and procedural algorithms which may be run on a completed map to populate select zones defined by terrain vectors with terrain features of some type, or based on some area specific properties of the map (such as slope).

Figure 1 - Schematic depiction of a Tile Descriptor

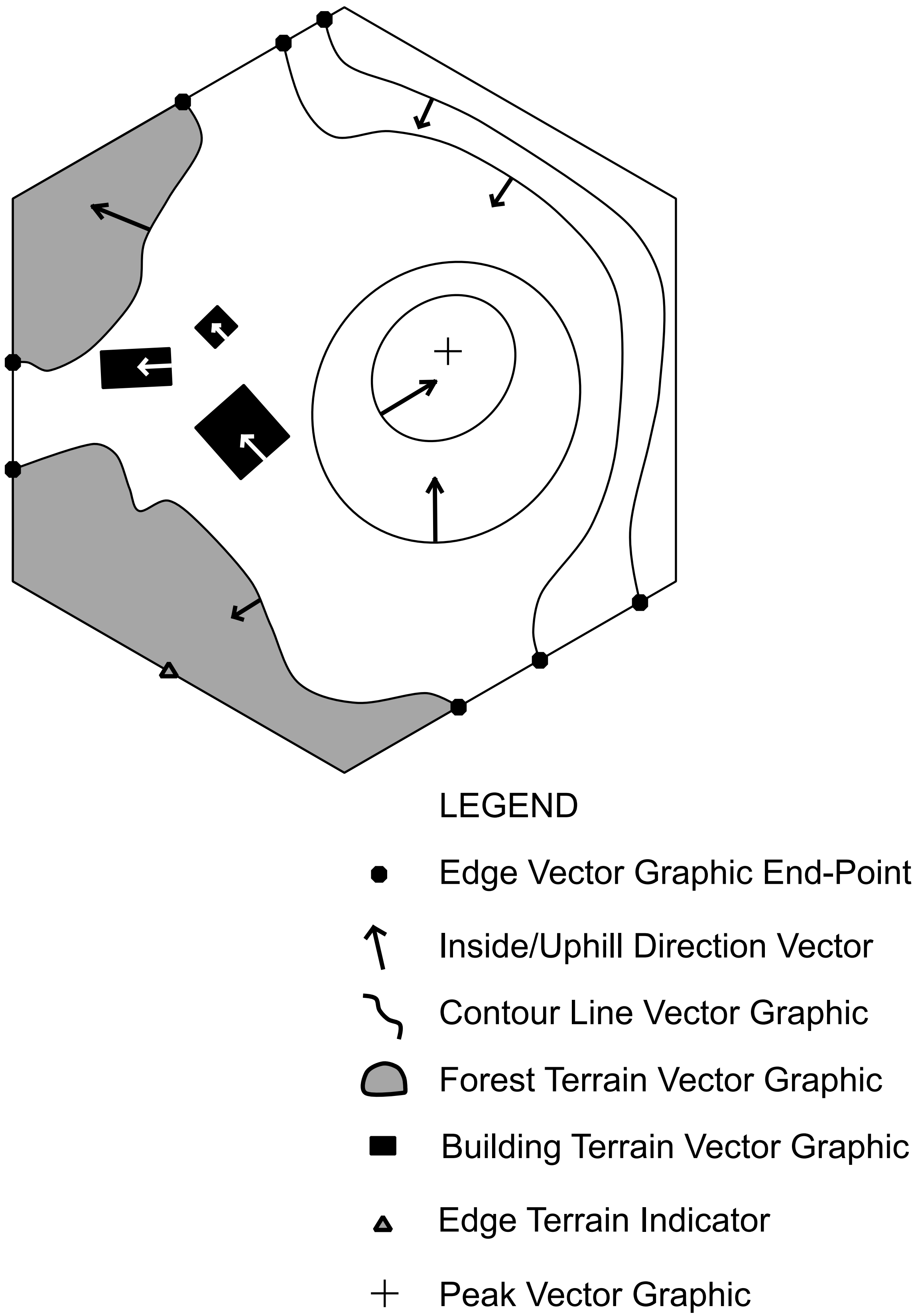
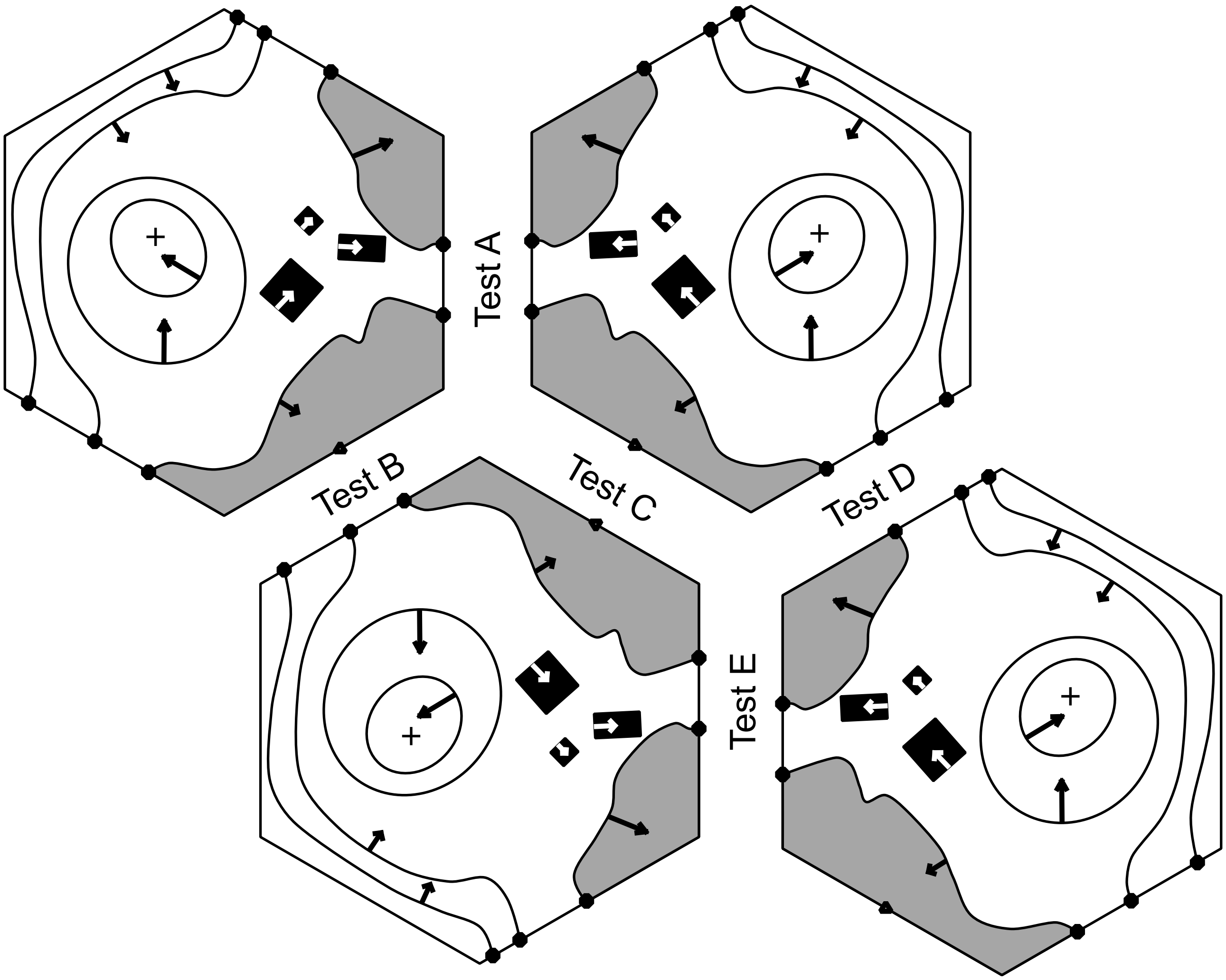


Figure 2 - Schematic depiction of the Matching Process



Test A: Two terrain vector end-points, both representing forest, both with direction vectors pointing towards vertices. This situation would match successfully.

Test B: This situation produces a match failure.

Test C: Both edges have forest terrain indicators. Match successful.

Test D: All vectors match in order, type, and direction of inside/uphill vector. Match successful.

Test E. Identical to A. Match successful.

Electronic Acknowledgement Receipt

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1	Specification	Specification.pdf	27860 4ffde4e3a46e7c41d6f6c7f970d6ee5857868533	no	4
Warnings:					
Information:					
2	Drawings-only black and white line drawings	Figure_1.pdf	22058 ce0746cdd3a6eed1a41feebbd2b114cbea6b3fbe	no	1
Warnings:					
Information:					
3	Drawings-only black and white line drawings	Figure_2.pdf	33462 feee6ba79a54d66f9e22f5e34e20510d358b2228	no	1
Warnings:					
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4	Certification of Micro Entity (Gross Income Basis)	sb0015a.pdf	2401516 18643085aab6962968b486cd4d9c955fdd2b3c15	no	1
Warnings:					
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5	Provisional Cover Sheet (SB16)	sb0016.pdf	3563000 721175c137f0ea9406da707fc442faf686cbf7fb	no	2
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