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Vector model for representing surfaces TIN model definition

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Abstract: Digital elevations can be used to define elevations, slope steepness, slope direction at an arbitrary point on the ground over a finite set of sample points

Keywords: GIS analysis procedures, determine, TIN model, Constructing a Delaunay triangulation

Introduction

Unlike digital representations of point, linear and area objects, three-dimensional objects require special presentation forms, because their location is described not only by two-dimensional, but also by high-altitude coordinates. The most common three-dimensional objects type includes the topographic earth's surface relief. Using three-dimensional objects can also be modeled of population density maps, atmospheric pressure, humidity and etc.

Digital elevations can be used to define elevations, slope steepness, slope direction at an arbitrary point on the ground over a finite set of sample points. It is possible to identify area features– river basins, drainage networks, peaks, troughs and so on. Such kinds of models are widely used in many GIS analysis procedures: when choosing a place for buildings and communications construction, in the drainage networks analysis, visibility, when choosing a route for driving on rough terrain.

Surfaces are continuous phenomena, as opposed to discrete objects such as points, lines, and polygons. But there are methods to represent surfaces that use finite points. Different approaches to the anchor points' selection, in which the surface elevation value is known, determine the two most common data models. In geographic information systems, surfaces are usually described using raster models and triangulation networks. In raster models, sample points are located at the regular raster lattice nodes, and in triangulation networks, they are located irregularly so as to best "circle" the surface (hence the name – triangulated irregular networks – TIN).

Geographic features TIN model - a surface model in the adjacent non-intersecting triangular faces network form, defined by the nodes and edges that cover the surface. (fig. 1.)

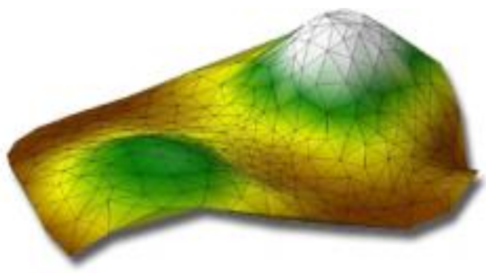

Fig. 1. TIN model

The TIN model geometry is formed by faces, nodes, and edges three-dimensional space.

Face –triangle surface in three-dimensional space.

Node –triangle vertex with coordinates X, Y, Z.

Edge –triangle side in three-dimensional space.

Each TIN face is part of a surface in 3D space.

TIN model properties. The TIN model has the following properties:

• allows to get an accurate idea of the local surface part, using a variable nodes density with Z value and surface inflection lines;

• the basis for 3D surface visualization;

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• allows to perform complex surface analysis (calculating heights, slopes, slope exposures, obtaining surface contours, calculating volumes, vertical profiles along the line route, visibility analysis).

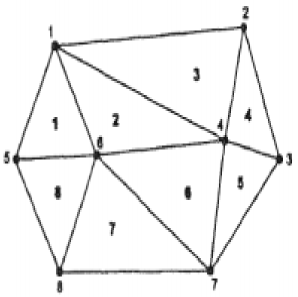
TIN topology. The TIN model is a topological data structure: edges are connected at nodes; each triangle is adjacent to next triangles.

Topological relationships are created by creating a reference to adjacent nodes in the database for each node. The space around the territory appears seems to a fictitious knot.

The TIN model (Fig. 2) is digitally described by linked files - a vertex, an index and a triangle files. For each split point, its unique number coordinates and points list with which it is connected by straight lines (clockwise) are saved.

Точка	X	Y	Z
1	X_1	Y_1	Z_1
2	X_2	Y_2	Z_2
3	X_3	Y_3	Z_3
4	X_4	Y_4	Z_4
5	X_5	Y_5	Z_5
6	X_6	Y_6	Z_6
7	X_7	Y_7	Z_7
8	X_8	Y_8	Z_8

Файл точек



Треуголь-ник	Вершины			Соседние треугольники		
1	1	6	5	2	8	-
2	1	4	6	1	3	6
3	1	2	4	-	4	2
4	2	3	4	3	-	5
5	4	3	7	4	-	6
6	6	4	7	2	5	7
7	6	7	8	6	-	8
8	5	6	8	1	7	-

Файл треугольников

Fig. 2. TIN topology

TIN model creating stages

The TIN model is created in the following sequence.

Step 1. Specifying a set of i points by coordinates Xi, Yi, Zi (fig. 3).

Fig. 3. Many points

Step 2. Constructing a Delaunay triangulation (Fig. 4.).

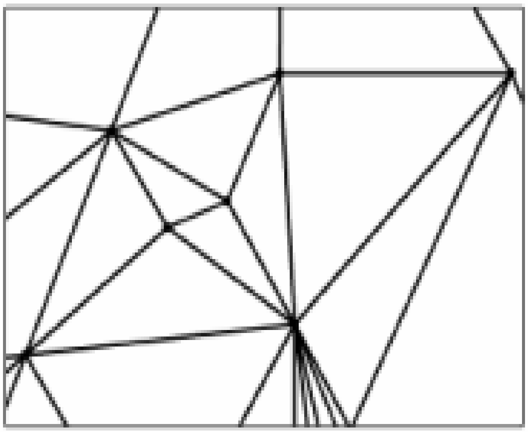


Fig. 4. Delaunay triangulation

Step 3. Entering breaklines and modifying the TIN taking into account breaklines. Terrain breaklines define abrupt surface changes such

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as top line, bottom slope, ridges, thalweg and more (fig. 5.).

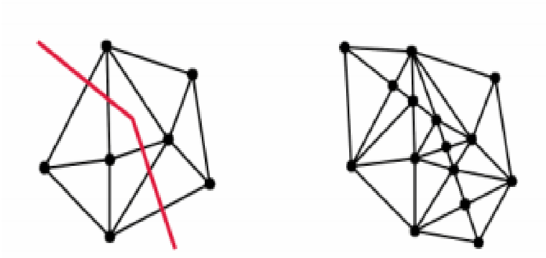

Fig. 5. Surface breaklines

Step 4. Entering exclusion areas with a constant Z value and modifying the TIN taking into account polygonal objects, such as a water surface. (рис. 6.).

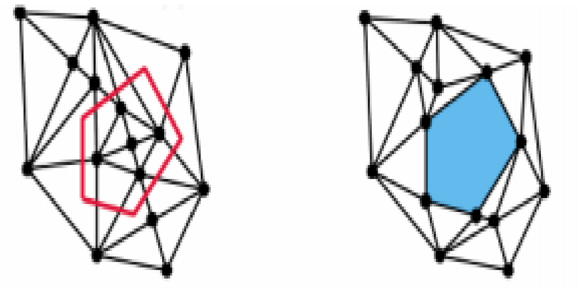

Fig. 6. Exclusion scopes

Step 5. Solving TIN surface model problems.

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