The 3D Studio Max plugin for simulation of the footprints on the ground surfaces

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Motivation

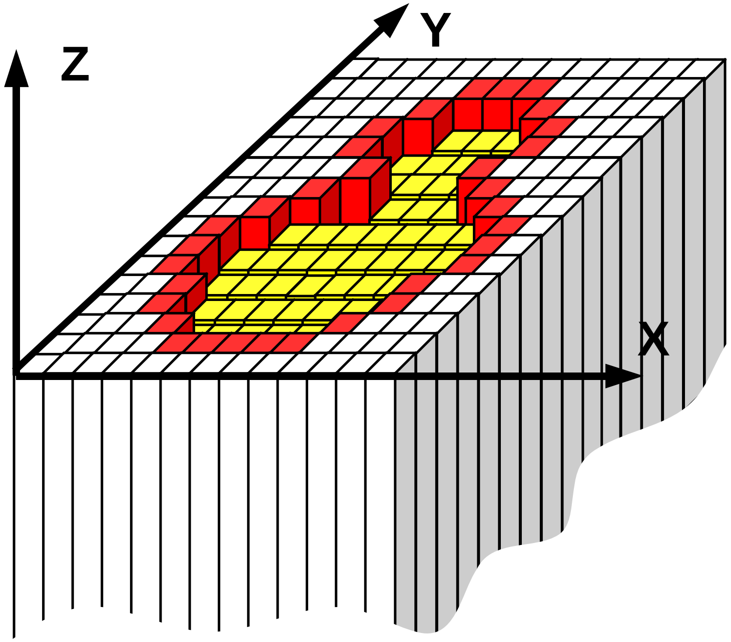
- Implementation of the algorithm for visualization of the footprints, appearing on the ground surface after the interaction with the moving object (for creation of the more realistic 3D scenes)

- Implementation of the algorithm as the plugin for some 3D modeling program (3DStudioMax), using standard instrumental tools (AppWizard, class library)

- Provision of the comfortable work with the module and its high performance during the scene visualization (usage of the adaptive representation of the object)

Algorithm basics

⌘ Model of ground material



⌘ Algorithm stages

- Collision test for affecting object (object is not necessary in mesh representation)
- Material displacement to the object periphery
- Erosion (downhill redistribution)

Algorithm description: **R.W.Summer, J.F.O’Brien, J.K.Hodgins,** ***Animating Sand, Mud and Snow***, *The Eurographics Assosiation*, 1999.

Parameters

- Height field resolution
  - = correct proportion between the feature size of affecting object and cell size: 4-5 cells per “feature”

- Compression ratio α
  - *(defines the amount of material, distributed from the affecting object to the periphery)*
- Roughness (irregularity of the ground deformations) σ
  - *(the amount of material, moved from one cell to another during erosion)*

Parameters (continuation)

- Inside and outside slopes toward the object Θ_{in}, Θ_{out}

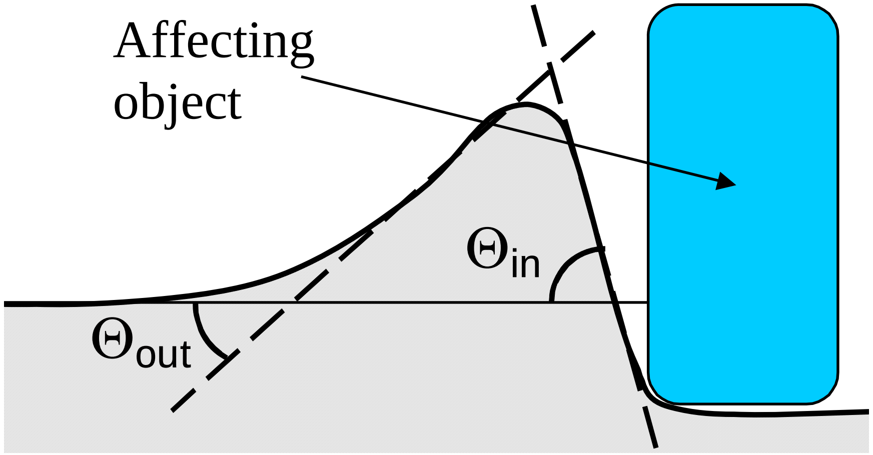
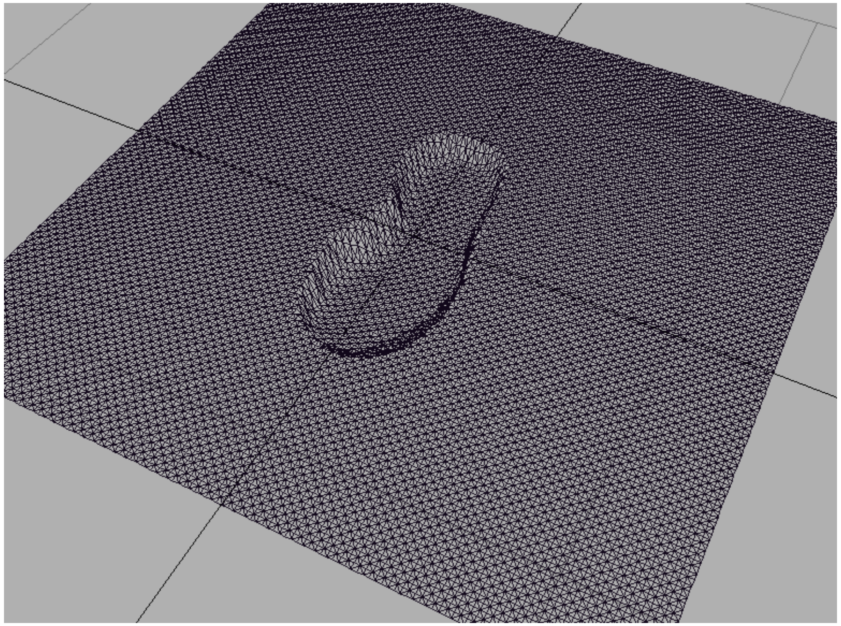
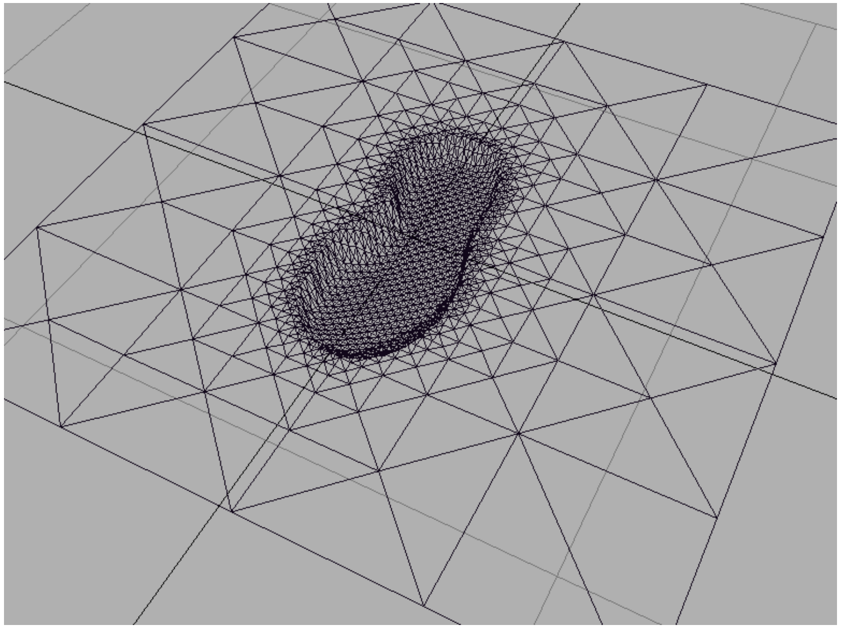


Table of parameter values for the three ground materials

	Sand	Mud	Snow
α	0.95	0.99	0.00
σ	0.2	0.2	0.2
Θ_{in}	0.8	3.0	10.0
Θ_{out}	0.436	2.0	10.0

Usage of the Adaptive Mesh for surface representation





Without Adaptive Mesh usage

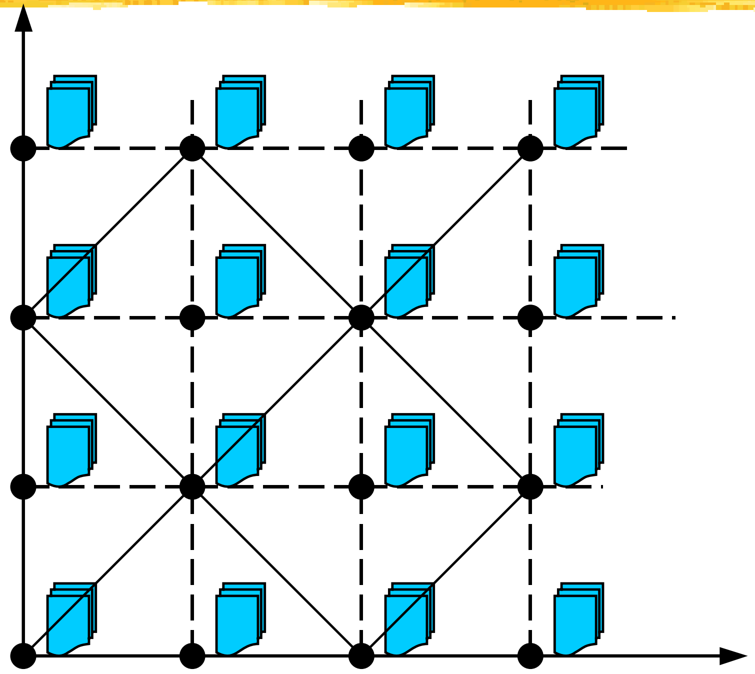
16641 points, 32768 triangles

Using Adaptive Mesh

1668 points, 3318 triangles

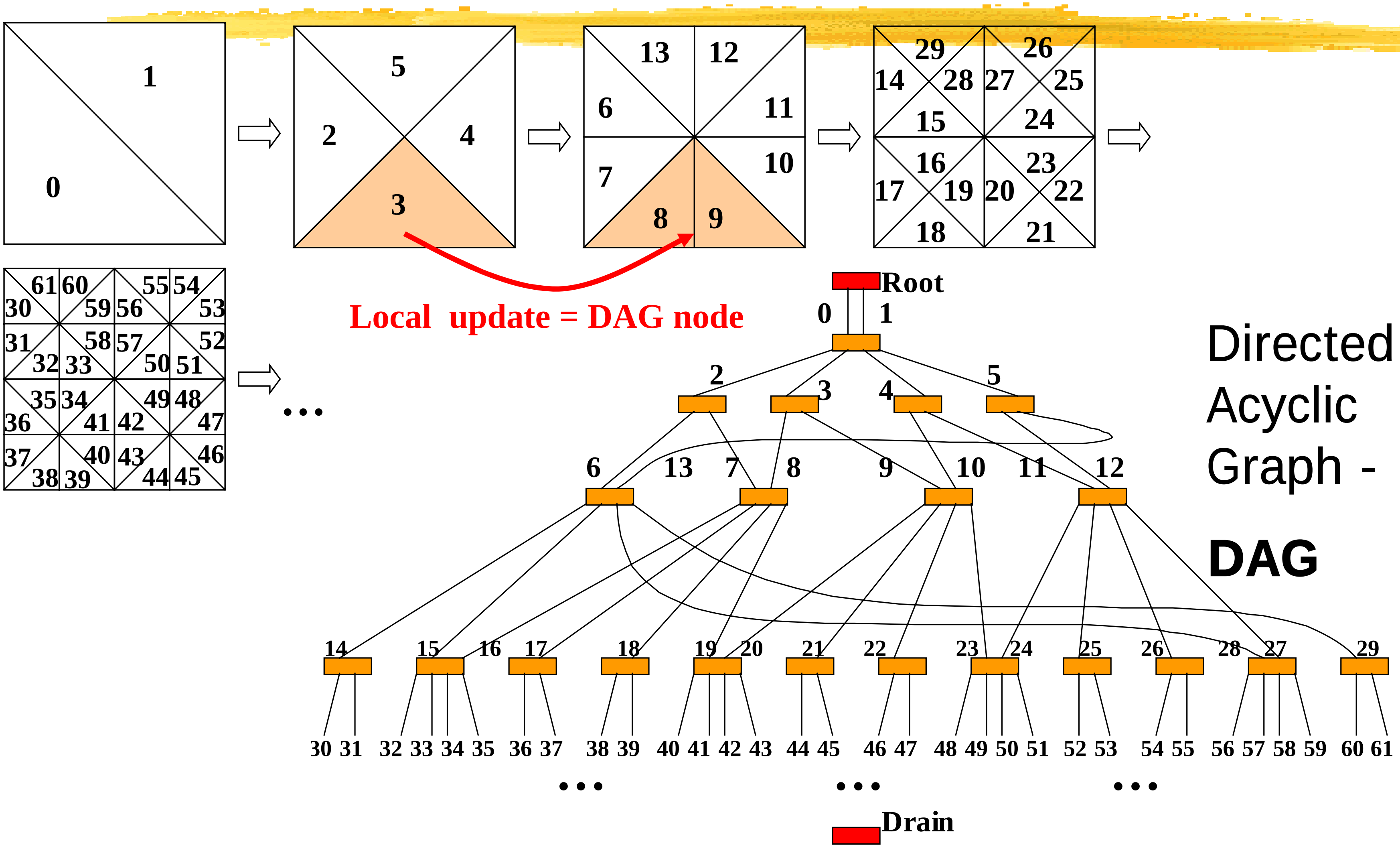
Adaptive Mesh

- Mesh bases on the 2D uniform grid (the most detailed mesh level)
- In every grid node user defines a set of attributes
- Based on the attribute’s values, continuous level of detail mesh is extracted



Structure of the Adaptive Mesh

it bases on the sequence of the regular local updates



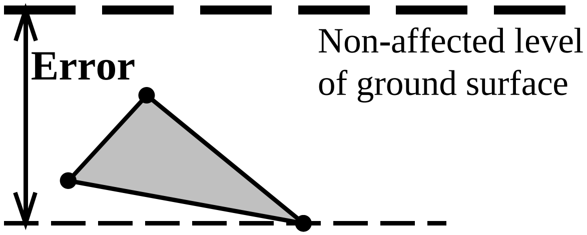
Local update = DAG node

Directed Acyclic Graph - **DAG**

Adaptive Mesh: surface extraction

- Every cut in the Adaptive Mesh DAG defines certain surface approximation
- Cut (surface) is naturally represented as the triangulation
- Cut is built, basing on the ***error function***, which is defined in DAG nodes

Error calculation

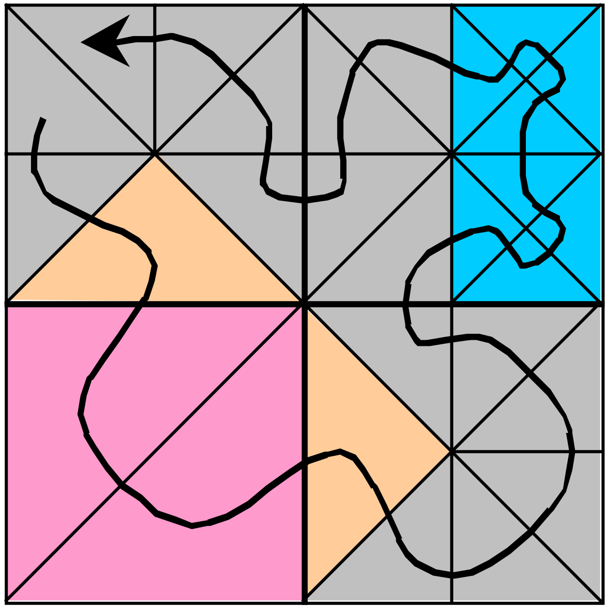


Note: directed acyclic graph (DAG) is widely used structure in multiresolution modeling

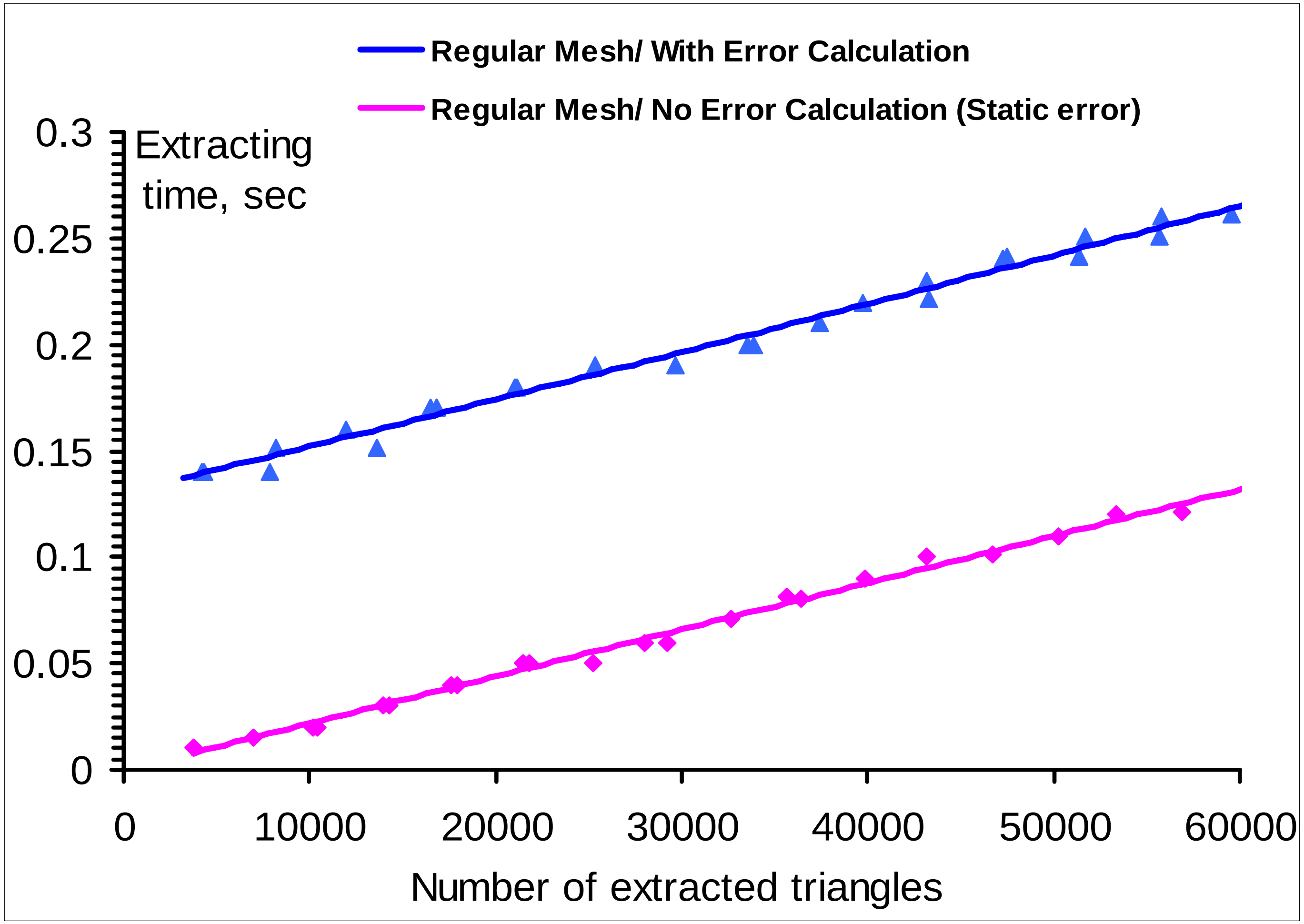
Mesh features, provided for the update’s regularity

- Compact data structures ->
  - DAG creation and mesh extraction algorithms are more simply
  - Significant reduction of memory usage (more than 4 times)

- Extracting triangulation can be represented as 1 strip



Time complexity of the mesh extraction algorithm

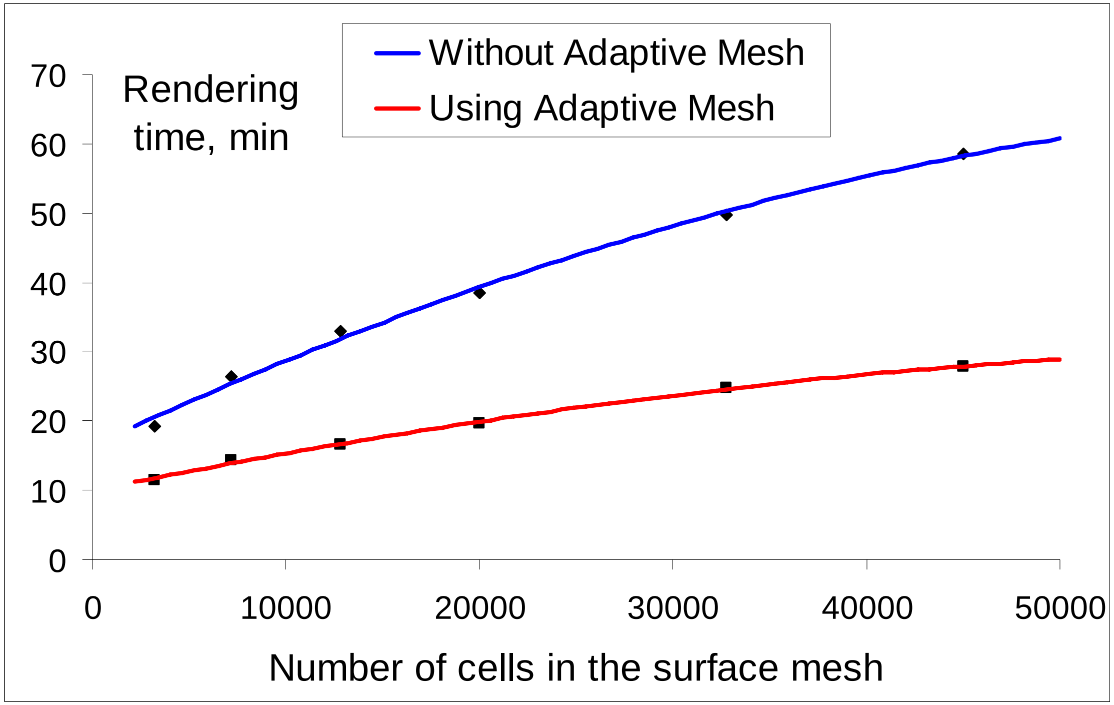


Computer:
Pentium II 400 MHz,
192 MB RAM

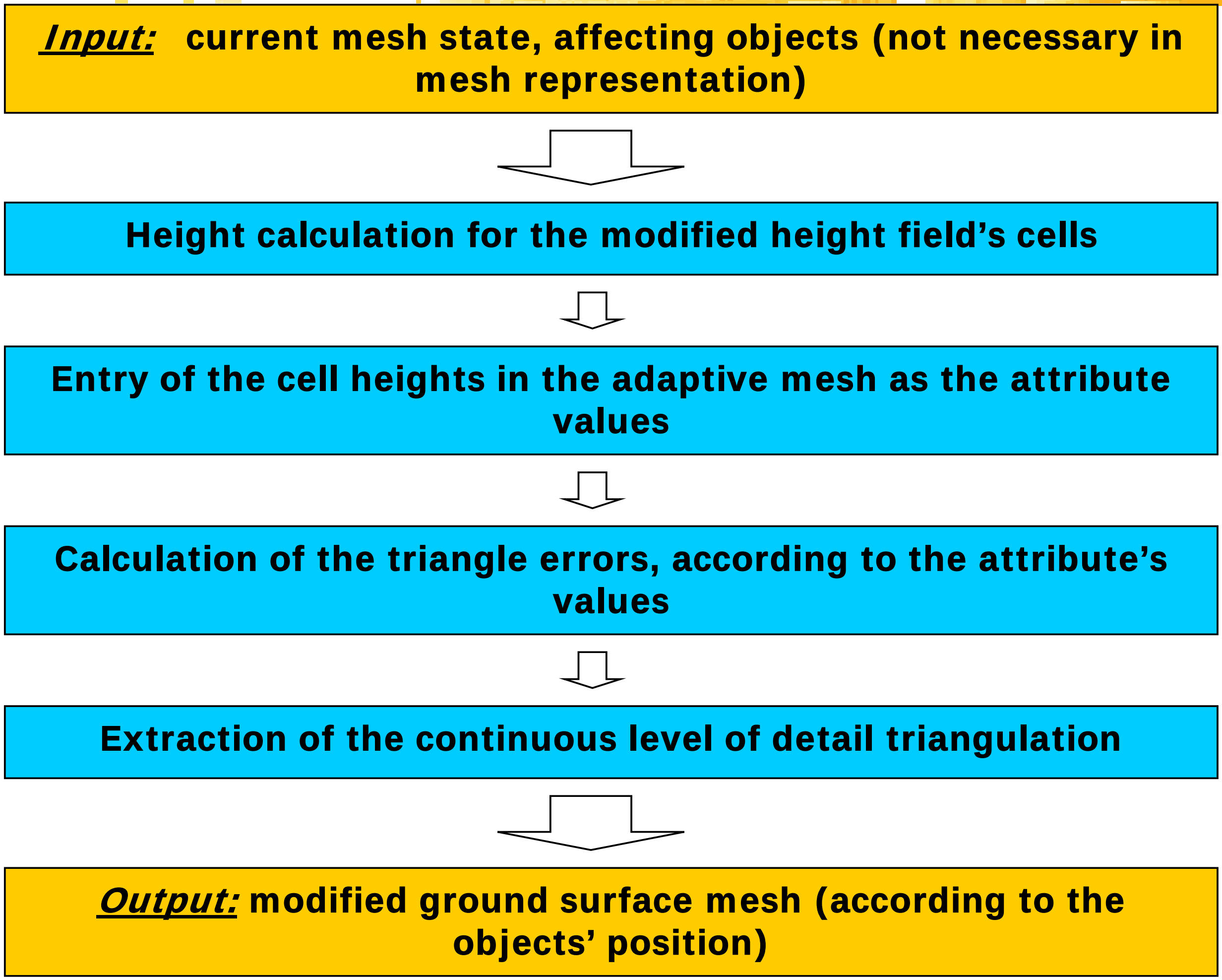
OS: Windows NT

Usage of the Adaptive Mesh in plugin allows

- to speed ground surface displaying in the 3DStidioMax viewports (during the scene modeling)
- to reduce memory usage for mesh storage
- to reduce time of scene rendering:



Block diagram of the algorithm



Input: current mesh state, affecting objects (not necessary in mesh representation)

Height calculation for the modified height field’s cells

Entry of the cell heights in the adaptive mesh as the attribute values

Calculation of the triangle errors, according to the attribute’s values

Extraction of the continuous level of detail triangulation

Output: modified ground surface mesh (according to the objects’ position)

Demonstrations