Grammar for general purpose procedural modeling

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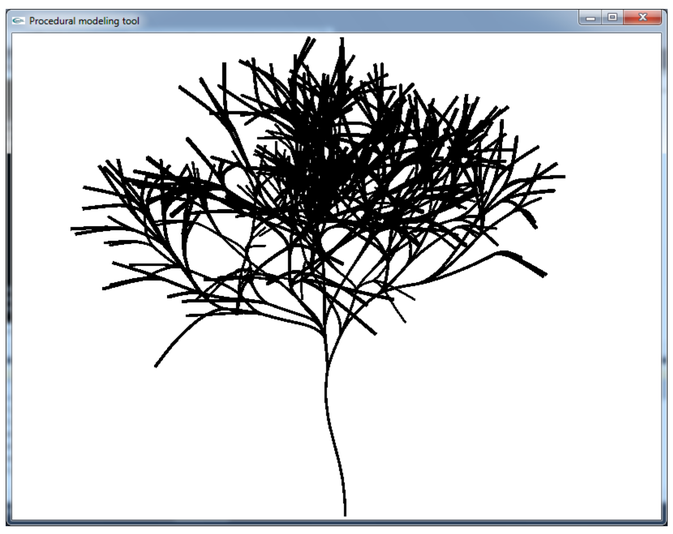
A novel approach for procedural (ie. semi-automated) modeling of 3D virtual objects is developed in this work. The focus has been on developing a procedural tool, with an unique capability to produce any type of 3D model. The contribution is a grammar, designed to work on directed cyclic graphs instead of strings as traditional grammars. The idea is then to procedurally generate a graph before converting it to a polygon mesh, by which an object is created.

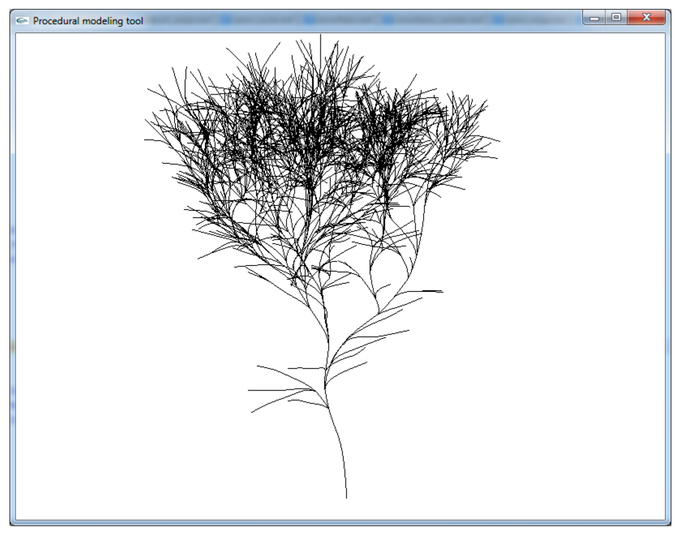
Motivation and goal

Modeling of 3D digital content is a severe economical challenge, because of an increasing demand for realism and because of a boom in size and number of virtual models for example for the game and movie industries. Today, almost all unique virtual models are created manually by an increasing number of designers. Automated or at least semi-automated content generation using procedural modeling, would increase the efficiency of a designer. This would either enhance the output quality and quantity or reduce the need for designers and thereby reduce the expenses of creating virtual models.

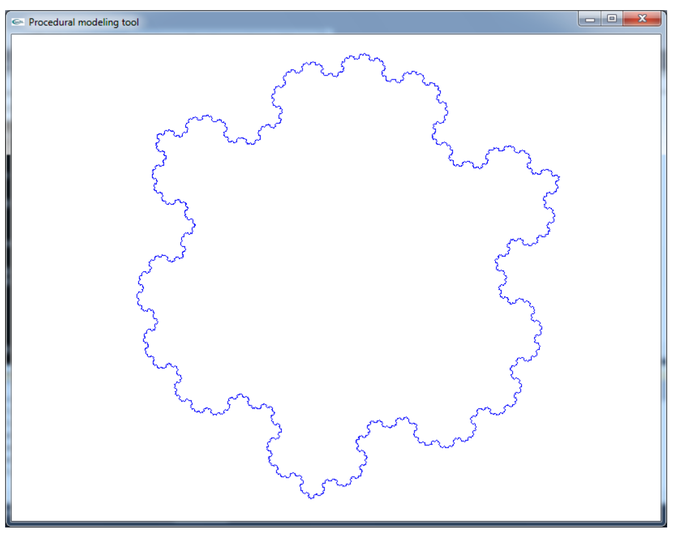
The goal of this research is to develop a grammar, which is suited for general purpose procedural modeling. More specifically it should be possible to construct any virtual model and at the same time do it as automated as possible. This is challenging, since the two properties oppose each other.

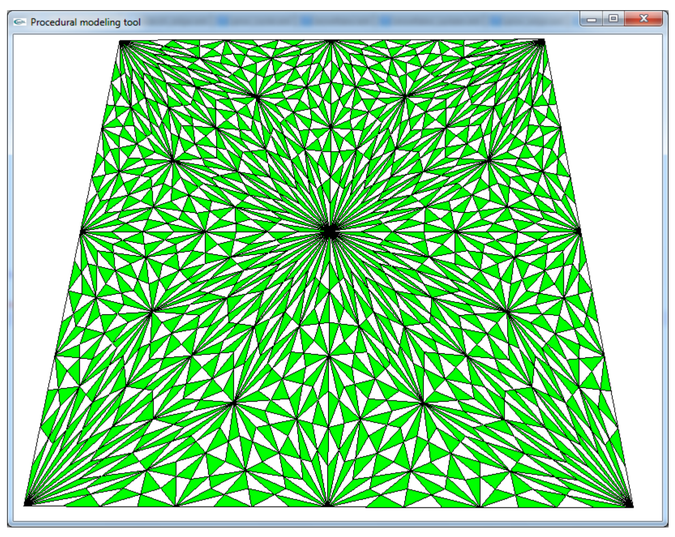
Results



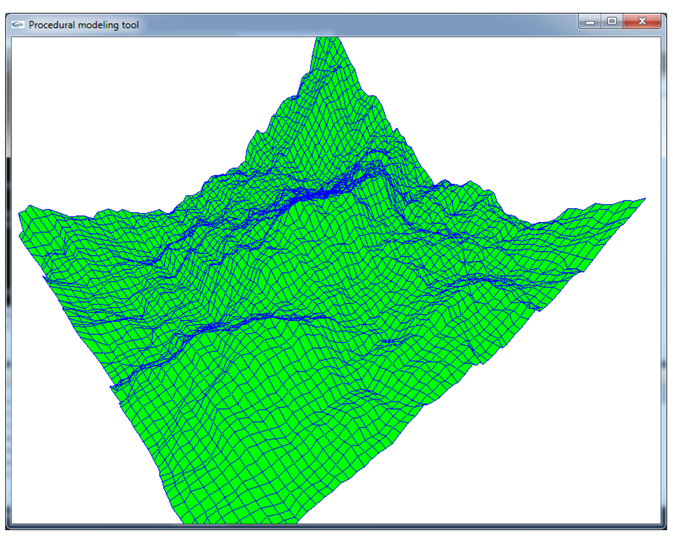


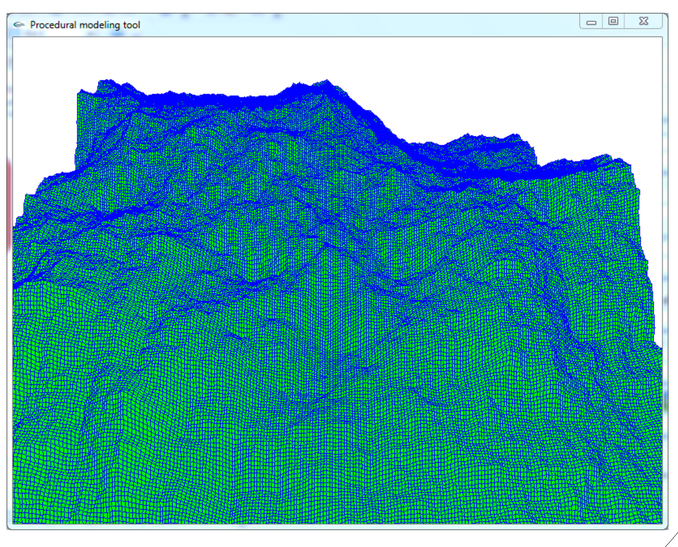
Two examples of random acyclic graphs or skeleton structures, which resemble trees. They are created automatically by the grammar, given only a few input parameters.





Left: A Koch snowflake generated by the grammar, which illustrates its capability to generate fractal curves. **Right:** A pattern created by subdividing a square repeatedly.





Two examples of fractal surfaces, which resembles terrain.

Contributions

The contribution of this work is primarily a grammar tailored for the special object modeling approach adopted in this research. The object modeling idea is to be able to handle three types of surfaces; skeleton, planar and fractal surfaces, which is sufficient to model any virtual object. The use of skeleton surfaces, ie. a skeleton is procedurally modeled before it is converted to a polygon mesh, is especially useful, since a skeleton is significantly simpler to model procedurally. The grammar developed in this research is unique because it is working on directed cyclic graphs instead of strings and it has chosen limitations to the terminals, non-terminals and production rules which make it possible to automate the modeling, but still maintain the full expressive power. Furthermore it uses a novel system to handle context sensitivity, which enables the grammar to be parallel, ie. applying production rule to several parts of the object simultaneously.