Interactive Procedural Street Modeling Handout

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Summary

The aim of this research paper is to solve the problem of modeling large street maps in a fast and effective manner. It is very time consuming and tedious to manually draw maps whether on paper or digitally. Through the implementation of tensor fields as an underlying framework to represent street networks, realistic and visually detailed maps can be procedurally generated. Additionally, with three-dimensional geometry modelling, fly ins of virtual urban cities can be produced for industries such as urban planning, entertainment, and advertisement. Tensors are algebraic objects that describe relationships between sets of algebraic objects in a vector space. These algebraic objects can also be other tensors. The simplest tensors are scalars and vectors. A simple comparison of tensor fields can be to a grid containing vector points. In this research paper each tensor is a 2x2 square matrix representing major streets. Each tensor has eigenvectors, and the tangents to the eigenvectors are called hyperstreamlines. From user inputs of a water map, forest map, height map, or density map as functions on a grid, tensors can be placed on this grid to represent roads. Changing the values of the tensors, eigenvectors, hyperstreamlines and eigenvalues, alongside rotational constants R1, R2 and R3 to modify the tensors, the resulting road network can be altered. Using procedural generation, a computer can easily model large scale and detailed maps from the original inputted maps and tensors.

Key Points of the research paper

1) A Tensor in this research paper is a 2x2 square matrix. Put simply it can be visualized as a vector with both direction and magnitude on a grid, where the grid is based upon the inputted map from the user.
2) Hyperstreamlines are tangents to the eigenvectors of a tensor. Hyperstreamlines represent the minor roads on the map. Previous study on generation of evenly spaced hyperstreamlines is the basis for the procedural generation of minor roads.
3) My modifying the mathematically properties of tensors, eigenvectors and hyperstreamlines, the corresponding roads can be modified. These changes to the roads include radial and grid patterns, and seed point creation, which is the layering of roads onto the map.

Questions

1. What is the relationship between tensors and hyperstreamlines?
2. What is an eigenvector and eigenvalues and its relation to the roads?
3. How does changing the tensor change the map?