CPS 713

TERRAIN RENDERING FOR A GEOGRAPHIC INFORMATION SYSTEM

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THE LIVING TEXTBOOK

Overview of the project

The Living Textbook Project is a joint project between the Northeast Parallel Architectures Center (NPAC), the School of Education at Syracuse University, NYNEX, and Columbia University, on the application of high performance computing and communications (HPCC) to K-12 education.

Several pilot projects involve designing multimedia educational applications, including interactive simulations, which will be hosted on computing facilities at NPAC and delivered to schools in Syracuse and other parts of New York state via the NYNet fast ATM network. This is a prototype for the use of the National Information Infrastructure (better known as the Information Superhighway) for education.

The Interactive Journey

As a part of the Living Textbook project, we are developing a flight simulator interface to geographical data of New York state. Students will be able to "fly" around a rendered 3D view of the state that is interfaced to a Geographical Information System, so that they can select landmarks and cities and obtain multimedia information about these places.

Currently high-quality real-time 3D terrain rendering is not feasible on single processor workstations, and certainly not on machines such as Macs that are likely to be used in schools. So we are aiming to interface existing 3D GIS software running on a Mac with a parallel terrain renderer running on a high-performance parallel computer connected via a fast ATM network.

Geographical Information Systems

The United States Geological Survey (USGS) defines a Geographical Information System (GIS) as

> "a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations."

Many types of geographical data can be used:

- Elevation
- Satellite image
- Digital line graph
- Land use / Land cover
- Geographic place names

Integrating these different data sets is a non-trivial problem.

SOURCES OF TERRAIN DATA

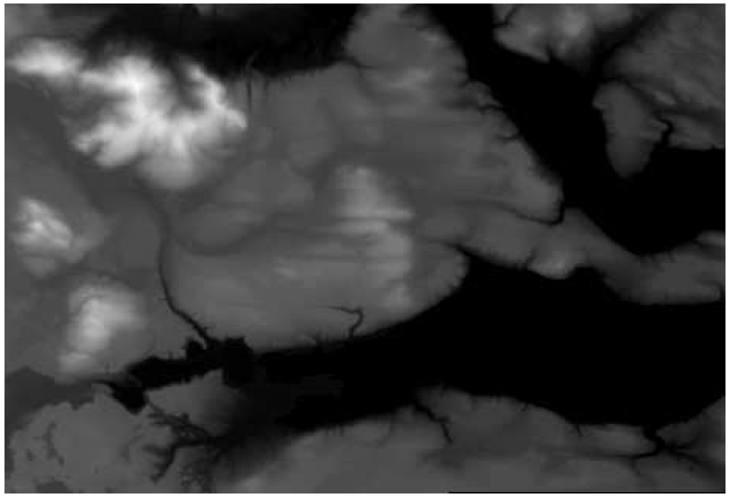
Elevation data

Elevation data is available from USGS as a Digital Elevation Model (DEM). This is obtained by digitizing contour lines on USGS topographical 1:250,000 scale maps. The data is set up as points on a grid covering a 1 degree quadrant with 90m resolution. 30m resolution data is being developed, but currently is only available for about half the US.

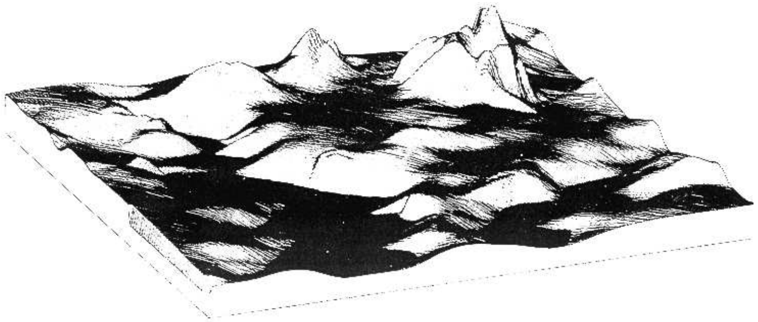
Data for New York state requires about 500 Mbytes, for the entire US it is about 10 Gbytes. This will increase 9-fold for 30m resolution data.

The US Defense Mapping Agency has 90m resolution data for the entire world, but it is classified. The only available world-wide data has 1km resolution, which is the same as is available for Mars!

Example DEM data



2D image, with brightness increasing with height.



3D image with shadowing.

Digital Elevation Model (DEM) data for part of the Cascade mountains in Washington state.

Satellite image data

Landsat satellite data of will provide realistic colors and texture for the polygons, with a resolution of 30m.

Data first has to be preprocessed to correct for distortion caused by for varying elevations, using the DEM data, so that it becomes like a 2D map. The satellite image data can then be "draped" over the DEM data to make a 3D image.

Satellite image data at better than 1km resolution is available for Mars and Venus from JPL.

Example satellite image data

Landsat image of Cape Cod

Digital Line Graphs

Digital Line Graphs (DLG) are made up of vector data marking objects such as roads, waterways, city, county, state and country borders.

Digital line graph of roadways

Other data

Land use / Land cover data is available from USGS. Areas are classified into 92 categories of land use (human activity such as residential, agricultural, etc) and land cover (vegetation, water, etc).

Geographic place name data is available from USGS, listing all known places, features and areas in the US that are identified by proper names. The database contains over 2 million place names referenced by geographic position.