GIS and Simulation System Integration in a Virtual Reality Environment

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GIS, Simulation and Virtual Reality

Outdoor simulation models may require huge GIS data amount. Therefore establishing an interface between simulation model and GIS is needed. This interface enables data representation and its use in the model.

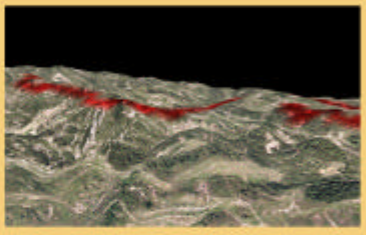
Virtual reality allows landscape representation and stores landscape physical structures that can be analyzed and modified by the simulator along simulation execution.

Automating data from GIS to Virtual Reality

Until present main GIS tools providers have been developing several techniques for data representation improvement, especially in 3D view. Some of them only show a static 3D view while others allow 3D view with navigation features (free fly or recorded animation) over data representation.

In our approach virtual reality techniques have been used, following VRML 2.0 format specification. This enables powerful interaction with the different models elements. Data modification is needed in order to transform GIS data to VRML data, adding sensors, scripts, to represent dynamic behavior and other functionalities based in EAI (External Authoring Interface). VirtualLands © as others specific tools allow easier data transformation.

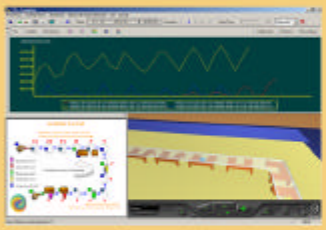
In wildfire model, GIS stores landscape's data (Digital Elevation Model, humidity, combustible layers, etc). Through virtual reality data representation, simulation model learns terrain configuration and enables interaction.



Fireline Simulation in VR

Leansim ® Simulator and Cellular Automata

Leansim® is an event oriented generic simulator based in a virtual reality environment, developed by LCFIB (Computing Laboratory of the Barcelona School of Informatics).



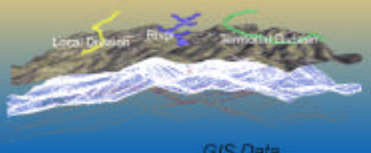
Leansim® Simulation Engine

A cellular automaton is a structure allowing raster data layers representation as combustible, humidity and DEM. This element is implemented using a matrix with its own logic behavior and an event scheduling facility to enable the simulation process. Simulation model is based in the Rothermel Mathematical model allowing fire spread time modeling in a forest. Simulation is driven by three simulation main events -EBurn, EPropagation and EExtinguish-.

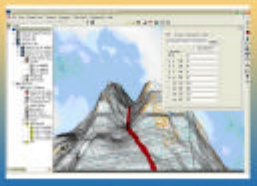
Mathematical model is evaluated every time that an EBurn event is generated by the simulator. This enables the dispatch EPropagation events to the eight neighbors cells (Moore neighborhoods) and additional event (EExtinguish).

Generating Virtual Landscape Simulation

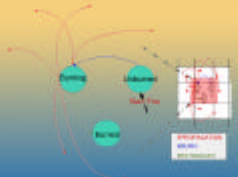
Automating data transformation from GIS to VR using specific tools as VirtualLands©, importing several format files -shape, raster, DEM, text, etc - from a GIS and convert to analogous layers in VRML, and enables Leansim® files data format export and build a VRML file containing all needed information to simulate or query GIS data in 3D View.



GIS Data



Convert Data GIS to VRML



Moore Neighbourhood Cellular Automata

Simulation Model

Conclusions

Integration between simulation systems and GIS enables simulation models to incorporate geographic complexity. Traditionally main application areas in simulation are manufacturing, logistic and the traffic flow modeling. Integrating GIS landscape related systems are suitable to be modeled. Cellular automaton simplifies geographic structures utilization. Using GIS layers in the simulation model through cellular automata is easy since geographical data can be used like a common simulation object, sending and processing events without any difference with other model elements. This new architecture clarifies the link between simulation and GIS based in decision support systems enabling the construction of detailed models incorporating GIS data in a way closer to the GIS common data representation, and integrating common layers inside simulation model, with no need of discrete simulation engine modification.

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