

# 3D Geo\_visualization Service for Grid\_oriented Applications of Natural Disasters

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## Abstract

The state-of-the-art visualization libraries and tools (both 2D and 3D) offer many features that can satisfy virtually all needs of a typical scientific application. However, the approaches of visualization toolkits differ. Our aim in this paper is to design a framework that will define a unified way of cooperation between Grid visualization applications and visualization clients. Working with the Grid technology implies increased complexity on one hand, and user demands for high interactivity on the other. The duration of the computations in the Grid environment being exceedingly long, the user naturally wants to see the intermediate results and requires means to modify the running computations if the intermediate results are not satisfactory. This paper describes a Visualization Service for Grid oriented applications, one of services of mentioned framework.

## 1 Introduction

Grid applications, by their nature, are very time consuming. Unfortunately, the existing Grid infrastructure supports particularly batch applications; the support for interactive applications is only in its experimental phase. However, the time-consuming nature of Grid applications makes the users to demand the support to be able to check the state of the running application and modify it if the progression is not satisfactory. This encompasses two things; first, to be able to monitor the progress of the computation, via the means of application statistics, and second, to be able to see the actual intermediate results the application has provided so far. Unfortunately, the current situation is far less pleasurable: the user has to wait until the whole application finishes and only then he can run the visualization job, which will present him the data in the form of imagery. Having to wait until the application finishes only to see the computation went wrong can be very irritating.

Majority of Grid applications can be extended to contain a subsystem that would, on a demand or in regular time intervals, provide some information about the status of the computation; the phase of the computation or a progress indicator are typical examples of such information. There is a category of tasks in which the time of computation cannot be estimated in advance (some optimization tasks, cipher breaking, etc.); for such applications, the progress indicator can be based on statistically obtained data about similar tasks. If the application is running on more cluster nodes (which is

nearly almost a rule in the Grid environment). The user might want to observe the computational load and the degree of completeness at each node.

In such event it is considerable to create visualization services, which are able and very quickly and simply to prepare visualizations outputs for clients. This paper is describing such visualization service developed and tested in our institute. Concrete 3D visualization tool for GRID oriented Natural Disasters applications and appropriate submit workflow.

Many applications from this area are using different kinds of simulation tools, which are producing output data for displaying the results of the computation. The purpose of Visual service is to model and display results of various simulations of natural disasters like fire spread in time, its intensity and erosion or floods in time or landslides as well [10],[11],[12]. The output of the service is terrain covered by orthophotomap or it is only shaded according to the altitude. On such prepared terrain is displayed the simulation of the fire spread in time, its intensity and erosion, flood water spread in time and so on. They are visualized statically or dynamically by adding red faces for the fire, blue faces for the water and brown faces for the landslides. Output of the service can also be the files representing the virtual reality of natural disaster. For example in case of fire the spreading red faces are replaced by virtual fire. Similarly in case of flood the blue faces are replaced by virtual water and so on. Visual service was tested by output from applications, which were solved in our institute and also by data from applications in project MEDIGRID.

## **2 Related work**

There are several tools solving the visualization of natural disasters. However, these tools lack common criteria for visualizations, unification of data formats, and a common approach to visualization. The integration of formats and a common solution for visualization of natural disasters, which has been solved in our visual service, provided the opportunity to create a visualization service for grid applications aimed to natural disasters. As the applications computing natural disasters work with big amounts of data, grid computing is used frequently. Using visualization service could be considered a big contribution. This has been proved by increasing interest of experts working on international projects. Searching for new facilities of preventing natural hazards, they are continually seeking to integrate the existing applications. One of them is the visualization service with it's submit workflow.

## **3 Architecture of 3D visualization tool**

3D visualization tool consists of modules, which was necessary to create. Each module is UNIX shell script in which is prepared starting of executables. The modules are divided into three groups according to what kind of output 3D models is the group generating. The functionality of each group described by appropriate schemas. This segmentation requires building three types of 3D models.

- Models of terrain or model of environment
- Models of simulations
- Virtual reality models of terrain and simulation (fire spread, flood, landslide etc.)

### 3.1 Models of terrain or models of environment

The first group of modules in the 3D tool is designed to creation of 3D terrain models and environment models. For 3D models of this type were created modules: CONVERTOR, TERRAIN, IVFIX and CONVERTTOWRL. Function of these moules described by Schema 1 (see Fig. 1)

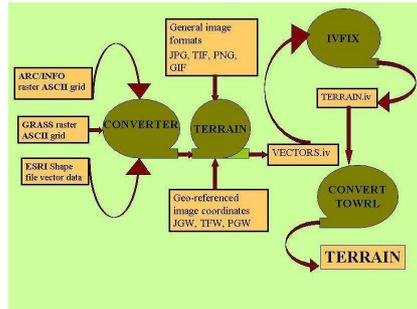


Fig. 1: Schema 1.



Fig. 2: Povazie Terrain

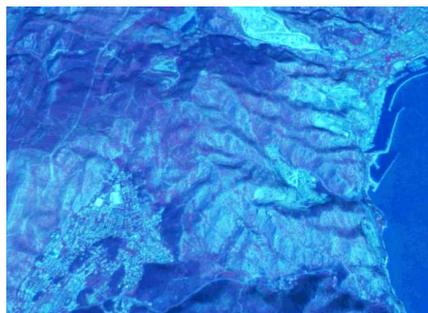


Fig. 3: Marseille industrial port Terrain

Most frequently used formats of input data for terrain are: ARC/INFO raster ASCII grid [2], GRASS raster ASCII grid [4], ESRI Shape files vector data [3]. The input formats for image textures are general image formats like JPEG, GIF, PNG, TIFF etc. and corresponding general ASCII image coordinates

formats are JGW, TFW, PGW etc. General image formats like JPEG, GIF, PNG and TIFF [6] are used as textures for ortophotomaps in our tool. Image formats JPEG, GIF, PNG and TIFF are geo-referenced by image coordinates in JGW, TFW or PGW files.

Data in one of mentioned formats are geo-referenced data [1], which have defined their location in physical space. They are commonly used in the area of GIS and other cartographic applications. Mentioned formats have different syntax. Input data are converted to singular format by one of modules named CONVERTOR (see Fig. 1). Then data can be exported to the TERRAIN module. Terrain module computes vectors and creates quad mesh for terrain models. Then modified IVFIX [5] module creates Indexed face sets in ivfile format. Indexed face sets files are converted by module CONVERTTOWRL, to Virtual Reality Modelling Language VRML (files with extension wrml). We created CONVERTTOWRL module according to the requirements of 3D tool. The final model of terrain is VRML file TERRAIN.wrl. It means that from input files: *TERRAIN.asc*, *picture.jpg* and *picture.jgw* the 3D tool is able to create 3D model of terrain. All modules are UNIX shell scripts by which is activated running of executable files.

Examples of terrain created by the tool:

*Povazie*, (see Fig. 2), from grid computing flood application, which is also solved in our institute. *Marseille industrial port* (see Fig. 3) terrain from fire application generated in EU project MEDIGRID EU 6FP RTD GOCE-CT-2003-004044 [9].

### 3.2 Models of simulations

The second group of modules in the 3D tool is designed to generation of Models of simulations. The following modules were created: CONVERTER, CLASSIFIER, COLOR SOTER, TIME SORTER and VIRTUAL SORTER and GENERATORS for static or for dynamic outputs. Process of creation of simulation models is described by Schema 2.( see Fig. 4).

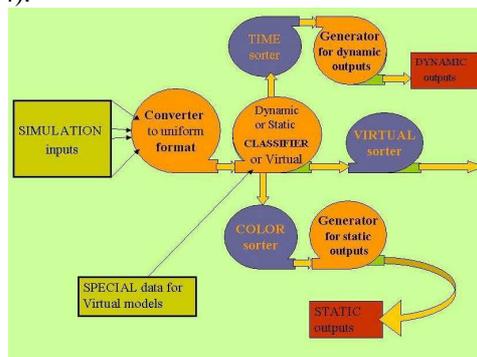


Fig. 4: Schema 2.

Input data for second part of 3D tool are output data from simulators in different formats. Module CONVERTER converts them to singular format. Then data can input to CLASSIFIER module. CLASSIFIER sorts data and exports them to COLOR sorter and TIME sorter and some of them, which are used for Virtual models to VIRTUAL sorter. Data from sorters input to GENERATORS. Generators are producing simula-

tion models. Generator for static outputs produces *Static models*. Generator for dynamic outputs produces *Dynamic models*. Final visualization consists of terrain model and some of simulation models. For example visualization of *fire spread in time* (see Fig. 5.) consists of TERRAIN.wrl and Firespread.wrl files. Intensity of fire can be displayed statically (see Fig. 6) or dynamically together with fire spread in time.

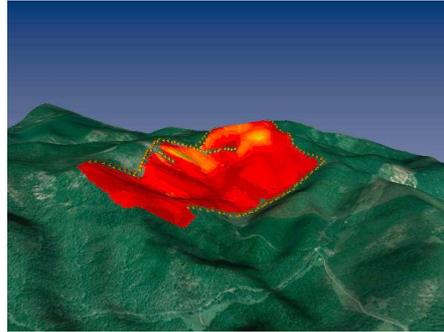


Fig. 5: Dynamic model – Fire spread

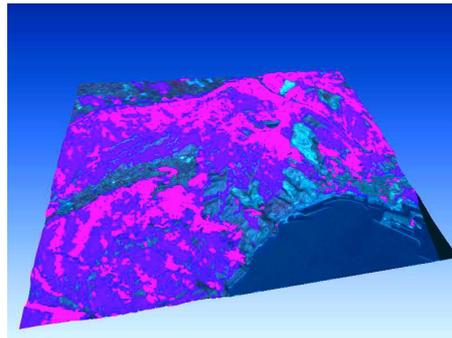


Fig. 6: Static model – fire intensity

### 3.3 Virtual reality models of terrain and simulation

The third group of modules in the 3D tool is designed to generation of virtual models. The following modules were created: DATA SORTER, VIRTUAL TERRAIN SORTER, VIRTUAL SIMULATION SORTER and several needed GENERATORS. Process of creation of virtual models is described by Schema 3. (see Fig. 7).

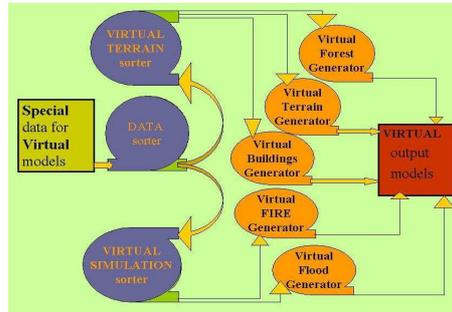


Fig. 7: Schema 3.

Outputs from Virtual sorter together with Special data for Virtual models are exported to DATA SORTER (Schema 3.). It sorts the data and exports them into VIRTUAL TERRAIN SORTER or VIRTUAL SIMULATION SORTER. Data from sorters are inputting to GENERATORS. They are producing a lot of virtual models like for example virtual terrain or forest, virtual buildings, virtual fire, or virtual flood.

To create virtual models, 3D tool needs *Special data for Virtual models* which can be variable. For example for generating virtual forest special data are *Grown maps*, or for generating some buildings they are *Project documentation* etc.

Following example demonstrates using of mentioned part of the 3D tool for creation of Virtual forest fire. Firstly was created virtual forest from Grown maps which were provided us by forestry. For generation of virtual forest was used forest grown simulator Sibyla. This software was developed in Forest faculty in Zvolen Slovakia.

In the end red faces were replaced by virtual fire textures using Virtual fire generator module (see Fig. 8). By similar methods using different modules of 3D tool is possible to create also virtual floods or landslides or some other natural disaster visualizations. By creating models of large forest scenes and real forest fire scenes or large flood were used graphic methods, which allow rendering such scenes in real time. In 3D tool modules are applied all last modern graphic methods (LODS, transparent textures, Billboard clouds etc). Final models from 3D visualization tool are files in VRML format and can be displayed by VRML browsers and viewers or they are displayable in CAVE too (see Fig. 9). In collaboration with Institute of Graphics and Parallel Processing of Johannes Kepler University Linz we are able to view some of the Virtual scenes in Cave system.

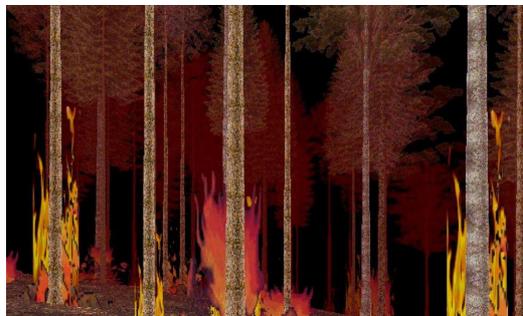


Fig. 8: Virtual Fire in Krompla hill



Fig. 9: Visualization in CAVE

#### 4 Creating Visual service

The Visualization Service is a common job submission service used to run the modeling by scripts. The service will produce visualization outputs and make them available them for the portal. The 2D visualization results can be browsed from within the portal, the results of 3D visualizations require a VRML browser plugin installed. It described Schema 4 (see Fig. 10).

Visual service was used and tested in MEDIGRID project. In a future can be used Visual service in projects by disasters problems.

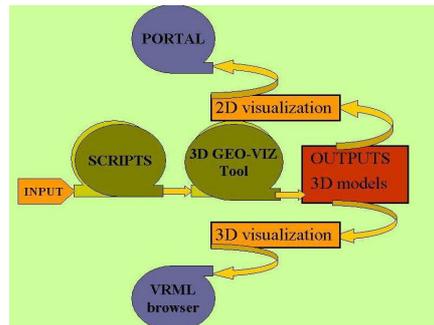


Fig. 10: Schema 4.

#### 5 Conclusion

3D visualization tool has several advantages. Integrates input formats, which are currently most frequently used. 3D tool provides for natural disasters applications different levels of complexity of the visualizations from simplest and fast to very complicated virtual scenes. Output files are in format VRML (Virtual Reality Modelling Language), which are displayable by commonly available applications like internet browsers, Freewrl, Blaxxun contact, Cortona client, Openwrl, VRED an also in CAVE etc. 3D tool can be used as Visual service for a lot of grid computing natural disasters applications.

## Acknowledgments

This work was partially supported by Science and Technology Assistance Agency under the contract No. APVT-51-037902 and by the EU project MEDIGRID EU 6FP RTD GOCE-CT-2003-004044. And also is supported by RPEU project GRID\_tools No. 0024-06 and VEGA project No. 2/7098/27.

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Subject:  
Author: Peter S.  
Keywords:  
Comments:  
Creation Date: 05.10.2007 09:23  
Change Number: 21  
Last Saved On: 20.11.2007 10:43  
Last Saved By: eva  
Total Editing Time: 281 Minutes  
Last Printed On: 20.11.2007 10:43  
As of Last Complete Printing  
Number of Pages: 8  
Number of Words: 2'245 (approx.)  
Number of Characters: 12'798 (approx.)