VR WebGIS: an OpenSource approach to 3D real-time landscape management

Calori L., Camporesi C.,
Forte M., Pescarin S.
CINECA Supercomputing Center,
Bologna Italy,
[l.calori],[a.guidazzoli],[s.imboden]@cineca.it
CNR ITABC (National Council of Research - Institute of Technologies Applied to Cultural Heritage), Rome, Italy.
[maurizio.forte],
[sofia.pescarin]@itabc.cnr.it
BOLOGNA CITY COUNCIL,
mauro.Felicori@comune.bologna.it

Abstract

OpenSource philosophy has reached to unexpected goals. The diffusion of OpenSource tools is increased quite a lot, but also the quality of the tools is improving. Their usability is slowing going even towards communities not exactly skilled in advanced programming. Open movement is penetrated in many sectors, often subverting, thank to its social impact, the traditional rules of companies and research institutions, pulling down sometimes hierarchies and pushing on innovative ideas because of their validity and values.

Even fields that until now were a bit apart, such as Cultural Heritage field but also land-management, are starting their first experiences.

There are many perspectives of development, indeed, in sectors that need to use carefully and cautiously the few economical resources they can dispose. Build an OpenSource project has meant for us to experience many advantages (together with some difficulties): low cost of the solutions, sustainability of the projects, push toward resources sharing, simplicity in the re-use of data already processed and in integration of known and well established methodologies, valorisation of 'human' investments more then on 'technology'. This lead the two interdisciplinary teams, that had a long skill in the development of immersive environment and of virtual reality systems and in the reconstruction of ancient landscapes through digital technologies (CINECA Visit Lab and CNR ITABC VHLab), to undertake a new parallel research activity dedicated to the construction of desktop and web-based VR applications based on OpenSource tools.

The system realised is based on two open projects: OpenSceneGraph library (www.openscenegraph.org) and Virtual Terrain Project (www.virtualterrain.org). They were used in combination, modifying partially the code and adding plugins, in order to create a system useful to reconstruct complex landscapes, starting from GIS data (DEM, GeoImages and vectorial data in standard format such as .shp). GIS data are used to build a three-dimensional terrain through a powerful tool, OSGdem, that generates paged and hierarchy terrain databases. OSG was integrated with VTP, whose original code was modified so to import even different terrain database formats (flt, txp, ive). Inside VT Enviro it's possible to modify dynamically, three-dimensionally and in real time the landscape, using external libraries of 3d models, ve-

getation, animals, etc. (based on xml) or inserting directly on the scene, in a defined geographical absolute coordinate, the models. We then implemented OSG potentialities of .ive files publication over the Web, allowing VT Enviro to export the modified landscape. We realised an ActiveX plug-in for Internet Explorer to load the paged landscape from a Web server in the browser.

The final goal is to realise a system, useful for Public Administrations, Research Institutions and other public institutions, but also for the worldwide community. This system let a user not only navigate in real time through the Web even large territories, but also interact dynamically with them, adding for instance point of views, personal paths, activating or deactivating vectorial layers that can be added on the terrain, better understanding in this way the landscape.

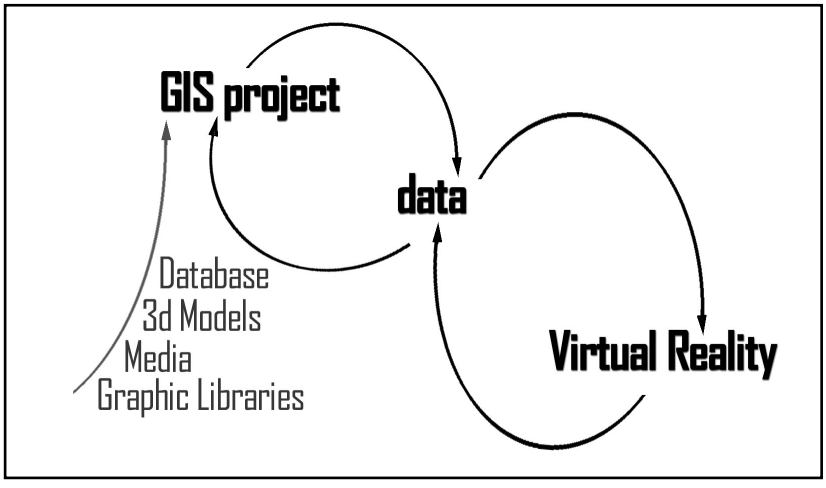
In the process that brings to the reconstruction and the virtual navigation of entire landscapes, even through the Internet, the spatial component of the data is a central issue.

Thanks to the spatial component of the data, it's possible, inside a VR system, to do some analysis and interpretation of those data and create new information that can be transformed into new layers back in the GIS, starting something like a "virtuous circle" that connect the bottom-up and top-down approaches [Forte, Pescarin 2004]. More open is the process more virtuous are its results (fig 1).

Even for this reason, we tried to construct a system that could use the same philosophy followed, in the last years, by the two teams involved of CNR ITABC and CINECA Visit Lab [Calori, Diamanti er alii 2004], that was based on Virtual Reality Desktop solutions and, in the meanwhile, that could be as much distributed and sustainable as possible.

After two years of research, still in progress, what we obtained is a Virtual Reality application based on Geographical Information Systems, that gives the possibility to exchange information, to share data, to open discussions, to test different hypothesis and eventually to revise some data and that can be published on the Web.

OpenSource offered us some solutions since it's first adoption in the projects we used as testing-cases, showing that this approach could be a possible challenge for the future of sectors such as Cultural Heritage or environment management, giving a possible alternative to actual commercial solution, strengthening the investments on human resources, focusing on contents and on new tools developments. .



Appia Antica Project

In the case study we choose at the beginning, we worked developing a part of a complex four-years project. It was a good chance, since it allowed a continuous comparison with other VR techniques thought for PC installation and based on commercial software and it gave also the possibility to follow the entire process of data production: from the fieldwork to virtual reality.

The Appia Park (the archaeological park of the Roman Via Appia, in Rome, Italy) project was developed by the interdisciplinary team of CNR ITABC, together with Rome Municipal Archaeological Superintendence. It was characterized by an intense activity of archaeological and architectonic survey (topographical and architectonic mapping and "micro-topographical" and "micro-architectonic" mapping) with the goal of acquiring data for a real-time spatial interactive system. All the techniques used (DGPS, Total Laser Station, 3D Scanner Laser, 3D Stereo Photogrammetry, Photo Modelling Techniques) were integrated, while the entire set of data acquired was post-processed, overlaid in a GIS project based on their spatial reference, connected with external multimedia databases (fig. 3). Even 3D information was geo-located and processed in order to be used - together with GIS data, DEMs and Geoimages - inside a Desktop Virtual Reality environment, based on VirTools for the off-line museum application (www.virtools.org).

We developed also an on-line VR application based on OpenSceneGraph and VTerrain libraries (www.appia.itabc.cnr.it). The project, through the Appia Antica case study, confirmed that the use of integrated technologies and the combination of different typological data is extremely useful in order to manage archaeological and historical information inside GIS and Virtual Reality Systems, in a 3dimensional, interactive and flexible way. At the same time, this approach allows 'scaled' version, useful even for cultural content dissemination, at different level, without loosing any scientific precision.

Fig 2. Fieldwork activities

Fig.3 GIS project

VR WebGIS

In order to develop our VR WebGIS system we found two OpenSource libraries that seemed quite promising: Virtual Terrain (VTP) and OpenSceneGraph (OSG). We start our work with Virtual Terrain Project because it offered a ready user-interface, a good integration with geographical formats, projections, 3d models formats, etc. and a good integration with the workflow we were following before, for landscape reconstruction [Forte, Williams, 2002].

Virtual Terrain Project is first of all a project and a community interested to 3D digital reconstruction of large territories. VTP have also developed an Open Source tool for real time landscape visualisation (VTEnviro) and a series of other tools for geospatial data processing and models or vector layers managing (VTBuilder, CManager...).

The tools used for the project were mainly two: VTBuilder and Enviro.

VTBuilder is a GIS-like software that allows to manipulate geospatial data. GIS file formats are imported and then prepared and exported for an optimised use inside the viewer. It produces DEM as height-field files (.bt). Geoimages are adapted and wrapped on the .bt file with a simple LOD-like function. Enviro is a complete viewer, partially based on OpenSceneGraph, that allows a navigation on large terrains, enabling or disabling parts of the models. The fundamental characteristic of this viewer is that with Enviro it's possible to modify in real time and in 3d all the objects included in the landscape. In this way any operation seems extremely natural, allowing to concentrate on reconstruction problems. With Enviro it's possible to add, put and cancel 3d models; to modify fences parameters procedurally, etc.

Unfortunately VTP doesn't manage terrain databases realised in hierarchical way, paged and with LOD (osg, flt, txp).

This didn't let the publication on the Web of the files or the management of large geoimages with a proper LOD approach. Even for these reasons we planned to extend VTP, integrating it fully with OpenSceneGraph.

The entire set of tools for terrain generation, reconstruction, navigation and interaction even through the Web in real-time, was possible, indeed, thanks to the use and partial extension of the 3D rendering library OSG and the tools Enviro and VTBuilder of VTP kit. VTP, after our adjustments, become a real plattform to generate, model and modify geographic scenarios.

It was enabled the utility of importing, inside VTEnviro, different terrain database formats (paged and lod terrains - flt, txp, osg, ive) or other 3d models formats (osg, ive, flt...). Moreover an export utility has been created. With this functionality it's possible to modify the landscape dynamically and then export it in OSG or

IVE format, ready to be published on other VR viewers or on the Web. Using specific OSG modules it was possible enabling the access to data even from remote sources. This extension was fundamental also for the development of an ActiveX plug-in for Internet Explorer and for VTP data loading from a web server.
In OSG distribution there are some applications included. The tools we used more to reconstruct the landscapes are: osgviewer (a basic to visualise 3d objects); osgconv (utility useful to convert in a simple way different 3d formats in OSG/IVE formats) and osgdem. This tool, in particular, is dedicated to large terrains generation, starting from geospecific data (DEM files and Geoimages). The terrain databases produced are perfect for real time navigation and remote fruition, thanks to the hierarchical structure of the files. (fig.4)

Fig 4. LOD and paged terrain reconstructed with OSGdem

The potentiality of OSGdem led us focusing our terrains generation activity on this tool. However, we planned to maintain VTEnviro as terrain-modifier, thanks to the simplicity of its already available user interface. As we said, for this reasons, we found that OSG and VTP used in combination could be a good solution. In the table below (table 1) there is a simple definition of the process. The work has been divided into different activities necessary to realise a complex landscape made of terrain, 3d models, vector layers, labels and so on.

Activities	OS Tool used	Other Tool used for comparison	Input	Output produced by *export-tool* realised for web publishing
Terrain generation	OSGdem	Terrex Terravista, Creator Terrain Studio	.dem, .ascii, .grd, geoimages	.ive or .osg hierarchy
3d models processing (buildings, objects, etc.)	Blender	Multigen Creator, 3DStudio Max	3ds, flt, obj, osg, ive	.osg, .ive
Vegetation	Grass and VTBuilder	ArcView	Shp	.osg, .ive
Vector layer processing (roads, rivers, ...)	Grass and VTBuilder	ArcView	Shp	.osg, .ive
Automatic 3d building generation from vector data with database of eights	Grass and VTBuilder	ArcView	Shp	.osg, .ive
3d models modification: move, cancel, add	VT Enviro	Multigen Creator, 3DStudio Max	3ds, flt, obj, osg, ive, shp	.osg, .ive
Label insertion	Grass and VT Enviro	ArcView	Shp+dbf	.osg, .ive, font
Final landscape publication on the Web (terrain with layers and labels)		ActiveX		
Interaction with 3d models, vector layers or other terrains (switch on and off)	PostgreSQL and PhP		Sql db	html

In the case of Appia Antica project, after the creation of the terrain hierarchy with OSGdem, we used VTEnviro uploading the OSG terrain instead of the proprietary “monolithic” terrain format. With VT-Builder and Enviro we imported culture data (3d models, plants, characters, animals, vector layers, etc) and we modified them directly in the 3d environment. The archaeological landscape was reconstructed in this way. Low-polygons 3d models, built with photo-modelling techniques [Pescarin, Pietroni et alii, 2005] could be added, together with vegetation information on the park, vector thematic layers on the ancient aspects of the landscapes and so on (fig 5).
After this phase it was possible to export culture data into an *.ive or *.osg format (fig 6).
The landscape could be then published through an ActiveX we have written, while all the components of the landscape could be managed, kept organised inside a Web database (based on postgreSQL and PhP) (fig.7).
The web site is now available at www.appia.itabc.cnr.it. At present there are some requirements that we would like to modify in the future: broadband or ADSL connection, OpenGL graphic card, Internet Explorer.

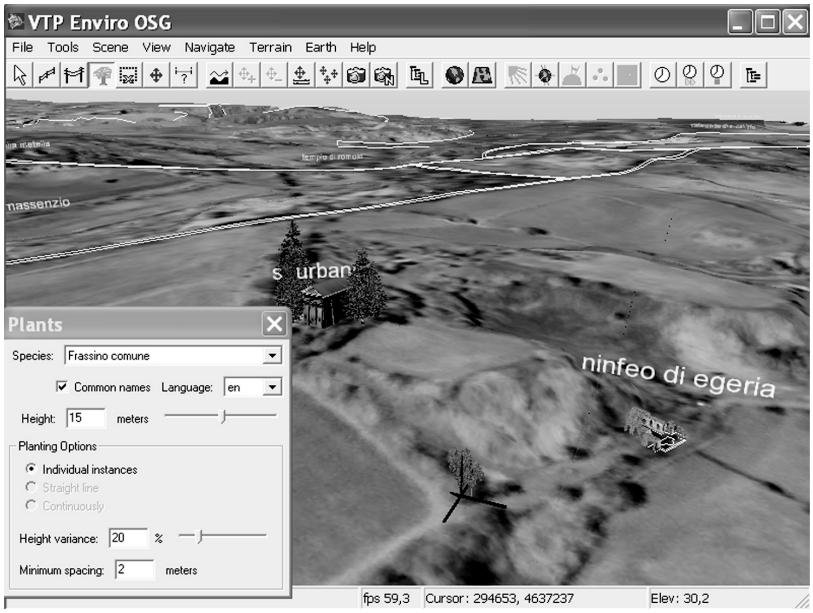


Fig 5.

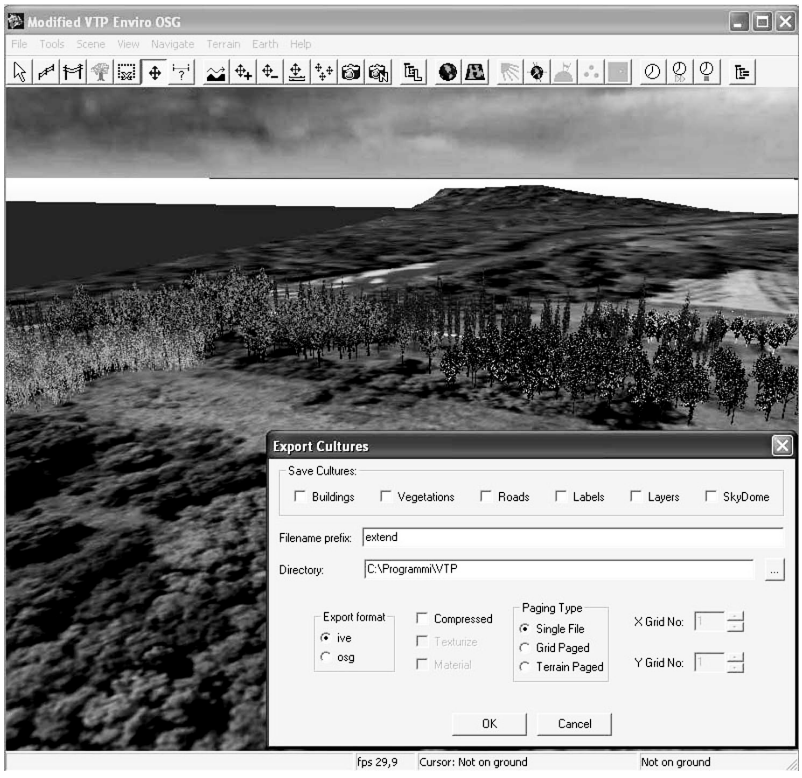


Fig 6.

The work of opening the system to as many formats as possible gave the possibility to use it also with other commercial or open software and for other uses. Terrains and 3d models generated by other external programs (paged terrain, 3d photo-modelled objects, 3d studio models etc.) can be fully integrated in the system. This allowed to take all the advantages of VTP kit, inside a wider and more effective working flow, and to create a medium useful to add, even on imported terrains, their own cultures, modifying and then exporting them in order to be used by other software.

After these experiences we are planning to go further on, toward a more ambitious and advanced project: the creation of a real "shared working system web-based". The idea is the integration of different OpenSource technologies, mainly based on OSG library, with the goal of create a system and put territorial data on a server, letting a user to navigate freely in the landscape adding or modifying part of the territory, uploading models from a web repository.

Fig 7.

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Fig. 7b. Modifying the landscape

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