

eGALab: a new dimension for artists

By Michal Masa*, Jiri Zara and Pavel Smetana



Presenting art in the age of the Internet brings along several misunderstandings: there occurs, for instance, a profound difference between online galleries or museums providing a simple point and click navigation in multimedia documents on the one hand, and some of the newly emerging presentation platforms that reflect contemporary artistic creation in its essential dependence on electronic media (e.g. net.art or virtual sculpture), on the other. The eGALab (Electronic Gallery and Laboratory) project advances possibilities to create and present artworks on the Internet. It introduces an intuitive approach in the field of virtual environments as well as communities oriented towards visual art and shared artistic collaboration. eGALab combines and transforms the advantages of collaborative virtual environments with the traditional aspects of artistic creation and presentation. In this paper we describe the architecture of the eGALab platform. We describe its networking part based on a concept of General Variables and discuss several implementation issues related to its specific character. Copyright © 2005 John Wiley & Sons, Ltd.

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Motivation

Artistic creation today is closely related to new and emerging technologies. Affordable computers capable of displaying fast 3D graphics together with Internet connection available widely provide an interesting base for the presentation of artworks in cyberspace. Thousands of virtual museums, galleries and exhibitions can be found nowadays on the Internet, mostly using HTML to present 2D images. Some also use QuickTime VR to provide visitors with a deeper sense of immersion. However, only few employ virtual environments to present new media installations consisting of 3D geometry, video, audio, integrated behaviour and interaction.^{1,2} These projects introduce a basic idea of a visitor navigating through the virtual space while viewing artworks and installations online, and they vary in terms of added features that provide interaction, improve presence and enable viewing of other visitors. Nonetheless, they still approach both artists and art-

works in rather an obsolete way, providing just a very limited variety of expressive means for contemporary new media artists.

There are also several commercial solutions available which enable a collaborative work on multimedia content within the virtual environments. Their disadvantage is that the data sharing is always based on the distribution of tasks. Every person involved in the production pipeline is dedicated to his or her own part and only those involved in a final composition are able to view the resulting whole.

The eGALab project was designed as a novel platform for international collaboration of new media artists and for presentation of their artworks to the public. It consists of virtual laboratories—shared collaborative environments for creation, and virtual galleries—exhibition spaces. These enable links to laboratories so that visitors can perceive construction of the installations as well as live performances online. Spaces are not constrained by walls, floors or similar obstructions typical of real-world museums and galleries. Collaborating artists are therefore able to compose their works freely.

Basic Principles

There are two key decisions in the design of a collaborative virtual environment. The first one concerns the

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rendering part while the second the part of networking. With eGaLab we decided to make use of a freely available VRML browser (Cortona) for the rendering part. We are aware of a number of disadvantages that VRML brings along and which mostly relate to the performance issues. On the other hand, VRML enriched with Cortona extensions offers a very wide range of possibilities to new media artists: they can seamlessly integrate 3D models with audio and video as well as responses to visitor's interaction.

The networking part is responsible for making the collaboration possible. We used our proprietary General Variables (GV) technology to distribute and store particular events (variables). This is based on the combination of a peer-to-peer network supported by a central server that stores all the events and keeps the later joined clients up to date.

The overall architecture of the eGaLab client is shown in Figure 1.

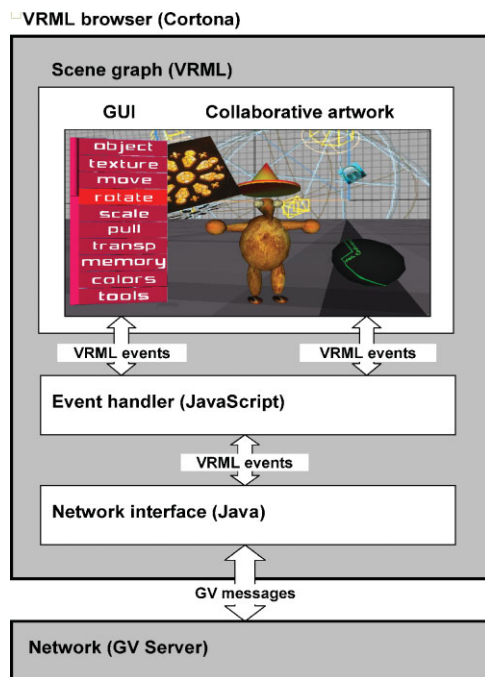


Figure 1. The overall architecture of the eGaLab client. The main part is the event handler, which modifies the scene according to artist's interaction with GUI and messages received from the network. All events were queued to prevent congestion, which results in high stability of the system.

Rendering Part: VRML

The main purpose of the eGaLab laboratory is to enable artists to collaboratively arrange an installation. It provides a set of basic tools to facilitate this task:

- *create* a primitive object (plane surface, cube, sphere, cone and cylinder);
- *import* a 3D object in VRML;
- *name, delete* or *change* the form of each object;
- *select, delete, copy* and *paste* operations;
- *move, rotate* and *scale* tools to change transformation of the object;
- *pull* tool to modify the shape of a plane surface;
- *colours* tool to change object's colour;
- *transparency* tool for changing object's transparency;
- *texture* tool to cover the object with still image, video, sound or text;
- *input devices* to connect object's properties to an input device (e.g. motion capture);
- *memory* tool to record or reload the entire scene with all its manipulations.

Figure 2 illustrates the use of the *move* and *rotate* tools. eGaLab laboratory was not designed as a full-fledged VRML editor. Complex models should be designed in a specialized 3D modelling software of the artist's choice. Nowadays any standard modelling software offers a possibility to export the model to VRML. Once exported, the model can be inserted into the laboratory using the *import* tool.

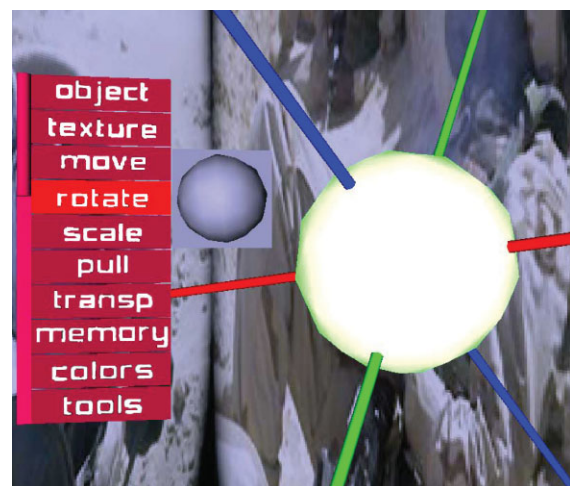


Figure 2. The rotation and move tools. The selected object can be positioned by pulling the axes. The sphere icon (on the left) is used to rotate the object.

The user interface as well as the creative tools were designed with respect to new situations and were subject to constant improvement and sometimes even re-definition, as feedback from artists was obtained. We find designing an optimal user interface very complicated and time consuming since the variety of common activities is repeatedly changing.

Networking Part: GV Server

eGaLab is a specific kind of net-VE (networked virtual environment) system. The crucial property of a net-VE system is that every user at any given moment sees the virtual environment in the same state. Maintaining this shared state is the most important part of the net-VE system.

We made an attempt to formalize the distribution and synchronization of the shared state among all the eGaLab users by designing and implementing the concept of *general variables*.³ An implementation of this concept employs the combination of a peer-to-peer network supported by a server for storing the shared state of the system. The key principle of the concept is depicted in Figure 3.

When a user attempts to interact with the world, the client application creates an adequate variable containing a value representing the user's action. The variable is then sent to the server, which updates the GV's database and broadcasts the variable to other connected clients. The variable can be also multi-cast directly to other clients without passing through the server. The actual distribution pattern comprising network protocol, echoing, reliability and sorted delivery options depends on the GV's flags settings. Receiving clients should decode the meaning of the variable and replay the original action locally. If a new client (*late join*) connects to the system, the server sends it the content of the GV's database so that the late joined client can update its state promptly.

While the concept covers the data distribution and synchronization, a concrete meaning of the data stored in general variables is left up to the application. Thus, the general variables can represent user interaction and modifications of the virtual environment, properties of the shared objects or other application specific data.

It is obvious that not every change of the shared state is of particular interest for every user. This filtering technique is referred to as *interest management* in net-VE systems. The GV concept provides means to parti-

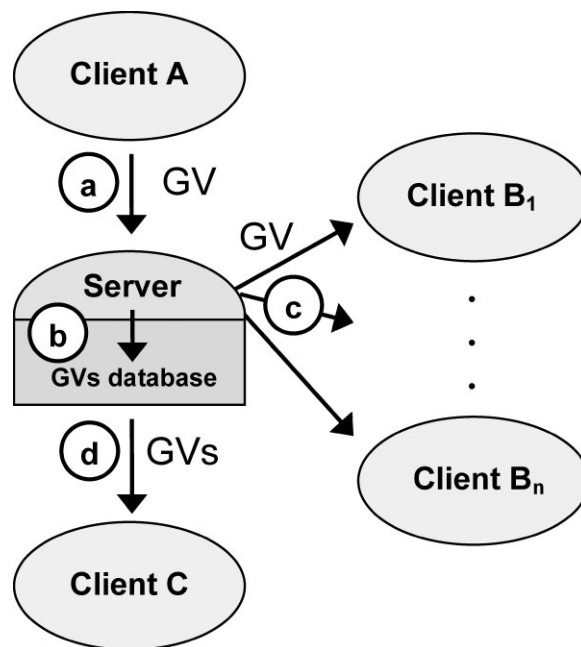


Figure 3. General variables (GV) concept. Storage and distribution of general variables. (a) Sending a GV to the server. (b) Storing a GV in the GV's database. (c) Forwarding a GV to connected clients. (d) Sending the GV's database to a late-joining user.

tion the shared state (represented by general variables) into *domains* and *sub-domains*. Domains represent categories of areas of interest; sub-domains represent their instances. Any state variable can belong to any number of domains that define the scope of the variable. For specifying users' interest we adopted the general auranimbus interest management model.⁴

Implementation Issues

VRML97 is an international standard for describing a 3D scene and its behaviour. It offers only a basic set of structural 3D elements and no means to support the creation of multi-user applications. Several working groups proposed their extensions to VRML, which resulted in the X3D standard draft. Since it is still under development, there are no freely X3D browsers available yet that would provide reasonable quality and performance.

In the two following subsections we describe our extensions of VRML97 capabilities and its standard functionality provided by Cortona.

Shared Interactivity

The *import* tool for importing VRML models enables artists to insert an arbitrary 3D object including its functionality stored in VRML format into the laboratory. The VRML file can contain not only the geometry but also some interactions using sensor nodes and routes. Sensors react to the user interaction (navigation, mouse pointing, clicking or typing) and generate events that are distributed by routes to the destination nodes. These nodes process the incoming events and generate an appropriate response (change colour of the object, generate sound, start playing a video clip or animation).

To fulfil the basic requirement that all visitors see the laboratory in the same state, all interactions should be shared among all clients. However, there are also interactions that should not be shared. This ought to enable visitors to explore an installation independently without interfering with each other (as in the case of interactive artwork that should be manipulated only by one visitor at a time). The final decision whether to share the interactivity or not is up to an artist.

In the eGaLab we have provided a technical facility to distribute interaction that is based on the Living Worlds draft specification of *Networkstate* nodes.⁵ The principle is that every route that delivers shared events is interrupted by an appropriate *Networkstate* node. The existence of the *Networkstate* node indicates to the VRML browser that every event passed through it should be shared. Such an event is delivered to other clients and injected to the corresponding *Networkstate* node that sends the event to its destination.

Since the current release of the Cortona VRML browser does not support the Living Worlds extension, an event handler part of the client emulates its functionality. Every imported VRML scene searches for the existence of *Networkstate* nodes. They are registered and all events passed through them are compiled into a GV and distributed.

We are aware that popular 3D modellers do not support the Living Worlds specification and not all artists are familiar with VRML to modify the interactions themselves. Thus, we have developed a simple command line tool that helps the artists to automatically convert the interactions in VRML file to *Networkstate* nodes. It parses the VRML file and searches for all routes that originate in sensor nodes. Such routes split into two routes connected to an instance of the appropriate *Networkstate* node.

Input Devices: MotionTracking

As stated in the first section, the eGaLab's laboratory is used not only for collaboration, but also for presentations including live performances. During the live performance the collaborating artists dynamically move the objects and manipulate their visual properties in real time. Since manipulation using regular input devices (keyboard and mouse) has inherent limitations, the artists demanded an integration of more complex devices including a motion tracking device.

For eGaLab we developed a simple concept of input device modules. The module receives data from the input devices and translates it according to its actual settings to VRML events. The output events can be connected to objects to change their properties dynamically. We implemented an input device module for Polhemus' ULTRATRAK PRO tracking system that features 12 sensors for position and orientation. The output data of the system was translated by our input module to 24 VRML events (12 SFVec3f and 12 SFRotations). The artists were then able to connect the output of the module to objects in the laboratory while producing human-like movements of selected objects.

Some artists also demanded more realistic performance that would include human-like characters driven by the tracking system. We tried to fulfil their aesthetic requirements while still keeping the performance of the system at a reasonable level. After some period of experiment we found a balanced solution represented by avatars produced by AvatarStudio.⁶ The freely available AvatarStudio produces VRML animated characters that were originally used by Blaxxun⁷ in their popular networked environments. The characters are fully articulated and their geometry is seamless, which was the crucial aesthetic requirement of the artists.

When integrating the characters from AvatarStudio into eGaLab we had to solve two problems. First, even if the characters are articulated, they are only capable of replaying a limited set (10) of predefined gestures. Second, the avatars from AvatarStudio were accelerated for use in Blaxxun. They exploit Blaxxun's extensions for fast animations of the avatar's seamless geometry consisting of one IndexedFaceSet node.

We solved both problems by implementing a conversion utility that modifies characters from AvatarStudio to be H-Anim⁸ compliant. The utility makes the rotations of joints publicly accessible. It orients the coordinate system for each joint to align with that of the overall character and sets the joint rotations for the initial standing position to zero.

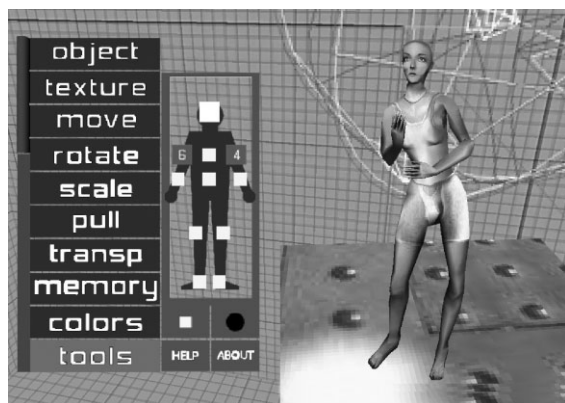


Figure 4. GUI of the input device module for a tracking system. Sensors can be connected to control an arbitrary geometry or to animate a human-like character. An Avatar-Studio character is on the right.

We have also exploited an undocumented extension of the Cortona VRML browser to accelerate animations in a similar way to the Blaxxun browser. Once the character has been converted by our utility, it can be imported into the laboratory and connected to an input device module to reproduce movements of the person being captured by the tracking device (see Figure 4). In this case the rotations cannot be applied directly to H-Anim joints, but the parent-child relation of the character's segments has to be considered.⁹ The input module offers the option to turn these calculations on or off depending on the type of object.

Experience and Lessons Learned

The eGaLab platform (www.egalab.net) is an outcome of one year's cooperation among CIANT (International Centre for Art and New Technologies in Prague), CYPRES (Centre Interculturel de Pratiques, Recherches et Echanges Transdisciplinaires), and MIDE (Museo International de Electrografia)—the international cultural centres that associate artists, technicians and computer scientists. CIANT also closely cooperated with the Computer Graphics Group at the Czech Technical University in Prague, which provided the GV technology and valuable advice.

The artists demanded construction of an interactive 3D digital space in VRML, consisting of digital phonemes, modelling and animations, texts, digital or digitized photos, of video sequences and sound fragments, molecules making up a dynamic audiovisual architecture broadcast and shared on the Internet.

One of the most interesting aspects of building the eGaLab was cooperation between artists and technicians. Sometimes it was very difficult to find a solution that would meet artistic requirements while keeping the project coherent as well as manageable until its final presentation. We often experienced misunderstandings caused by the community-based different points of views. To provide an example: when we finally finished the first release of the motion capture device module, the movements of the character were not very realistic. We strived for more realistic movements of the animated character and spent significant time implementing the corrections. Then we presented our results to the artists, but by mistake we left out the calibration phase. The character started to perform unnaturally distorted movements that did not resemble anything we had seen before. While we classified it as a buggy situation, the artists were astonished since they had just observed something that had pushed their perception in a surprising direction.

The final public presentation (see Figure 5) took place in Prague on 28 and 29 March 2003. It was joined by members of all cooperating centres that together prepared several live performances. The visitors could either come to a venue and view the performances



Figure 5. Public presentation of the eGaLab in Prague. A dancer is connected to a motion tracking device. The collaborative space is projected on to the screen in the background.

projected on to large screens or stay at home to watch it directly on their computers through the Internet.

According to performing artists we succeeded in creating a shared virtual environment that enables collaboration among its participants. They complained about several issues related mostly to the performance of the system, even though we spent a significant amount of time optimizing the code. VRML is a very powerful as well as universal visualization tool. Its universality and complexity is the main reason why VRML browsers can never perform as fast as narrowly specialized visualization engines.

Future Work

The eGaLab platform is definitely not a completely finished product. Rather, we consider it a prototype that largely contributed to an ongoing discussion about art in cyberspace.

During several weeks of using the platform we have received number of ideas and thoughts on how to improve and enhance the system. We will take them into account especially in the framework of the ALTERNE (Alternative Realities in Networked Environments) project, which aims to construct an Alternative Reality platform to support the development of digital, interactive and participative artistic activities.

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Michal Masa was born in Prague, Czechoslovakia. He is studying for a PhD at Czech Technical University in Prague (CTU), where he graduated with an MSc in Computer Science in 1999. His PhD topic is multi-user collaboration in virtual environments. He cooperates closely with the International Centre for Art and New Technologies in Prague (CIANT).



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Pavel Smetana was born in 1960 in Usti nad Labem, Czechoslovakia. Since 1998 he has been the director of CIANT (International Centre for Art and New Technologies) in Prague. Since 2003 he has been an evaluator in the MEDIA Plus programme. He teaches 3D in the Computer Arts and Virtual Reality Department at the Academy of Fine Arts (École Supérieure des Beaux Arts) in Aix en Provence, France. He has coordinated several European projects and authored a number of video and computer based artistic installations, for which he received several awards, e.g. Grand Prix de Locarno (1996) and UNESCO Prize (1996).