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How to easily develop a VR experience from a 3D desktop application thanks to the TechViz TVZLib API

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ABSTRACT

As advanced interaction scenarios in Virtual Reality become more common in the industry, there is a need of new rendering and interaction systems. Combining both the TechViz XL driver and the TechViz TVZLib provides a new approach to answer that need. Using existing 3D applications made of known 3D engine, and where interactions are based on the keyboard and mouse inputs, we added the TechViz driver and library to turn the desktop designed applications to VR experiences. The benefit of this combination is the limited requirement needed for code modification to export the desktop application to a VR experience.

1. Introduction

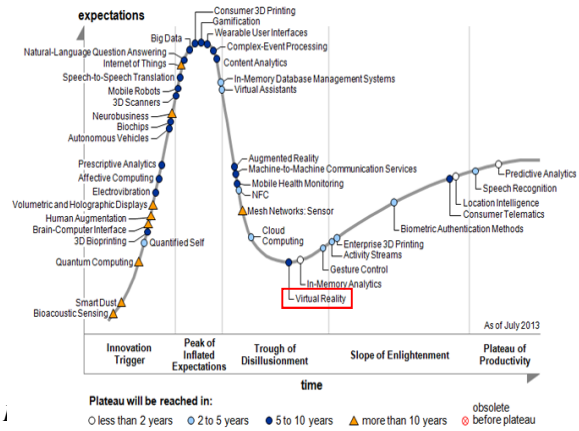
The VR technologies offer solutions to the industries to create virtual worlds where various operations (like designing, training or maintenance simulation) can be more easily achieved than in reality in a fully controlled environment. Within the past years we have seen advanced scenarios of use becoming more common, with higher requirements of customers needs to experience more complex scenario such as advanced training. Now, existing solutions for doing so either require advanced development skills or limit the scope to one kind of environment.

In this paragraph, we present a rapid overview of the Virtual Technology state, and the TechViz approach to answer the growing needs of the industry.

1.1 Virtual Reality

As presented in [FAA*06], the goal of the Virtual Reality technology is "to allow one person (or several) to experience a sensory-motor and cognitive activity within an artificial world, numerically created, that can be from totally imaginary to close to reality". Over the years, the hardware and software solutions have been progressively coming on the market, from the first HMD designed by I.Sutherland [Sut65] to the Oculus Rift, or from the work at the NASA Ames research center [FMH*86] to the different VR commercial software that are available today.

While it has been used in the industry for virtual prototyping for more than half a century, as at [Caterpillar] or [Ford], using such a technology for other purposes, such as advanced virtual training has been limited to a few number of applications, such as firefighters training. As shown in the Gartner Hype Curve, Virtual Reality is today in an enlightenment phase: people take into account what new technologies can offer, for a more affordable price, and what was done in the past, to design more advanced scenarios such as specific training.



1.2 TechViz XL

While several approaches exist on the software side to create Virtual Reality worlds, they usually require either some expertise in development, for the different VR libraries such as VRJuggler or WorldToolKit, or working in only one particular environment for full software solutions such as 3DVia Studio from Dassault Système or COVISE from the High Performance Computing Center in Stuttgart.

TechViz XL is a driver solution that renders any kind of 3D OpenGL application within any kind of VR environment such as CAVE, Wall or HMDs. Moreover, it combines the tracking information so as to create the appropriate user's point of view in order to immerse this latter. This solution is configured, through two files containing the hardware physical information and the GUI. Thanks to that no work needs to be done for users to display within a VR environment, besides opening the native desktop application and models on the master computer.

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Then, add-ons options may be added to create a dynamic interaction with models such as cutting models, doing snapshots, etc.

The architecture of TechViz XL is unilateral: models from the native desktop 3D application are sent to the computer(s) connected to the display system without any import or modification of the existing models. This feature is also designed to ensure the integrity of the data while using it in the Virtual Environment VE.

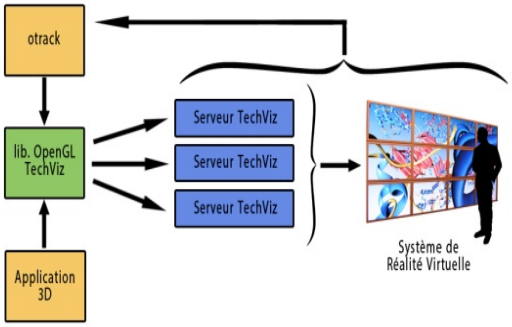

Figure 2: *TechViz XL Architecture*

1.3 TechViz TVZLib API

In order to satisfy the growing need of new scenarios and with the knowledge about VR within the academic centers and industries (where VR systems are used along the PLM process based on the use of 3D applications) becoming more and more widespread, the TechViz TVZLib API was developed. This later includes functions to connect, retrieve information from the VR environment or call TechViz inherent functions. As it is coded in C language such that it can be included in numerous other languages such as C++/C#/Ruby, etc.

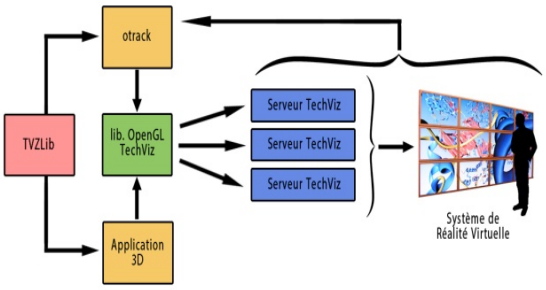

Figure 3: *The TVZLib option combined to TechViz XL Architecture*

One of the goal of this library is to give access to information on where and what users are doing in the VE side, which can then be sent back to the native desktop application. The data can be used as inputs to modify the 3D models. Combined to the TechViz XL driver, every modification done in the native desktop application is directly seen on the VR side. The figure 3 summarizes the complete architecture.

The TechViz TVZLib API allows the users to develop their own metaphor of interaction with the 3D models, without the need to take into account all aspect of synchronization (stereo, rendering, etc) while the TVZLib gives access to all necessary information. Thanks to it, the full system becomes bilateral, as shown in figure 4.

Eventually, it is designed as an asynchronous library, increasing the robustness of development so that it can be integrated within an existing application where mouse and keyboard interaction can be easily replaced by inputs from the VE.

2. Integrating the TechViz TVZLib to an existing 3D application

This paragraph presents how it was applied on a simple 3D Unity based example.

2.1 Unity 3D

Unity3D is a real-time software developed by Unity Technologies [http://unity3d.com/unity]. Its main purpose is for game development. Running thanks to a powerful 3D engine, it includes several assets such as a physical engine and a store where to find 3D models.

This solution was selected as it is more and more used among 3D application developers. Its community is particularly widespread. Hence the first example selected was the demo *Shadow Demo*.

2.2 The Shadow Demo example

This Shadow Demo example is a desktop application where one can either drag objects – using the 2D mouse combined to a picking method) – or toggle lights – by clicking on the light menu at the bottom left corner or directly by pointing the light) within an apartment model.

Figure 4: *The Shadow Demo example where users can interact with the scene, using the mouse.*

2.3 Display the models in a VR environment.

Thanks to the TechViz XL solution, we were able to display the 3D model within a CAVE system and immerse the users thanks to the tracking inside the virtual environment.

Following the architecture of TechViz XL, one dll is copied in the directory of the desktop application and with the VR setup described in TechViz configuration files, the 3D geometry is sent to the display system in real time. Besides, all modifications made in the native application are directly applied to the model in the VR environment: if users click on the 2D mouse to drag an object or toggle a light, it is seen in parallel in the virtual environment.

Nonetheless, the developed metaphors of interaction in the desktop application are not directly accessible in the VR environment.

2.4 Integrating the library to the project

The purpose of integrating the TVZLib library is to allow the user to do the same things in a VR environment, namely to be able to use the interactive tracked device to grab objects and move them or toggle the lights, instead of the desktop mouse clicking desktop metaphor. For that matter, the position and the orientation of the interactive tracked device will be acquired so as to determine the 6 Degrees of Freedom (DoF) position of the user's hand.

2.5 Code modification

The benefits of the TVZLib, and its combination with TechViz XL driver, is that users do not have to consider any technical features related to the VR environment – such as the display configuration (CAVE, WALL, HMD…), the stereo technology (active, passive, …), the tracking brand, and all the synchronization problematic (rendering synchronization or stereo one).

When adding the library within the project, one wrapper was developed to adapt C calls to the C# calls of Unity. Besides that, which is a one-time operation, the modifications brought to the original code are minimal. The following algorithm describes the 'dragging object' operation, where added TechViz calls are underlined.

Algorithm 1 Catch and drag object algorithm with TechViz

Requirement: TechViz connection set up

while 1 **do**
  Get mouse 2D position Pos2D
  If (RayCast(Pos2D) hits an object
    || RayCast(Pos6D) hits an object)) **then**
      If (the hit object is interactive) **then**
        Compute dragging distance and move object
        if (object is a light) &&
          (short pressure on (2D mouse button||6D wand button))
        then
          Toggle light
        end if
      end if
  end if
end while

Thanks to that code modification and the TechViz XL client, the application was able to run within a 4 sided CAVE environment, cf figure 5.

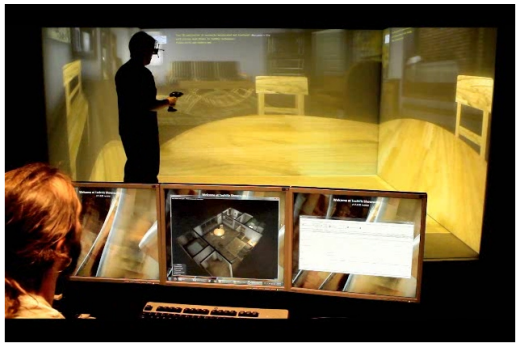

Figure 5: Running the 3D desktop application within the VR environment thanks to TechViz XL and the TVZLib.

3. Advanced VR application for Training

To answer the growing need of pertinent training, we designed a more advanced scenario where users could be trained to perform a task in an oil and gas environment, based on a Serious Gaming approach. This POC was developed to present on the one hand the ease of development as well as o present this example to existing customers looking for efficient solution for developing advanced VR scenario.

3.1 VR for training

Using Virtual Reality for training purpose has been already used as a research topic such as in [Lou01] where railway worker are trained in the rail shunting operation. Among the benefits offered by the use of Virtual Environment are the fact that there is no limitation of time and runs, as well as the fact that users may be immerse in a simulation without any risk. Therefore, such a technology fits the needs of training and simulation in sectors such as the oil-and-gas industry, the nuclear sector, the mining industry [Man01] or the space exploration [NBE*01].

3.2 Serious Gaming approach

Serious Games, that can be defined as "a game whose main purpose is not entertainment", namely it can be used for education, training, marketing or advertisement' [MC05].

When thinking of training, the Serious Gaming approach has proven to be a successful way of doing so. For example in [TBN12], where users are trained for breast biopsy procedures, the authors note that he ludic aspect increase motivation and users engagement.

Better engagement in Serious Game, which may results in a better transfer of skill, combined to the safe and the numerous possibilities offered by VR, seems to provide an adequate solution for advanced and efficient virtual training

3.3 A platform training example

As a POC, we designed a VE in the Oil and gas sector: a 3D model of a platform was created, and two procedures where designed to be taught:

a) Getting acquainted with the environment and learning a path between the landing pad to the pipes area.
b) Teaching a task to perform for maintenance.

Both procedures are divided in a 3 phases learning process and time to perform the taught task is the competitive and ludic aspect added to bring competition when performing the task.

3.4 Development done

Using both the TechViz XL driver and the TechViz TVZLib, the work done for the development on this second POC focused on the creation of the 3D model, and the main loop to switch between, representing the different phases of the teaching scenario. Two particular objects were added: one representing the user position on the platform and one for his hand.

Figure 6: Workers on the virtual platform for getting acquainted and trained to perform a maintenance task.

4. Conclusions

In this paper, we presented how the TechViz XL and the TechViz TVZLib technologies were combined and used to easily create VR applications from desktop designed ones, the TechViz driver taking care of the display and immersion, the library offering the fastest and simplest solution to turn the desktop application to a VR one. Furthermore, our work in progress aims at designing more advanced scenarios where focus is brought to other features than dealing with the VR technology specificities.

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