A unified environment for collaborative CAE and immersive simulation results' processing

Antonis Perifanis[1], Stavros Kleidarias[1]

[1]BETA CAE Systems S.A.

1 Introduction

The realistic display of digital, CAE (Computer Aided Engineering), models has been a fundamental requirement for engineers and indeed, from the early 1990s, a promising VR (Virtual Reality) solution emerged, the CAVE (Cave Automatic Virtual Environment). This paper examines the history of this solution, its advantages and disadvantages, followed by presenting the latest developments of BETA CAE Systems in virtual reality applied to CAE simulation results' processing and collaboration among the engineers involved

2 First steps in VR ::: CAVE room-scale

The CAVE is an immersive virtual reality environment in which projectors are directed to the rear of the walls of a room-sized cube. Apart from its obvious resemblance to one, CAVE is a reference to the work/writing "Allegory of the Cave" of the classical Greek philosopher Plato, in which a philosopher contemplates perception, reality and illusion(2).

Figure 1: CAVE room

Upon its release this immersive solution provided unique opportunities for room-scale photorealistic visualization of computer models and helped prove the feasibility and usefulness of the VR concept. Throughout the following years and still today, the CAVE system is the standard for such visualization applications and, coupled with task-specific software, was successfully integrated in product life management, from design phase to manufacturing. Automotive companies in particular invested in such facilities, utilizing them for design phases ranging from ergonomics, to detailing/selection of interior materials and even to manufacturing.

This technology is not without its disadvantages though. By design installed in a substantial and dedicated physical space, it requires powerful and purpose-built hardware and specialized software. Its operation and maintenance requires highly skilled personnel and yields high running costs. As such and to justify these costs CAVE comprises a large scale investment meaning that, even large enterprises, can afford to install and maintain a handful, if not a single one, that should be utilized as much as possible. This can prove to be very challenging considering that several design teams have to share the same CAVE facility while design teams from different locations need to travel in order to use the facility and collaborate with their colleagues there.

3 Latest VR hardware ::: HTC VIVE & Oculus Rift

Recent developments in increasing display quality by reducing pixel size have led to the development of HMD (head-mounted display) hardware that brings virtual reality inches or centimeters from our eyes. In the past year two such devices have prevailed from the many that were or are being developed: the HTC VIVE and the Oculus Rift. The visualization quality of this generation of devices does not yet match that of CAVE but their portability, hardware requirements and relatively low pricing

have made them accessible to a large audience, mainly for gaming purposes, but also to a growing number of scientific and engineering uses.
For a significant number of use cases, a CAVE setup can literally be replaced by one of these headsets:

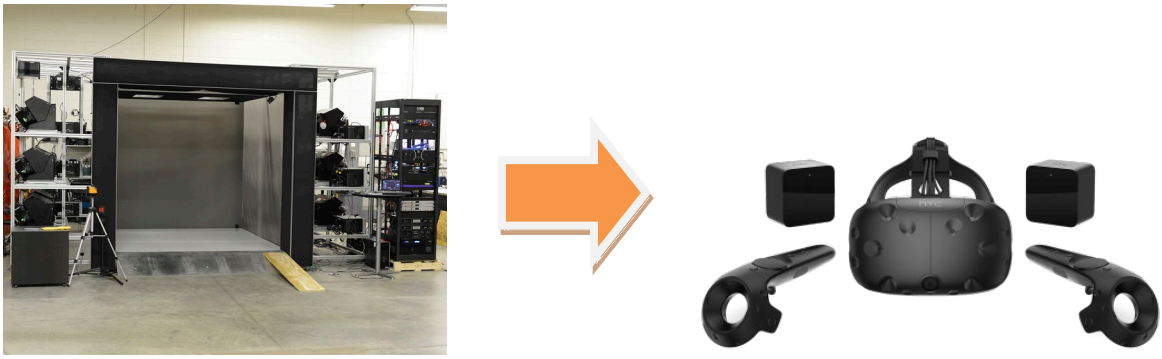

Figure 2: CAVE room vs HTC VIVE headset

4 VR software ::: META from BETA CAE Systems

The requirement of engineering software, particularly for an immersive CAE simulation results' visualization, led BETA CAE Systems to develop the support of the HTC VIVE and Oculus Rift virtual reality headsets from META, its multi-disciplinary CAE simulation post-processing software. Multi-disciplinary implies that META natively supports and is able to read a wide array of CAE files from different types of analyses (crash, durability, NVH, CFD) and solvers, including LS-DYNA®. META is highly optimized for results' extraction and reporting through automation and, coupled with high quality graphics and advanced rendering capabilities using PBR (physically based rendering) materials and HDR (High Dynamic Range) environment images, can present supported simulation results in a very realistic manner.

Figure 3: High quality rendering in META

In META the CAE simulation expert can load a wide range of results, create new user-defined results, import videos or plot curves in the same environment and correlate between physical and simulation results. Then, having connected one of the supported VR headsets on the daily work PC and with the press of a button the CAE simulation expert can be immersed to an environment where all model data, curves and physical test videos, will be visualized in the virtual 3D space without leaving the physical office space. The in-VR tablet of META can be used as a toolkit to manipulate the model position, to control the animation, to create inspection planes, to add or remove model parts from visibility and to sketch.

As a result, it is a cost effective, practical and intuitive way of visualizing simulation results in the most realistic way without requiring any additional software or translation of model data.

5 Collaboration in META

The globalized allocation of workload has proven to be challenging in various aspects of daily work as engineers from different physical locations have to communicate CAE model data and simulation results or propose design changes. Common tools for casual communication have been used

successfully to some extend however this software may raise issues of security and connection speed.
BETA CAE Systems has developed collaboration capabilities embedded into META through two modes of collaboration:
1. Web Viewer: the host META transmits the workspace information to a web address so collaborators can join from a web browser from a PC or even a handheld device, through a secure connection protocol. The collaborators can work on the model data as if they were using META locally.
2. META-to-META collaboration: the host META transmits commands through a server executable (local or cloud). The collaborators open META at their end, connecting to the server and receiving the commands of the host.
The latter scheme requires META to be running for all collaborators and allows the following modes of collaboration:
1. Desktop META to desktop META
2. Desktop META to VR META
3. VR META to VR META

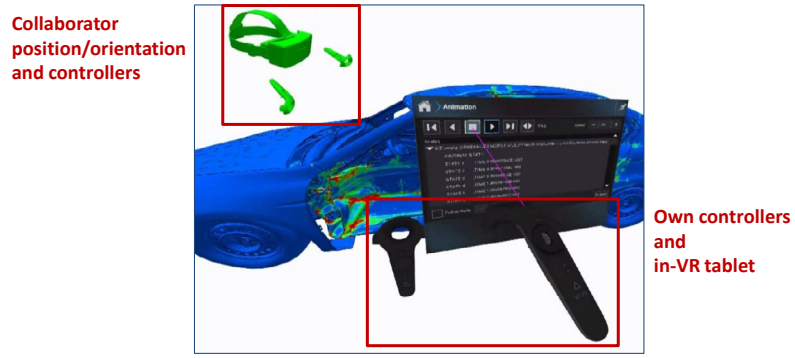

Fig.1: VR collaboration in META

The offered solutions span rom process orchestrating, data management, modelling, solving, and results visualization. Collaboration can be in the 2D field, using common PC monitors, handheld devices, or virtual reality. It also offers the capability for communicated with text or audio/video and file posting and sharing with encryption. Sessions can also be recorded for later playback along with notes (sketches, annotations, etc.).

6 Summary

The CAVE room VR solution is still relevant as an established link in the chain of product life development with high-end rendering capabilities, albeit at a cost. However, the recent advances in virtual reality headsets have proven that this technology is here to stay and evolve. BETA CAE Systems embraced this technology through META post-processor, even providing a user-friendly but secure and robust solution to easily create a collaborative VR room for simulation experts to join and meet even from remote physical locations.

7 Literature

[1] META v18.1.0 User Guide, BETA CAE Systems S.A.
[2] "Cave automatic virtual environment" Wikipedia: The Free Encyclopedia. Wikimedia Foundation