The Pipeline from CAD to Virtual Reality in VISIONAIR Project

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Abstract: The VISIONAIR project aims at federating and providing a unique access to advanced visualization resources available at research centers and universities from Israel and other 11 countries in Europe. The physical visualisation facilities are supported by the Virtual Visualisation Service Infrastructure providing repositories of shape models and archives of tools for their creation and processing. Here we present the newly developed service for the documentation of workflows aimed at supporting the preparation of Virtual Reality Environments from CAD /PLM data.

1 The VISIONAIR project and the VVS

Visualization tools and techniques provide important support to analyze and display large volumes of multidimensional data, often time varying, in such a way as to allow the user to extract significant features and results quickly and easily. Newly available technologies allow for greater realism in the visualization perception. Unfortunately, the use of such tools is still limited because they are still expensive, and their costs are not always justified with respect to the actual usage for most of researchers. To overcome these limitations and to enhance research and innovation capacities, the European

Commission is supporting the integration and the access to advanced visualization facilities around Europe through the VISIONAIR (VISION Advanced Infrastructure for Research) project financed in the frame of the FP7 Capacities program[1].

In the industrial manufacturing field, Virtual Reality environments offer good facilities for the assessment of product design solutions according to various points of view (e.g. productivity, working conditions, safety and ergonomics). Unfortunately, some limitations exist that prevent the full exploitation of such capabilities. In addition to the high costs, the direct use of design data is not possible because PLM/CAD systems provide detailed specification of the conceived product solution, which does not satisfy requirements of VR environment, both in terms of type and complexity of representation. Therefore, these data need to be prepared and adapted to the VR applications. Understanding the exact requirements to fulfill and the needed data transformation and processing sequence requires specific skill and experience that somehow limits a wider adoption of VR facilities to a larger audience.

The VISIONAIR project aims at federating and providing a unique access to advanced visualization resources available at research centers and universities from Israel and other 11 countries in Europe. Each site offers capacities in one or more specific rendering and visualization technologies including Virtual Reality, Augmented Reality, Holography, and High Quality Image Processing. The involved research teams and institutes have developed complex visualization environments for their own usage. By joining the VISIONAIR infrastructure, they open the access to these environments to the research community. The 29 facilities made available by VISIONAIR are clustered according to their main research and capabilities focus. The first cluster addresses tools and methods to navigate in huge data set issued from scientific simulations. The second cluster focuses on tools and methods that facilitate sharing and visualization of high quality images and videos over very high bandwidth networks. The cluster on Virtual Reality provides high-end immersive facilities that allow users to experience virtual environments and to interact with them. The last cluster involves platforms for synthetic environments mixing a large set of advanced facilities for remote collaborative works.

The access to these facilities is freely open during the project lifetime. The hosting institutions financially and technically support the usage of the physical facilities.

To aid the preparation of the experiments, a Virtual Visualization Service (VVS) facility is provided. It is based on an upgrade of the Digital Shape Workbench, initially developed by the AIM@SHAPE Network of Excellence[2,3] [At13]. The VVS acts as an e-science infrastructure enhanced with collaboration capabilities for the sharing and retrieval of shape data and related processing software tools. It is conceived as an ontology- and web-based resource repository, which involves the integration of the Shape Repository, the Tool Repository and the Ontology and Metadata Repository,

[1] VISIONAIR: VISION Advanced Infrastracture for research, http://www.infra-visionair.eu/.
[2] http://visionair.ge.imati.cnr.it/.
[3] AIM@SHAPE Advanced and Innovative Models and Tools for the Development of Semantic-based Systems for Handling, Acquiring, and Processing knowledge Embedded in multidimensional digital objects, ContractFP6 IST NoE 506766, http://www.aimatshape.net.

together with an advanced Search Framework [Va10]. Within VISIONAIR the VVS is aimed at supporting the experts in several activities either, to find processing tools thus avoiding to implement already existing components and to find and store shape data necessary to run their experiments and to create virtual environments.

2 From CAD to VR

The design and development of a VR application may involve a relevant amount of modules, such as 3D modelling, rendering, interaction, data exchange, behavior, sounds and physics. In industrial applications such as the simulation of manufacturing environments, the 3D models (that can represent very simple objects or complex assemblies or a working environment) are edited and managed so that their characteristic information are preserved as much as possible for being imported by the VR application.

Within the VISIONAIR project, a specific analysis of the elements involved in the CAD to VR pipeline has been carried out, in order to identify some key issues of the migration from CAD to a VR application: the objective was to verify the possibility of suggesting hints on how to overcome them more efficiently or of developing some specific services for their execution.

The first issue derives from the fact that a single specific file format for VR applications, describing and storing the information related to an object in terms of geometry, shape and structure does not exist; a set of various 3D formats are available, each one supporting certain properties and missing other ones. Moreover, software applications for VR are able of correctly loading certain 3D formats but does not cover all the included features. For example, in CAD objects are represented by precise surface models (e.g. NURBS) and in terms of functional features, such as holes, pockets and kinematic joints that are stored in the native file format. On the contrary, the 3D formats for the real-time graphics for visual simulation and virtual reality support a real-time rendering-oriented representation of the 3D model (i.e., tessellated geometry, textures).

Another identified key issue is that users of the CAD tools are, in general, not aware about how to manage the features of the 3D models into a VR application nor about the suitable tools for doing it; therefore, the CAD to VR pipeline is not limited to file conversion. VISIONAIR Partners have worked on the identification of a set of tasks that can be done when going from CAD-tool to VR application in order to preserve the original information or in order to apply some workarounds to the existing limits. This has been done by exploiting the partners' experience and by performing some tests of communication with the available VR facilities.

The categorization and formalization obtained from the analysis is represented with an ontology built on top of the Common Tool Ontology of the VVS. A software tool, exploiting such ontology, has be developed to support people in transforming 3D CAD models tools in a representation suitable for virtual reality environments applications.

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