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CAD/CAE visualization in virtual environment for automotive industry.

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Abstract
In this paper we propose a method to link CAD models to an immersive environment. Since CAD models can not be directly viewed in a real-time visualization environment, we present here a complete chain of adaptation steps to view adapted CAD models in an immersive environment with high quality rendering. Our method allows high quality visualization of complex scenes in an immersive environment such as design reviewing for example.

Keywords:
Digital mock-up, tesselation, real time, immersive environment, peripheral vision.

Categories and Subject Descriptors (according to ACM CSS): I.3.7 [Computer Graphics]: Virtual Reality, J.6 [Computer Applications]: Computer-Aided Engineering, J.7 [Computer Applications] Real Time.

1. Introduction.

In this paper, a solution is introduced to help the process of design reviewing in an immersive environment (CAVE like display). Regular users are not virtual reality experts. So, they do not have to prepare new models for the application. Therefore a complete chain of adaptation steps starting from the project data manager up to the VR application has to be performed.

The first section of this paper deals with the compatibility problems between the project data manager (PDM) and the virtual reality (VR) environment. The second section explains our approach to simplify and clean the models. The third section describes the peripheral vision and an application.

2. From CAD's data base to VR application.

The main problem to export conception aided design (CAD) model to a VR application is to tessellate and to decimate them for real time rendering. During the past years, Several solutions have been developed [1,2,3,4,5,6,7]. All these approaches present an uniform solution. The entire model is then simplified with the same criteria in each part of the model. Furthermore most of these works use a percentage of reduction. The scattering created is not controlled. The geometry quality is an outcome and not a criteria. The solution [8] describes a technique which allows to decimate a polygonal model in a non-uniform way. In addition to that, it is able to control the quality of the geometry. The user has to specify the maximum acceptable error. Then the algorithm decimates the model in order to respect the user's criteria.

Our solution has two steps. The first step is a pre-processing one that consists in preparing, structuring and storing the 3D models in a real time database. This step can not be done in real time because of the complexity of this process (format conversion, cleaning and simplification of models). The help of a user is almost unavoidable. The second step consists in loading the model and managing it for real time visualization.

3. Controlling the simplification.

The proposed method is based on simplifying the 3D model in a non-uniform way. This simplification is controlled by a map. This map is a distribution of spheres around the model (cf. Figure 1). The radius of the spheres represents the ability of points to be moved or removed during the simplification process. The solution allows to detect and identify all the useless parts of model. The original models are made to be able to construct the real parts. They contain mechanical information (i.e. rib, …) that are useless for visualization. The algorithm used for managing the map can drive the decimation in a specific way, but this technique has another advantage. The map used for the decimation can be saved into a file. Therefore, if the geometry of the model changes because of a new design or a technical reason, then he map can be applied on the new version of the model. Thus, all the work done for the first version is not lost. The conversion is faster and can be done without an operator. The solution consists in following the mesh vertex by vertex and finding the correspondence into the map.

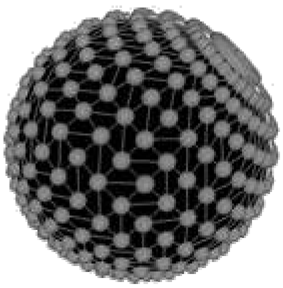

Figure 1 : Map size (repartition of the spheres).

4. Peripheral vision.

CAVE-like display called MoVE ™ is used. The user is inside the 3D scene. This position makes him believe that all the objects are not seen with the same quality (or with the same level of detail) because all the models are approximately at the same distance. We have to know how the eye sees details [9]. To define the different areas in the human field of view, it is possible to use a model of vision [10, 11]. Others methods use the same management of level of details (LOD). It depends on the distance between the user and the object. We propose to segment the space into several cones of vision (cf. Figure 2). Each cone represents a particular zone, where details can be seen. Thus, the model can be more simplified in the areas which are far from the focusing point.

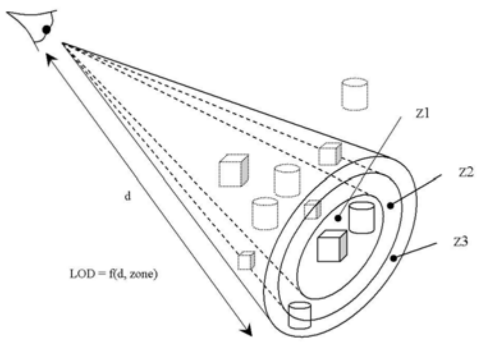

Figure 2 : Peripheral vision.

5. Conclusion.

These two steps allow us to keep a good image quality because of we are looking for an appropriate repartition of triangle. That means that polygons are stored where they are useless. Several techniques have to be tested like the Binary Space Partition (BSP), or hierarchical BSP, hidden surface removal, … This would help us to keep only the polygons that must. The study of the human eye gives the limit of the human field of view. But some additional tests have to be made before any implementation in a software for an immersive application.

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