

From CAD to virtual reality: modelling approaches, data exchange and interactive 3D building design tools

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Abstract

Virtual reality has the potential to improve visualisation of building design and construction, but its implementation in the industry has yet to reach maturity. Present day translation of building data to virtual reality is often unidirectional and unsatisfactory. Three different approaches to the creation of models are identified and described in this paper. Consideration is given to the potential of both advances in computer-aided design and the emerging standards for data exchange to facilitate an integrated use of virtual reality. Commonalities and differences between computer-aided design and virtual reality packages are reviewed, and trials of current system, are described. The trials have been conducted to explore the technical issues related to the integrated use of CAD and virtual environments within the house building sector of the construction industry and to investigate the practical use of the new technology. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

Virtual reality (VR) has been used within the construction industry for design applications, for collaborative visualisation and as a tool to improve construction processes [9], but it is currently implemented in an ad hoc fashion [4]. At Loughborough University, the effective implementation of PC-based VR systems in the industry is being researched. A number of VR systems, including Superscape, VRML and World Tool Kit, have been tested to assess their

suitability for integrated use in the house building sector of the construction industry.

VR forms a natural medium for building design as it provides 3D visualization, can be manipulated in real-time and can be used collaboratively to explore different stages of the construction process. In the future, it may be possible to generate and print 2D CAD drawings directly from the VR models that are being used for architectural design. However, in order for the use of VR to mature to such a level, the integration of its use with existing technologies such as CAD needs to become the focus of research [39], and appropriate standards and protocols need to be developed.

Although it is already possible to create VR models from within VR packages, for the use of VR in

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construction industry, the transfer of geometrical data between CAD and VR is desirable to avoid repetitive work [2,10]. The trials undertaken by the authors have posed the question of how to transfer data from traditional CAD systems into VR, and have also assessed the suitability of different approaches to the creation of VR models for different situations.

After a description of the three different modelling approaches identified in the literature, the related technical issues of data exchange, VR systems and 3D graphical standards are explored. The trials of VR systems conducted at Loughborough University are then described.

2. Data translation and practical modelling approaches

2.1. Data translation from CAD to VR

The current process of translation from CAD into VR is normally a one-way or “downstream” process (Fig. 1). The CAD model is translated into VR, either directly, or through the intermediate stage of a rendering package. To facilitate the translation process, data on the CAD drawing is often reordered, usually in non-industry standard ways, to control features of the resultant VR model. The user relies on previous experience and prior knowledge of the translator and VR system to create a satisfactory model. Bourdakis [10] notes that there is a trade-off between the amount of time spent reordering the CAD model to suite the translator and the time spent optimising the resultant VR model and “It is normal

to spend a few hours or even days, hand-optimising the translated file” [11].

Complex and highly detailed CAD data, common in the construction industry, translate into excessively large VR models, but the computational time required to run these must not slow user movement to an unacceptable level. Optimisation to allow real-time viewing is achieved by reducing the information to be processed and hence reducing the computational effort required during each simulation loop.

Three different approaches to the creation of VR models have been identified in commercial applications and VR research projects [39]; these are to build a library of standard parts, to rely on imperfect model conversion through translators, and to use VR as an interface to a central database.

2.2. A library-based approach

A library-based approach, where a library of components is archived for reuse within the VR environment (Fig. 2a), eliminates the need for repetitive data transfer and optimisation of common parts. Significant time and effort is initially required to build up the library, and the library components can be created from CAD data that has been optimised and had behaviours added.

Adeji-Kumi and Retik [1] and Retik [30] have taken this approach for research into the simulation of the construction sequence. As in the work of Op den Bosch and Baker [29], the interest is in the representation of construction activities. Direct translation of a whole model from CAD is inefficient as an item is simply a geometric description in CAD

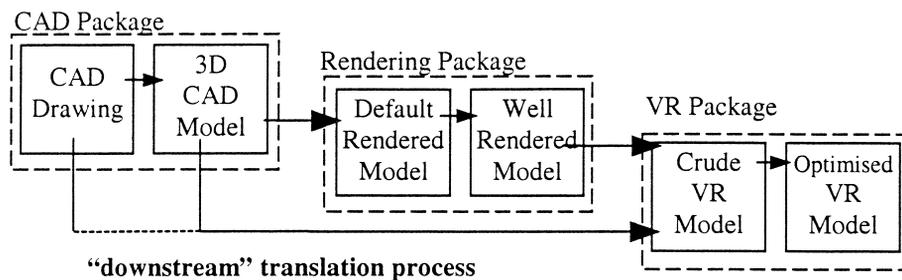


Fig. 1. The current process of translation from CAD to VR is a one-way “downstream” process.

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