

Chapter 5

Three-Dimensional Information Retrieval (3DIR): A Graph Theoretic Formulation for Exploiting 3D Geometry and Model Topology in Information Retrieval

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ABSTRACT

The 3DIR project investigated the use of 3D visualization to formulate queries, compute the relevance of information items, and visualize search results. Workshops identified the user needs. Based on these, a graph theoretic formulation was created to inform the emerging system architecture. A prototype was developed. This enabled relationships between 3D objects to be used to widen a search. An evaluation of the prototype demonstrated that a tight coupling between text-based retrieval and 3D models could enhance information retrieval but add an extra layer of complexity.

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INTRODUCTION

In building modelling environments, information is increasingly being crammed into 2D/3D building and product models. This is particularly true given the rise of Building Information Modelling (BIM). The Three-Dimensional Information Retrieval (3DIR) project investigated information retrieval from these environments, where information or documents are linked to a 3D building model. In these situations, the 3D visualisation or 3D geometry of a building can be exploited when formulating information retrieval queries, computing the relevance of information items to the query, or visualizing search results. Managing such building information repositories in this way would take advantage of human strengths in vision, spatial cognition and visual memory (Lansdale and Edmonds, 1992; Robertson et al., 1998).

Information retrieval is associated with documents, and a critic might argue that documents are relics from the pre-BIM age that are no longer relevant in the era of BIM. However, the challenge of information retrieval is pertinent whether we are dealing with documents which are coarse grains of information or building object parameters/attributes as finer grains of information. Demian and Fruchter (2005) demonstrated that traditional retrieval computations can be applied with good results to 3D building models where textual or symbolic data are treated as very short documents. In this sense, it is almost a question of semantics whether the information being retrieved comes from object properties embedded in the BIM, or from external documents linked to the BIM. The challenge remains of retrieving non-geometric or textual information.

This chapter describes developments of the 3DIR project whose aim was to improve information retrieval when retrieving information or documents linked to a 3D artefact, or retrieving non-geometric information embedded in the model of the artefact. It proposes a formulation based on graph theory as a useful theoretical lens for research and software development for information retrieval from 3D models. The central objective was to develop an information retrieval toolset for documents/information linked to 3D building models which exploits 3D geometry and linked information. Such a toolset is essentially a search engine for retrieving information within a BIM platform.

RELATED WORK

Building design, construction and operation are information intensive activities. For example, even over a decade ago in the UK construction industry, on average, one computer-aided design (CAD) document was produced for every 9 m² of building floor space (Gray and Hughes 2001). Several researchers (Leslie, 1996; Veeramani

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