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Chapter IV

Similarity Search for Voxelized CAD Objects

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Abstract

Similarity search in database systems is becoming an increasingly important task in modern application domains such as multimedia, molecular biology, medical imaging, and many others. Especially for CAD (Computer-Aided Design), suitable similarity models and a clear representation of the results can help to reduce the cost of developing and producing new parts by maximizing the reuse of existing parts. In this chapter, we present different similarity models for voxelized CAD data based on space partitioning and data partitioning. Based on these similarity models, we introduce an

industrial prototype, called BOSS, which helps the user to get an overview over a set of CAD objects. BOSS allows the user to easily browse large data collections by graphically displaying the results of a hierarchical clustering algorithm. This representation is well suited for the evaluation of similarity models and to aid an industrial user searching for similar parts.

Introduction

In the last ten years, an increasing number of database applications have emerged for which efficient and effective support for similarity search is substantial. The importance of similarity search grows in application areas such as multimedia, medical imaging, molecular biology, computer-aided engineering, marketing and purchasing assistance, and so forth. Particularly, the task of finding similar shapes in 2D and 3D becomes more and more important. Examples for new applications that require the retrieval of similar three-dimensional objects include databases for molecular biology, medical imaging, and virtual engineering.

Especially in the area of modern engineering, the development, design, manufacturing, and maintenance of products is a very expensive and complex task. Shorter product cycles and a greater diversity of models are becoming decisive competitive factors in the hard-fought automobile and plane market. To cope with this rapidly growing amount of data, effective and efficient similarity models are required for two- and three-dimensional CAD applications.

Accurate representations of CAD surfaces are typically implemented by parametric bi-cubic surfaces, including Hermite, Bézier, and B-spline patches. For many operations, such as graphical display or the efficient computation of surface intersections, these parametric representations are too complex (Möller & Haines, 1999). As a solution, approximative polygon (e.g., triangle) meshes can be derived from the accurate surface representation. These triangle meshes allow for an efficient and interactive display of complex objects, for instance, by means of VRML-encoded files, and serve as an ideal input for the computation of spatial interference.

By means of a uniform three-dimensional voxel grid covering the global product space, the geometry of the CAD parts is often converted into a set of voxels (cf. Figure 1). The voxelization of polygon meshes is a major research topic in the field of computer graphics and CAD. Voxelization techniques and applica-