3D Head Models Retrieval Based on Hierarchical Facial Region Similarity

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Abstract

This paper presents a technique for 3D head models retrieval. The approach combines a 3D shape representation scheme and hierarchical indexing of 3D models based on facial region similarity. The proposed shape similarity measure is based on comparing 3D model shape signatures computed from the Extended Gaussian Images of polygon normal. The technique is made highly efficient and scalable by partitioning the 3D head model into distinctive facial regions and building a hierarchical index for the head model database. In our database, there are over 1,000 models and all the head models are represented up to about 3,000 polygons. Furthermore, we have developed a novel user interface for specifying the visual queries and to interact with the retrieval system. We have desmonstrated that our approach performs similarly with Eigenheads but computationally more efficient by several orders of magnitudes. This makes our approach a practical solution for large model databases.

1. Introduction

With the general availability of 3D digitizers and scanners, one can readily build up large collections of 3D graphical models for different applications e.g. in CAD/CAM, games design, computer animations, and manufacturing. The retrieval of specific 3D models from a database of 3D objects becomes an issue to be tackled for both the manufacturing and entertainment industry. In computer vision, previous work on 3D model retrieval has been concentrated on 3D model invocation and pose estimation from 2D images within the context of scene interpretation [10-15], but the models involved were mainly rigid objects or CAD generated models. However, the need to retrieve non-rigid models and models of free-form surfaces is increasing particularly within the entertainment and graphics design industry.

Previous works [1,2,5,7] on model retrieval and instantiation are mainly related to 3D objects recognition and representation for rigid geometric objects, e.g. machine parts, airplanes and vehicles. In this work, we focus on developing retrieval techniques for a class of deformable 3D object, e.g. the human heads. However, it is expected that the techniques may also be generalized to 3D head models of other species. The technique computes model shape signatures based on an analysis of the distributions of the polygon normal of 3D objects as represented by the Extended Gaussian images (EGI) [9]. It is well known that the normal of a polygon defines its orientation in 3D space and an analysis of how these normals are distributed in 3D space can give an indication of the global shape of a 3D object. Previous work has discussed the applications of polygon normals and EGI for various applications, for example, in image security of watermarking [8].

A survey of the literature reviews that almost no work has been done on indexing 3D head models. Work related to indexing and retrieval of 3D objects can be found in [2, 4, 5, 6]. Relational indexing [2] and Topological surface indexing [6] are similar in concept. The idea of both is to model a 3D object from basic primitives. They define their own structure of primitive model and a 3D model is represented using graph-theoretic techniques. Both techniques apply only on simple CAD-based objects. Syeda-Mahmood [4] applied 3D object invariants to poses from 2D images. In this case,