

Editorial

Search and Retrieval of 3D Content and Associated Knowledge Extraction and Propagation

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Received 30 May 2007; Accepted 30 May 2007

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With the general availability of 3D digitizers, scanners, and the technology innovation in 3D graphics and computational equipment, large collections of 3D graphical models can be readily built up for different applications (e.g., in CAD/CAM, games design, computer animations, manufacturing, and molecular biology). For such large databases, the method whereby 3D models are sought merits careful consideration. The simple and efficient query-by-content approach has, up to now, been almost universally adopted in the literature.

The existing 3D retrieval systems allow the user to perform queries by example. The queried 3D model is then processed, low-level geometrical features are extracted, and similar objects are retrieved from a local database. A shortcoming of the methods that have been proposed so far regarding the 3D object retrieval is that neither is the semantic information (high-level features) attached to the (low-level) geometric features of the 3D content, nor are the personalization options taken into account, which would significantly improve the retrieved results. Moreover, few systems exist so far to take into account annotation and relevance feedback techniques, which are very popular among the corresponding content-based image retrieval (CBIR) systems.

Recently, many research groups in companies and universities have proposed several solutions towards improving the state of the art in search and retrieval of 3D content. There are many initiatives to investigate issues such as rotation invariant feature extraction methods for 3D content, partial matching of 3D objects, annotation and relevance feedback techniques for 3D objects and motion segmentation of 3D video. The purpose of the special issue was to bring together the researchers working on diverse aspects of this important

emerging area in order to identify current status, fundamental issues, future problems and applications.

We have selected six papers which represent various aspects of search and retrieval of 3D content. The paper “Representation of 3D and 4D objects based on an associated curved space and a general coordinate transformations invariant description” by E. Paquet presents a new theoretical approach for the description of multidimensional objects. The proposed approach is based on a curved space which is associated to each object. This curved space is characterised by Riemannian tensors from which invariant quantities are defined. A descriptor or index is constructed from those invariants for which a statistical and an abstract graphs representation are associated. The obtained representations are invariant under general coordinate transformations.

The work entitled “3D model search and retrieval using the spherical trace transform” by D. Zarpalas et al. presents a novel methodology for content-based search and retrieval of 3D objects. The method is as follows: after proper positioning of the 3D objects using translation and scaling, a set of functionals is applied to the 3D model producing a new domain of concentric spheres. In this new domain, a new set of functionals is applied, resulting in a descriptor vector which is completely rotation invariant and thus suitable for 3D model matching. Further, a novel method of assigning weights is proposed, which takes into account the discriminative power of each descriptor. By doing so, the retrieved results are significantly improved.

The paper “Density-based 3D shape descriptors” by C. Burak Akgül et al. presents a novel probabilistic framework for the extraction of density-based 3D shape descriptors using kernel density estimation. The descriptors are derived

from the probability density functions (pdf) of local surface features characterizing the 3D object geometry. Assuming that the 3D object shape is represented as a mesh consisting of triangles with arbitrary size and shape, the method provides efficient means to approximate the moments of geometric features on a triangle basis. The proposed framework produces a number of 3D shape descriptors that prove to be quite discriminative in retrieval applications.

The paper “Content-based object movie retrieval and relevance feedbacks” by C.-C. Chiang et al. deals with object movies. An object movie refers to a set of images captured from different perspectives around a 3D object. Object movie provides a good representation of a physical object because it can provide 3D interactive viewing effect, but does not require 3D model reconstruction. In this work, in order to retrieve the desired object movie from the database, the authors first map an object movie into the sampling of a manifold in the feature space. Two different layers of feature descriptors, dense and condensed, are designed to sample the manifold for representing object movies. Based on these descriptors, they define the dissimilarity measure between the query and the target in the object movie database. The query they considered can be either an entire object movie or simply a subset of views. They further design a relevance feedback approach to improve the retrieved results.

The work entitled “Motion segmentation and retrieval for 3D video based on modified shape distribution” by T. Yamasaki and K. Aizawa presents a similar motion search and retrieval system for 3D video based on a modified shape distribution algorithm. In the presented work, three fundamental functions for efficient retrieval were developed: feature extraction, motion segmentation, and similarity evaluation. Stable-shape feature representation of 3D models was realized by a modified shape distribution algorithm. Motion segmentation was conducted by analyzing the degree of motion using the extracted feature vectors. Then, similar motion retrieval achieved by employing the dynamic programming algorithm in the feature vector space.

Finally, in the paper “Adaptive processing of range scanned head: synthesis of personalized animated human face representation with multiple-level radial basis function” by C. Chen and E. C. Prakash, an animation system for personalized human head, is presented. Landmarks compliant to MPEG-4 facial definition parameters (FDP) are initially labeled on both template model and any target human head model as priori knowledge. The deformation from the template model to the target head is through a multilevel training process. Both general radial basis function (RBF) and compactly supported radial basis function (CSRBF) are applied to ensure the fidelity of the global shape and face features. Animation factor is also adapted so that the deformed model still can be considered as an animated head. Situations with defective scanned data are also discussed in this paper.

This special issue has only covered a small portion of the various research directions in the arena of Search and Retrieval of 3D Content and Associated Knowledge Extraction and Propagation. However, we hope that it provides with ample motivation for the readers to investigate challenging

problems in this new and exciting field. We hope that you will enjoy this special issue.

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Petros Daras was born in Athens, Greece, in 1974, and he is a Senior Researcher at the Informatics and Telematics Institute. He received the Diploma degree in electrical and computer engineering, the M.S. degree in medical informatics, and the Ph.D. degree in electrical and computer engineering from the Aristotle University of Thessaloniki, Greece, in 1999, 2002, and 2005, respectively. His main research interests include computer vision, search and retrieval of 3D objects, the MPEG-4 standard, peer-to-peer technologies, and medical informatics. He has been involved in more than 15 European and national research projects. Dr. Daras is a Member of the Technical Chamber of Greece.



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