Shape Codification Indexing and Retrieval Using the Quad-Tree Structure

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ABSTRACT

The author presents in this paper a new approach for indexing and Content-based image retrieval based on the Quad-tree structure. The 3D objects are represented by their silhouettes and codified following the filling rate of each quadrant at different levels of the quad-tree subdivision. The author proposes a modified linear codification for silhouettes, this method improves the processing time because, in opposite to the traditional algorithms, the author’s algorithm has not a processing time that is proportional to the number of pixels in the image. As the same descriptor may characterize a set of different shapes, the author proposes also, efficient similarity measures to distinguish different objects having the same index in order to apply the approach to the retrieval process.

Keywords: Classification, Filling Rate, Indexing, Quadrant, Quad-Tree, Silhouette, Similarity Measure

1. INTRODUCTION

The easiest way to recognize a query object is to find the model (or the models) in the image database that look alike the query. The problem can be considered like an indexing problem. The indexing and retrieval processes lead to characterize the objects with descriptors and distances in order to compare and classify them.

Various methods have been developed in order to represent shapes in an abstract and efficient way while still preserving important shape features. The most interesting methods may be classified as follow:

Part-based methods where a silhouette is decomposed into parts (Aouat & Larabi, 2009a; Aouat & Larabi, 2009b; Mokhtarian, 1995; Pitas & Venetsanopoulos, 1990; Rosin, 1990; Siddiqi & Kimia, 1995; Wang et al., 2011), aspect-graph methods that are viewer-centered representations of a three-dimensional object (Cyr & Kimia, 2004; Koenderink & Doorn, 1976), methods that use medial axis of silhouettes (Geiger et al., 2003; Ruberto, 2004; Arandjelovic & Zisserman, 2010), methods based on the shock graph (Trinh & Kimia, 2011; Siddiqi & Kimia 1996), methods using graph for shape representation (Badawy & Kamel, 2010).
Hierarchical data structures are important representations in many domains. Quad-trees and related hierarchical data structures are surveyed in (Samet, 1980; Samet, 1984).

Quad-trees are used extensively in computer graphics and computer vision. Mainly, quad-trees can be manipulated and accessed much quicker than other models. For that reason, quad-trees are very popular in fractal graphics. Recursive pictures can be implemented easily using quad-trees. Other advantages of quad-trees include:

- Erasing a picture takes only one step. All that is required is to set the root node to neutral;
- Zooming to a particular quadrant in the tree is a one step operation;
- To reduce the complexity of the image, it suffices to remove the final level of nodes;
- Accessing particular regions of the image is a very fast operation. This is useful for updating certain regions of an image.

The only drawback of quad-trees is that they take up a lot of space. If a quad-tree is implemented using links, most of the memory will be taken up by the links. Nevertheless, there are ways of compacting quad-trees, which is important for transferring data efficiently.

To overcome with such drawback, we propose in this paper to study the images indexing following the subdivision decomposition levels of the quad-tree. We have already developed an approach, showing that three levels will be sufficient to index all images of the database (Aouat & Larabi, 2010a). We propose, also a linear codification method in order to reduce the processing time and the storage memory space. The last step will be the computation of similarity measures between quadrants of the same level of the tree in order to refine our indexing approach and complete therefore the retrieval process.

Objects considered in this paper are represented by their silhouettes (binary images). Using silhouettes for image indexing and recognition is very popular in computer vision applications(Aouat & Larabi, 2009b; Mokhtarian, 1995; Sethi et al., 2004).

This paper is structured as follows:

- Representation of shapes using the quad-tree structure will be explained and detailed in Section 2.
- In Section 3, our codification method will be presented, such codification is important for the indexing process of binary images (silhouettes).
- Section 4 is about the proposed indexing and classification process, we will see that few decomposition levels are sufficient to index all images of the database.
- In Section 5, we detail our retrieval approach; the approach will be achieved by computing distances and similarity measures using the explored levels of the tree.
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