Preface

With the explosive growth of multimedia applications, the ability to index/retrieve multimedia objects in an efficient way is challenging to both researchers and practitioners. A major data type stored and managed by these applications is representation of two dimensional (2D) objects. Objects contain many features (e.g., color, texture, shape, etc.) that have meaningful semantics. From those features, shape is an important feature that conforms with the way human beings interpret and interact with the real world objects. The shape representation of objects can therefore be used for their indexing, retrieval, and as a similarity measure. The object databases can then be queried and searched for different purposes. For example, a CAD application for manufacturing industrial parts might intend to reduce the cost of building new industrial parts by searching for reusable existing parts in a database. For an alternative trade mark registry application, one might need to ensure that a new registered trademark is sufficiently distinctive from the existing marks by searching the database. Besides similarity matching, many other applications require to represent and process spatial relations between objects. Two important types of spatial queries are: topological and direction queries. With topological queries, we are interested in finding objects that are in the neighborhood, incident, or included in the query object. While, with direction queries, we are interested in finding the objects that satisfy a certain location in space (north, south) with respect to the query object.

Based on the above discussion we can identify an important basic problem: given a query object, a set of similar objects or objects satisfying some spatial relation should be retrieved without accessing all the objects in the database. Efficient solutions to this problem have important applications in database, image and multimedia information systems as well as other potential application domains. There are two obstacles for efficient execution of whole match queries. First, the general problem of comparing two 2D objects under rotation, scaling, and translation invariance is known to be computationally expensive. Second, the size of the multimedia and CAD databases are growing and hence given a query object the matching objects should be retrieved without accessing all the objects in the database.

In this book, we present a new shape-based object retrieval technique based on minimum bounding circles (MBCs). Our proposed MBC-based method can be used for efficient retrieval of 2D objects by utilizing three different index structures on features that are extracted from the objects' MBCs. Furthermore, we provide metrics and criterions to evaluate and compare the effectiveness and robustness of different shape retrieval methods. Besides similarity retrieval, we describe the support of spatial queries (e.g., topological and direction queries) using spatial data structures also based on MBC. This book provides a comprehensive survey of the most advanced and powerful shape retrieval techniques used in practice. In addition, it addresses key methodological issues for evaluation of shape retrieval methods. It is intended for undergraduate, graduate students, and researchers in the field of multimedia databases, information retrieval, image retrieval, shape analysis, data mining, geographic information systems, and digital libraries. The concepts and techniques can be used for the representation, indexing, and querying of visual shapes.

1. Outline

Chapter 1 describes various methods for shape representation and in Chapter 2 we describe what is used as similarity comparison during the query processing process. Chapter 3 lists different image shape features that are used by the different shape representation techniques for organizing the useful shape information in index structures for efficient retrieval. Next we present a general background and provide an overview of definitions and notations used in this book. In Chapter 4 we briefly describe four boundary based methods for shape representation and retrieval. Chapters 5 and 6 describe how to support similarity queries and support spatial queries, respectively. Following that, Chapter 7 briefly describes multidimensional index structures that can be used to support shape retrieval queries. In addition, it explains in details three alternative index structures based on *MBC* features. In Chapter 8, we show how to expedite the processing of spatial queries by using the *Sphere-tree* index structure. Then, we address the mismatch between approximation relations and actual relations for intermediate nodes of the tree, and how to handle complex queries. Chapter 9 begins by addressing key methodological issues for the evaluation of shape retrieval methods with real data and under different scenarios [72, 73]. We describe several metrics and criterions to evaluate the effectiveness of a given shape representation technique based on : 1) accuracy in terms of recall and precision, 2) computation and storage costs, 3) sensitivity to noise and boundary points representing a shape, 4) support for different query types, and 5) impact of human perception. Finally, in Chapter 10 we explain two optimization techniques that further improve the performance of *MBC-based* shape retrieval method in several aspects.

Appendix 1 describes the algorithm used to find the minimum bounding circle of an object, and provides the cost analysis of the index structures. Appendix 2 describes the primitive topological and direction relation sets as defined in [25, 62, 63, 64, 92]. We start by defining the primitive topological relations as defined by the 9-intersection model for objects represented by their MBR. Then we define the two topological relation sets $mt1$ and $mt2$ as defined in [64]. Finally, Appendix 2 describes and compares the efficiency of the alternative shape representation techniques in terms of computation and storage requirements.

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