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Book review

***Integrated Region-Based Image Retrieval*, J.Z. Wang; Kluwer Academic Publishers, Boston, MA, 2001, Hardbound, xiii + 178 pages, US\$ 99.50/EUR 114, ISBN 0-7923-7350-2**

The digitization of information has become increasingly popular recently. There are many merits to digitization. Some obvious ones include the convenient sharing and efficient distribution properties of digital data, especially for a large number of users. This trend has motivated research in image databases, which imposes new challenges in information processing and challenges due to the large data size of digital images and the difficulty in filtering, sorting, analyzing, and managing images in comparison with textual data. Recently, storage is becoming less of an issue due to the rapid advances made in hardware technology that drives down the price yet improves performance of storage capacities. However, the software issue, i.e., the effective indexing and searching of large-scale image databases on the basis of semantics and features of images, remains a complex and challenging problem.

The publication of the book, *Integrated Region-Based Image Retrieval*, by Prof. James Wang from the Pennsylvania State University, is timely and important. Content-based image retrieval (CBIR) is the set of techniques for retrieving images from an image database on the basis of automatically derived image features. CBIR functions differently from text-based image retrieval functions that are prevalently deployed in current commercial image databases. Features describing image content, such as color histogram, color layout, texture, shape and object composition, semantically meaning regions, are computed for both images in the database and query images. These features are then used to select the images that most satisfy the constraints of the query.

The author proposed a semantics-sensitive approach to the CBIR problem of general-purpose image databases. The strategy is to use semantic classification methods to categorize images so that semantically adaptive search methods applicable to each category can be applied. Then, the system can narrow down the searching range to a subset of the original database to facilitate fast retrieval. An experimental SIMPLIcity (Semantics-sensitive Integrated Matching for Picture Libraries) prototype system is developed, targeted for applications such as Web and biomedical image retrieval and applied it to several domains including the screening of objectionable images and Web sites, picture libraries, and medical image databases.

In CBIR research, statistical clustering and classification are important machine learning methods that are used to extract visual features, index the feature space, and classify images into semantic categories. Clustering is an example of unsupervised learning while classification is an example of supervised learning. The author reviewed three important statistical clustering and classification methods, including the k -means algorithm, the Tree-Structured Vector Quantization (TSVQ) algorithm, and the Classification and Regression Trees (CART) algorithm. He explored

some alternatives for improving both the speed and accuracy of earlier color layout image indexing algorithms used in large multimedia database systems. An efficient wavelet-based multi-scale indexing and matching system using Daubechies' wavelets has been demonstrated. The system is capable of handling both full-specified queries and partial sketch queries. Also, like color layout indexing, it has limitations with respect to cropping, translational, and rotational changes. In addition, the strategy of matching used is to match the most similar region pair first. This matching scheme is referred as Integrated Region Matching (IRM) to stress the incorporation of regions in the retrieval process. After regions are matched, the similarity measure is computed as a weighted sum of the similarity between region pairs, with weights determined by the matching scheme.

An important aspect of this dissertation work makes it stand out is the considerable amount of effort put into experimental design and systematic evaluation of the practicality and robustness of the prototype systems. The SIMPLIcity system has been implemented with a general-purpose image database including about 200,000 pictures, which are stored in JPEG format. Its variant, the Pathfinder system, has been tested on a pathology image database with more than 70,000 image fragments in raw format. Evaluation using a variety of data sets, ranging from photographic stock images and clip art to pathologic images. The evaluation results indicated that the SIMPLIcity system is robust to intensity variations, sharpness variations, color distortions, shape distortions, cropping, scaling, shifting and rotation.

In summary, the scientific contributions of this original work are many. It experimented with the idea that images can be classified into global semantic classes, such as textured or nontextured, graph or photograph, and that much can be gained if the feature extraction scheme is tailored to best suit each class. For the purpose of searching general-purpose image databases, it developed a series of statistical image classification methods, including the graph–photograph, textured–nontextured, objectionable–benign classifiers. It also explored the application of advanced wavelets in feature extraction and image coding. Furthermore, it developed an image region segmentation algorithm using wavelet-based feature extraction and the k -means statistical clustering algorithm and relied on a robust region matching measure than on precise image segmentation.

Although it is arguable that CBIR for general-purpose image databases is achievable, the innovative methods and approach described in the book certainly creates the potential for new content and applications to originate from a whole new combination of image sources. This book is highly recommended for information engineers, computer scientists and informatics researchers working in the exciting field of image information management.

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