Chapter I
Genetic Algorithms and Other Approaches in Image Feature Extraction and Representation

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ABSTRACT

The novel technologies used in different application domains allow obtaining digital images with a high complex informative content, which can be exploited to interpret the semantic meaning of the images themselves. Furthermore, it has to be taken into account that the complex informative content extracted from the images, that is, the features, need of flexible, powerful, and suitable ways to be represented and managed. The metadata through which a set of images can be described are directly tied to the quality and quantity of the extracted features; besides the efficient management of the metadata depend on the practical and capable feature representation. The more used approaches to analyze the image content do not seem able to provide an effective support to obtain a whole image understanding and feature extraction process. For this reason, new classes of methodologies that involve computational intelligent approaches have been developed. In particular, genetic algorithms (GAs) and other artificial intelligent-(AI) based approaches seem to provide the best suitable solutions. The artificial intelligent technologies allow for the obtaining of a more semantically complex metadata image representation through which to develop advanced systems to retrieval and to handle the digital images. This new method to conceive a metadata description allows the user to make queries in a more natural, detailed, and semantically complete way. As a result it can overcome the always more sophisticated duties caused by the use of wide local and/or distributed databases with heterogeneous complex images.

INTRODUCTION

Digital images, that describe objects and/or situations in the real world, are frequently used to support complex human being activities. Furthermore, the pervasive use of image capture devices, and the increasing relevance of the image analysis in specialized fields (such as: medical, military, satellite, engineering, and so on) have brought an exponential growth of the image data sets into the local and/or distributed image databases. This growth makes the database management, and in particular the image retrieval, a complex task. Moreover, the entropy level of the images contained in these databases makes the optimal exploitation of the images and the performance of several operations (such as: intelligent indexing, comparisons, inference, special query, analysis, processing, and so on) not easy. All these factors contribute to the data mining processes inefficiency. This kind of problems can be overcome exploiting the images themselves. In fact, the novel technologies used in the different application domains allow to obtain images with high level details. These images often possess an informative content that goes beyond the simple visual representation. That is, by observing the relationships among pixels (or clusters of pixels) meaningful features of what is represented in the image can be brought out. This information content is connected to features of an image (such as: textures, colours, patterns, local and global characteristics, and so on). For this reason, the feature extraction matter is one of the main issues in image processing, since the understanding of the meaningful image features implies understanding the image (and parts of it) with its own semantic content. These features can be exploited, by the image analysis processes, to evaluate deeply the semantic informative content of every image, that is, to understand the morphological structure of every object contained in the image and the whole image itself. By the semantic content, and the connected features, it is possible to obtain an exhaustive and great metadata image representation through which to accomplish more effectively the mentioned database operations. In particular, store and retrieval operations can be performed in powerful, efficient and effectiveness way.

It is important to observe that the complex features extracted from images with high level details need new approaches to be represented. In fact, as well known, high level semantic characteristics (such as: textures, objects, shapes, patterns, local and global characteristics, and so on) need of more complex logical structures than low level semantic characteristics (such as: colours, statistical content information, gradients, and so on) to be represented. Moreover, it has to be taken in account that a single high level semantic characteristic on an image (as the texture) can require several feature images (called feature space) to be expressed. The quality and the accuracy of the feature space allow to classify every image according to the connected semantic characteristic, while the capacity to manage of the feature space (that is, the related feature space representation) drive the effectiveness with which the developed systems can store and retrieve the images into the databases. This chapter introduces and discusses the different Artificial Intelligent (AI) approaches used to extract and to represent the features of any image. In particular, the role of the Genetic Algorithms (GAs) has been highlighted. The chapter starts from a brief discussion about the feature extraction process, then it introduces a general description of some of the most interesting AI approaches and their application in image feature extraction problems. A more complete and exhaustive description of the GAs is given. Finally the possibility of combined AI approaches (used in the hybrid systems) to solve more complex feature extraction problems is faced. Therefore, some of the most recent and powerful applications exploiting the AI image feature extraction are shown.

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