

# Chapter XI

## Preference Extraction in Image Retrieval

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### ABSTRACT

*In this chapter, we describe two new approaches to content-based image retrieval (CBIR) based on preference information provided by the user interacting with an image search system. First, we present the existing methods of image retrieval with relevance feedback, which serve then as a reference for the new approaches. The first extension of the distance function-based CBIR approach makes it possible to apply this approach to complex objects. The new algorithm is based on an approximation of user preferences by a neural network. Further, we propose another approach to image retrieval, which uses reference sets to facilitate image comparisons. The methods proposed have been implemented, and compared with each other, and with the earlier approaches. Computational experiments have proven that the new preference extraction and image retrieval procedures here proposed are numerically efficient. Finally, we provide a real-life illustration of the methods proposed: an image-based hotel selection procedure.*

### 1.0 INTRODUCTION

Multimedia technologies have been developing rapidly over the last few years and have yielded a large number of databases containing graphical documents. Tools for content-based search of graphical objects have been the subject of intensive research (cf. e.g. (Liu, et al. 2007)), but their performance is still unsatisfactory for many applications, opening up a field for further research and technology develop-

ment. Up till now, all popular Internet search engines have been only text-based, including those that search for images. Moreover, only a few existing content-based image retrieval systems, like MARS (Rui et al. 1997), MindReader (Ishikawa, Subramanya, & Faloutsos, 1998) or VisualSeek (Smith, & Chang, 1996) allow for an interaction with the user during the search process. The idea of an interactive search consists in changing search parameters based on the user's assessment of the relevance of images presented by the search system in consecutive iterations of the search process.

In section 2, we briefly describe existing image retrieval methods and point out their limitations. The theoretical foundations of the utility function approximation for relevance feedback are given in section 3. In the following part we propose two different methodologies of content-based image retrieval, both based on elicitation of user preferences from his/her interactive feedback. They are complementary in the sense that they cover two different search problems and have different approaches to solving the problem of "semantic gap" (between low-level features extracted from the image and high-level features which the user uses to describe the image).

The first approach, presented in section 4, is designed for graphical objects which can be broken down into sub-objects with homogenous texture and colour distribution, in such a way that the main object can be classified by the low-level features of sub-objects (texture, colour distribution and shape) and spatial relations between them. The method can be used for development of multimedia atlases and thematic encyclopaedias equipped with effective visual search capabilities, so the user who does not know e.g. the name of a species, may have an option to look for it by its memorized appearance. In this approach, user preferences are approximated with an RBF neural network (Park, & Sandberg, 1991). This method has been tested with an interactive atlas of fishes, which we have developed in Matlab.

The second approach, proposed in section 5, is especially well-suited to images that cannot be recognized by directly matching sub-objects and the relations between them. The retrieval process is based on high-level features, calculated from the entire image. Depending on the set of features foreseen in a specific implementation, this method can be used either with a homogeneous database containing a specific class of images or with heterogeneous database, which most Internet search engines have to deal with. The method is based on reference sets, introduced by Skulimowski (1996; 1997). For testing purposes, we have developed a Matlab application for photo-based searching of a hotel according to user preferences.

*Figure 1. Image of a butterfly is an example of an object which can be classified by low-level features of sub-objects and spatial relations between them. Segmentation into sub-objects was performed automatically with Edge Flow algorithm (Manjunath, 1997)*



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