Chapter 2.24
Efficient Method for Image Indexing in Medical Application

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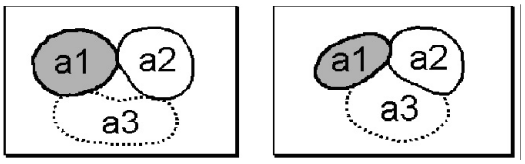
INTRODUCTION

In last two decades, image retrieval has seen a growth of interests in several domains. As a result, a lot of work has been done in order to integrate it in the standard data processing environments (Rui, Huang, & Chang, 1999; Smeulders, Gevers, & Kersten, 1998; Yoshitaka & Ichikawa, 1999). To retrieve images, different methods have been proposed in the literature (Chang & Jungert, 1997; Guttman, 1984; Lin, Jagadish, & Faloutsos, 1994). These methods can be grouped into two major approaches: metadata-based and content-based approaches. The metadata-based approach uses alphanumeric attributes and traditional techniques to describe the context and/or the content of the image such as title, author name, date, and so on. The content-based approach uses image processing algorithms to extract low-level features of images such as colors, textures, and shapes. Image retrieval using these features is done by methods of similarity and hence is a non-exact matching.

The requirement of each method depends on the application domain. In this paper, we address the domain of medicine where image retrieval in particular is very complex and should consider:

- Both content-based and metadata representations of images and salient objects. This guarantees a pertinent integration of all the aspects of image in order to capture pertinent information and to assure the relevance of all query types (Chbeir, Atnafu, & Brunie, 2002).
- High-precision description of images. For example, the spatial data in surgical or radiation therapy of brain tumors is decisive because the location of a tumor has profound implications on a therapeutic decision (Chbeir, Amghar, & Flory, 2001; Chbeir et al., 2002). Furthermore, it is crucial to distinguish between similar situations. Figure 1 shows two different images of three salient objects that are traditionally described by the same spatial relations in both cases: topological relations: a1 Touch a2, a1 Touch

Figure 1. Two different spatial situations



a3, a2 Touch a3; and directional relations: a1 Above a3, a2 Above a3, a1 Left a2.

- The evolutionary aspect of image content (Chbeir, Amghar, Flory, & Brunie, 2001) such as tumor development in brain (Figure 2), virus changes, and so on. The detection of the evolutionary aspects of objects (displacement, deformation, contraction, rotation, etc.) can significantly help physicians to establish an appropriate diagnosis or to make a therapeutic or surgical decision. An example for such a query is: "Find treatments of lesion detected inside brain images where a size increasing has been observed at every examination between time t and t+n".

In this article, we address the spatial and evolutionary issues of images. We propose a novel method that considers different types of relations. This method allows providing a highly expressive and powerful mechanism for indexing images.

Figure 2. Tumor growth inside the brain

The rest of this article is organized as follows: the next section is devoted to detail the related work. In the following section, we define our method of computing the different relations and we show how image indexing can be done. The subsequent section demonstrates how our method can adequately index medical images. Finally, we conclude and give future work orientations.

RELATED WORK

The problem of image retrieval is strongly related to image representation. Computing relations between either salient objects, shapes, points of interests, etc. have been widely used in image representation such as R-tree and its variants (Beckmann, 1990; Guttman, 1984), hB-tree (Lomet & Salzberg, 1990), ss-tree (White & Jain, 1996), TV-tree (Lin et al., 1994), 2D-String and its variants (Chang & Jungert, 1997; Chang & Jungert, 1991; Chang, Shi, & Yan, 1987), and so on. Spatial relations are mostly used for indexing and retrieval purposes for its automatic detection capability.

Three major types of spatial relations are generally proposed in image representation (Egenhofer, Frank, & Jackson, 1989):

- Metric relations measure the distance between salient objects (Peuquet, 1986). For instance, the metric relation "far" between two objects A and B indicates that each pair of points A_i and B_j has a distance grater than a certain value d.
- Directional relations describe the order between two salient objects according to a direction, or the localisation of salient object inside images (El-kwae & Kabuka, 1999). In the literature, fourteen directional relations are considered:
  - **Strict:** north, south, east, and west.
  - **Mixture:** north-east, north-west, south-east, and south-west.