Chapter 5
Annotation of Medical Images

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ABSTRACT

Automatic image annotation is a technique that automatically assigns a set of linguistic terms to images in order to categorize the images conceptually and provide means for effectively accessing images from databases. This chapter firstly introduces fundamentals and techniques of automatic image annotation to give an overview of this research field. A case study, which describes the methodology for annotating mammographic lesions, is then presented. This chapter is intended to disseminate the knowledge of the automatic annotation approaches to the applications of medical image management and to attract greater interest from various research communities to rapidly advance research in this field.

INTRODUCTION

In the last decade, a large number of digital medical images have been produced in hospitals. Such digital medical images include X-ray, computed tomography (CT), magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), magnetic resonance spectroscopy (MRS), magnetic source imaging (MSI), digital subtraction angiography (DSA), positron emission tomography (PET), ultrasound (US), nuclear medical imaging, endoscopy, microscopy, scanning laser

ophtalmoscopy (SLO), and so on. These medical images are stored in large-scale image databases and can facilitate medical doctors, professionals, researchers, and college students to diagnose current patients and provide valuable information for their studies. Due to the increasing use of digital medical images, there is a need to develop advanced information retrieval techniques, which can improve the effectiveness of browsing and searching of large medical image databases. Among various advanced information retrieval techniques, image annotation is considered as a prerequisite task for image database management (Hersh, 2009). If images are manually annotated

with text, keyword-based search can be used to retrieve the images. However, manual annotation suffers from the following limitations, especially in massive image databases (Feng, Siu, & Zhang, 2003).

- Manual annotations require too much time and are expensive to implement. As the number of media in a database grows, it becomes infeasible to manually annotate all attributes of the image content. For instance, annotating a 60-minute video containing more than 100,000 still images consumes a vast amount of time and expense.
- Manual annotations fail to deal with the discrepancy of subjective perceptions. When people perform image annotation, they provide the different description with their different subjective perceptions. Furthermore, the same annotators may have different subjective perceptions as time evolves;
- It is difficult to provide concrete description for some image contents. For example, the shape of organs in medical images is too complex to describe.

In an attempt to addressing these limitations, automatic image annotation is necessary for efficient image retrieval. Automatic image annotation is a hot topic in the areas of multimedia, information retrieval, and machine learning. To correspond to this trend, this chapter presents an image annotation scheme, which includes mammographic feature extraction and a supervised classification approach to mammogram annotation. The rest of the chapter is organized as follows: Section 2 reviews the methods of visual features and classification in medical images. Section 3 presents a case study, which describes the methodology of annotation for digital mammograms. Section 4 discusses potential research issues in the future research agenda. The last section concludes this chapter.

LITERATURE REVIEW

Visual Features

Automatic image annotation refers to a technique that automatically assigns a set of linguistic terms to images in order to categorize the images conceptually and provide means for effectively accessing images from databases (Deselaers, Deserno, & Muller, 2007). To make computers automatically assign linguistic terms to images, the region of interests in images need to be represented from corresponding visual features. Visual features, also called low-level features, are objectively derived from the images rather than referring to any external semantics (Feng et al., 2003). As the visual features extracted from the images should be meaningful for image seekers, the visual features used in the image retrieval systems are mainly divided into three groups: color, shape, and texture.

Color

Color, one of the most frequently used visual features for content-based image retrieval, is considered as a powerful descriptor that simplifies object identification (Gonzalez & Woods, 2002). Several color descriptors have been developed from various representation schemes, such as color histograms (Ouyang & Tan, 2002), color moments (Yu, Li, Zhang, & Feng, 2002), color edge (Gevers & Stokman, 2003), color texture (Guan & Wada, 2002), and color correlograms (Moghaddam, Khajoie, & Rouhi, 2003). For example, color histogram, which represents the distribution of the number of pixels for each quantized color bin, is an effective representation of the color content of an image. The color histogram can not only easily characterize the global and regional distribution of colors in an image, but also be invariant to rotation about the view axis.

For the retrieval of medical images, color allows images to reveal many lesion characteristics (Tamai, 1999). Color also plays an important role in

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