Chapter 19 Recent Survey on Medical Image Segmentation

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ABSTRACT

This chapter presents a survey on the techniques of medical image segmentation. Image segmentation methods are given in three groups based on image features used by the method. The advantages and disadvantages of the existing methods are evaluated, and the motivations to develop new techniques with respect to the addressed problems are given. Digital images and digital videos are pictures and films, respectively, which have been converted into a computer-readable binary format consisting of logical zeros and ones. An image is a still picture that does not change in time, whereas a video evolves in time and generally contains moving and/or changing objects. An important feature of digital images is that they are multidimensional signals, i.e., they are functions of more than a single variable. In the classical study of the digital signal processing the signals are usually one-dimensional functions of time. Images however, are functions of two, and perhaps three space dimensions in case of colored images, whereas a digital video as a function includes a third (or fourth) time dimension as well. A consequence of this is that digital image processing, meaning that significant computational and storage resources are required.

INTRODUCTION

Image segmentation is one of the most important stages in artificial vision systems. It is the first step in almost every pattern recognition process. In some context other terms like object isolation or object extraction are used.

The human vision system essentially segments the observed scene. One does not see a complex scene, but rather a set of objects. The importance of the process of visual segmentation (grouping) is claimed by the Gestalt theory Metzger (1953) as an early step in the analysis of a visual scene. It states, "whenever points (or previously formed visual objects) have one or more several characteristics in

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common, they get grouped and form a new larger visual object: a gestalt" Desolneux et al. (2003). The psychologists belonging to this school provided a set of guidelines for predicting the process of visual segmentation Tonder et al. (2002). Five main guidelines often called Gestalt laws have inspired many image segmentation techniques. One of them is the similarity law elements that look more similar are grouped together. Shape or brightness can be meant by the similarity, where bright objects are grouped together and dark objects are grouped together. Figure 1(a) shows an illustration of the similarity law based on the brightness taken from Metzger (1953). We think that this law has inspired the pixel-based segmentation approaches. The similarity law can be extended to the self-similarity of the natural patterns that often happened at multiple spatial scales. Objects can be grouped together if they share the same shape although they are in different scales as shown in Figure 1(c). Another example is the enclosedness law: Objects are grouped together if they are arranged on a closed path. In Figure 1(b) two regions can be easily recognized because they are closed inside two different paths. The edge-based and region growing-based segmentation approaches may be inspired from this law.

The segmentation is an unconscious activeness by the human observer. However, in the computer vision system it is computationally expensive and a logically non-trivial task.





(a)

(b)



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