

Chapter 8

Construction of Digital Statistical Atlases of the Liver and their Applications to Computer–Aided Diagnosis

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ABSTRACT

Digital atlases of the human anatomy are a new and hot topic in medical image analysis. The basic idea of the digital atlas is to capture the variability of an organ's location, shape, and voxel intensity (texture) from a training set. In this chapter, the authors present current progress toward constructing digital atlases of the liver and their applications to liver segmentation and diagnosis of hepatic disease. They also introduce a new mathematic framework (generalized N -dimensional principal component analysis) based on multi-linear algebra for medical volume analysis.

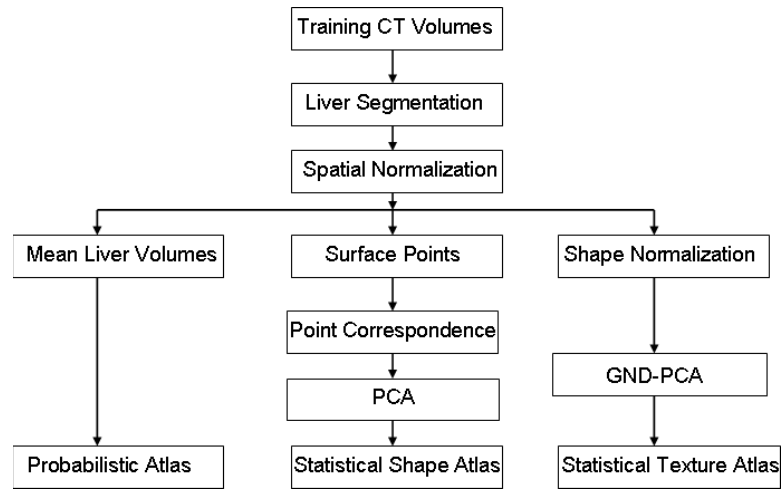
INTRODUCTION

The atlas of human anatomy is an important teaching tool in the medical community (Netter, 2006). In the recent years, digital atlases of human anatomy have become a popular topic in the field of medical image analysis (Hoene, Pflesser, & Pommert, 1995; Hunter & Borg, 2003; Sato, 2007). The digital atlas can be categorized as a probabilistic atlas, a statistical shape atlas

(statistical shape model) and a statistical texture atlas (statistical texture model). The basic idea of the digital atlas is to capture the variability of the organ's location, shape and voxel intensity (texture) from a training set (either data from different individuals (inter-patient variability) or from the same individual (intra-patient variability)). The atlas is also very useful for organ segmentation and computer-aided diagnosis (CAD) because it can be used as *a priori* information of human anatomy. To date, only a few researchers have

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Figure 1. A framework for constructing digital atlases



constructed probabilistic atlases and statistical shape models of anatomical organs, such as the brain (Tompson et al., 2000), heart (Peyrat et al., 2007), liver (Okada et al., 2008), and spleen (Tateyama, Foruzan, & Chen, 2009). The probabilistic atlas and the statistical shape model have also been applied to automatic segmentation of medical images (Okada et al., 2008; Linguraru et al., 2009).

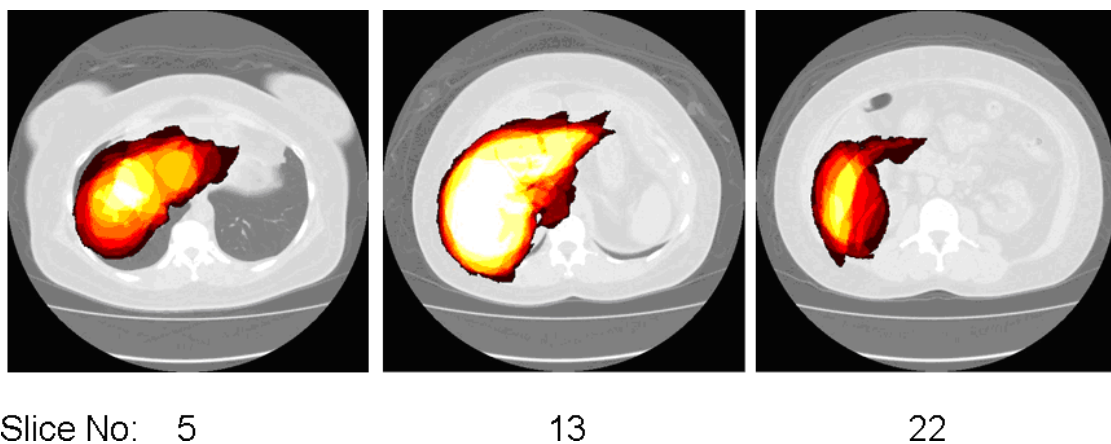
In this chapter, we present a framework for constructing probabilistic atlases, statistical shape atlases and statistical texture atlases of the liver from a set of training samples and discuss their

applications to liver segmentation and diagnosis of hepatic disease. Our framework is shown in Figure 1.

PROBABILISTIC ATLASES OF THE LIVER

A probabilistic atlas of the liver is a mean model of the liver’s location in the abdomen. We used 10 patients’ abdominal CT scans and manually segmented the livers. A 3D affine registration was used to align the data. The 3D affine registration

Figure 2. Probabilistic atlas of the liver



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