Abstract

Processing brain Magnetic Resonance (MR) images is a challenging problem primarily due to the complex anatomical structure of the human brain. In addition, inhomogeneous intensity distribution, background noise, and low contrast between adjacent brain tissues that is prevalent in these images, make various processing tasks, such as registration, segmentation, etc., even more difficult. In this thesis, an anatomical model-guided technique is proposed to perform these tasks, which simplifies the computation for extraction and identification of various organs, and registers an MR image in a reference coordinate system. Comparison with an existing segmentation algorithm has shown that the performance of the proposed segmentation algorithm is better both in the quality of results and in the time taken for computation. Registration (also called alignment) of brain images with a reference model is further used for generating a brain atlas from a set of MR images belonging to a representative sample of a population. These atlases are useful in exploring the brain anatomical structures, functions and their relationships. In traditional atlas generation methods, wide variation of the anatomical structures in different brain volumes poses a great difficulty as a result of which the generated atlas may not represent the population of the brain studied. Also, the atlas generated from selectively chosen brain volumes may be biased on the choice of volumes within a population. In this thesis, a novel technique has been introduced for the generation of a brain atlas based on identifying invariant feature key-points obtained from several brain volumes. The experiments are based on the hypothesis that the invariance of these feature points across a population makes it robust to variations in anatomical structures and selective bias due to choice of volumes.

As an application, the invariant key-points are used for the diagnosis of Alzheimer's disease (AD). Usually for the purpose of diagnosis, the brain MR images are acquired as a sequence of 2D images independently in three orthogonal views, namely, sagittal, coronal and axial view. The acquired images do not span the entire brain. So, the volumes reconstructed independently from each of these views do not cover the whole region of the brain. In this work, an algorithm has been developed for reconstructing a high resolution volume of human brain from low resolution image sequences in multiple views. Further, it has been shown that the proposed technique for AD diagnosis from low resolution MR images is also possible through this high resolution reconstruction of multiple views.

Keywords: *Brain MR image, Registration, Anatomical brain model, Segmentation, Brain atlas, Alzheimer's disease, Volume reconstruction*