A novel approach to Segmentation and Registration of Echo-cardiographic Images

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Abstract

Echo-cardiographic images provide a wealth of information about the heart(size, shape, blood flow rate, etc) and are therefore used to assess the functioning of heart. Automated analysis of echo-cardiographic images are aimed at extracting a displacement field which represents the heart motion. Such a field is critical for extracting higher order information which is needed for diagnosis of heart diseases. However, these images are very noisy which poses a huge challenge to image analysis.

Most of the methods used for the analysis of the echo-cardiographic images are designed in such a way that they are very specific to the noise present in the echo-cardiographic images. These methods can be categorized into two categories: (i) de-noise the signal prior to analysis and (ii) formulate input as a noisy signal to model the noise using statistical noise model. In this thesis we propose algorithms for analysis of echo-cardiographic images which do not require any pre-processing step or explicit handling of noise present in the images.

We present novel algorithms for segmentation and registration of echo-cardiographic images in this thesis. These two algorithms are designed based upon noise-robust image representation. This image representation is obtained by computing a local feature descriptor at every pixel location. The feature descriptor is derived using the Radon-Transform to effectively characterise local image context. The advantage of this representation is that, in addition to being robust to noise, it provides a good detail of the distribution of the pixel intensities in the image. Next, an unsupervised clustering is performed in the feature space to segment regions in the image. This feature-space representation is also used to extract hierarchical information for image registration.

The performance of the proposed methods is tested on both synthetic and real images. A comparison against well established feature descriptors is carried out to demonstrate the strengths and applicability of the proposed representation. Overall, the results indicate promise in the strategy of doing segmentation of noisy data in image.

In this thesis, the algorithms are designed in such a way that the algorithm works efficiently even in presence of high level of speckle noise and doesn't require any pre-processing. Moreover it can be easily adapted to any other modality. The main contributions of this thesis are:

1. Noise-robust representation of an image in feature space.
2. Segmentation of an image using feature space
3. Registration of images using hierarchical information.