CHAPTER 6: CONCLUSION & FUTURE WORK

Deformable image registration is a challenging problem due to various types of possible deformations and high chance of false registration. In particular, registration of CT image stacks/sequences is a very difficult task because of the sheer number of landmark feature points involved in the registration process. DIR techniques able to account for displacement and deformation of organs in a series of medical images acquired in connection with fractions of radiotherapy are a key component in the efforts to improve the treatment guided by image data. The conclusions of work of this thesis and suggestions for future research are presented in this chapter.

6.1 Concluding Remarks

The study was set out to explore new and accurate deformable image registration techniques for thoracic CT image pairs and image sequences. The investigations were set up on a three dimensional CT image database of 10 subjects. For each subject there were 10 images in temporal sequence through all three anatomical positions i.e. axial, coronal and sagittal, out of which first six were temporally aligned with a gap of 0.1 seconds from full inhale to full exhale position. The objective was to register the image pair and sequences accurately from the above mentioned data (or any other modality image) by applying geometrical transformation based registration algorithms. Three such registration algorithms were proposed, both standalone and composite algorithms. One of the objectives of the algorithms was to determine an image registration model for a variety of breathing motion data from many subjects. It is known that different individuals have different breathing frequencies depending on many factors like their respective lifestyles, genetic or hereditary diseases etc. The study was conducted

to develop algorithms to adjust and normalize these variations, thus providing a common denominator upon which more accurate analyses can be made in future, both from medical imaging and clinical research perspectives. There hasn't been a consolidated method to assess the deformations happening in the thoracic region during the process of breathing. The proposed method helps in assessing this deformation in form of average displacement of all common landmark points in that image sequence from full inhale to exhale positions. This has been implemented on all test subjects and has been demonstrated for one subject in further detail. Also, the displacing points on the image leave clear and color coordinated paths which reflect the exact motion of those points through frames of the image sequence. This would help in assessing and analysing individual motion separately at every point of the medical image if required. This would be highly beneficial in detecting abnormal behaviour in organs when compared to normal established baselines. Accuracy of these algorithms was determined using metrics like Target registration error, image similarity metrics etc. Lower values of target registration error for applied algorithms in comparison to those prevalent indicated higher deformable image registration accuracies. Likewise, similarity metrics indicating higher percentage of correspondence between the transformed image and target image (post registration) in comparison to the initial similarity between source and target image indicate better registration than the usually employed methods to achieve same objective.

6.2 Scope for Future Work

The proposed methods proved to be accurate and fulfilling the objectives keeping in mind which the work was started, they can be seen as the stepping stones to more accurate and fast techniques to achieve deformable image registration in the

future. The proposed methods seem to exhaust the scope of this thesis, there are a few modifications in already existing methods and few new ideas that are in order to be taken up in the future to enhance and push the boundaries of image processing and medical imaging in particular. One of the primary modifications would be soft computing based feature point marking system. The idea is to use an automatic/semiautomatic learning based relevant landmark point marking system. Organ based information from both medical and image processing perspectives will be used as a pre-requisite for the learning procedure to enable the landmark point marker to highlight only relevant areas instead of either manually plotting points or using an automatic method which marks landmark points randomly (based on presumptions other than the medical kind). This would help in highlighting those areas of the medical image which actually do move rather than those which do not most of the time thus making better use of the resources and making the whole process faster and more relevant. The image registration resulting from these relevant common landmark point cloud would be less erroneous and more dynamic according to the organ of which the medical images are being registered.

Deformable image registration has been playing a pivotal role in correcting the ‘human error’ aspect of medical image acquisition irrespective of the image modality it is being used for and has been a major contributor in clinical research based on these images for similar reasons. The methods proposed in this work will become a small part of an already vast cluster of similar algorithms, all working in tandem towards a common objective: fast, accurate and efficient image based clinical intervention as when required.