ECSE 626 Project Proposal: Maximum-Distance Gradient for Robust Image Registration

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Paper: Maximum distance-gradient for robust image registration by Rui Gan, Albert C.S. Chung *, Shu Liao. Medical Image Analysis, 12 (2008), 452–468.

When first introduced, the use of mutual information (MI) in image registration has caught the attention of many researchers. The advantage of MI is that it assumes no prior functional relationship between images (i.e. image intensities), instead it measures the statistical dependence among image intensities in two images. An obvious problem of using MI in image registration was its lack of spatial information. Many research groups have suggested enhancements to solve this deficiency in MI measure.

This paper uses MI in a new form for image registration. It incorporates a measure called maximum distance-gradient(MDG) to MI that represents images' spatial information. The MDG vector field represents both global and local spatial information by using intensity difference, distance and direction of the voxel to a MDG source point. Both magnitude and the orientation of signed-MDG feature field are added to MI to give a multi-dimensional MI measure. A four-dimensional histogram is constructed by binning feature vector pairs. Finally, a multi-resolution approach is applied for registration process.

This paper is chosen because it provides a very robust extension to traditional MI registration by including spatial information locally and globally. It shows statistical algorithms with help of additional information can still provide very robust registration at a relatively low performance cost and low complexity. Regarding replicability, the paper clearly explains the MDG measure calculation and algorithm used with detailed discussions of equations and values of variables used in each step, making it easily replicable despite its complexity.

This project will implement the code for signed-MDG feature field measure. It will also add the MDG measure to MI registration algorithm to form enhanced multi-dimensional spatial MI similarity measure. The source codes for multi-resolution approach for registration process, as well as optimization at each resolution, will be copied from open source resources. The measure's robustness will be measured by applying it on a set of images, and measuring the success rate of registration. This will be compared with other measures success rate on same dataset. The source code of other MI measures will be extracted from an open source library. If possible, this project will also look at the accuracy of registration of proposed measure in comparison to other MI measures by comparing the error in alignment.