Automatic Localization of the Anterior and Posterior Commissures in MRI Brain Images Using Artificial Neural Networks

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Introduction

Localization of the anterior commissure (AC) and posterior commissure (PC) is an important pre-processing step in many MRI post-processing workflows. For example, SPM5 registration requires the origin of the input image to be set to the location of the AC prior to running. For small image data sets manual identification of the AC-PC is a simple step that requires little time. However, manual intervention is not an option for large image data sets, like ADNI [1] and OASIS [2], and for automated workflows. Calculating the center-of-mass of the image gives a rough estimate of the location of the AC, an option in SPM5 registration, but based on years of experience this technique fails frequently. Similarly, rigid-body registration may be used as a means to roughly set an image origin to the AC [3], but this method fails 29% of the time when using the OASIS data set. acpcdetect, a recently developed method for AC-PC detection [4], does not rely on the identification of the corpus callosum or the underlying MRI contrast. However, this method also fails on 29% of the OASIS images. The method proposed in this abstract uses artificial neural network training to identify the AC-PC in MR images. Like [4] it is not limited by identification of specific landmarks, is not limited to a specific MR contrast, and is fast.

Methods

acpcdetect was used to identify the AC-PC in 294 out of 416 images in the OASIS data set. The remaining 121 images were used as a test set. The OASIS data set was chosen because it contains a sufficient number of images for training and because the subject ages range from 18 to 96, which covers the normal adult lifespan. Using a home-built tcl script, the AC-PC voxel coordinates were extracted from the text output of acpcdetect and converted into a “boxes” xml file readable by LONI ICE [5]. Artificial neural networks were created for the AC and PC in LONI ICE as shown in Figure 1. After creating the networks, “samples” files were generated using the “boxes” files and the networks were trained using LONI ICE using the generated “samples” files. After training, correct identification of the AC-PC in the test data images was performed manually by inspecting slice “snapshot” images in each orthogonal plane about the identified coordinate using a home-built program. A 5x5 cross marked the location in the image. Images where the center of the cross was more than 5 voxels away from the true location were identified and used to test the x, y, z center offset and 95% confidence interval for the trained network.

Results

The AC-PC was identified within a 10-voxel cube in all of the test images. The center of the cross was more than 5 voxels away from the true AC location in 33 out of the 121 test images. For the PC the center of the cross was more than 5 voxels away from the true location in 19 out of the 121 test images. The center offset and 95% confidence interval was [-1,-1,-1] +/- [2,3,2] voxels for the AC and [-1,0,-1] +/- [2,3,2] voxels for the PC.

Conclusion

The proposed artificial neural network method for automatic AC-PC localization in MR images lowered the AC localization error rate from 29% to 8% and the PC localization error rate from 29% to 5% when compared to acpcdetect. The benefit of using this method is the ability to add images to the training set, where AC-PC localization has failed, thereby improving the performance with time. Also, the current network was created using only T1-weighted images. Other image modalities may be added to the training set without much difficulty using the graphical user interface provided by the LONI ICE tool.

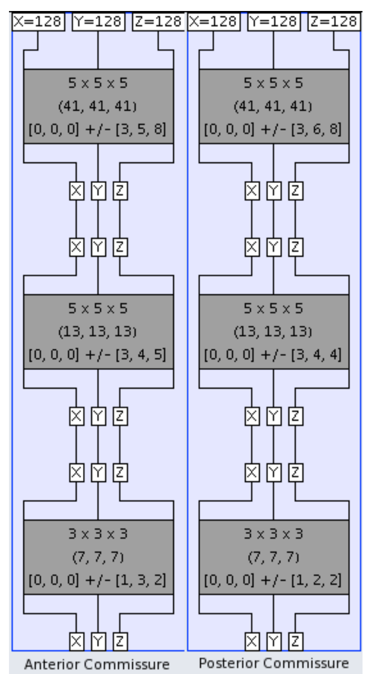

Figure 1. AC-PC training networks created in LONI ICE. The ?x?x? refer to the input grid size, the (?,?,?) refer to the number of voxels in the grid, and the [?,?,?] +/- [?,?,?] refer to the x, y, z center offset and 95% confidence interval for the trained network.

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