

# Co-registration of Human Brain MR and PET Images using the AC-PC Line

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## Abstract

The intercommissural(AC-PC) line is automatically detected for MR and PET images. With the detected AC-PC lines from MR and PET images, fully non-iterative automatic co-registration is accomplished. It provides a new automated method for image co-registration.

## Introduction

The registration of 3-D objects is an important problem in computer vision and especially in medical imaging. It arises when data acquired by different sensors and/or at different times have to be fused. Under the basic assumption that the objects to be registered are rigid, the problem is to recover the nine parameters of a rigid transformation. The non-iterative method is proposed. Several techniques[1,5] have been developed for automated detection of the AC-PC line for positron emission tomography(PET). The AC-PC line is estimated from the location of four landmarks[1]: the frontal and occipital poles, the inferior aspect of the anterior corpus callosum, and the subthalamic point. Also the algorithm is also applied to MR images for detecting the AC-PC line of MR images automatically.

## Methods

The transaxial MR images are acquired on a GE Signa Advantage 1.5T MR scanner applying SPGR pulse sequence, with 124 slices having 256x256 resolutions and 1.5 mm thickness. For PET images, the 35 transaxial [<sup>18</sup>F]FDG PET or H<sub>2</sub><sup>15</sup>O activation PET images are acquired on a GE Advance PET scanner having 128x128 resolutions, 4.25mm thickness. We implemented algorithm[1] on a common workstation(SUN SPARC station).

Four landmarks are estimated as follows;

The corpus callosum(CC) point is defined as the most anterior ventral aspect of the corpus callosum located on the gray-white matter border between the anterior corpus callosum and the cingulate gyrus. The occipital pole point(OP) is defined as the most posterior point of the brain and detected on the posterior edge of the brain at greatest distance from CC. The frontal pole point of the brain(FP) is defined as the most anterior point of the brain located on the anterior edge of the brain as the furthest point of thalamus and detected by application of a cutoff threshold to thalamic activity. The AC-PC line is estimated on the basis of these four points by simple linear regression. The center of the AC-PC line is defined as the midpoint between the anterior and posterior edges of the brain in the mid-sagittal slice. For detecting the AC-PC line of MR image, the skull of the brain is detached as pre-processing step because the brain boundary is required for applying the algorithm to MR images. Fig. 1 and Fig. 2 show the PET and MR images of same patient. Brain image detaching skull portion is shown in Fig. 3. The AC-PC line is drawn in the midsagittal slice of PET image after automatic detection and shown in Fig.4. The algorithm is applied to the MR image of Fig. 3 and its result is shown in Fig. 5.

The slope of the AC-PC line of the PET image shown at Fig. 4 is

$$Y = 0.125 * X + 14.0,$$

The AC-PC line slope of MR image at Fig 5. is

$$Y = 0.156 * X + 25.0,$$

With these slopes, the MR and PET images are co-registered with few pixel error rates, after reslicing of the PET image.

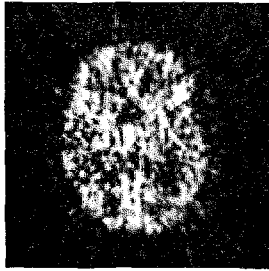


Fig.1 H<sub>2</sub><sup>15</sup>O PET image

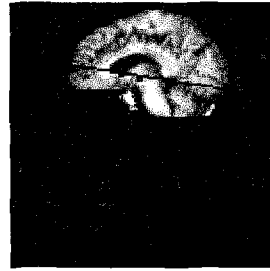


Fig. 5 Midsagittal MR slice with AC-PC line

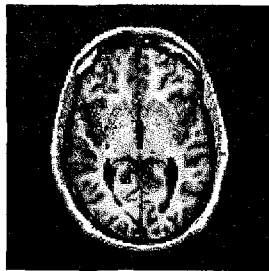


Fig.2 SPGR MR image

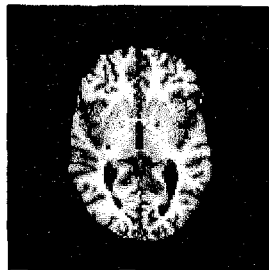


Fig. 3 Brain MR image without skull

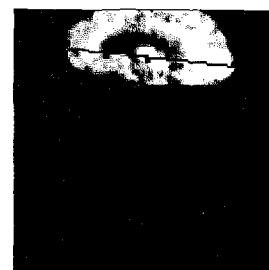


Fig.4 Midsagittal PET slice with AC-PC line

### Conclusion

The integrated and automated method enables objective and reproducible image co-registration. The estimation of the AC-PC line allows precise stereotactic alignment and helps the image data normalization for matching the Talairach[2] brain atlas.

### References

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