Sulci and curvature: detection of the roof

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Automatic labelling and identification of cortical sulci which can be used as landmarks in registration between patients or between different modalities. Methods used to achieve this goal are the segmentation of the brain, the detection of sulci using classification and threshold or morphologic tool, the statistical or structural recognition techniques. Our previous work proceeds with segmentation of the brain by thresholding the LCR, and skeletonisation of the LCR. We present here a method based on geometrical feature (curvature) which doesn't require the fine segmentation of the LCR-Grey Matter or of the Grey Matter-White Matter interface. Although our previous work [1] used the superficial trace of sulci, we detect the roof of the sulci, which presents less intersection between sulci than the superficial trace of sulci.

Materials and Methods

MRI of healthy volunteers are acquired on a 1.5 Tesla GE Signa scanner using a SPGR sequence (124x256x256 voxels, 1.3 mm3). Let be K_1, K_2 the principal curvatures, t_1, t_2 the associated directions [3], of an isosurface $I(x,y) = M$. To find the deeping part of the sulci, starting from one voxel, the vector t_2 gives the direction of the next voxel belonging to the sulci. Figure 1 shows this method on an ellipsoïdal volume. The desired curve is the meridian of the ellipsoid. The errors of the obtained curve are due to the discretisation of the image and of the computed derivative values. First, MLvv operator [2], similar to mean curvature, is computed. The obtained image is thresholded. Negative values of MLvv are kept. The image is labelled and each connected component is a volume representing one sulcus. The starting point is chosen as the strongest curvature in each connected component. The next point is obtained in the t_2 direction. Since discrete derivative values are not accurate enough to ensure a precise detection, we use a sub-voxel following. The next point is the point in the t_2 direction, at the distance of λ_1 using trilinear interpolation. This process is stopped when the next voxel has a positive MLvv value, or when the curvatures are not defined or when the curvature K_1 et K_2 are equal.

Results

We have presented a method to extract roof of sulci with a sub-voxel precision without segmentation. Figure 2 shows the result of the proposed method from several slices of an image. The next step is to use this methodology to extract the medial surface of the sulci.

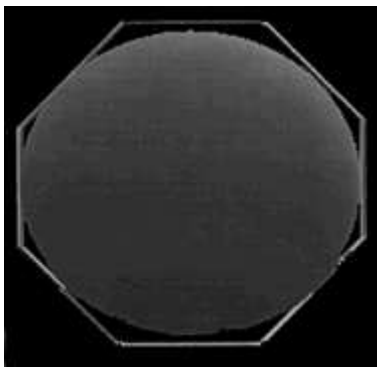

Fig1: Results on ellipsoïdal volume without subvoxel following.

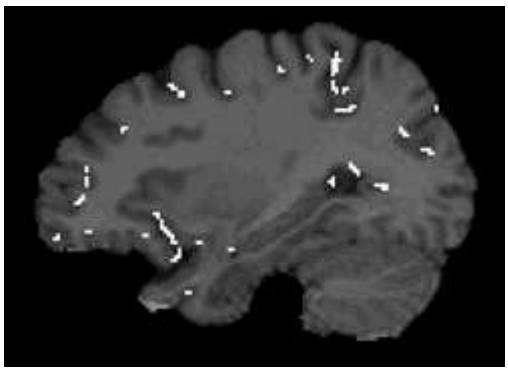

Fig 2: Results on a slice of MRI volume

References

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