4th Annual Research Symposium
HFMG Academic Affairs
(To be held on April 13, 2007 at Henry Ford Hospital, E&R Building)
Abstract Deadline: March 23, 2007

Multi Subject fMRI analysis using fuzzy clustering

Hesamoddin Jahanian[1], Hamid Soltanian-Zadeh[1,2]
1. Image Analysis Lab., Radiology Department, Henry Ford Health System, Detroit, Michigan, USA.
2. Control and Intelligent Processing Center of Excellence, ECE Department, University of Tehran, Tehran, Iran.

Purpose

Recently, fMRI multisubject analysis has emerged as a new topic to embrace differences of the brain responses in the analysis. State-of-the-art multisubject methods, like general linear model (GLM), suffer from lack of sensitivity. A novel method, based on feature space fuzzy cluster analysis for fMRI group inference is introduced to address this issue. In the proposed method, a vector is obtained using the cross-correlation analysis of each subject. Then, a feature space is derived from the obtained vector. Fuzzy cluster analysis of the proposed feature space generates an "active cluster membership map." Statistical significance of the membership map is then assessed using randomization to derive the group inference activation map. We show that the proposed method detects larger activated regions in an experimental visual task dataset (consisting of 11 subjects).

Method

The proposed method consists of the following 5 steps: 1) A vector is extracted for each brain voxel whose elements are the cross-correlation coefficients of time-series of that voxel with the reference signal in different subjects. In this step, for each voxel of the brain, we produce *n* features corresponding to *n* subjects. 2) Using L2 norm, elements of each vector are combined. Thus, in this step, we obtain a feature space whose elements are the L2 norms of vector elements obtained from step 1. 3) The Fuzzy c-means (FCM) algorithm is applied to the obtained feature space and the map of "membership degrees to the active cluster" is obtained. 4) The statistical parametric map corresponding to the "membership degree" (obtained in the previous step) is derived using the method proposed by Jahanian et. al in [1]. 5) The statistical parametric map is thresholded at the desired confidence level (p-value).

fMRI experiment and preprocessing

A set of 11 sensory-motor fMRI data is analyzed in this research. This set is provided by fMRI data center (http://www.fmridc.org). They were acquired during an event-related fMRI experiment in a 1.5 T scanner. During the experiments, 128 T2*-weighted volume images were acquired using asymmetric spin echo pulse sequence. Each volume image consisted of 16 slices and each slice was composed of 64×64 pixels. A set of anatomical images was also acquired from each subject, which consists of 128 sagittal slices with 256×256 pixels.

Results

Experimental fMRI datasets, described in the previous section, have been used to evaluate the proposed method. The proposed method was compared to GLM multi-subject analysis [2]. The comparison study should be done at the same false alarm rates. Since the proposed method is a single level analysis and GLM is a two level analysis method, we used the thresholds obtained from the simulated data to achieve similar conditions for both methods. Analysis of rest data produces realizations of its parameters under the null hypothesis, which can be used to construct an empirical histogram. This histogram is used for computing the thresholds of the GLM parameter for different false alarm rates. Single voxels were removed from the activation maps. In the analysis of sensory-motor fMRI data, both methods detected activation in Occipital Cortex (BA 17, 18), Thalamus, and Precuneus which were also reported in previous fMRI investigations of visual task [3]. The proposed method also detected activations in Cerebellum, Superior Temporal Gyrus, Cingulate Gyrus (BA 24), Precentral Gyrus, Superior Frontal Gyrus and Cuenus, where GLM method did not detect any activation

Conclusion

A novel method, based on feature space clustering for activation detection in group fMRI data, is presented. This method is applied to experimental fMRI data. The proposed method detected much more activated voxels in expected areas with much fewer false alarms at the same false alarm rates which means considerable higher activation detection sensitivity.

References

[1] H. Jahanian *et al; Magn Reson Imaging*, vol 22, pp. 631-638, 2004.
[2] J. Worsley *et al; NeuroImage*, vol 15, pp. 1–15, 2002.
[3] M. S. Beauchamp *et al; NeuroImage*, vol 14, pp. 310-321, 2001.