ADAPTIVE GRAPH CUTS WITH TISSUE PRIORS FOR BRAIN MRI SEGMENTATION

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MEDICAL IMAGE RESEARCH LAB

Problem Statement

- The problem statement.

  Segmentation is a process of partitioning an image space into some non-overlapping meaningful homogeneous regions. In conventional brain tissue segmentation, each voxel is labelled as one of three main tissue types, i.e. white matter (WM), grey matter (GM), or cerebrospinal fluid (CSF).

- References

1 . Song, Zhuang, et al. "Adaptive graph cuts with tissue priors for brain MRI segmentation." Biomedical Imaging: Nano to Macro, 2006. 3rd IEEE International Symposium on. IEEE, 2006.

- 2. Boykov, Yuri, Olga Veksler, and Ramin Zabih. "Fast approximate energy minimization via graph cuts." Pattern Analysis and Machine Intelligence, IEEE Transactions on 23.11 (2001): 1222-1239. (ICCV 2001 paper with citation count approx. 3200)

Basic Algorithm

- Think of images as a weighted undirected graph, in which each image voxel is represented by a node and each edge links the voxel p to its neighbouring voxel q is edge of the graph.

- Create graph-cut of the nodes, Graph-cut partitions the vertices of a graph into two disjoint subsets. This approach can be extended to multiple labels [2].

- The graph-cuts are created such that certain energy functions (defined by Markov Random Field) minimizes.

$$E(f) = \gamma E_I(f) + (1-\gamma)E_A(f),$$

- Here $E_A(f)$ term in energy equation represents Atlas prior, which is given by prior knowledge (by registering a sufficient number of pre-segmented MRIs)

Basic Algorithm cont.…

- $E_I(f)$ is particular energy function, given by

$$E_I(f) = \lambda \sum_{p \in \mathcal{P}} D_p(f_p) + \sum_{\substack{\{p,q\} \in \mathcal{N} \\ \{f_p \neq f_q\}}} V_{p,q}.$$

here $D_p(f_p)$ denotes the data term that measures how well label f_p can be assigned to voxel p. Vp,q represents the neighbourhood interaction term that penalizes discontinuities between each voxel pair {p, q}.

Here the parameters γ and λ are set empirically

Results(from the paper)

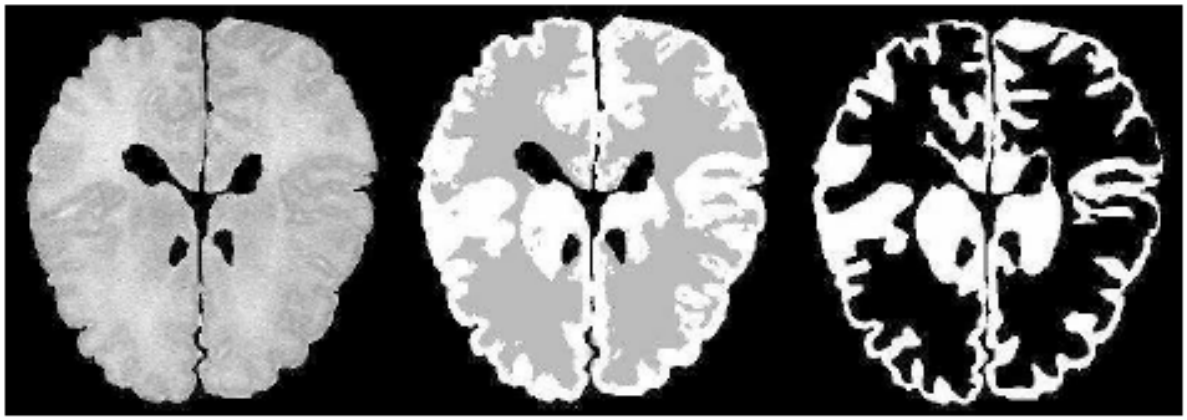

Fig. 1. Experiment results on the real neonatal image data. The first is one example slice in a T2-weighted image. Other brain tissues were excluded except white and gray matters. The second is the segmentation result of our method. The third is the manual segmentation to be compared in the quantitative analysis.

Deliverables

Working system of MRI segmentation using graph-cut method [1], and analysed results.

Novelty

None at the initial implementation, can try to automate the γ and λ parameters values using some adaptive algorithm.

Other details

- This paper is explained for two-label tissue segmentation, i.e. to differentiate grey and white matters.
- Segmentation was done slice by slice due to the ex-pensive computation of graph cuts
- Inhomogeneity correction was done in the 3D volumes.

Datasets

Many excellent datasets are available on web, link for some are:

1. http://brainweb.bic.mni.mcgill.ca/brainweb/
2. http://www.imageprocessingplace.com/root_files_V3/image_databases.htm/

Thank-You