

Brain Structure Classification in MRI Images

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Overview

- Objective, Difficulty & Strategy
- Knowledge-based Coarse-to-Fine Classification
- Result & Validation
- Summary



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Objective, Difficulty & Strategy

- Objective
 - Segment & Classify Neuroanatomic Brain Structures
 - MRI Volume
- Difficulty
 - Overlapping & Inhomogeneous Intensity, Noise, PVE
- Strategy
 - Talairach Atlas
 - Knowledge-based Coarse-to-Fine Classification



Image GREYC-ISMRA



Knowledge-based Coarse-to-Fine Classification: Block Diagram

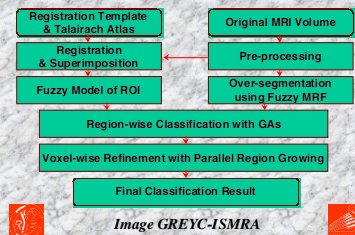


Image GREYC-ISMRA



Pre-processing & Over-segmentation

- Applied on MRI Volume
- Pre-processing
 - Skull Removal
 - Noise Suppression
 - Intensity Inhomogeneity Correction
- Over-segmentation
 - Pure Tissues (CSF, GM, WM) & Mixtures
 - Fuzzy MRF (Markov Random Field)



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Registration & Fuzzy Model of ROI

- Register Talairach Atlas onto MRI Volume
 - Registration Template
 - Register Template onto MRI Volume
 - Register Talairach Atlas onto MRI Volume
- Fuzzy Model of ROI
 - Applied on Registered Talairach Atlas
 - by Analogy with Electrostatic Potential Field
 - for 4 Important Brain Structures



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Registration Result Sample



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Fuzzy Model of ROI



Image from Fuzzy ROI of Ventricle Image from Fuzzy ROI of Caudate Image from Fuzzy ROI of Thalamus Image from Fuzzy ROI of Putamen



Image GREYC-ISMRA



Region-wise Classification with GAs

- Applied on Over-segmented Volume
- Genetic Algorithms (GAs)
 - Fitness Function 1:
 - Relates to Matching of Area between: Registered Atlas & Classified MRI Volume
 - Fitness Function 2:
 - Relates to Matching of Intensity Mean between: Classified Voxels & Estimated Value



Image GREYC-ISMRA



Voxel-wise Refinement

- Why need Refinement?
 - Coarse Intensity-based Over-segmentation
- Parallel Region Growing
 - Select Seeds from Region-wise Classification
 - Growing Criteria:
 - Significant Membership in Fuzzy ROI
 - Fall into Neighborhood of Estimated Intensity Mean
 - Multifractal Dimension to Decide Ridge



Image GREYC-ISMRA



Result & Validation

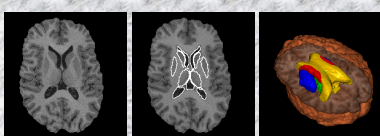


Image from Original MRI Volume Image from Classified MRI Volume Rendering of Classified MRI Volume



Image GREYC-ISMRA



Result & Validation

	FP	FN	Kappa
Ventricle	0.070	0.018	0.957
Caudate	0.112	0.086	0.902
Thalamus	0.090	0.063	0.924
Putamen	0.083	0.049	0.934

FP: False Positive Ratio; FN: False Negative Ratio



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Summary

- Achievement
 - Segment & Classify 4 Important Brain Structures: Ventricle, Caudate, Thalamus & Putamen
- Knowledge used
 - Intensity-based: Statistics, Multifractal Singularity
 - Atlas-based: Shape, Size, Distance & Relationship
- Conclusion
 - Knowledge-based Classification is Promising



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