A Novel Method in Extracranial Removal of Brain MR Images

Information Technology and Quantitative Management (ITQM 2014)
Outline

- Abstract
- GVF Snake Model
- Proposed Algorithm
- Experiment Result
Abstract

- This paper proposes an automatic morphology-based algorithm to generate the initial contour for active contour model to implement the removal.
- Experimental result shows that with simple steps and little time, the proposed algorithm can finish the segmentation task successfully, and is of good robustness as well as high accuracy.
GVF Snake Model

Overview

A parameter-based deformable model defined within an image in the form of curve that can move under the interaction of **internal force** and **external force** to approach desired features of an object.

![Initial State](Image)
![Deformation](Image)
![Final State](Image)
GVF Snake Model

Definition

- Traditional model is defined as a curve:
  \[ v(s) = [x(s), y(s)] \quad s \in [0,1] \]

- The corresponding energy functional:
  \[ E_{snake}^* = \int_0^1 [E_{int}(v(s)) + E_{ext}(v(s))] ds \]

- \( E_{int} \) is the internal force exists within the curve itself
- \( E_{ext} \) is the external force from features of the image
- Deformation means minimize the energy formulation
Proposed Algorithm

**Idea**

- GVF Snake model are implemented by iteration, the more it takes, the more resources are required.
- Orthogonal force field can be found in a small range of space surrounding the true boundary.
- If initial contour is close enough to the described area, the curve converge fast and correctly even iteration is reduced.
Proposed Algorithm

Introduction

- We preform a two-layer contour generator to dynamically generate the curve shape of the corresponding MR image.

- Those curve shapes will be combined and transformed in a specific manner, and the initial contour is produced.
Proposed Algorithm

Contour Generator - layer 1

- Island layer
  - Regard the binary image as a map. The background is ocean and the foregrounds are island collections.
  - Define a center island, while other islands are changing from active to inactive as distance grows.
  - The center intends to find a stable state by attracting all other islands and discarding those are too inactive.
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Proposed Algorithm

Island Layer
Proposed Algorithm

Contour Generator - layer 2

- Ellipse layer
  - we construct a discrete sphere model based on human brain structure, from which each slice could be obtained.
  - When extracting a slice from the sphere model, the slice are calculated and relocation by aligning the centroid of the MR image.
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Proposed Algorithm

Ellipse Layer
Proposed Algorithm

**Final Refinement**

- We combine the island layer and ellipse layer together by overlapping to form a new curve shape.
- The Canny’s method is introduced to detect and extract the outline of the hybrid layer.
- In order to simplified members of the outline, we use a greedy algorithm to eliminate redundant points efficiently.
- Points will be ordered to yield the initial contour.
Proposed Algorithm

Final Refinement
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Proposed Algorithm

Flowchart

1. Load Brain Volumes
2. Pre-processing
3. Contour Generator
4. GVF Snake Deformation
5. Segmentation and Refinements
6. Export and Evaluate Results
Experiment Result

Accuracy

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<tr>
<th>Traditional GVF Snake model</th>
<th>Proposed algorithm</th>
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Experiment Result

Robustness

![Graph showing the robustness of a novel method in extracranial removal of brain MR images. The x-axis represents the slices, and the y-axis represents the standard deviation.]
Thank You