
IMAGE SEGMENTATION WITH EXPLICIT MESH

Abstract:

[June 15] The project have been proposed.

1 Objective

Image segmentation try to segment image to piecewise constant function. The purpose is to minimize the objective function (Reduced Mumford-Shah functional)

$$E = \int_{\Omega} (I - g)^2 d\Omega + \alpha \int_{\Omega} |\nabla I|$$

or it is similar to other form

$$E = \int_{\Omega} (I - g)^2 d\Omega + \alpha \text{Length}(\Gamma)$$

where Ω is the image domain, I is approximated image, g is original image and Γ is the boundary of the piecewise region. This formulation is similar to total variation.

There are several different approaches to solve this problem. Generally, they employ level set function to represent the piecewise constant region. This method works well with two phases and provides advantage in handling topology change. However they have difficulties in multiple phases.

In compare to level set (implicit function), represent piecewise constant functions by explicit mesh give some advantages: Explicit quantitative, precision as desired, etc.

In this project, I want to solve multiple-phase segmentation using explicit mesh. As the problem is non linear and large, the main approach is using conjugate gradient method. Besides, I want to study effects of parameters to accuracy and convergence. Also I want to proposed better approach if there will exist problem in accuracy and convergence.

2 What I have already had

I have had the draft version that works: Segment the image with multiple phases. DSC framework is employed to handle topology change during mesh evolution.

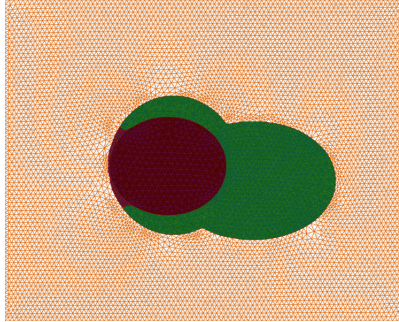


Figure 1: A 3-phases segmentation with explicit meshes

2.1 Piecewise constant representation

The mesh is a set of triangles. Each triangle is labeled with a number that denotes the phase the triangle belongs to. The problem include

- Optimize the triangle label
- Optimize the boundary position of the mesh

2.2 Issues

There are some issues that I want to solve in this project

- Triangle-label is integer. I have no idea to solve it with iterative method.
- Convergence: Because the segmentation is multiple-phase, there is no single value of time step that is optimal for all phases.